Science & Mechanics

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101 ELECTRONIC PROJECTS FOR UNDER $10

SPECIAL THIS ISSUE
How IC OpAmps make for Better Projects

BONUS

21 INTEGRATED CIRCUIT PROJECTS

- Auto Tachometer
- Spy-Size Amplifier
- Home Intercom
- CB Booster
- Phono Amplifier
- SWL Freq Spotter

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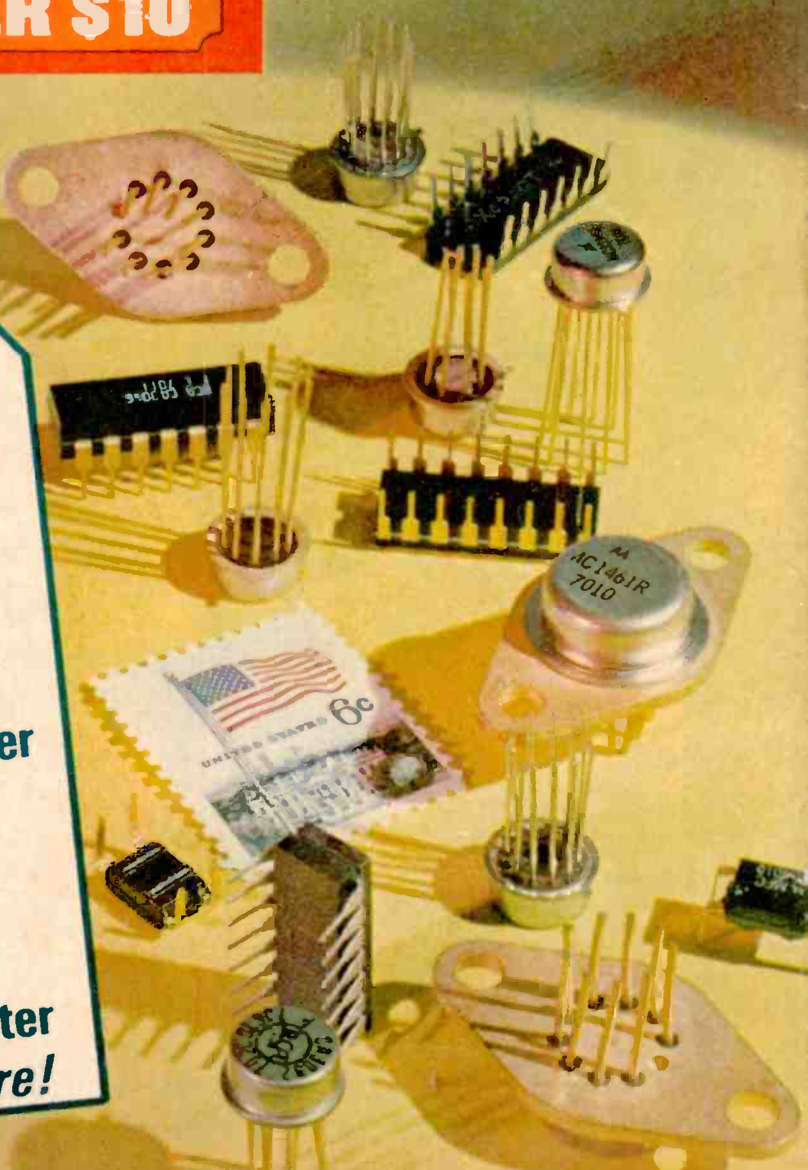

by the Editors of ELEMENTARY ELECTRONICS

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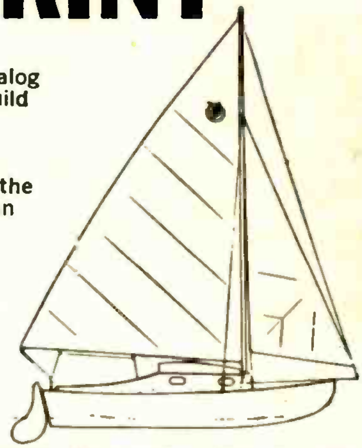

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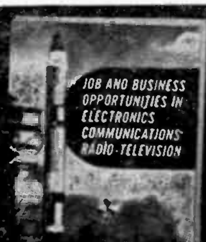

CIRCLE NO. 1 ON PAGE 8

101

101 Electronic Projects

The Extras

ELECTRONIC PROJECTS FOR UNDER $10

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CIRCLE NO. 5 ON PAGE 8

New Products...

Get on the IC Wagon

RCA has a new series of integrated circuit project kits, which, they tell us, are the industry's first IC kits to contain both active and passive components, pre-drilled printed circuit boards, and complete instructions. There are four projects. KC4000 is a mike preamplifier for use with tape recorders, PA, radio trans-

RCA IC Project Kits

mitters, phonograph preamplifier and it sells for $5.95. KC4001 is a two-channel mixer kit that combines two input signals into a single output ($6.50). KC4002 is an audio oscillator which may be used as a code-practice oscillator or to test amateur radio transmitters, hi-fi, other audio equipment ($4.95). KC4003, an oscillator-amplifier, provides ½ watt of audio power for use in portable, low-power amplifier systems, or as a variable-tone audio oscillator ($8.95).

Circle No. 15 on page 8

Zap—Your Clean

Formulated especially for difficult TV tuner problems, new Magic Vista golden foam tuner cleaner from GC Electronics Division of Hydrometals, Inc., is packaged in a handy, versatile, 8-ounce aerosol can. Included with the dispenser is a plastic spray extension tube to help reach into tight places. The aerosol can features a new, any-angle constant discharge valve that lets the technician use the spray regardless of the can's position—even *upside down!* The special golden foam formulation cleans, polishes and lubricates TV tuner contacts without running off or evaporating. The chemical is completely safe for plastics. Retail price of the 8-ounce aerosol can (Catalog No. 10-800) is $3.85. GC Electronics manufactures a full line of electronic components, accessories

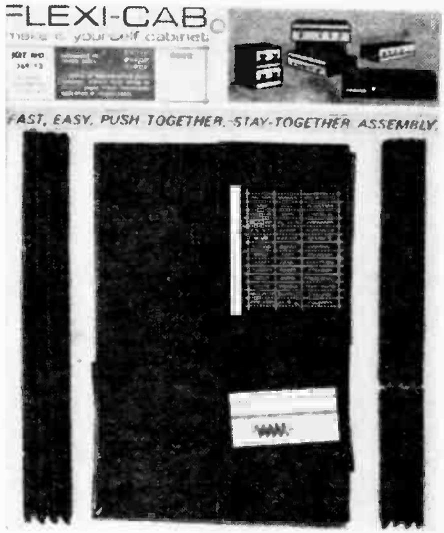
GC Electronics Magic Vista Tuner Cleaner

and hardware for use by hobbyists, consumers, service technicians and industry. Available at most electronic parts store.

Circle No. 16 on Page 8

Fresh Help for the Home Brewer

EICO has acquired a line of build-it-yourself vinyl-clad steel cabinets, called Flexi-Cab, which should take a lot of the sweat out of the electronics hobbyist's life. They recommend Flexi-Cab as a natural complement to the EICOCRAFT line of 39 build-it-yourself



EICO Flexi-Cab Custom Cabinets

(Continued on page 9)

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• The Editor of 101 ELECTRONIC PROJECTS offers readers an easy and convenient way to get additional information about products and services advertised in this issue. Also, if you want to know more about any new product mentioned in our "New Products" column, it's yours for the asking. Just circle the number(s) in the coupon that correspond to the key number(s) that appear at the bottom of the item in 101 ELECTRONIC PROJECTS, and mail the coupon to us. We'll do the rest!

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New Products...

(Continued from page 6)
solid-state electronic science project kits. The do-it-oneself custom cabinets are available in three sizes and the prices range from \$3.49 to \$4.69 each.

Circle No. 17 on Page 8

DIAL YOUR SPEED CONTROL

Unlike conventional halfwave controls the Solid-State Motor Speed Control from Dremel Mfg. Co. gives controlled full-wave output. Motor Speed Control comes with an *on/off*

Dremel Motor Speed Control

switch and built-in pilot light, 3-wire grounding cord, and overload protector with manual reset button. The unit can be used with all universal (brush type) motors and fixed-load, shaded-pole motors. Speed can be dialed from zero to full rpm. Also, Motor Speed Control can double as a temperature control on soldering irons or guns to provide just the right heat. Price is \$16.95.

Circle No. 18 on Page 8

Fet VOM

The B & K Division of Dynascan Corp. have made their VOM more functional by incorporating a field-effect transistor. The new battery-

B & K FET/VOM

operated Model 176 FET/VOM has the (Continued on page 108)

LITERATURE LIBRARY

1. *Edmund Scientific*'s new catalog contains over 4000 products that embrace many sciences and fields.

2. Bargains galore, that's what's in store! *Poly-Paks Co.* will send you their latest 8-page flyer.

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4. Get it now! *John Meshna, Jr.*'s new 96-page catalog is jam packed with surplus buys

5. Troubleshooting without test gear? Get with it—let Accurate *Instrument* clue you in on some great buys for your test bench.

6. *Burstein-Applebee* offers a new giant catalog containing 100s of big pages crammed with savings.

7. Now available from *EDI (Electronic Distributors, Inc.)*: a catalog containing hundreds of electronic items.

8. Pick Cornell's *Electronics*' 10th anni. catalog and discover yesterday prices. Tubes go for 36¢ and 33¢. Plus many other goodies!

9. *Allied Radio Shack* wants to introduce you to the colorful world of electronics. Discover great buys from wide selections. Get the details from *Allied* today!

10. It's just off the press—*Lafayette*'s all-new 1971 illustrated catalog packed with CB gear, hi-fi components, test equipment, tools, ham rigs, and more—get your free copy!

11. Get all the facts on Progressive *Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools, and instructions included.

12. *Olson*'s catalog is a multi-colored newspaper that's packed with more bargains than a phone book has names.

13. You can select the right tool for easy, speedy driving of Bristol Multiple Spline and Allen Hex socket screws from Xcelite's compact, interchangeable blade sets—get bulletin N365.

14. Before you build from scratch, check the *Fair Radio* Sales latest catalog for surplus gear.

15. Here's a free 20-page booklet that tells you how to improve your TV pic and a do-it-yourself approach to installing a Master Antenna TV (MATV) system. *Mosley Electronics* will wing it your way.

16. *RCA* Experimenter's Kits for hobbyists, hams, technicians and students are the answer for successful and enjoyable projects.

17. *B&F Enterprizes* has an interesting catalog you'd enjoy scanning. Goodies like geiger counters, logic cards, kits, lenses, etc. pack it. Get a copy!

18. *Heath*'s new 1971 full-color catalog is a shopper's dream. Its 116 pages are chock full of gadgets and goodies everyone would want to own.

19. Get two free books—"How to Get a Commercial FCC License" and "How to Succeed in Electronics"—from *Cleveland Institute of Electronics*.

20. *National Schools* will help you learn all about color TV as you assemble their 25-in. color TV kit.

21. Bone up on CB with the latest Sams books. Titles range from "ABC's of CB Radio" to "99 Ways to Improve your CB Radio."

22. You can become an electrical engineer only if you take the first step. Let *ICS* send you their free illustrated catalog describing 17 special programs.

23. For success in communications, broadcasting and electronics, get First Class FCC license. *Grantham School of Electronics* will show you how.

24. CB antenna catalog by *Antenna Specialists* makes the pickin' easy. Get your copy today!

25. Kit builder? Like wired products? *EICO*'s 1971 catalog takes care of both breeds of buyers at prices you will like.

26. Want some groovey PC boards plus parts for communication projects? Then get a hold of *International Crystal*'s complete catalog.

27. *H. H.* Scott has a parcel of pamphlets describing their entire 1971 line of quality hi-fi products. They have Scottkits, too!

28. CBers, Hams, SWLs—get your copy of *World's Radio* Lab's 1971 catalog. Circle 28 now!

29. *Hy-Gain*'s new CB antenna catalog is packed full of useful information. Get a copy.

30. Get your copy of *Hallicrafters*' "Shortwave Puts You Where It's At." Get started today on shortwave radio for more fun tomorrow!

31. Want a deluxe CB base station? Then get the specs on *Tram's* super CB regs.

32. Get the scoop on *Versa-Tronics*' Versa-Tenna with instant magnetic mounting.

33. Prepare for tomorrow by studying at home with *Technical Training International*. Get the facts on how to step up in your job.

34. Pep-up your CB rig's performance with *Turner*'s M+2 mobile microphone.

35. CBers, *Midland* has come up with a neat colorful brochure on their line. Before you buy, check on *Midland*.

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HOW TO GET STARTED IN RADIO

by Jack Schmidt

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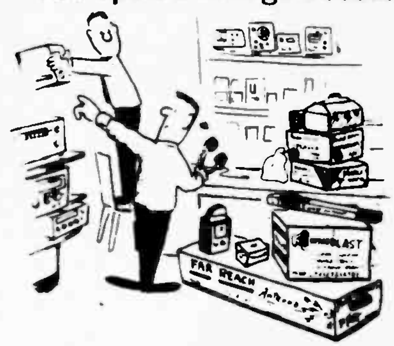

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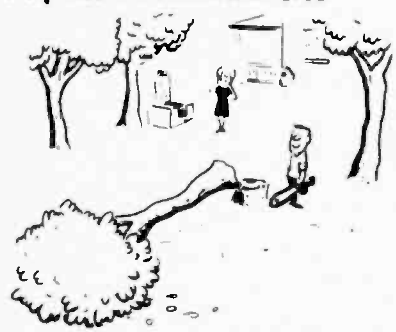


. . . locate the studio

. . . plug it in

. . . get a license

101 Electronic Projects
1971 Edition

No doubt you're an electronics experimenter whose first love is the construction of electronic projects. And, judging by the mail heaped upon my desk from fellow enthusiasts, your range of interests spans the entire electronics gamut! The 1971 issue of 101 ELECTRONIC PROJECTS is our answer to your never ending requests for easily-built projects. The magazine's bulging with 101 useful projects for your shop, home, or shack. We've also included bonus sections featuring pre-tested integrated circuit (IC) projects and theory.

We've expended considerable effort to make certain you can build the projects and get them working; no industrial-only components are specified. And in almost all projects, the solid-state devices are readily available at your local distributor or from major electronics mail-order houses. Before you begin any of the projects found in 101 ELECTRONIC PROJECTS, send away for the catalogs offered by these parts houses.

Construction details are provided where necessary. If there are no instructions, you can build the circuit in any manner and in any cabinet. When metal cabinets must be used we tell you so; the same thing goes for heat sinks. When nothing is said about a heat sink you don't need one, even for power transistors or ICs. When a heat sink is needed we specify one.

To make things as easy as possible, capacitor symbols in the schematics have two parallel lines, while others have a straight and curved line. Those with a curved line have a "+" symbol over the straight line. Two straight lines mean a non-polarized capacitor (not an electrolytic) and you can install it without regard to any markings; there is no polarity. Capacitors indicated by a curved line are polarized and must be wired according to the polarity shown. The curved line is a warning that polarity must be double-checked, since the project will probably not work if capacitor connections are reversed.

Some capacitor voltage ratings might seem excessive, such as a 500-V disk specified for a 9-V circuit. In all instances we have specified the lowest-cost capacitor. A 500-V disc would cost less, than, say, a 10-V miniature capacitor. Since electrolytic capacitors often represent the biggest expenditure for a project, we suggest you use the cheapest ones you can get whenever possible. When a capacitor value is critical we specify a silver mica type. The minimum silver mica voltage rating you can easily obtain is 100 V so use this rating for lowest cost. To be on the safe side, never use a capacitor with a voltage rating lower than that specified.

Potentiometers can be any taper unless a specific taper is specified. When batteries are specified do not use a smaller size than recommended. Current requirements for a project are taken into account for the battery type suggested in the Parts List.

We have tried to ensure that every circuit will work with the specified transistors, but there is a normal variation in transistor characteristics that might affect performance. For example, a 2N3391 transistor has a possible gain range of 250 to 500, a 2:1 difference. If the unit you obtain has a gain of 500, the base bias becomes critical and the specified bias resistor might not work in your project. If you have an amplifier that distorts at high levels, or an oscillator that won't start, try changing the base bias resistor. It's usually the one connected from the collector power source to the base. Vary it approximately 20% in value, either higher or lower, then trim the resistance for optimum performance.

We'd like to hear from you concerning your favorite projects and circuits, and any other thoughts you might have on 101 ELECTRONIC PROJECTS.

Julian M. Sienkiewicz

JULIAN M. SIENKIEWICZ
Editor in Chief

ALL NEW!

21 INTEGRATED CIRCUIT PROJECTS

INTEGRATED CIRCUITS, or **ICs** as they are more commonly called, are made like transistors. Yet, they don't necessarily behave like their three-legged counterparts. Many ICs appear to be, in fact, nothing more than several transistors and/or diodes in a single building-block package, with each semi-conductor treated as a separate component within this block. Most ICs that the experimenter will run across are complex "single" circuits in which all the packaged components—transistors, diodes, and resistors—deliver a specific level of performance: the performance level being determined by components external to the IC such as resistors, capcitors, inductors and even other transistors. These components not included in the IC package are termed *discrete* components.

The actual function of the IC depends on the overall design. For example, an IC voltage regulator might consist of 15 transistors, 5 diodes and a handfull of resistors in a package no larger than a pencil eraser. And though the 15 transistors in this package might all be functioning as amplifiers, the IC itself cannot be used as an amplifier: its actual performance characteristics would appear to more nearly equal a zener diode regulator.

Some ICs, particularly those known as "operational amplifiers," have their function determined by a simple change in external components or wiring connection. For example, changing just one component of an operational amplifier makes the device function as an amplifier, oscillator, or flip-flip multivibrator. It is much more difficult to pull this "change of functon" trick with a discrete transistor circuit by simply changing one component or connection.

One difficult problem with ICs the experimenter rarely runs across when dealing with transistors is *high frequency instability*. Many IC devices have extremely wide bandwidths, often extending into the VHF spectrum. Direct Current to 30, 50 or even 100 MHz bandwidth is not uncommon. While transistors have similar bandwidths, they don't have the gain of many linear ICs. Furthermore, they can be stabilized on an individual basis, or the component layout of individual transistors can be arranged so that various stages are physically isolated. Or shielding or other isolation techniques can be used. This is not necessarily true of ICs where the input terminal is about one-half inch from the output terminal. And, to compound the problem, the open loop (no feedback) gain of many linear ICs run from 5000 to 50,000—and even higher!

● **When you combine** extreme high gain with extreme bandwidth, just the length of the IC's power supply terminal can become a

101 ELECTRONIC PROJECTS
1971 EDITION

WHAT YOU CAN BUILD		
auto tachometer	recorder preamp	tape preamp
frequency spotter	dynamic mike preamp	stereo phono preamp
spy-size amplifier	1-watt amplifier	audio signal tracer
intercom	audio compressor	1 kHz oscillator
phono amplifier	stereo system balancer	regulated 9V supply
CB booster	100X instrument amp	bi-polar supply
tape dubbing amp	4-channel mike mixer	regulated variable supply

high frequency inductor. The L and C of a bypass capacitor's foil can even become a resonant circuit. This is the reason why some of the IC circuits you build have a 0.1 uF capacitor shown in parallel with the electrolytic power supply bypass capacitor. The 0.1 uF capacitor is installed directly to the IC's plug-in socket terminals and serves as the high frequency bypass.

All ICs used in the projects are currently available as "standard stock." To avoid the common problem of trying to buy ICs from non-consumer or industrial-only sources, where *you*, the reader, cannot locate the IC, all the ICs in this book, except one, are from major manufacturers. They make their "line" available through local stocking distributors, in addition to mail order houses such as Newark Electronic.

The one exception is Fairchild NSJ716H, which is available through some mail order houses and local distributors catering to the hobbyist trade.

From time to time you will see ads from surplus or close out distributors offering the ICs for our projects at rock bottom prices. As a general rule, these ICs are either "overruns" or units which did not quite meet manufacturer's specifications. But, for all practical purposes, they are perfectly usable for our projects because the project's design is well within the maximum specifications of the IC. There's no good reason why you can't save a dollar by buying surplus ICs.

● **Most of the ICs** used in our projects are available in one of three case configurations. First is the *TO-55 can* (or a modified form of the TO 55), where the leads are arranged in a circular pattern. Next, we have the *inline*, which is generally a plastic case about ¼" wide, an inch or so long, and with the terminals arranged in rows on either side. And, lastly, there's the plastic or ceramic square with very fine leads sticking out towards the side.

For all the projects, we have specified the easiest case configuration to handle. However, if you can get a good buy on one of the other configrations, by all means use it. Keep in mind, however, that the TO-55 and inline configurations are relatively easy to handle. But the flatpack is often more trouble than the whole project is worth, and it should be avoided unless it's impossible to do so. (The flatpack IC is designed only for automated installation at a factory.)

Though the ICs can be soldered directly into the circuit, they are extremely difficult to remove without damage. And, it generally takes special desoldering equipment to remove an IC from a printed circuit board. Although IC sockets cost just a few cents more, we suggest they be used at all times. Should there be a wiring error, the most you will lose is a low-cost socket—rather than an expensive IC. Another benefit you'll gain is that the socket also allows you to easily substitute another IC for the first when you have a hanker to experiment with the circuit.

Some of the ICs used in the power amplifier projects have large tabs that are not terminals. These tabs are heat sink solder "lugs" to which an external heat sink must be soldered. The sinks can be metal squares cut from an ordinary tin can.

If there is a single tab on the IC, then cut the sink approximately 1½" square. If there are two heat sink tabs use a sink approximately 2" square on each sink. Tin the heat sinks first, then solder them to the tabs. Since the tabs are generally connected to some part of the IC circuit, make certain the heat sinks do not short to any other component or lead.

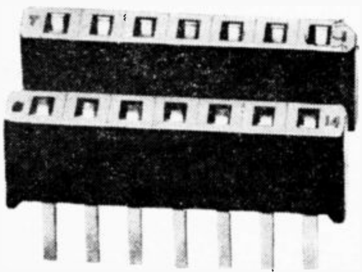
If you assemble a power amplifier project on a PC board, you can etch the required sink into the copper foil. If there isn't enough foil area, simply notch the PC board and slip in the tin heat sink adjacent to the tab. Then solder the tab and sink together on the foil side of the board (directly to a section of foil).

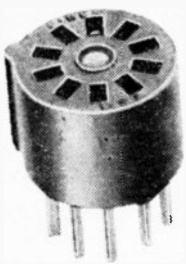
● **Take particular care** in noting an IC's lead arrangement. This is the knottiest problem you'll encounter with ICs as lead arrangement is even less standard than those of transistors. The circular T0-55 type IC has an index tab; however, the terminal number opposite the tab might be the first—or last—terminal. For example, if the IC has 10 leads, the lead opposite the tab might be number 1 or number 10. So note carefully the lead arrangement provided specifically for each project.

Do *not* assume one manufacturer's lead arrangement is that of another. And further, do not assume one manufacturer has followed the same arrangement on two different IC types. Stick with the arrangement provided for each project!

Inline ICs are somewhat more consistent regarding lead arrangement. As a general rule, the plastic case ICs have an index *notch*. When looking at the top of the transistor with the notch to the left, terminal number 1 is generally the lower left terminal. It's the one usually indicated by the numeral 1, or a raised ridge, or a scribed circle.

Sometimes, the numeral or ridge is not used you just position the notch to the left.





Using IC sockets makes troubleshooting projects lots easier. Sockets also prevent destruction of IC if it must be removed from project's circuit. Inline type of socket is one furthest to left; T0-55 type is to right of it. Both types are readily available from electronics supply houses.

Ceramic inline ICs often have no coding whatsoever—not even a notch. Position the ceramic inline so that when looking at the top the lettering or type number is right side up; pin number 1 is the one on the lower left.

● **As a general rule,** inline IC terminals are numbered consecutively (1,2,3,4,etc.). Some *General Electric* ICs, however, use alternate terminal numbers, eg: 1,3,5,7,*8,10,12,14*.

In all instances we show the correct terminal designation for the IC specified in the parts list. If you substitute different cases, for example, an inline IC for the specified TO-55 type, make certain you know the correct terminal arrangement for your substitution. They are not usually the same; for example, while terminal 1 might be the input to a T0-55 IC, terminal 3 might be the input for the same device in an inline package.

IC terminals are relatively close together. Usually so close that direct soldering is made somewhat difficult. Whenever possible, fan-out the leads from a TO-55 IC so they form a circle of approximately ¾" diameter. This will give you a little more room, and reduce the possiblity of "solder bridges" across the connections.

If you insist on soldering inline ICs directly into the circuit, offset every other terminal by gently bending the terminal outward and downward. Some ICs are factory offset especially for direct soldering: if you obtain such a unit do not suspect it is damaged because the terminals are offset. As previously stated, however, we strongly suggest an IC socket be used whenever possible.

If you make a wiring error in a transistor circuit, the most that would happen is the transistor might run excessively hot. Or, at worst, one or two transistors might be destroyed. But a wiring error in an IC circuit often results in instantaneous destruction of the IC. Take extra care with IC wiring!

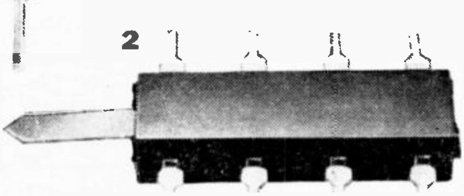
If possible, complete all wiring before the IC is installed. Check carefully for correct connections and lack of short circuits, and then install the IC. Finally, before applying power, doublecheck so that the IC's installation has not resulted in a short circuit. If you are using a battery power supply, also make double certain the power supply polarities are correct, particularly if the project calls for a bi-polar battery power supply.

Unless you are skilled in working with linear ICs, it is best to make circuit modifications by building around our circuits. For example, if you decide you need more amplification provided by the signal tracer projects, add an additional input transistor amplifier. Do not try to squeeze extra gain out of the IC circuit.

If you are the type of experimenter to whom anything is a challenge, and insist on modifying the IC circuits, don't do anything until you have the manufacturer's data or application notes. Just a small resistance change in a critical circuit is all that's needed for instant IC destruction.The only room left for modification to the IC circuits is within the power supply. You can safely lower the power supply voltage to almost half in all the circuits. The most that might happen is the output power or gain will be reduced. Do not—under *any* circumstances—increase the specified power supply voltages!

Now that you've found out about an integrated circuit's "what fors," turn to our article entitled "introducting. . .Op Amp," and discover the "whys" of the IC. Lars Jorgenson, one of 101 ELECTRONIC PROJECTS' authors, prys the lid off of the IC's microsized technology—and uncovers some little known IC facts for you, the electronics enthusiast.

1



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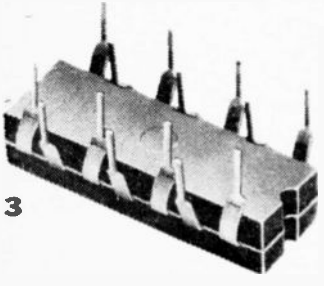

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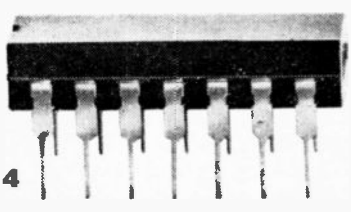

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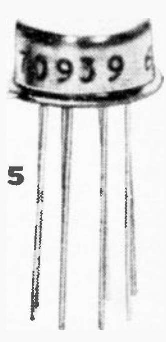
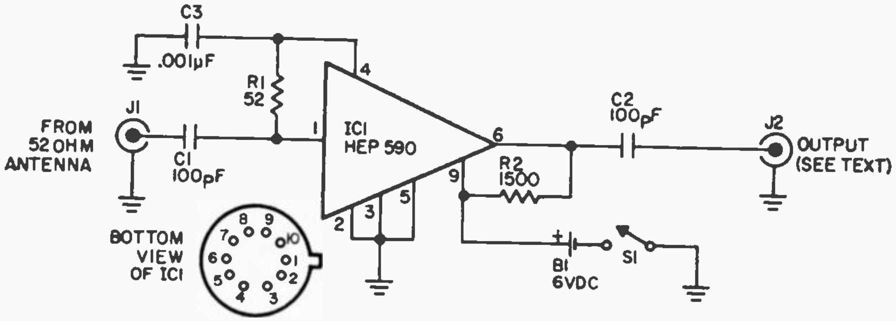


5

Rectangular or round, each IC has distinctive physical characteristic. Figures 1, 2 show two types of ICs with heat-sink tabs internally connected to circuit. Figure 3 indicates method of oending IC's leads when soldering unit into circuit. Figures 4, 5 show same type of IC available in two distinct case configurations—inline, TO-55 can.

IC 1 CB Booster



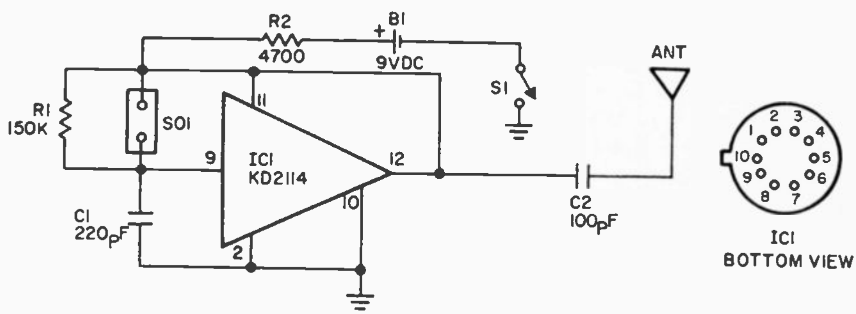
Connect CB Booster ahead of a low cost receiver, and you'll hear CB signals as if they were coming from your back-yard. Using no tuned circuits, the CB Booster delivers approximately 15dB over-all gain—that's about 3 S-units! Only re-striction is that this little rf amplifier be used with a communications-type receiver having an antenna trimmer. It cannot be used in front of a low-impedance-input type CB transceiver. Seems the low impedance antenna input common to CB transceivers will sharply reduce the booster's gain.

Typical of all RF amplifiers, the booster requires very short connecting leads. In particular, solder capacitor C3 right at pin 4. Integrated circuit IC1 can be soldered directly into the circuit or a socket can be used. Battery B1 is a 6V Z4 type or larger.

PARTS LIST FOR CB BOOSTER

B1—6V battery
C1, C2—100 pF, 15 VDC
C3—0.001 uF, 15VDC
IC1—HEP 590
R1—52-ohms, ½-watts, 10%
R2—1,500-ohms, ½-watt, 10%
J1, J2—Phono or coaxial jack
S1—SPST switch
B1—6V battery

IC 2 Rock Spotter



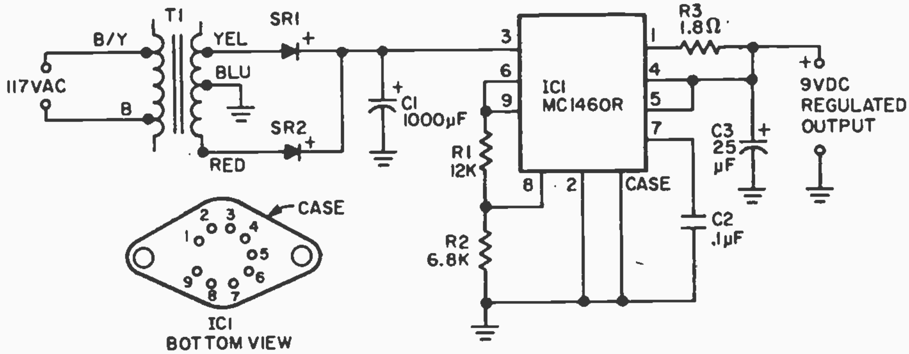
Ever try digging some QRP DX from under the pile up? It's a lot easier if you can get your receiver tuned smack dab on fre-quency to begin with. Pop a rock into this spotter and hold its antenna near the re-ceiver's input. You'll have no problems pretuning your rig.

Frequency coverage is from 4 to 20 MHz, the heart of DX SWLing. Though Rock Spot-ter might work on frequencies outside this range, it might not if your crystal isn't sufficiently active. Socket SO1 should match the crystals you intend using. The antenna can be any length of stiff, solid wire about 12-in. long. The battery can be a 2U6 type or equivalent. The circuit shown utilizes only half the internal circuit of the IC. You could use both sections so that two crystals could be employed. Battery B1 can power both sections through a SPDT center-off switch.

PARTS LIST FOR ROCK SPOTTER

- B1—9V battery type 2U6 or equiv.
- C1—220 pF, 15 VDC
- C2—100 pF, 15 VDC
- IC1—RCA KD2114
- R1—150,000-ohms, ½-watt, 10%
- R2—4,700-ohms, ½-watt, 10%
- S1—SPST switch (see text)
- SO1—Crystal socket

IC 3 Current Swinger



Supplying a precise 9V at currents up to 300 mA DC, the Current Swinger power supply features laboratory grade regulation and overcurrent protection. Whenever the device being powered attempts to draw more than 300 mA—such as caused by a short circuit—the IC voltage regulator section of Current Swinger automatically removes the applied voltage from it. The 300 mA current limitation is determined by transformer T1's rating. If a transformer capable of delivering higher current, resistor R3 can be changed to 0.5 ohms for a 600 mA maximum output (the IC limit).

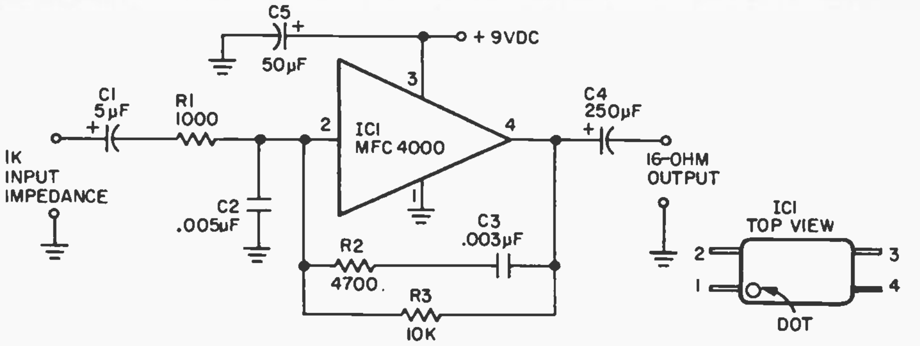
Leads to the IC should be as short as possible, with capacitor C2 installed directly at terminal 7 and connected as close to ground as possible. The transformer we used in the Current Swinger supplies 20V rms centertapped across the Yellow and Red secondary leads.

PARTS LIST FOR CURRENT SWINGER POWER SUPPLY

- C1—1000 uF, 15 VDC
- C2—0.1 uF, 15 VDC
- C3—25 uF, 15 VDC
- IC1—Motorola MC 1460R
- R1—12,000-ohms, ½-watt, 5%
- R2—6,800-ohms, ½-watt, 5%
- R3—1.8-ohms, ½-watt, 1 or 5% (see text)
- T1—Low voltage rectifier transformer, Allied Radio series 54 A 4731 (1970 catalog)
- SR1, SR2—Silicon rectifier, 750 mA, 50 PIV

IC 4 Spy-Size Amplifier

Using an IC no larger than a fly, Spy-Size Amplifier delivers almost 250 mW into a 16-ohm speaker. A 50 mV input signal coming from a source whose output im-



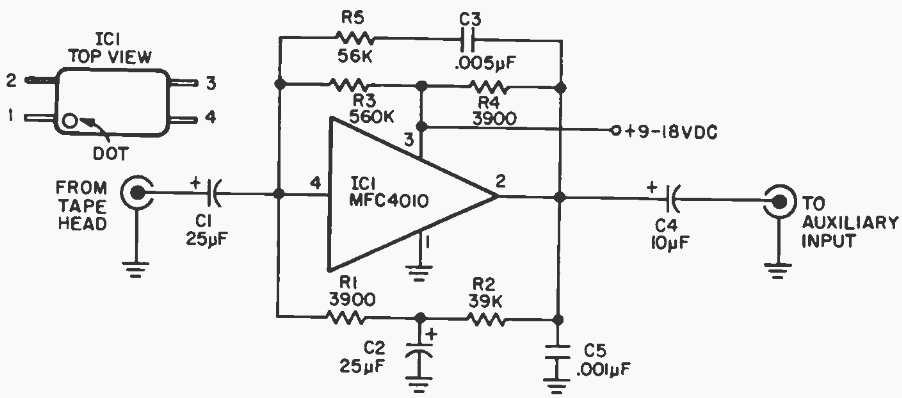
pedance is 1000 ohms or lower is required for maximum output. The power supply can be a 9 volt type 2U6 battery; the idling current is no higher than 6mA. Best way to keep things small is to use a printed circuit board assembly.

Spy-size amplifier can serve as a general utility amplifier for checking out low-level audio projects, or it can serve as a monitoring amplifier for tape and cassette decks.

PARTS LIST FOR SPY-SIZE AMPLIFIER

C1—5uF, 10 VDC
C2—0.005 uF, 10 VDC
C3—0.003 uF, 10 VDC
C4—250 uF, 10 VDC
C5—50 uF, 10 VDC
IC1—Motorola MFC 4000
R1—1,000-ohms, ½-watt, 10%
R2—4,700-ohms, ½-watt, 10%
R3—10,000-ohms, ½-watt, 10%

IC 5 Great Equalizer



From time to time you'll find bargains at dealers selling tape and cassette deck mechanisms at rock bottom prices—often less than $20! Complete with heads, these decks need only the electronics to get them working. The Great Equalizer provides both the amplification and equalization. You can feed its output directly into an amplifier's auxiliary input. The Great Equalizer's overall frequency response is suitable for cassettes and reel-to-reel tapes. Since the actual required equalization is determined partially by the playback head characteristics, it might be necessary to modify or

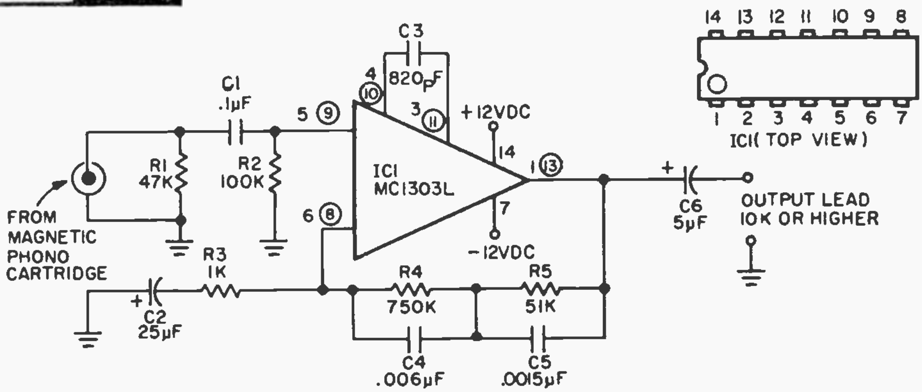
PARTS LIST FOR THE GREAT EQUALIZER

C1, C2—25 uF, 6 VDC
C3—0.005 uF
C4—10 uF, 20 VDC
C5—0.001 uF
IC1—Motorola MFC-4010
R1, R4—3,900 ohms, ½-watt, 10%
R2—39,000-ohms, ½-watt, 10%
R3—560,000-ohms, ½-watt, 10%
R5—56,000-ohms, ½-watt, 10%

"tailor" the equalization; this is done by small changes in the value of capacitor C3 and resistor R5.

If assembled on a small printed circuit board, the Great Equalizer can be tucked under the tape mechanism's base plate. The power supply can be anything from 9 to 18 volts at approximately 3mA. Transistor type radio batteries will do; if batteries are used they must be bypassed with a 25 uF capacitor. And, be sure you observe proper IC polarity.

IC 6 Groove Booster



Using a dual operational amplifier IC, the Groove Booster will provide a fully equalized 1 V RMS output from standard magnetic pickups. The terminal numbers which are circled on the schematic are the connections for one of the two independent amplifiers in the single IC case. The uncircled numbers are the terminals for the second IC. Power supply terminals #14 and #7 are common to both amplifiers. Note that the power supply is ±12 volts to ground. Two 6 volt batteries in series can be used for each side of the power supply. If batteries are used, connect a 25 uF capacitor from pins 7 and 14 to ground—and get the polarity correct.

PARTS LIST FOR GROOVE BOOSTER

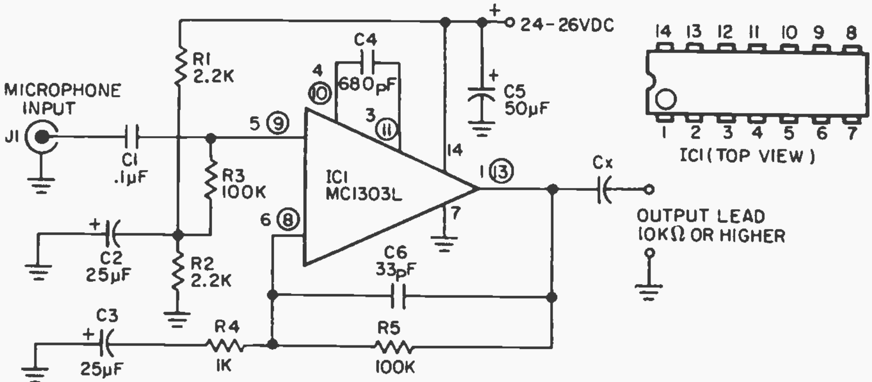
C1—0.1 uF, 3 VDC
C2—25 uF, 3 VDC
C3—820 pF, 500V disc
C4—0.006 uF, 100V disc
C5—0.0015 uF, 100V disc
C6—5 uF, 25 VDC
IC1—Motorola MC1303L
R1—47,000-ohms, ½-watt, 10%
R2—100,000-ohms, ½-watt, 10%
R3—1,000-ohms, ½-watt, 10%
R4—750,000-ohms, ½-watt, 10%
R5—51,000-ohms, ½-watt, 10%

IC 7 Hot Lips

A dual IC gives Hot Lips its hi-fi amplification for a stereo microphone pair. But there's no mumbo-jumbo with Hot Lips—low distortion and full-fidelity frequency response characterize this mike preamp. With resistors R1 and R2 providing a center-tap for the power supply, the IC can be powered from a standard single-ended power supply, or series connected batteries. Be very careful to observe the cor-

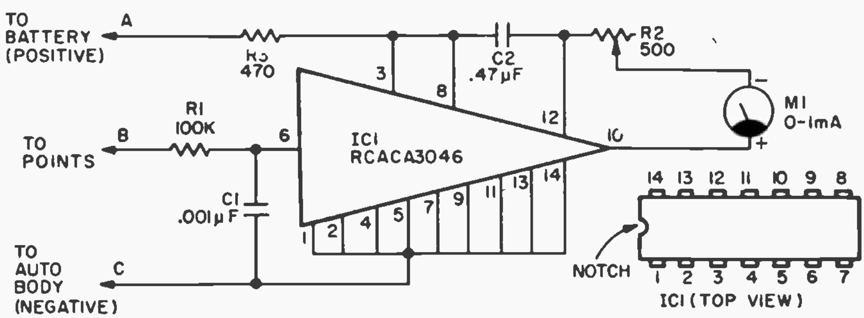
PARTS LIST FOR HOT LIPS

C1—0.1 uF, 100 VDC
C2, C3—25 uF, 25 VDC
C4—680 pF disc
C5—50 uF, 25 to 50 VDC
C6—33pF disc
Cx—See text
IC1—Motorola MC1303L
J1—Microphone jack
R1, R2—200-ohms, 5%
R3, R5—100,000-ohms
R4—1,000-ohms



rect polarity for capacitors C2 and C3. In the event the unit motorboats (low frequency oscillation), install a 0.1 uF capacitor from pin 14 to ground. The connections for one of the two amplifiers is shown circled; the connections for the second amplifier are uncircled. Pins 7 and 14 are common to both amplifiers. Capacitor Cx's value is determined by the load impedance connected to Hot Lips. It should be of such value as to provide the desired overall low frequency response; 0.1 uF is suggested for high impedance output loads (100K and higher), while 10 uF is suggested for low impedance loads.

IC 8 RPMeter



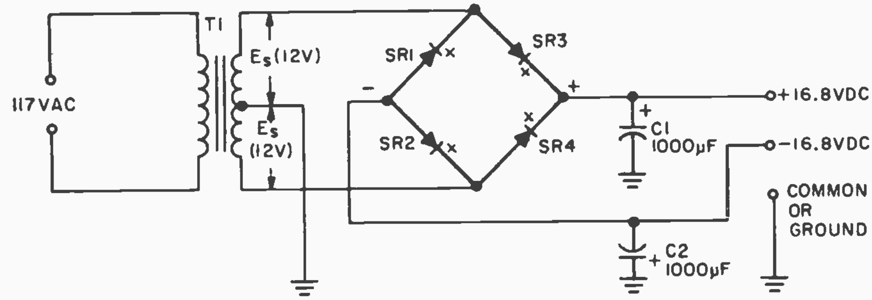
Our RPMeter is the hi-range type, used to find optimum shift points at a specific engine speed. Using the parts values given, meter M1 will indicate full scale from 5,000 to 6,000 RPM depending on resistor R2's adjustment. If lower RPM full scale readings are desired, capacitor C2's value should be reduced accordingly. For a custom installation, meter M1 can be mounted in your auto's dashboard. Integrated circuit IC1 should be mounted under the dash or in the air-stream under the hood for cooling. The rpMeter should be calibrated against a tach of known accuracy. It is only necessary to adjust R2 for the correct full scale reading—meter M1's scale will be linear.

To use the tach, connect lead A to the car battery's positive terminal, lead C to the negative battery terminal or the car body and lead B to the distributor points. The distributor point connection is easily made at the high voltage coil terminal; one coil terminal connects to the battery, the other to the distributor points.

PARTS LIST FOR RPMETER

C1—0.001 uF, 1000 VDC disc.
C2—0.47 uF, 25 VDC or higher, see text
IC1—RCA CA3046
R1—100,000-ohms, ½-watt, 10%
R2—Potentiometer, 500 ohms linear taper
R3—470-ohms, ½-watt, 10%
M1—Meter, 0-1 mADC

IC 9 Bi-Polar Power Supply



Most IC circuits require a Bi-Polar power supply. That is, a power source with two outputs—one positive with respect to ground and the other negative with respect to ground. A standard bridge rectifier circuit will provide a Bi-Polar output if the transformer's secondary is center-tapped to ground.

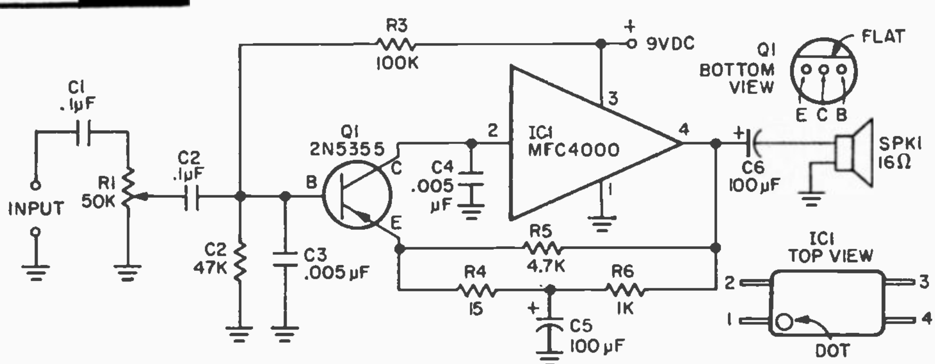
Filter capacitors C1 and C2 should be at least 1000 uF (2000 uF preferred) at a voltage rating at least equal to the supply's output voltage.

The supply's output voltage is equal to 1.4 times Es. Voltage Es equals one-half Transformer T1's peak secondary voltage. For example, assume that T1's secondary voltage is 24 volts (rms) center-tapped; the voltage on each side of the center-tap (Es) is 12. The supply's output voltage is therefore 12 x 1.4 or ± 16.8VDC. Always remember that each Bi-Polar output is derived from half T1's secondary voltage.

PARTS LIST FOR BI-POLAR POWER SUPPLY

SR1-SR4—Silicon rectifiers PIV rated to at least the supply's output voltage
C1, C2—1000 or 2000 uF at the supply's output voltage
T1—Power transformer with center-tapped secondary

IC 10 Mighty Mite

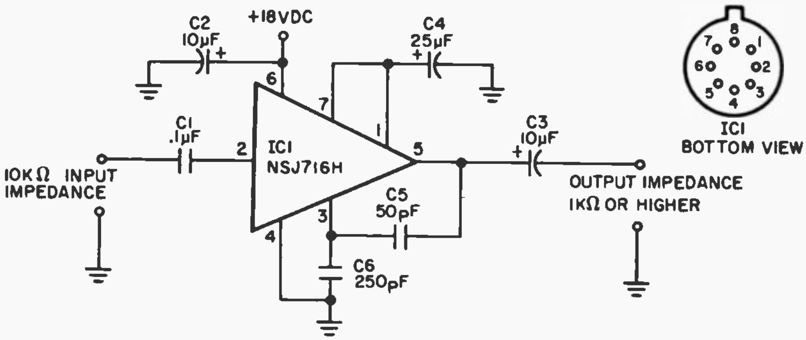


Featuring extremely high gain suitable for tracing signals directly from microphones and magnetic pickups, our Mighty Mite Signal Tracer can be made small enough to sit directly on the back of the speaker magnet. Though intended for checking transistor circuits, Mighty Mite can be used with tubed equipment if capacitor C1 has a 600 VDC minimum rating, and if Volume control R1 is always started from its off position. Regardless of the size speaker used, Mighty Mite's speaker impedance must be 16 ohms minimum, though higher impedances work better. Power output is approximately 250 mW; more than sufficient output level from a solid-state signal tracer small enough to hide on the back of a speaker magnet.

PARTS LIST FOR MIGHTY MITE SIGNAL TRACER

C1—0.1uF, 600 VDC, see text
C2—0.1 uF, 10 VDC
C3, C4—.005 uF, 10 VDC
C5—100 uF, 3 VDC
C6—100 uF, 10 VDC (250 uF for better low-frequency response with large speakers)
IC1—Motorola MFC-4000
R1—Potentiometer, 50,000-ohms, audio taper
R2—47,000-ohms, ½-watt, 10%
R3—100,000-ohms, ½-watt, 10%
R4—15-ohms, ½-watt, 10%
R5—4,700-ohms, ½-watt, 10%
R6—1,000-ohms, ½-watt, 10%
Q1—PNP transistor, G.E. 2N5355 or equiv.
SPK1—16-ohm speaker, see text

IC 11 Gabber Grabber



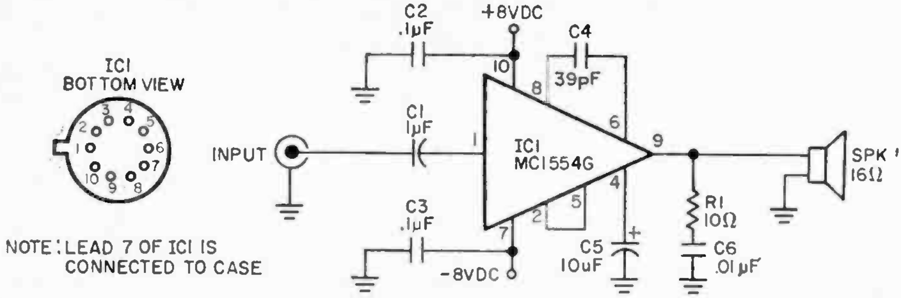
Gabber Grabber works best with the 10,000 ohm microphones and telephone pickup coils supplied with most solid-state recorders. It provides 20dB gain, and is ideal when a single microphone is used for conference recording or when remote telephone monitoring through a pickup coil is desired. The 18V power supply can be two series-connected 9V transistor radio batteries. Since the IC is a high frequency device, its leads should be kept as short as possible. A socket holding the IC is suggested but not required. A soldering iron rated no higher than 25 watts helps you whip together Gabber Grabber.

PARTS LIST FOR GABBER GRABBER

C1—0.1 uF, 25 VDC
C2, C3—10 uF, 25 VDC
C4—25 uF, 25 VDC
C5—50 pF
C6—250 pF
IC1—Fairchild NSJ716H

IC 12 Bi-Polar Amp

It is inconvenient when working with IC preamplifiers requiring bi-polar power sources to convert to a single-ended power source for the power amplifier. Our Bi-Polar Amp, however, can be driven from a bi-polar power supply. One of the benefits enjoyed by Bi-Polar Amp is that a large, expensive output coupling capacitor isn't needed. Since the device responds well into the high frequency range, capacitors C2 and C3 must be placed directly at the IC terminals to prevent high frequency oscillation. While capacitor C1 can be an electrolytic type, a non-polarized 1 uF is sug-

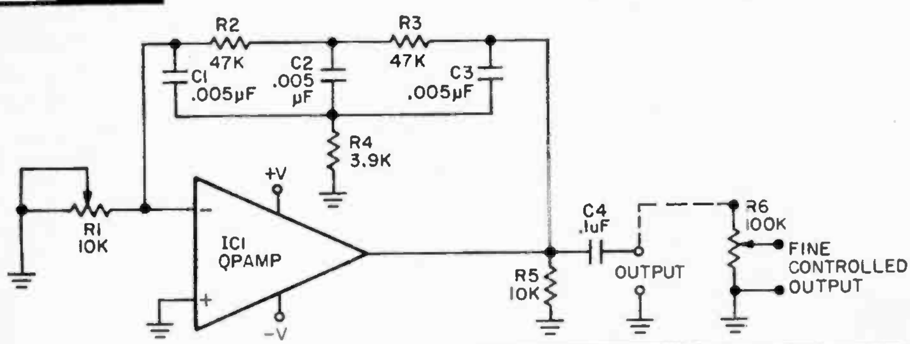


gested. The amplifier's input impedance is 10,000 ohms, a suitable value for solid-state projects. Voltage gain is 36. If less overall gain is required (say, 10X), connect pins 2 and 4 and connect pin 5 to ground through capacitor C5.

PARTS LIST FOR BI-POLAR AMP

- **C1—1uF, voltage rating at least equal to peak input voltage from preceding stage**
- **C2, C3—0.1 uF, 10 VDC**
- **C4—39 pF, 100 VDC disc**
- **C5—10 uF, 10 VDC**
- **C6—C.01 uF, 25 VDC**
- **IC1—Motorola MC-1554G**
- **R1—10-ohms, ½-watt, 10%**
- **SPK1—16-ohm speaker**

IC 13 Notch Filter Oscillator



Every experimenter's spare parts box has the necessary components for our Notch Filter 1 kHz Oscillator. It's suitable for testing audio equipment, signal tracing or tape recorder bias adjustments. Integrated circuit IC1 can be just about any operational amplifier sold through "surplus dealers." The 1 kHz "notch filter" from the amplifier output to the inverting or negative (−) input determines the output frequency. Notch Filter Oscillator's non-inverting or positive (+) input is grounded.

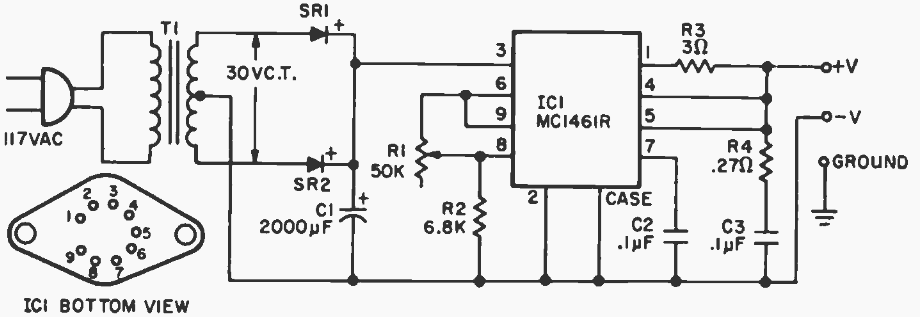
The power supply is bi-polar; use any voltage up to the maximum rating of the particular OpAmp you use. While resistor R5 is not needed in many instances, its use insures your Notch Filter Oscillator project's success. Potentiometer R1 sets the output level; its maximum value will approach the total power supply voltage. If fine output control is desired, add potentiometer R6. When your Notch Filter Oscillator is connected to a DC circuit, connect a DC blocking capacitor in series with

PARTS LIST FOR NOTCH FILTER OSCILLATOR

- **C1, C2, C3—0.005 uF, 75 VDC**
- **C4—0.1 uF, see text**
- **IC1—"surplus" operational amplifier**
- **R1—Potentiometer, 10,000 ohms**
- **R2, R3—47,000-ohms, ½-watt, 5 or 10%**
- **R4—3,900-ohms, ½-watt, 5 or 10%**
- **R5—10,000-ohms, ½-watt, 10%, see text**
- **R6—Potentiometer, 100,000 ohms, audio taper, see text**

R6's wiper arm. If the oscillator is to drive circuits of less than 10K ohm impedance, substitute a 1 uF non-polarized capacitor for C4, rated to the power supply's voltage.

IC 14 Protect-A-Volt



A simple turn of a knob sets Protect-a-Volt's output voltage anywhere in the 3 to 20 volt range—and with full short circuit protection! Should there be a wiring error in the powered project, this supply automatically shuts down the output voltage until the overload is removed. The maximum output current (short circuit protection) has been established by resistor R3's value to 200 mA. Power transformer T1's rating should not exceed 200 mA as extra current capacity could not be handled by the integrated circuit. To make this project easy to build, and to sharply reduce total cost, it was necessary to eliminate a fully off, or zero output, setting for Voltage Adjust control R1. The minimum output voltage is 3V. The maximum voltage from T1's secondary must be 30V RMS if the secondary is center-tapped; 15V RMS if there is no center-tap and a bridge-rectifier is substituted for silicon rectifiers SR1 and SR2. The input voltage to pin 3 is 1.4 times the secondary RMS voltage, and C1's voltage rating must be 25 volts minimum. Do not eliminate high-frequency-compensation network components R4/C3.

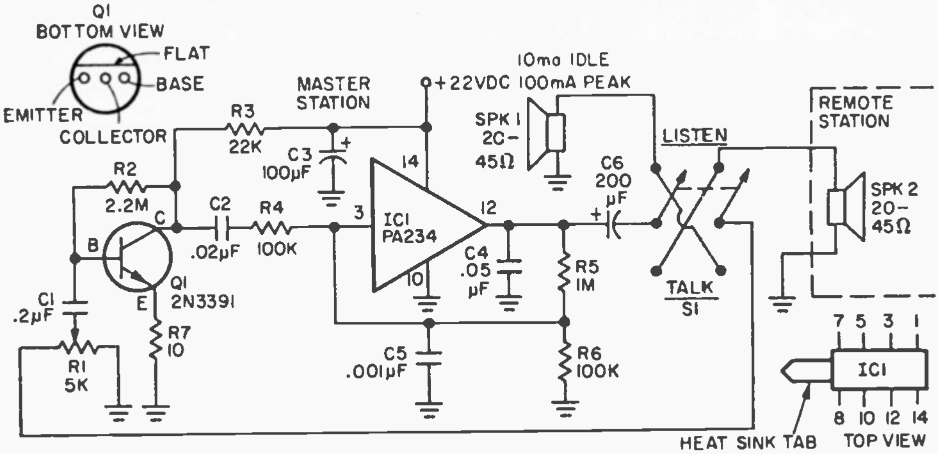
PARTS LIST FOR PROTECT-A-VOLT

C1—2000 uF, 25 VDC, see text
C2, C3—0.1 uF, 75 VDC disc or Mylar
IC1—Motorola MC-1461R
R1—50,000 ohm linear potentiometer
R2—6,800-ohms, ½-watt, 10%
R3—3-ohms, ½-watt, 10%
R4—27-ohms, ½-watt, 10%
SR1, SR2—Silicon rectifier, 50 PIV, 500 mA
T1—Power transformer: 117 VAC primary, 30 VC.T.: 200 mA secondary (see text)

IC 15 Electric Butler

Using a miniature 1 watt IC power amplifier, our Electric Butler provides very high sensitivity and a loud, clean output. Wiring and layout is not critical as long as capacitors C4 and C5 are installed directly at IC1's terminals. Capacitor C6 can be as low as 100 uF if you want to cut costs and are willing to give up a little bass response. While S1 can be a standard DPDT switch, a spring-return type will keep the Master station always monitoring the Remote. The speakers can be any "intercom type" rated from 20 to 45 ohms. Though miniature 16 ohm speakers can be used, they do not have the power handling capacity of the "intercom" speaker. If there appears to be some high frequency instability, use a shielded wire between S1 and R1; make a single-shield ground at R1.

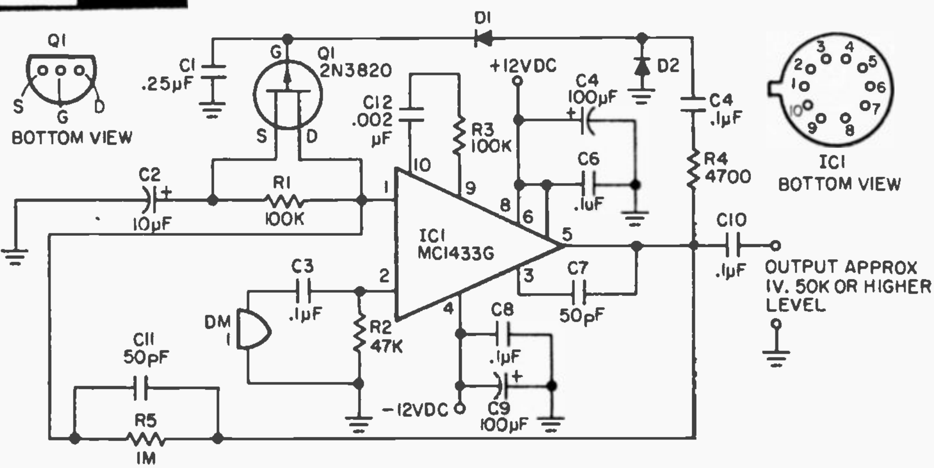
If an AC power supply is used, it must be rated for at least 100 mA drain. If a battery supply is used, figure the 10 mA idling current; the batteries will be able to deliver the 100 mA maximum output peak current. Solder a 1 inch square tin heat sink to IC1's tab during construction.



PARTS LIST FOR ELECTRIC BUTLER

C1—0.2 uF, 3 VDC
C2—0.02 uF, 3 VDC
C3—100 uF, 25 VDC
C4—0.05 uF, 75 VDC
C5—0.001 uF, 10 VDC
C6—200 uF, 25 VDC, see text
IC1—General Electric PA-234
Q1—NPN transistor, G.E. 2N3391
R1—Potentiometer, 5,000-ohms, audio taper
R2—2.2 megohms, ½-watt, 10%
R3—22,000-ohms, ½- watt, 10%
R4, R6—100,000-ohms, ½-watt, 10%
R5—1 megohm, ½-watt, 10%
R7—10-ohms, ½-watt, 10%
SPK1, SPK2—Speaker, 20 to 45 ohms, see text
S1—Switch, DPDT, see text

IC 16 Squeeze Box



Operating directly from microphone level and providing a nominal 1V output, Squeeze Box delivers 20db of compression (essentially distortion-free limiting) and will give ultimate talk-power to P.A. systems and ham or CB transmitters. Fact is, some sideband transmitters might not be able to handle the almost continuous "peak power" output of our Squeeze Box!

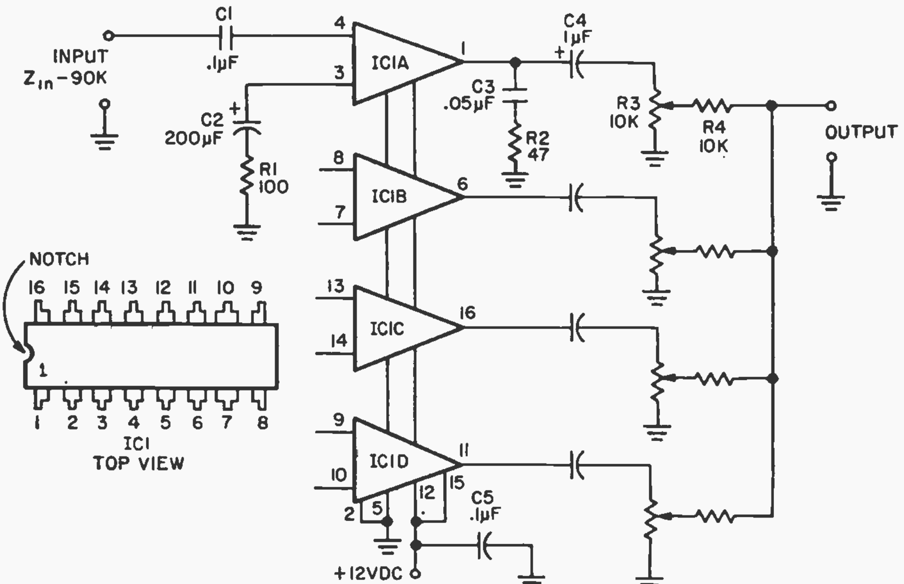
The only restriction on its use is that the microphone, DM1, must be the dynamic type: any impedance from 50 to 50,000 ohms will work. If DM1 can be permanently connected to the circuit, components R2 and C3 can be eliminated. But they must be used if there is any possibility DM1 will be disconnected. No substitution can be made for transistor Q1.

Capacitors C6 and C8 must be installed directly at the IC terminals for instability supression. Capacitors C5 and C9 can be installed anywhere that's convenient. A bipolar 12V supply (well filtered) is required. Power can be provided by batteries (for total hum-free operation) because the current requirement is approximately 15mA. Any gain controls must come after Squeeze Box's output.

PARTS LIST FOR SQUEEZE BOX

C1—0.25 uF, 10 VDC
C2—10 uF, 10 VDC
C3, C4, C6, C8, C10—0.1 uF, 75 VDC
C5, C9—100 uF, 15 VDC
C7, C11—50 pF, 75 VDC disc
C12—0.002 uF, 25 VDC
IC1—Motorola MC-1433G
R1—100,000-ohms, ½-watt, 10%
R2—47,000-ohms, ½-watt, 10%
R3—100-ohms, ½-watt, 10%
R4—4,700-ohms, ½-watt, 10%
R5—1 megohm, ½-watt, 10%
DM1—Dynamic microphone, see text
D1,D2—Germanium diode, 1N60 or equiv.
Q1—FET transistor, type 2N3820

IC 17 Pro-Mix



Best signal to noise ratio in a microphone mixer is always obtained if amplification is provided ahead of the loss in the mixer network. You can easily put this idea to work with our Pro-Mix—a full-fidelity, professional-grade microphone mixer that contains four independent amplifiers within the integrated circuit.

For simplification, our schematic shows only the connections for one of the four amplifiers; the others are identical to the first.

Note that the power supply is a single-ended 12VDC (negative grounded); it must be well filtered, or, use a battery supply.

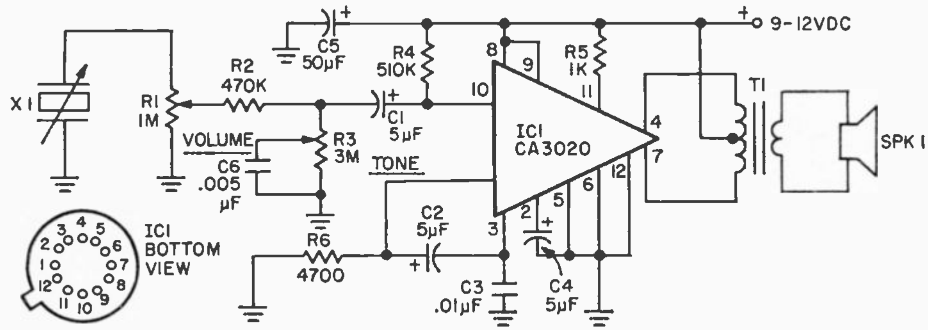
PARTS LIST FOR PRO-MIX

C1—0.1 uF, 3 VDC
C2—200 uF, 3 VDC
C3—0.05 uF, 75 VDC disc
C4—1 uF, 15 VDC
C5—0.1 uF, 15 VDC
IC1—RCA CA3052
R1—100-ohms, ½-watt, 10%
R2—47-ohms, ½-watt, 10%
R3—Potentiometer, 10,000-ohms audio taper
R4—10,000-ohms, ½-watt, 10%

The current requirements are approximately 30 mA total. The power supply is internally connected to the amplifiers.

To prevent high frequency oscillation, components C3, R2 and C5 must be installed directly at the IC's terminals.
Any 50 to 50,000 ohm dynamic microphone can be used. However, crystal and ceramic mikes won't work with Pro-Mix; the medium impedance IC's medium input impedance will excessively load down a high impedance mike, resulting in sharp, low-frequency attentuation.

IC 18 Porta-Groove Amp



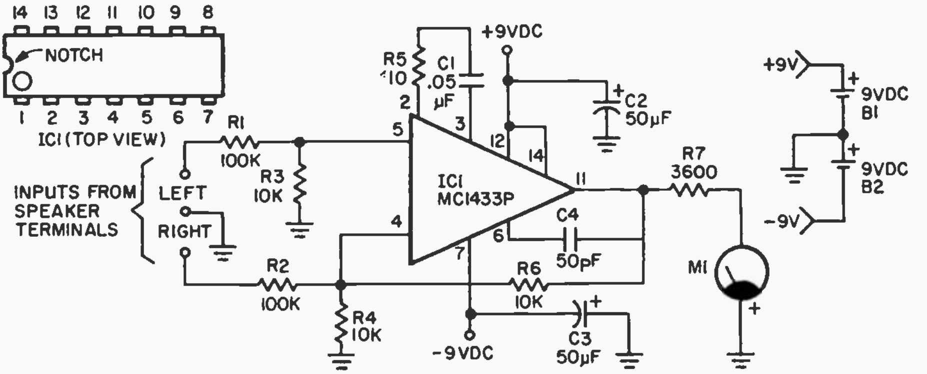
Just add a battery-powered motor to our Porta-Groove Amp, and you've made a portable phonograph of considerably better quality than you can buy. Phono pickup X1 must be the ceramic type—either the usual high impedance or so-called low impedance (actually several thousand ohms) ceramic type can be used.
Transformer T1 should have a primary impedance anywhere from 150 to 300 ohms center-tapped. The secondary should match the speaker impedance. Do not use a subminiature T1; for good sound quality T1 most have sufficient "iron", so make certain it can handle approximately 25mA average current.
A 6 inch speaker will deliver remarkably good sound quality, at least the equal of a good quality table radio. Two 6V lantern batteries or eight D cells easy give Porta-Groove Amp enough oomph. Do not use C or AA cells; they cannot give even reasonable life with the 20mA idling drain, 140 mA peak power drain.

PARTS LIST FOR PORTA-GROOVE AMP

C1, C2, C4—5 uF, 6 VDC
C3—0.01 uF, 10 VDC
C5—50 uF, 15 VDC
C6—.005 uF, 15 VDC
R1—Potentiometer, 1 megohm audio taper
R2—470,000-ohms, ½-watt, 10%
R3—Potentiometer, 3 megohms
R4—510,000-ohms, ½-watt, 10%
R5—1,000-ohms, ½-watt, 10%
SPK1—Speaker, 3.2, 4 or 6-8 ohms, see text on T1
T1—Output transformer, 150 to 300 ohms center-tapped primary coil to speaker impedence
IC1—RCA CA3020 or CA3020A
X1—Ceramic phono pickup

IC 19 Stereo See-Saw

By comparing the difference between channel outputs when feeding a mono signal, this differential stereo balancer allows you to set your stereo amplifier for precise electrical balance. Wiring is not critical; the Stereo See-Saw can easily be battery powered using a bi-polar battery connection as shown. To use, set your stereo amplifier to mono—then adjust the balance control until meter M1 indicates a null (minimum reading). If you cannot obtain a null it indicates there is a phase reversal—which should be corrected—between the signal input and the speaker terminals. Stereo See-Saw works on the differential principle. When an amplifier is in perfect balance there is no difference in mono output voltage between channels. So our Stereo See-

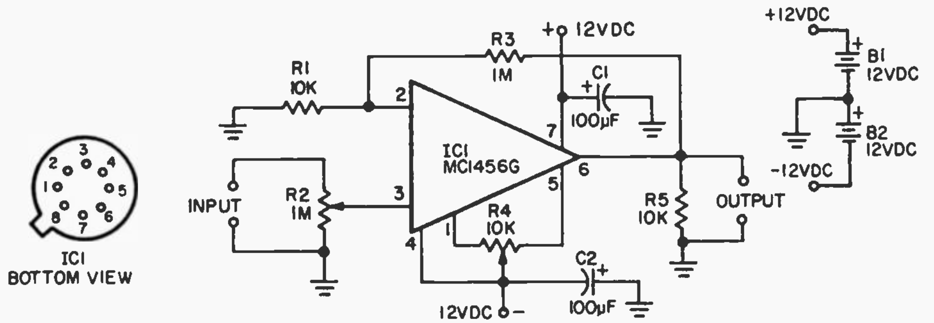


Saw differential amplifier indicates zero difference on the meter.

PARTS LIST FOR STEREO SEE-SAW

B1, B2—Battery, 9V, type 2U6
C1—0.05 uF, 10 VDC
C2, C3—50 uF, 10 VDC
C4—50 pF, 10 VDC
IC1—Motorola MC-1433P
M1—VU meter
R1, R2, R6—100,000-ohms, ½-watt, 10%
R3, R4—10,000-ohms, ½-watt, 10%
R5—10-ohms, ½-watt, 10%
R7—3,600 ohms (usually with VU meter)

IC 20 100X Instrument Amp



When voltages drop too low to be indicated on your scope or VTVM, just connect our 100X Instrument Amplifier ahead of your test gear and you get full-screen or full-scale readings. With an input impedance of 1 megohm, and a flat frequency response from DC to 20 kHz and beyond the 100X Instrument Amplifier provides a gain of exactly 100 (20dB) when potentiometer R2's wiper is at the top (full gain).

Connected ahead of a VTVM, the 100X Instrument Amplifier will convert, for example, a 10mV DC level into 1V. Here's a value that can be read on your VTVM! Similarly, if connected ahead of a scope's vertical input, the amp boosts a signal that will just cause a wiggle on the CRT to almost a full screen trace. The maximum input signal level for undistorted output is 0.1 (100 mV) peak-to-peak. Naturally, higher input signals can be used because of the attenuation provided by sensitivity control R2.

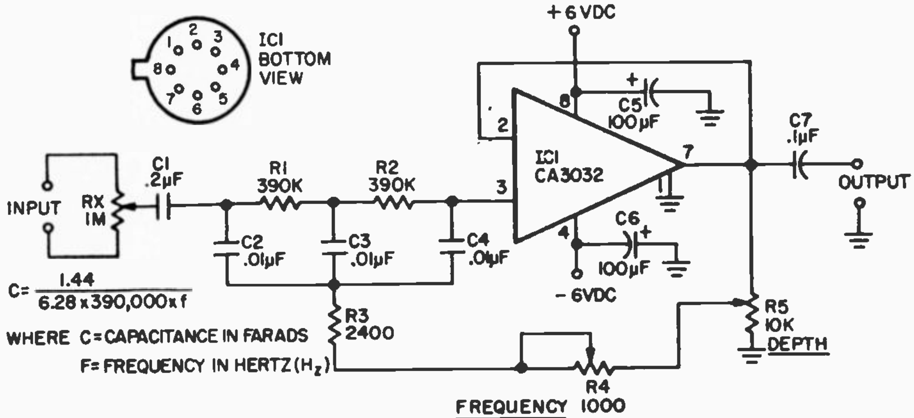
After you've completed the 100X Instrument Amplifier, connect a VTVM across

PARTS LIST FOR 100X INSTRUMENT AMPLIFIER

B1, B2—Battery, 12V
C1, C2—100 uF, 15 VDC
IC1—Motorola MC-1456G
R1—10,000-ohms, ½-watt, 5%
R2—Potentiometer, 1 megohm
R3—1 megohm, ½-watt, 5%
R4—Potentiometer, 10,000 ohms linear taper
R5—10,000-ohms, ½-watt, 10%

the output, adjust R4 for a zero DC meter reading. From time to time check the DC output; if it has drifted off zero, simply readjust R4. It might happen that changing R2's setting over a wide range might cause the output to drift off zero; if so, simply readjust R4. If you are primarily concerned with AC measurements, the output DC zero drift is unimportant, and a 0.1 uF capacitor can be connected between the 100X Instrument Amplifier and your VTVM or scope.

IC 21 Hum Buster



Ever try to play back an important tape which somehow was recorded with an objectionably high hum level? This active hum filter, called Hum Buster, is connected between the playback recorder and the amplifier. Hum Buster will sharply notch out the hum frequency, with little effect on other low frequencies.

The notch filter itself consists of components R1/R2/R3/R4 and C2/C3/C4. The values shown are for a 60Hz filter. If your tapes contain hum of a different frequency, say for example, 50 Hz, the proper values for capacitors C2/C3/C4 (which are all the same value) can be calculated from the formula given.

Simply plug into the formula the new value for frequency "f". The answer is in Farads. If you come up with an unusual value for "C", such as 0.08 uF, simply parallel two capacitors to get the proper value. For example, a 0.05 uF capacitor in parallel with 0.03 uF capacitor equals 0.08 uF.

Hum Buster's components need not be of precision tolerance because a slight amount of tuning is provided by Frequency control R4. Potentiometer R5 is the Depth control; it sets the degree of attenuation and the self-oscillation point. Adjust R5 for maximum filtering coincident with maximum hum suppression.

Potentiometer Rx is needed only if there is no way to control the level of the input signal to prevent overload. If the playback recorder has an output level control, Rx is not needed. The filter's input can be connected either to line level outputs or across speaker outputs. The filter's output should be loaded by 50,000 ohms minimum. Hum Buster's power supply can be two 6V Z4 type batteries in a bi-polar arrangement.

PARTS LIST FOR THE HUM BUSTER

C1—0.2 uF, 100 VDC tubular or 75 VDC disc or Mylar
C2, C3, C4—0.01 uF, 25 VDC, see text
C5, C6—100 uF, 6 VDC
C7—0.1 uF, 25 VDC
IC1—RCA CA3032
R1, R2—390,000-ohms, ½-watt, 5%
R3—2,400-ohms, ½-watt, 5%
R4—Potentiometer, 1,000-ohms linear taper
R5—Potentiometer, 10,000-ohms linear taper
Rx—Potentiometer, 1 megohm audio taper

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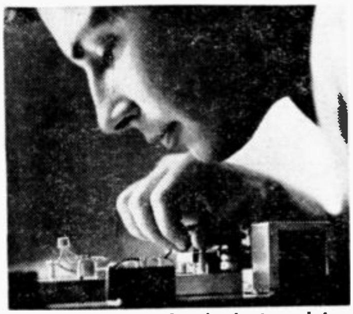
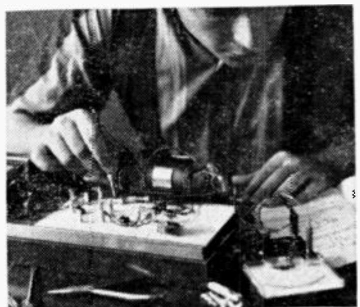
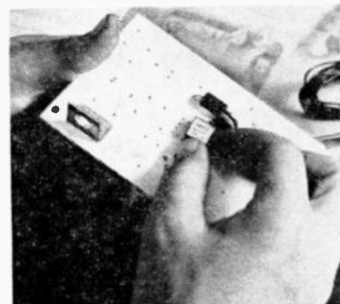


Working with basic single transistor circuit — Student learns best installation and troubleshooting techniques. He has constructed a basic single transistor circuit, first step toward understanding more complex solid-state circuitry.



Observing transistor operating as shunt-fed amplifier — Student has installed an oscillator and shunt-fed amplifier. He takes various measurements and observes the transistor operating as an amplifier. This is a typical solid-state circuit.



Assembling integrated circuit on a printed circuit board — Circuit is identical to one used in latest IBM System 360 computers. Student is constructing an oscillator combined with a Darlington pair output amplifier.

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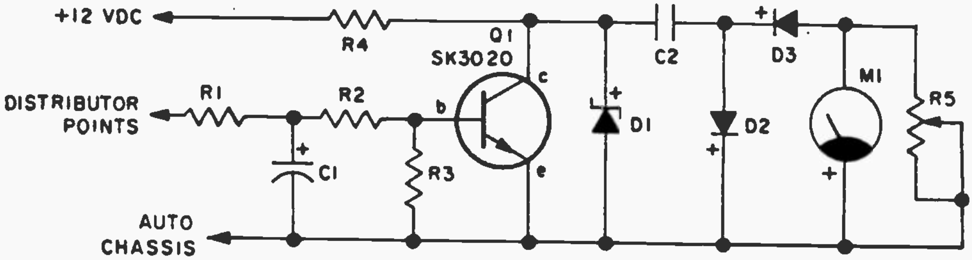
CIRCLE NO. 8 ON PAGE 8

1 RPM Meter



PARTS LIST FOR RPM METER

C1—1-uF, 100-VDC electrolytic capacitor
C2—0.47-uF, 15-VDC capacitor
D1—9.1-V, 250-mW Zener diode
D2, D3—100-mA, 50-PIV silicon rectifier
M1—0-1 mA DC meter
Q1—SK3020 npn transistor (RCA)
R1—200-ohm, ½-watt resistor
R2—220-ohm, ½-watt resistor
R3—1500-ohm, ½-watt resistor
R4—330-ohm, ½-watt resistor
R5—1000-ohm potentiometer

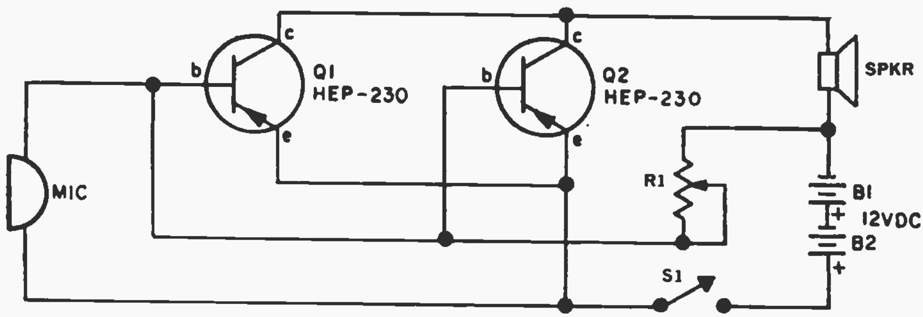
You can adjust a car engine to specified idle and choke rpm with this one-transistor tachometer.

Wiring is not critical and the unit can be assembled in a plastic box or metal cabinet. Zener diode D1 is any 250-milliwatt unit rated as close to 9 V as possible.

The unit can be used only on cars with a negative ground. The power lead connects to a positive 12-V point in the car's wiring, the ground lead connects to the car chassis. The distributor lead connects to the lead between the distributor and ignition coil. Do not connect it to a solid-state ignition system.

The meter scale is linear, with full scale representing approximately 10,000 rpm. Calibrate the tach against a commercial tach (at your local garage?) by noting the commercial tach's reading and adjusting R5 till your tach reads the same.

2 Power Megaphone



Just about any power transistor can be used in this megaphone. It's suitable for boats, playing fields, etc. Transistors Q1 and Q2 are the 2N301 type, generally available in "five-for-$1" experimenter kits.

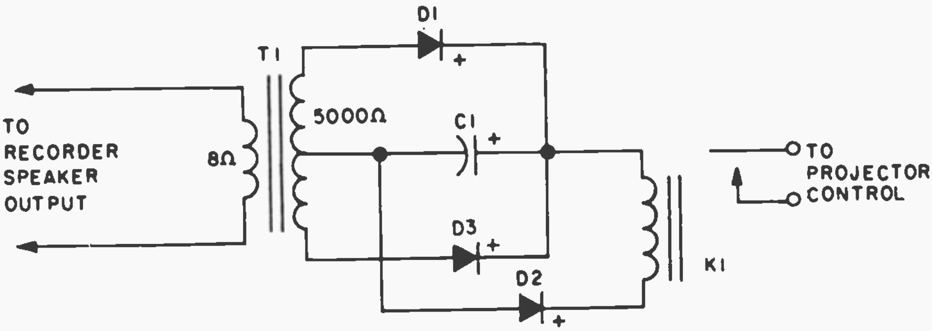
Transistors Q1 and Q2 are parallel-connected to handle the required power and speaker matching. The microphone is a carbon type such as a telephone handset. If a regular carbon mike is used, the push-to-talk (PTT) switch can be connected in place of S1 to provide PTT operation. There's no warm-up or "capacitor charge" time. Batteries B1 and B2 are 6 V lantern types. The unit should be built in a metal case which can also serve as a transistor heat sink. Use insulators coated with silicon heat-sink grease between each transistor and the case.

Potentiometer R1 is adjusted for maximum sound output consistent with lowest distortion.

PARTS LIST FOR POWER MEGAPHONE

B1, B2—6-V lantern battery
M1—Carbon microphone
Q1, Q2—HEP-230/232 pnp transistor (Motorola)
R1—5000-ohm. potentiometer
S1—Spst switch
SPKR—4-ohm speaker or horn

3 Slide Programmer



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 comemtary 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 PROGRAMMER

C1—25-µF, 50-VDC electrolytic capacitor
D1, D2, D3—500-mA, 100-PIV silicon diode
K1—2500-ohm coil plate-type relay
T1—5000-ohm CT audio output transformer

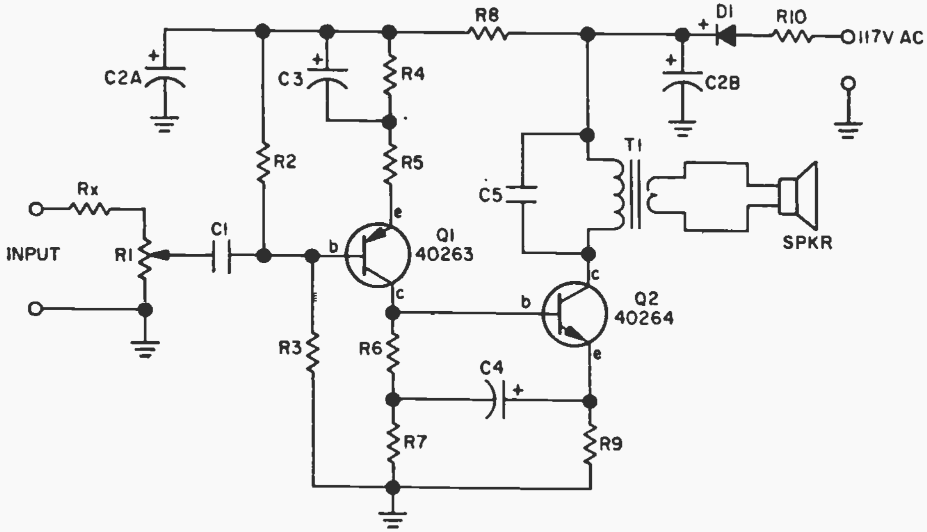
4 Line-Powered Phono Amp

Old tube phonographs are easily updated with this transistorized line-powered amplifier. It offers one-watt output—somewhat greater than is usually provided by phono amps.

No power transformer is needed since transistors Q1 and Q2 are designed to work directly from a high voltage power source. Full output is obtained from phono pickups providing at least 0.5 V output. If a "low impedance" ceramic pickup is used, eliminate resistor Rx since the input impedance will be approximately correct. If a "standard" high impedance ceramic pickup is used, install a resistor of 300K-500K ohms for RX.

Tone control circuits, if desired, should be installed ahead of volume control R1.

Since one side of the AC line provides the ground connection, for maximum safety make certain no wire or part connected to "ground" is exposed on the phonograph.
Sound quality is mainly determined by the size and characteristics of the speaker. Optimum sound balance can be obtained by slight changes in the value of C5. A higher value attenuates the highs while a lower value increases the highs.



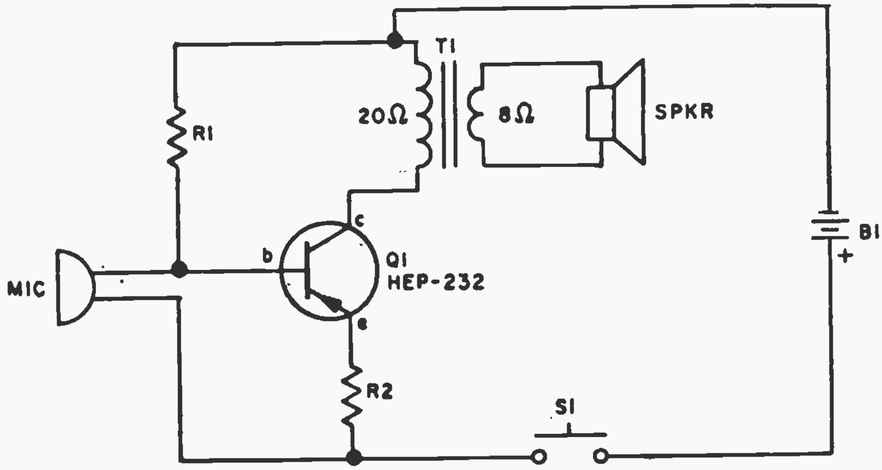
PARTS LIST FOR LINE-POWERED PHONO AMPLIFIER	
C1—0.01-uF, 200-VDC capacitor	R4—1000-ohm, ½-watt resistor
C2—80/80-uF, 150-VDC electrolytic capacitor	R5—68-ohm, ½-watt resistor
C3, C4—25-uF, 6-VDC capacitor	R6—470-ohm, ½-watt resistor
C5—0.01-uF, 400-VDC capacitor	R7—820-ohm, ½-watt resistor
D1—750-mA, 250-PIV silicon rectifier	R9—120-ohm, ½-watt resistor
Q1—40263 pup transistor	R10—250-ohm, ½-watt resistor
Q2—40264 pnp transistor	Rx—See Text
R1—2-megohm audio taper potentiometer	T1—2500-ohm pri., 4-ohm sec, audio output transformer
R2, R8—18,000-ohm, ½-watt resistor	SPKR—4-ohm PM speaker, 8-12-in. dia.
R3—33,000-ohm, ½-watt resistor	Misc.—Heat sink for Q2

5 Loudhailer

Though the design is simple and easy to build, this one-transistor loudhailer puts out a powerhouse shout. The circuit, except for the mike, can be mounted in a metal cabinet with a paging horn or trumpet speaker mounted on top.
Transistor Q1 must be provided with a heat sink, which may be the cabinet itself. Take care, however, that Q1's case—the collector—is insulated from the cabinet with hardware provided in a power transistor

PARTS LIST FOR LOUDHAILER

- B1—6-VDC battery, lantern type or four "D" alkaline cells in series
- MIC—Carbon microphone
- Q1—Motorola HEP-232 pnp transistor
- R1—270-ohm, ½-watt resistor
- R2—1-ohm, 4-watt resistor
- SPKR—8-ohm impedance, horn-type speaker
- S1—Normally-open pushbutton switch
- T1—8 to 20-ohm impedance, 5-watt audio output transformer



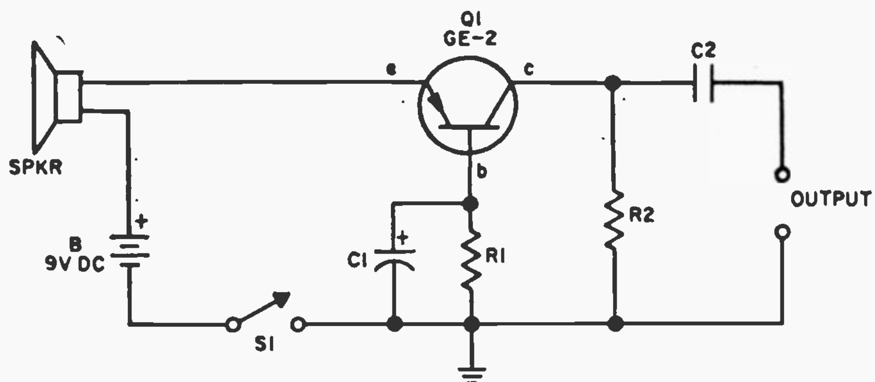
mounting kit.

The microphone can be a surplus carbon type or telephone transmitter element.

The entire unit can be assembled inside a speaker-trumpet if care is taken to acoustically isolate the microphone from the speaker to prevent howling feedback.

Note carefully that transformer T1 must be rated for at least 5 watts. Do not use a miniature transistor transformer.

6 Speak-A-Mike Preamp



A speaker can often serve as a microphone in intercoms, "one-way telephones" or as an emergency microphone. All the speaker needs is amplification to raise "voice power" output to normal mike level.

A small speaker-mike preamp can easily be thrown together with junk box parts and just about any general purpose transistor with a beta of 30 to about 150. While an pnp transistor is shown, an npn type can be substituted if the battery and C1's polarity are reversed. No other changes are needed.

Q1 is a common base amplifier providing a low impedance input to match a low impedance speaker of 3.2, 4, 6-8, or 16 ohms. The collector output is medium impedance and the .47 uf capacitor at C2 allows the preamp to work into loads of 7000 ohms or higher.

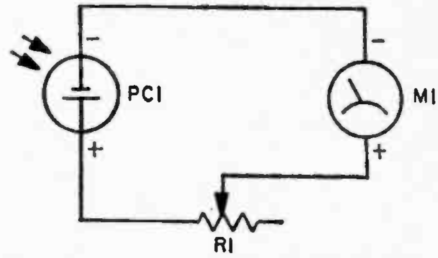
PARTS LIST FOR SPEAK-A-MIKE PREAMP

B1—9-V battery
C1—6-uF, 25-VDC electrolytic capacitor
C2—0.47-uF, 10-VDC capacitor
Q1—GE-2 pnp transistor
R1—270,000-ohm, ½-watt resistor
R2—27,000-ohm, ½-watt resistor
S1—Spst switch
SPKR—Any PM speaker, 4-10-ohms

7 Enlarger Meter

PARTS LIST FOR ENLARGER METER

M1—100, 250, or 500-mA DC meter
PC1—Solar cell (Radio Shack 27-1710)
R1—5000-ohm potentiometer linear taper



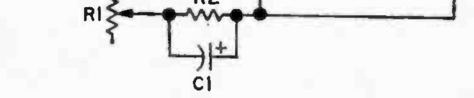
Every print a good print! That's what you get with the Enlarger Meter.

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.

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.

8 Fish Caller



PARTS LIST FOR FISH CALLER

B1, B2—1.5-V AAA battery
C1, C2—50-uF, 25-VDC electrolytic capacitor
E1—Crystal earphone
Q1—Motorola HEP-230 pnp transistor
R1—2500-ohm potentiometer
R2—27,000-ohm, ¼-watt resistor
S1—Spst switch, part of R1
T1—Subminiature transistor output transformer: 500-ohm center tapped primary to 3.2-ohm secondary

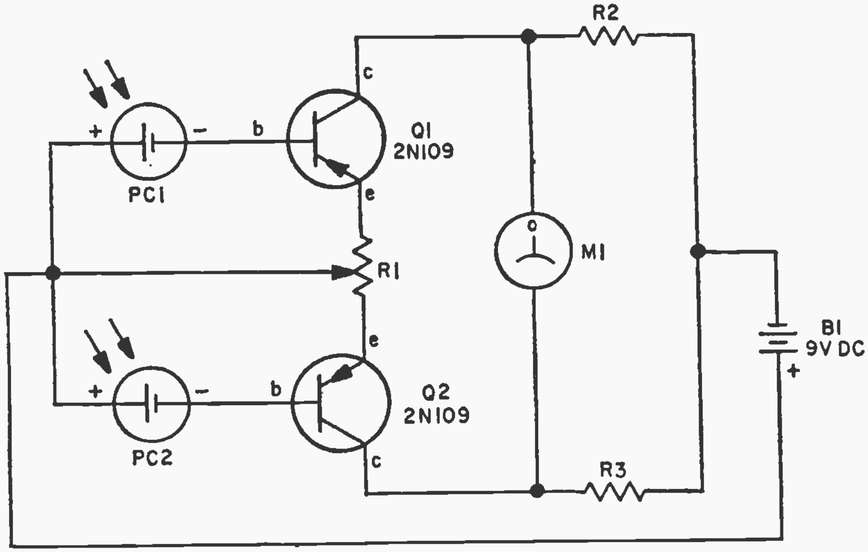
Click-click might not sound like much to you but to a fish it's the dinner bell. That's the lure of this electronic circuit. Shove the whole works in a watertight container, lower it over the side, and wait for the fish to hit the hooks.

For proper operation T1 must be subminiature type about half as large as your thumb. E1 must be a crystal headphone (supplied with some transistor radios).

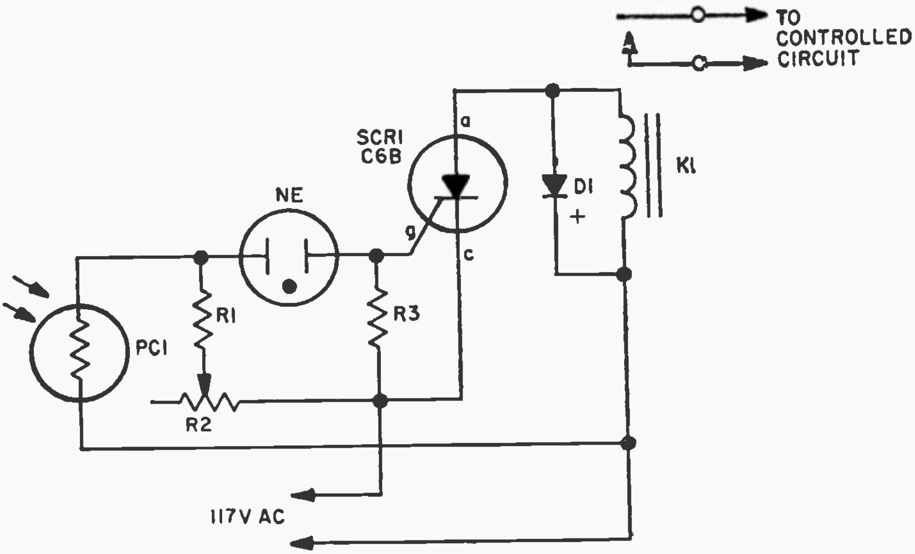
9 Light Comparator

The Light Comparator will check or adjust two light sources for equal intensity. The metering circuit is a balanced bridge consisting of R2, R3, Q1, and Q2. With solar cells PC1 and PC2 exposed to the same light source, balance control R1 is adjusted for zero indication on the meter. In operation, unequal light falling on the cells changes the base bias of the transistors. This upsets the collector currents, causing the meter to indicate.

PARTS LIST FOR LIGHT COMPARATOR
B1—9-V battery
M1—1-0-1 mA DC meter, zero center
PC1, PC2—Solar cell
Q1, Q2—2N109 pnp transistor
R1—5000-ohm potentiometer
R2, R3—1000-ohm, ½-watt resistor



10 Light-Controlled Switch



A flashlight beam stabs out—the irritating TV commercial for underarm deodorant vanishes. Moments later, when the program returns, the flashlight beam stabs out again. The sound snaps back on. Between the flashlight and TV speaker circuit is the light-controlled switch.

When a beam of light strikes the photocell, the voltage across neon lamp NE-1 rises sharply. When conduction voltage is reached NE-1 turns on and fires the SCR. K1 is an impulse relay whose contacts stay in position even after coil current is removed. So the first impulse opens K1's contacts, the second impulse closes them, etc. To prevent ambient light from tripping the photocell, it should be recessed at least an inch inside a metal or cardboard tube.

PARTS LIST FOR LIGHT-CONTROLLED SWITCH

- D1—200-PIV silicon diode
- K1—Guardian IR-610L-A115 latching relay
- NE—NE-83 neon lamp
- PC1—Clairex CL505 for high light level; CL704 or CL705 for low light level
- R1—22,000-ohm, ½-watt resistor
- R2—1-megohm potentiometer
- R3—100-ohm, ½-watt resistor
- SCR1—GEC6B silicon-controlled rectifier

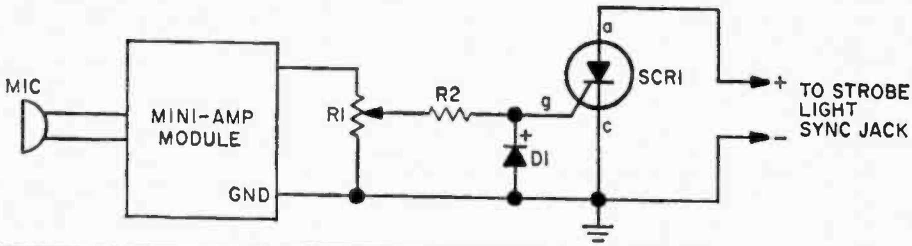
11 Stop Motion

PARTS LIST FOR STOP MOTION

- D1—Motorola HEP-154 50-PIV silicon rectifier
- MIC—Ceramic microphone
- R1—5000-ohm potentiometer
- R2—2700-ohm, ½-watt resistor
- SCR1—GE C5G silicon-controlled rectifier

You, too, can take strobe-flash pictures the instant a pin pricks a balloon, a hammer breaks a lamp bulb or a bullet leaves a gun. You'll need a mini-amp—one of those transistor amplifier modules of 1-watt rating or less. *It must have an output transformer.* Don't use an "OTL" (no transformer) amplifier. The amplifier is terminated with a resistor on its highest output impedance, preferably 16 ohms. Make certain the connections to the strobe flash sync terminals are correctly polarized.

Darken the room lights, open the camera shutter and break a lamp bulb with a hammer. The sound of the hammer striking the lamp will trigger the flash, and the picture will have been taken at that instant.



12 Vitamin A Crystal Rig

That old favorite, the crystal radio, becomes more than just a weak voice buried in the headphone when it's amplified with a "junk box" amplifier.

Transistor Q1 can be just about any general purpose pnp germanium type such as the 2N107, 2N109, etc. The SK3003 specified gives a little extra gain.

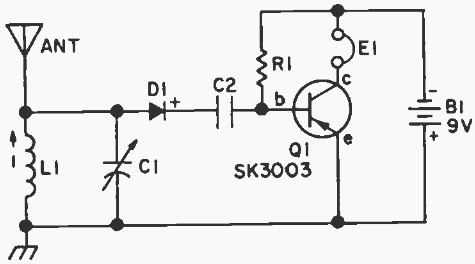
L1 is any ferrite antenna coil for the broadcast band, while E1 must be a magnetic headset for maximum output level. To align the receiver, set C1's dial to the known frequency of a strong local station and adjust L1's slug until you hear the station in the phones.

For reception of weaker signals the receiver should be connected to an earth ground such as the cold water pipe. The longer the antenna, the better the reception. Try 20 feet or more.

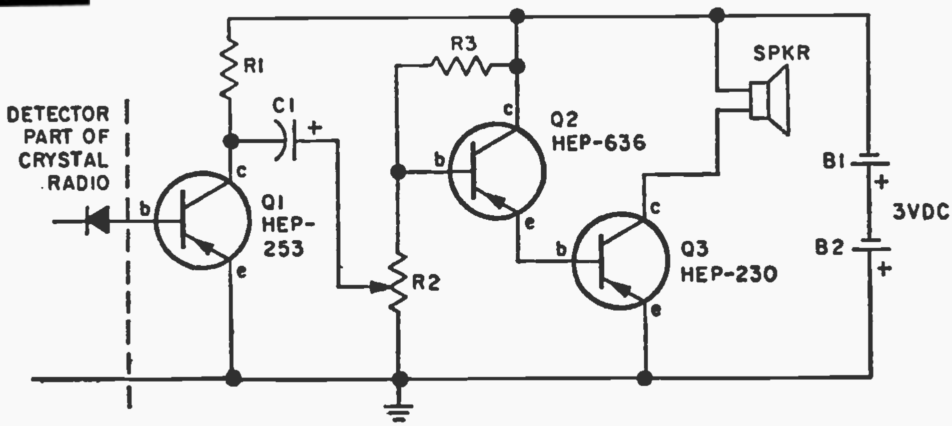
To feed the radio's output into an amplifier and speaker, replace the headphone with a 1000-ohm ½-watt resistor. Connect a .1 mfd, 25VDC capacitor from Q1's collector to the amplifier input. Then be sure to connect radio's ground to the amplifier ground.

PARTS LIST FOR VITAMIN A CRYSTAL RIG

B1—9-V battery
C1—365-pF tuning capacitor
C2—0.2-uF, 10-VDC capacitor
D1—1N60 diode
E1—1000-3000-ohm impedance magnetic earphone
L1—Ferrite antenna coil
Q1—SK3003 pnp transistor
R1—100,000-ohm, ½-watt resistor



13 Crystal Radio Amplifier



Even with junk box parts, this three-stage OTL (Output Transformerless) amplifier will produce table-radio volume from a simple crystal detector.

Note the unusual connection for volume control R2. This arrangement is used because the end-to-end resistance of R2 is part of R3's base bias divider. The only critical connection is between Q1's base and the detector diode in the crystal radio. Transistor Q1's base must connect to the detector's anode, as shown. If the diode is presently wired in the crystal radio so that the output is taken from the cathode end (marked "+"), reverse the diode's polarity. It will have no effect on the radio's operation.

Any general-purpose transistors equivalent to those specified can be used.

PARTS LIST FOR CRYSTAL RADIO AMPLIFIER

B1, B2—1.5-V D battery
C1—6-uF, 6-VDC electrolytic capacitor
Q1—Motorola HEP-253 pnp transistor
Q2—Motorola HEP-636 pnp transistor
Q3—Motorola HEP-230 pnp transistor
R1—10,000-ohm, ½-watt resistor
R2—10,000-ohm potentiometer
R3—100,000-ohm, ½-watt resistor
SPKR—3.2-ohm speaker

14 Broadcast Band Booster

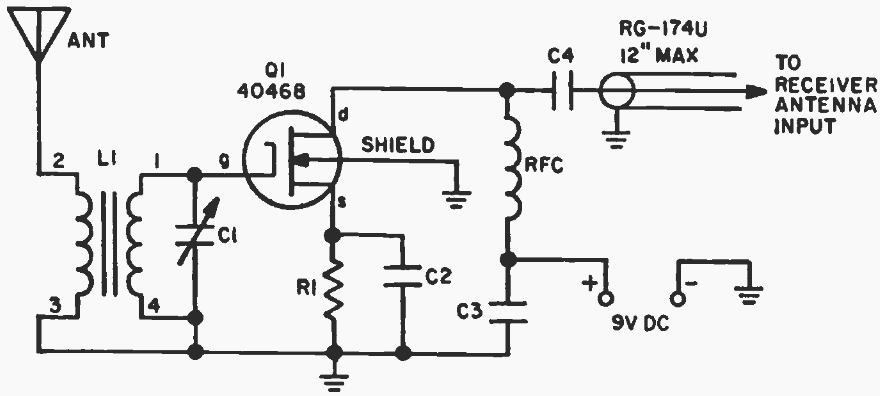
Signals you never knew existed can be dug out from under the "dead" spaces of your BC radio dial with this one-evening project. The high input impedance of the FET (field effect transistor) does not load down the antenna coil, hence, an overall circuit gain of some 3 to 5 S-units.

L1 is connected using the terminal arrangement given in the instructions provided with the coil. Capacitor C1 is any 365 uuf tuning capacitor; one salvaged from an old radio or one of the low-cost miniatures. The RF choke (RFC) must be no larger than 1 mH or the unit will break into oscillation across most of the BC band. Connection from the booster can be through a plug and jack, but the connecting cable, made of RG-174U coaxial cable, must be no longer than 12 inches or severe signal attenuation will result.

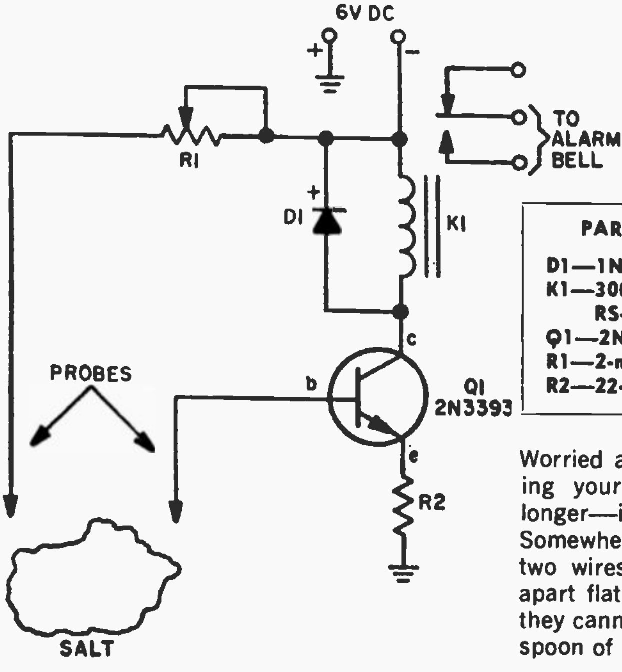
The high gain of the booster can cause oscillation if the output cable gets near the antenna. For best results, assemble the booster in a metal cabinet and ground the cabinet to a cold water pipe. If the BC receiver is the AC/DC type, connect a .05 uf, 400 VDC capacitor between the output cable shield and the receiver's ground.

PARTS LIST FOR BC BAND BOOSTER

C1—365-pF tuning capacitor
C2, C3—0.05-uF, 25-VDC capacitor
C4—100-pF, 100-VDC disc capacitor
L1—Broadcast band antenna coil (J.W. Miller A-5495A)
Q1—RCA 40468 FET transistor
R1—1000-ohm, ½-watt resistor, 10%
RFC—1-mH RF choke



15 Flood Alarm



PARTS LIST FOR FLOOD ALARM

D1—1N60 diode
K1—300-ohm, 6-VDC relay (P&B type RS-5D-6)
Q1—2N3393 npn transistor
R1—2-megohm potentiometer
R2—22-ohm, ½-watt resistor

Worried about water in the basement ruining your electronic equipment? Fear no longer—if you use a flood alarm.

Somewhere near the water pipes, position two wires spaced approximately one inch apart flat on the floor. Secure the wires so they cannot be moved. Place about one teaspoon of salt between the wires. If the floor is cement, mount wires and salt on a sheet of plastic because the salt can affect the cement.

When water comes in contact with the salt, current flows between the wires, completing Q1's base bias circuit. Collector current in Q1 will cause K1 to close, whose contacts ring an alarm bell. To set up the circuit, apply water to a test mound of salt and adjust R1 until K1 closes.

16 Direct-Coupled Radio

PARTS LIST FOR DIRECT-COUPLED RADIO

B1, B2—1.5-V battery
C1—365-pF variable capacitor
E1—2500-5000 ohm earphone
L1—Tapped ferrite antenna coil
Q1, Q3—Motorola HEP-641 npn transistor
Q2—Motorola HEP-253 pnp transistor
R1—5000-ohm potentiometer
R2—100-ohm, 1/2-watt resistor

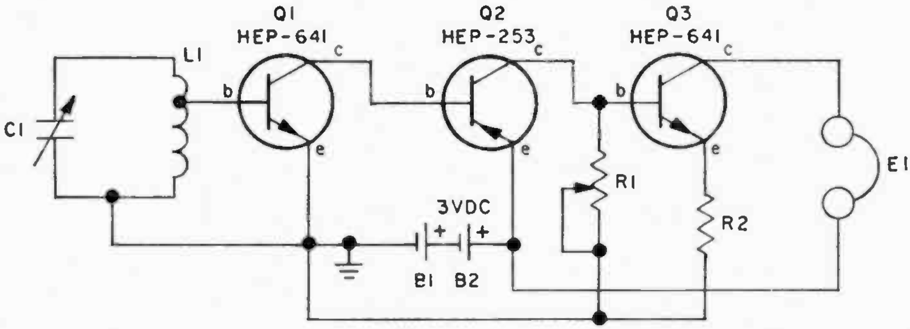
A shirt-pocket project, this direct-coupled radio uses transistor Q1 as a diode detector and first audio amplifier. Detection is across the base-emitter junction which operates as a diode. Normal base-emitter capacitance provides RF filtering. L1 can be a tapped (transistor type) ferrite antenna coil. Tuning capacitor C1 is a miniature *poly*-type variable.

Earphone E can be magnetic or crystal as long as its impedance is in the 2500- to 5000-ohm range.

Control R1 is adjusted for best earphone sound—or least distortion consistent with maximum volume.

During construction, carefully note that npn and pnp transistors are used. Don't intermix them since reverse polarity voltage can destroy a transistor.

Batteries B1 and B2 are the penlight (AAA) type—good for many hours of service.



17 Click Clack Timer

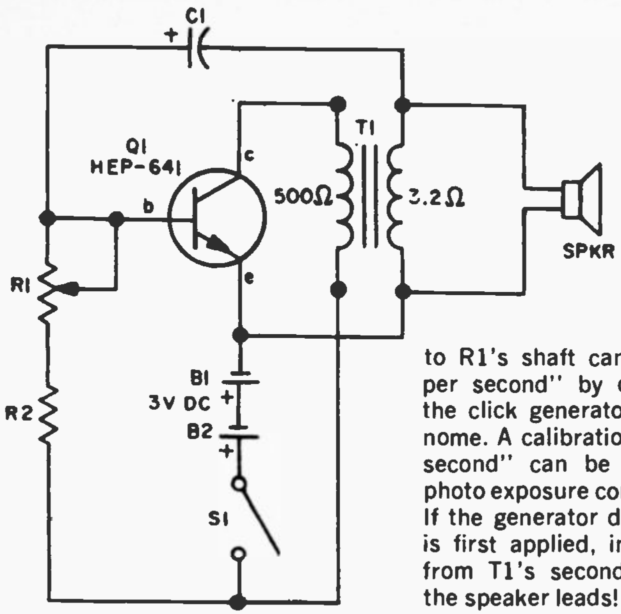
PARTS LIST FOR CLICK CLACK TIMER

B1, B2—1.5-V D battery
C1—10-uF, 6-VDC electrolytic capacitor
Q1—Motorola HEP-641 npn transistor
R1—1-megohm potentiometer
R2—7500-ohm, 1/2-watt resistor
S1—Spst switch
SPKR—3.2-ohm, 2 1/2-in. dia. speaker
T1—50 to 3.2 ohm miniature audio transistor transformer

Providing equally spaced clicks from 3 to 300 per minute, this click generator is either an electronic metronome or an interval timer, say, for photo enlarging.

Transistor Q1 functions as an amplifier, but positive feedback from T1's secondary to Q1's base causes the circuit to regenerate. This produces a steady stream of clicks in the speaker. The rate of oscillation, or number of clicks per minute, is determined by R1's setting.

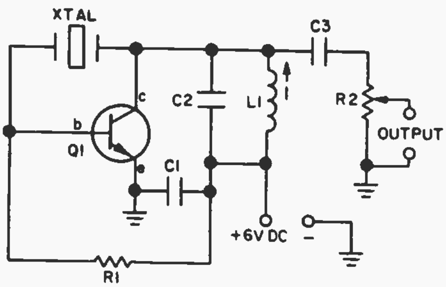
With a little time and patience, a dial affixed



to R1's shaft can be calibrated in "beats per second" by comparing the output of the click generator with a standard metronome. A calibration point for "one click per second" can be marked on the dial for photo exposure control.

If the generator does not click when power is first applied, interchange the two leads from T1's secondary. Do not interchange the speaker leads!

18 Simple IF Signal Generator



PARTS LIST FOR SIMPLE IF SIGNAL GENERATOR

C1—0.05-uF, 25-VDC capacitor
C2—50-pF silver mica capacitor
C3—15-pF silver mica capacitor
L1—3.4-5.8 mH RF coil (J.W. Miller 21A473RB1)
Q1—GE-5 npn transistor
R1—330,000-ohm, ½-watt resistor
R2—5000-ohm, potentiometer
XTL—455-kHz crystal

Using a 455-kHz crystal, this 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 starts consistently. If 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.

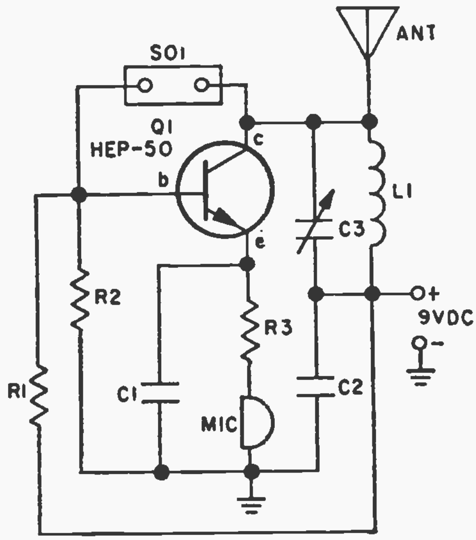
19 Radio Pager

Small enough to fit into a cigarette pack, this pocket pager produces a low-output signal on the Citizen's Band (27 MHz) suitable for paging inside a building. The signal is strong enough to be heard on a standard transceiver, but not enough to cause receiver overload.

If only one crystal frequency is needed, socket SO1 can be eliminated and an overtone type crystal soldered directly into the circuit. Salvage crystals from junked units. The whip antenna is a standard walkie-talkie three-section replacement type. The carbon microphone can be a telephone transmitter. You may want to use the portable CB antenna described in circuit 22 on page 26 or Extended CB Antenna in circuit 31 on page 31.

To tune; receive the signal on an S-meter-equipped receiver and adjust trimmer C3 for maximum output. Key the transmitter a few times to check crystal activity. If starting is intermittent, slightly alter C3's adjustment until operation is consistent.

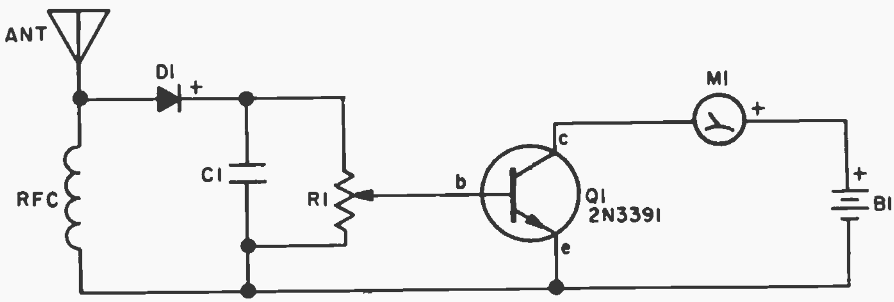
The power supply can be a standard 9V (2U6 type) battery.



PARTS LIST FOR RADIO PAGER

C1, C2—0.001-uF, 100-VDC disc capacitor
C3—50-pF trimmer capacitor
L1—10 turns #16 enameled wire wound on 3/8-in. form, spaced 1 in. end to end
MIC—Carbon microphone element
Q1—Motorola HEP-50 npn transistor
R1—47,000-ohm, 1/2-watt resistor
R2—10,000-ohm, 1/2-watt resistor
R3—330-ohm, 1/2-watt resistor
SO1—Crystal socket

20 Supersensitive FSM



PARTS LIST FOR SUPERSENSITIVE FSM

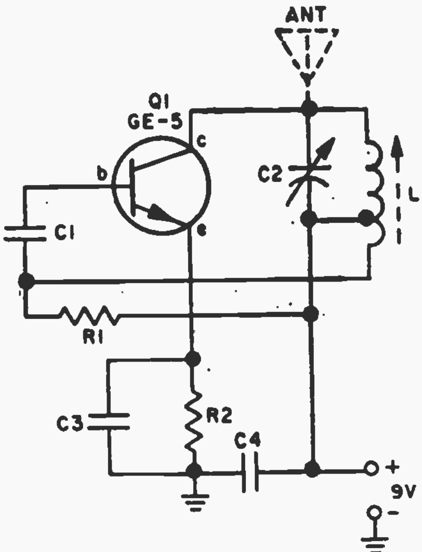
B1—1.5-V battery
C1—0.001-uF, 100-VDC capacitor
D1—1N60 diode
M1—0-1 mA DC meter
Q1—2N3391 npn transistor
R1—50,000-ohm potentiometer
RFC—2.5-mH choke

A kilowatt transmitter may pin the needle of regular FSMs (field strength meters), 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 300 times that of ordinary models. It indicates full scale when other meters can't budge off the pin.

Dependable frequency range is approximately 3 to 30 MHz. A metal enclosure is recommended, with a stiff wire antenna about 6 in. long. For compactness, RFC 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 Q1.

21 Sideband Sideman



Placed near a multiband transistor portable, this BFO allows reception of CW and SSB signals in addition to the normal reception.

The BFO is a Hartley oscillator tunable across the broadcast band. Oscillator harmonics extend to the higher shortwave frequencies where they "beat" against CW and SSB stations. It provides standard BFO tone reception of CW signals and reasonably good reception on moderate to strong SSB signals.

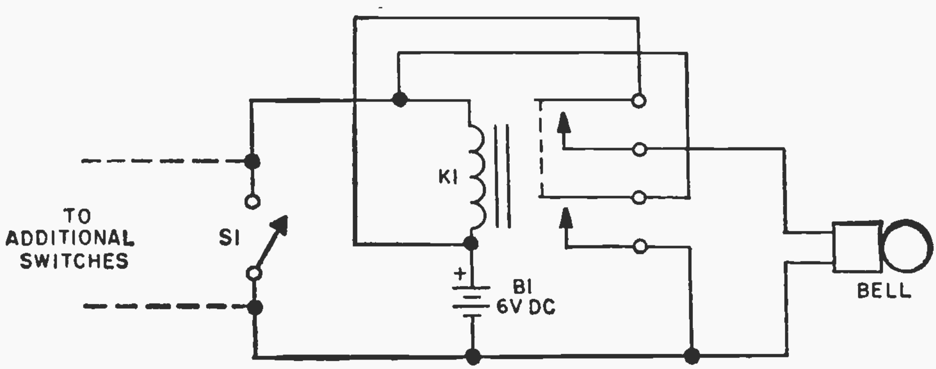
Once C2 is adjusted to the proper beat frequency, the BFO is positioned near the transistor radio for optimum reception. No antenna is needed if the unit is assembled in a plastic cabinet.

The BFO can also be used as a radio-type code practice oscillator with a range of approximately 20 feet. Connect a 10-ft. antenna on a nearby BC radio. To send Morse code, insert a key in series with one battery lead.

PARTS LIST FOR BFO FOR SIDEBAND SIDEMAN

C1, C3, C4—0.05uF, 25-VDC capacitor
C2—360-pF variable capacitor
L1—Tapped BC antenna coil
Q1—GE-5 transistor
R1—2200-ohm, 1/2-watt resistor
R2—68-ohm, 1/2-watt resistor

22 Latching Burglar Alarm



PARTS LIST FOR LATCHING BURGLAR ALARM

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

Open a fancy commercial burglar alarm and all you'll find inside is this ordinary relay latching 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 ball 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 close 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.

23 3-Way Tone Generator

Add a terminal or two and an ordinary CPO (code practice oscillator) becomes a three-way threat, serving as a CPO, tone generator or intruder alarm.

The circuit is a Harley oscillator whose tone is determined by R2's value. Just about any wiring or layout will work, but 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.

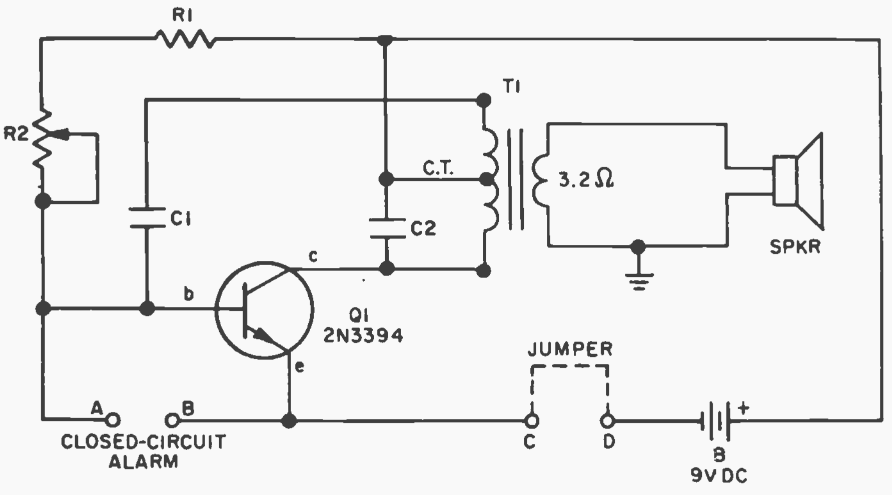
For CPO operation connect a hand key across points C and D. For a "make" intruder alarm, connect one or more normally open magnetic switches across points C and D. For a "break" intruder alarm connect a jumper across C and D and connect a series wire circuit across A and B, which disables the oscillator 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.

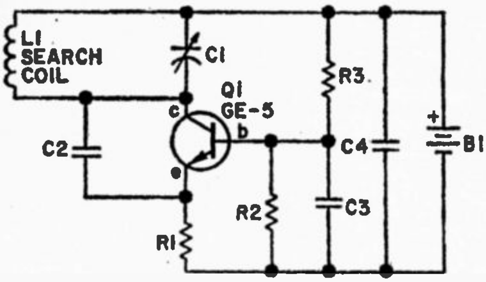
Service Note: If the unit fails to oscillate, generally due to transistor differences, change C2's value slightly.

PARTS LIST FOR THREE-WAY TONE GENERATOR

B1—9-V battery
C1, C2—0.02-uF, 25-VDC capacitor
Q1—2N3394 npn transistor
R1—10,000-ohm, ½-watt resistor
R2—250,000-ohm potentiometer
SPKR—3.2-ohm speaker
T1—Output transformer: 5000-ohm, center-tapped primary to 3.2-ohm secondary (must *not* be miniature transistor type)



24 Treasure Locator



You won't find Long John Silver's buried treasure but you will have lots of fun finding bottle caps and uneaten sandwiches at the beach; maybe even some quarters and dimes.

This treasure locator keeps costs down by using a transistor radio as the detector. The unit is assembled on a perf-board, with rigid component mounting a must. It is strapped to a broom handle close to the bottom where the search head is mounted. A transistor radio is mounted near the top of the handle.

With the radio tuned to a "weak station," Capacitor C1 is adjusted so the locator oscillator "beats" against the received signal, producing a whistle in the receiver. When the search head passes over buried metal, the metal changes the inductance of L1, thereby changing the locator oscillator's frequency and changing the "beat tone" in the radio.

The search coil consists of 18 turns of #22 enameled wire *scramble wound* (which means don't be neat) on a 4-in. diameter form, which can be a cardboard tube or a wood puck or even plastic—anything but metal. After the coil is wound and checked for proper operation, saturate the coil with *coil dope* or G.E.'s *RTV* adhesive (do not use *Silastic* or any other similar product but *RTV*.) If a single loop of the coil is not firmly cemented the unit will be unstable.

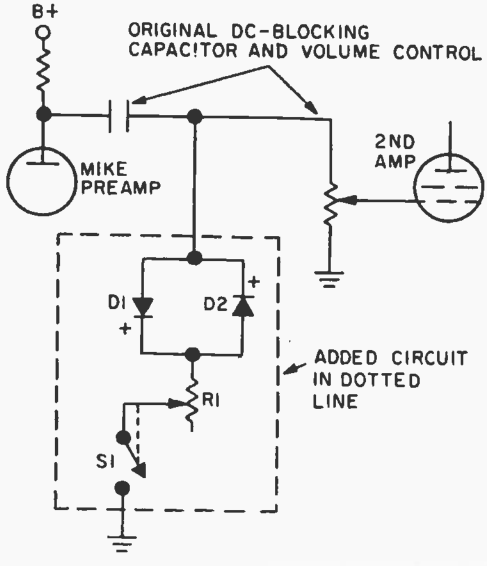
PARTS LIST FOR TREASURE LOCATOR

B1—9-VDC transistor battery
C1—280-pF trimmer or variable capacitor
C2—100-pF, 100-V silver mica capacitor
C3—0.05-uF, 25-V disc capacitor
C4—5-uF, 12-V electrolytic capacitor
L1—Search coil consisting of 18 turns of #22 enamel wire scramble wound on 4-in. diameter form
Q1—GE-5 npn transistor
R1—680-ohm, ½-watt resistor
R2—10,000-ohm, ½-watt resistor
R3—47,000-ohm, ½-watt resistor

25 Freq-y Fuzzbox

Want fuzz for the *Now* sound, but haven't got the loot for a fuzzbox? Try this one until you come across some extra "bread". The cost will be under three bucks.

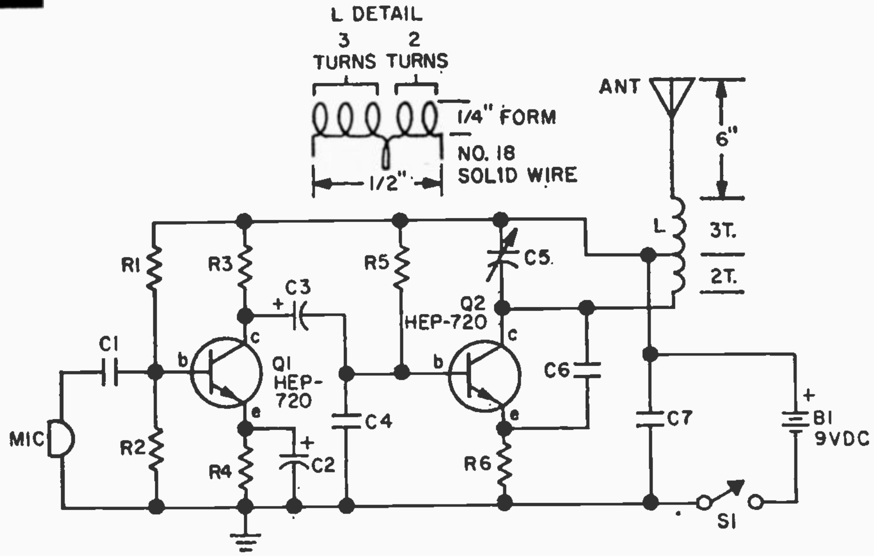
Install the two diodes and potentiometer across the guitar amplifier's volume control. The diodes clip the normal sound, producing the fuzz effect. R1 sets the degree of fuzz. It's not as much as you would get from a professional fuzzbox, but fuzz it is. One restriction is that an audio signal at the plate of the amplifier before the fuzz must be at least 1-volt RMS—generally true in most amplifiers.



PARTS LIST FOR FREQ-Y FUZZBOX

D1, D2—1N60 diode or 1N34A
R1/S1—10,000-ohm miniature potentiometer with spst switch

26 FM Wireless Mike



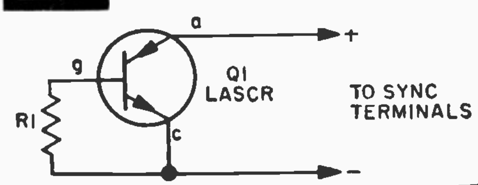
PARTS LIST FOR FM WIRELESS MIKE

B1—9-V battery, Type 2U6
C1—0.05-uF, 3-VDC capacitor
C2—20-uF, 3-VDC electrolytic capacitor
C3—5-uF, 12-VDC electrolytic capacitor
C4—47-pF, 25-VDC capacitor
C5—5-30 pF trimmer capacitor
C6—6.8-pF ceramic capacitor
C7—0.01-uF, 10-VDC capacitor
L1—See pictorial detail
MIC—Crystal or ceramic microphone element
Q1, Q2—npn transistor HEP—720
R1—47,000-ohm, ½-watt resistor
R2—33,000-ohm, ½-watt resistor
R3—1500-ohm, ½-watt resistor
R4—3300-ohm, ½-watt resistor
R5—100,000-ohm, ½-watt resistor
R6—470-ohm, ½-watt resistor
S1—Spst switch

Just speak or play into the microphone and you'll broadcast to an FM receiver at distances up to 50 feet (maybe 100 feet if the wind is right). Use standard RF wiring precautions and make coil L1 exactly as shown. Best speech clarity is obtained by using a crystal or ceramic mike. For music reproduction, substitute a dynamic mike element.

The unit can be assembled on a perfboard using push-in terminals for tie points. The case must be metal to prevent hand capacitance from continuously changing the output frequency. Pass the 6-in. solid wire antenna through the metal case using a ¼-in. hole and a matching rubber grommet for an insulator.

27 Remote Flash



PARTS LIST FOR REMOTE FLASH

Q1—300-V light-activated silicon-controlled rectifier (LASCR)
R1—47,000-ohm, ½-watt resistor

Even if you spend $18 or $20 for a super-duper professional remote flash tripper, you'll get little more than this two-component circuit. Price is important if the results are equal.

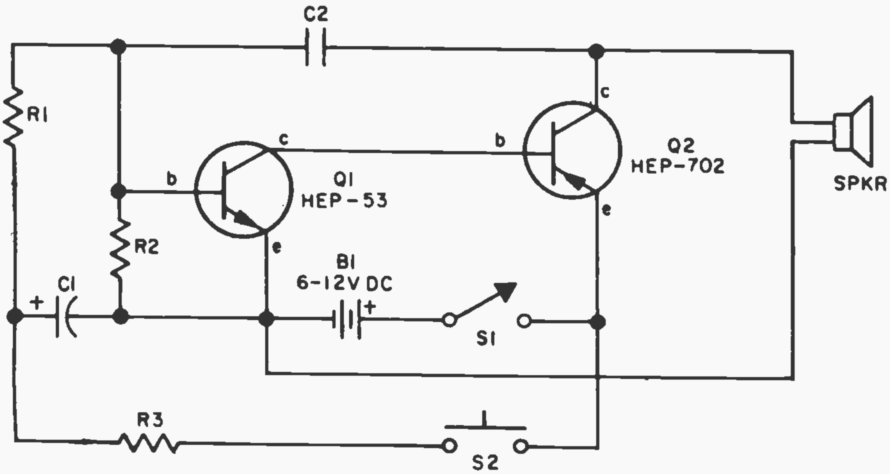
Transistor Q1 is a light-activated silicon-controlled rectifier (LASCR). The gate is tripped by light entering a small lens built into the top cap.

To operate, provide a 6-in. length of stiff wire for the anode and cathode connections and terminate the wires in a polarized power plug that matches the sync terminals on your electronic flashgun (strobelight). Make certain the anode lead connects to the *positive* sync terminal.

When using the device, bend the connecting wires so the LASCR lens faces the main flash. This will fire the remote unit.

No reset switch is needed. Voltage at the flash's sync terminals falls below the LASCR's holding voltage when the flash is fired, thereby turning off the LASCR.

28 Electronic Siren



A real screamer! Use a public-address type horn under the hood of your car and you'll punch a hole in the tightest traffic jam. (Be certain, of course, that you hold a position that entitles you to a siren.)

Press push-button switch S2 and the siren starts up, shifting to a higher frequency. Release it and the tone slides down until you send it up again by punching S2.

Adjustment of overall tone quality is made by changing C2's value. If the siren pulsates before the pushbutton switch is pressed, Q1 is too "leaky". Try a different transistor.

PARTS LIST FOR ELECTRONIC SIREN

B1—6-V or 12-V battery
C1—30-uF, 15-VDC electrolytic capacitor
C2—0.02-uF, 75-VDC capacitor
Q1—Motorola HEP-53 npn transistor
Q2—Motorola HEP-702 pnp transistor
R1, R2—56,000-ohm, ½-watt resistor
R3—27,000-ohm, ½-watt resistor
S1—Spst switch
S2—N.O. pushbutton switch
SPKR—8-ohm speaker or PA horn

29 Budget Lamp Dimmer

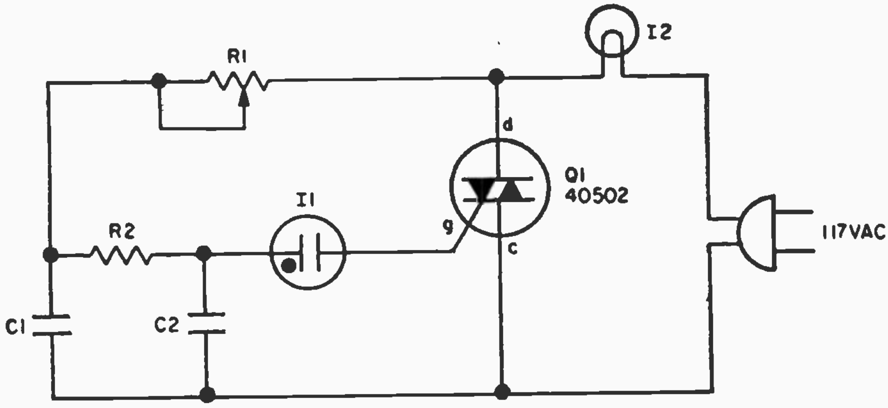
With miniature components and extreme care you can build a low power lamp dimmer right into a socket. Without a heat sink, Triac Q1 handles up to a 400-watt lamp.

Instead of a relatively expensive trigger diode, an ordinary neon lamp of the NE-83 or NE-2 variety can be used. (An NE-83 is treated for dark operation and will provide more consistent operation.)

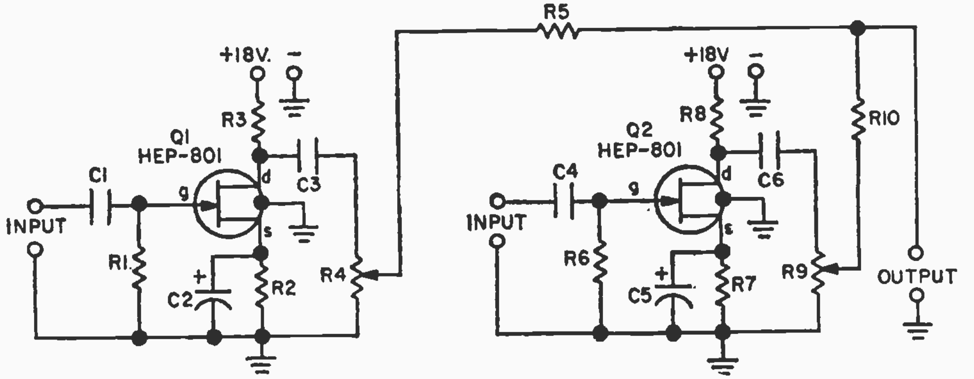
PARTS LIST FOR BUDGET LAMP DIMMER

C1, C2—0.068-uF, 200-VDC capacitor
I1—NE-83 or NE-2 neon lamp
I2—External lamp not to exceed 400 watts
Q1—RCA 40502 Triac
R1—50,000-ohm, potentiometer
R2—15,000-ohm, ½-watt resistor

Because the neon does not trip the gate until it conducts, the lamp turns on at medium brilliance. The lamp can then be backed off to a soft glow. Because the neon drops out when the applied voltage falls below the neon holding voltage of approximately 40V the lamp cannot be adjusted as low as it can with a diode trigger.



30 Super Mike Mixer



For serious recording of anything other than speech and sound effects, two mikes are always better than one. Our super 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.

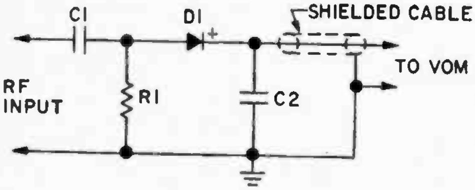
Using FET semiconductors with their *high input* impedance, this basic mixer can be used with high impedance crystal and ceramic microphones. It does not attenuate low frequency response whatsoever through low impedance loading of the microphone. The mixer's response is 10 to 20,000 Hertz.

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 SUPER MIKE MIXER

C1, C4—0.05-uF, 10-VDC capacitor
C2, C5—25-uF, 6-VDC electrolytic capacitor
C3, C6—0.1-uF, 25-VDC capacitor
Q1, Q2—Motorola HEP-801 FET transistor
R1, R6—2-megohm, ½-watt resistor
R2, R7—6800-ohm, ½-watt resistor
R3, R8—560-ohm, ½-watt resistor
R4, R9—500,000-ohm, audio taper potentiometer
R5, R10—100,000-ohm, ½-watt resistor

31 RF Probe for VOM



PARTS LIST FOR RF PROBE FOR VOM

C1—500-pF, 400-VDC capacitor
C2—0.001-uF, disc capacitor
D1—1N60 diode
R1—15,000-ohm, 1/2-watt resistor

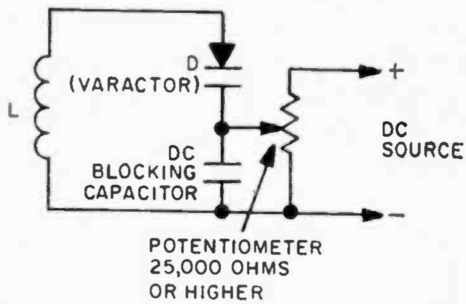
Assemble this accessory in a metal can, add a shielded cable and you'll make relative measurements of RF voltages to 200 MHz on a 20,000 ohms-per-volt multimeter. RF voltage must not exceed approximately 30V, the breakdown rating of the 1N60 diode.

32 Electronic Tuning

We can't assign specific values because each case is different. But here's how to use varactors for electronic tuning. The varactor is a diode whose capacitance between anode and cathode is determined by an applied voltage. If a varactor is substituted for a tuning capacitor in an LC resonant circuit, the tuned frequency is determined by the applied voltage.

L1 and D1 form an LC parallel resonant circuit. The DC blocking capacitor, which prevents the power supply from shorting to ground, must equal zero impedance at the tuned frequency; its reactance should be at least 20 times the maximum value of D1. In effect, the blocking capacitor is a short to an AC signal and the external circuit "sees" only L1 and D1.

The appropriate diode can be selected from catalogs which list the voltage capacity ratio for different varactors. No Parts List offered for this project because of its special application to a particular tuner and design consideration.



33 Appliance Tester

PARTS LIST FOR APPLIANCE TESTER

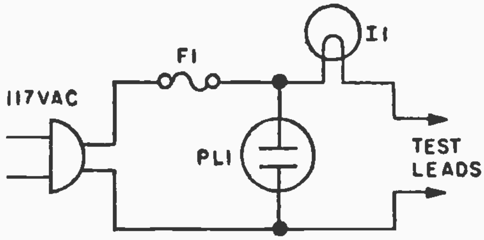
F1—Fuse to match load
I1—50-watt lamp
PL1—AC receptacle

A simple circuit consisting of a 50 watt lamp, fuse and power outlet is all that's needed to check out appliances such as toasters and electric coffee pots.

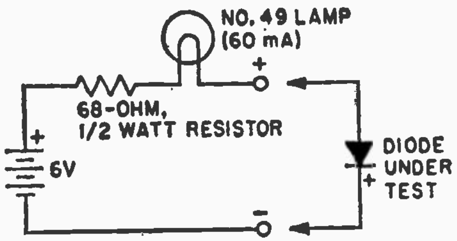
To check for opens, first plug the tester into a live outlet. Next, connect the test leads to the appliance's power cord; if the lamp lights the circuit is good (not open). Because the appliance is in series with the lamp the lamp may not light to full brilliance. You are only interested in whether the lamp lights at all—not the level of brilliance.

If you suspect there is a short from the appliance's motor or heating coil to the appliance frame which can cause a shock hazard, connect one test lead to the appliance frame and connect the other test lead first to one prong of the appliance's plug and then to the other prong. If the lamp lights with either connection there is a short to the frame. If the lamp fails to light at all, the appliance frame is safe.

After the repair is made try out the appliance by using the fused power outlet, PL1. This way, if the appliance is still defective it will blow fuse F1 rather than a fuse in the basement.



34 Low Voltage Diode Tester



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. Diodes such as the IN34 cannot be checked since test current is too high.

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

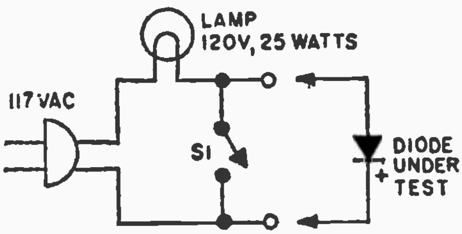
To test diodes rated under 60 mA, a lower current lamp must be substituted in the checker.

35 Silicon Rectifier Tester

This simple GO/NO-GO tester spots defective rectifier diodes before they are connected into a circuit. It is intended only for silicon rectifiers rated higher than 200 mA and indicates open and shorted conditions.

The lamp must be as specified: 120 V at 25 watts. Do not use a larger lamp or the diode might be destroyed.

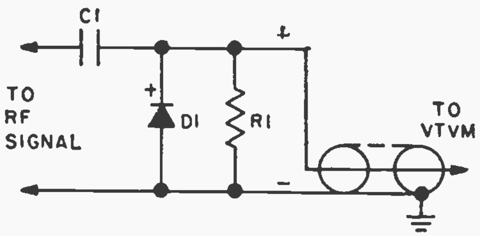
Close switch S1 to check the lamp by turning it on. Connect the diode both ways, opening S1 for the test. One way the lamp should go on; reversing the diode should cause the lamp to extinguish. If the lamp stays on in both directions, the diode is shorted. If the lamp stays out in both directions the diode is open.



36 RF Probe

PARTS LIST FOR RF PROBE
C1—50-pF disc capacitor
D1—1N60 diode
R1—20-megohm, ½-watt resistor

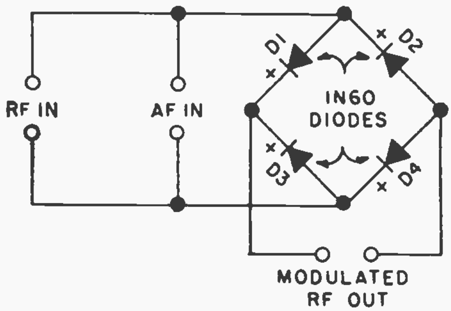
Three components are all that's needed to make a VTVM measure RF voltage up to 200 MHz (depending on the diode used). The probe should be built in a metal can with shielded wire for the connecting lead to the VTVM. Connect the shielded wire to the metal can and solder if possible. The diode rectifies the RF voltage, while the capacity of the shielded cable provides filtering. The output of the probe is positive, with the VTVM indicating the peak value of the RF waveform. To determine the RMS value, multiply the VTVM reading by 0.707. The maximum RF voltage that can be applied is limited by the diode. A 1N60 is limited to 30V peak RF voltage. For higher voltage-handling capacity, substitute a higher voltage small signal detector diode.



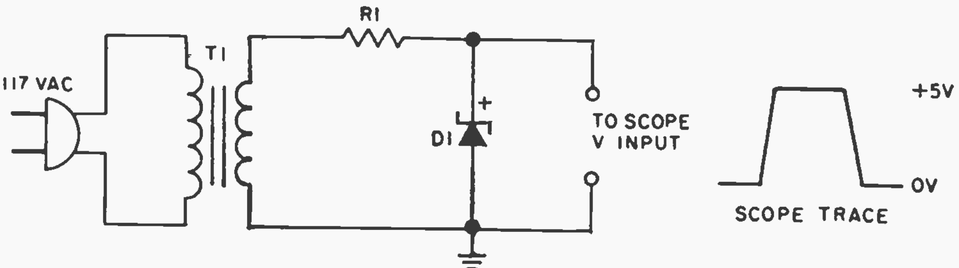
37 Signal Generator Modulator

Most RF signal generators have built-in 400 Hz modulation. This four-diode circuit allows you to modulate the signal with other audio-frequency tones.

Using an unmodulated RF output from the generator, set the audio generator's output level to approximately 1/10 that of the RF generator. The signal appearing at the modulated RF output terminals will be modulated approximately 30 percent by the audio (AF) signal.



38 Budget Scope Calibrator



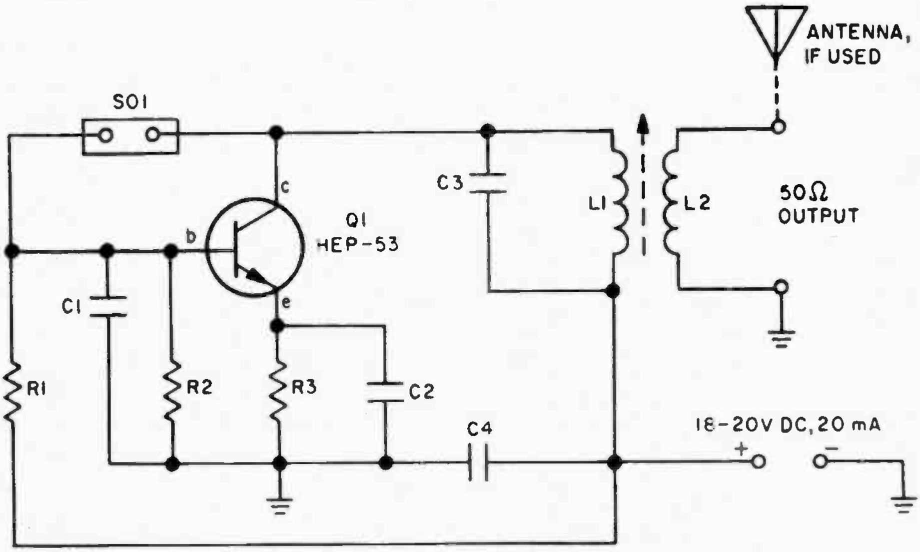
You can make accurate voltage measurements with your oscilloscope if you calibrate the vertical input with a Scope Calibrator.

When the top of zener diode D1 goes negative it conducts and voltage across the diode is essentially zero. When the voltage at the top of the zener goes positive, it builds until it reaches 5 V. At that point the diode conducts, dropping five volts across D1. The result is a square wave which varies from zero to +5 V, as shown. The scope's vertical input is connected across the diode and the vertical attenuator control is adjusted so the square wave exactly fills one vertical division. This provides a calibration of 5 V peak-to-peak per division. The scope's vertical attenuator then provides multiples of the calibration such as .5 V/div., 50 V/div., etc. Since calibrator output varies from zero volts it may be necessary to adjust the vertical centering when the scope's DC input is used.

PARTS LIST FOR BUDGET SCOPE CALIBRATOR

D1—5-V, ¼-watt Zener diode
R1—270-ohm, ½-watt resistor
T1—117 to 6.3 VAC filament transformer

39 Multipurpose CB Oscillator



Utilizing 27 MHz overtone crystals, this low power oscillator provides precise frequency markers for CB transceiver dial calibration or for general receiver alignment. It can also serve as the transmitter for a 27 MHz radio-control circuit for remote camera tripping, models and other devices.

Coils L1 and L2 are wound on a J. W. Miller 4400-3 coil form having a 20-50 MHz powdered iron slug. Attach the end of a piece of No. 22 enameled wire to the coil terminal nearest the mounting screw and wind 15 close-spaced turns. Push the bottom terminal against the coil and solder the coil's free end to the bottom terminal. Then wind coil L2, which consists of 2 turns of No. 18 enameled wire, over the bottom end of L1. Twist L2's wires together to secure L2. Finally, cover the entire coil with coil dope and allow to dry overnight.

Plug in an overtone crystal at socket SO1 and adjust the coil's slug for maximum output as indicated on a field strength meter or a receiver's S-meter. The crystal frequency can be slightly shifted by small misalignment of the coil slug.

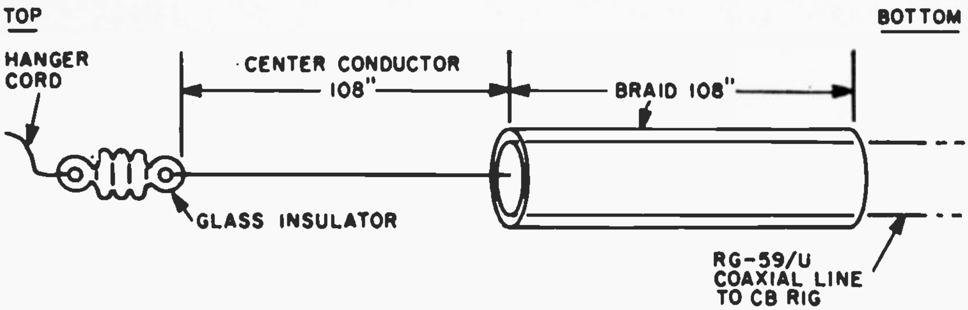
PARTS LIST FOR MULTIPURPOSE CB OSCILLATOR

C1—30-pF, 75-VDC disc capacitor
C2, C4—0.01-uF, 75-VDC disc capacitor
C3—22-pF, 100-VDC silver mica capacitor
L1—15 turns #22 enamel wire close-wound on 3/8-in. powdered iron slug form (J.W. Miller 4400-3)
L2—2 turns #18 enamel wire over cold end of L1
Q1—Motorola HEP-53 npn transistor
R1—10,000-ohm, 1/2-watt resistor
R2—680-ohm, 1/2-watt resistor
R3—180-ohm, 1/2-watt resistor
SO1—Crystal socket to match Xtal pins

40 Portable CB Antenna

A large antenna always beats the small one, so why use a dinky loaded whip for portable work? Make your own coaxial antenna from a length of RG-59U coaxial cable.

Cut away the outer insulation for 108 inches and fold the shield braid back along the cable. Attach a glass or ceramic insulator to the end of the center conductor and hang the antenna from a tree, roof, pole or window. Attach the lower end of the cable to your transceiver. Keep away from metal poles and buildings.



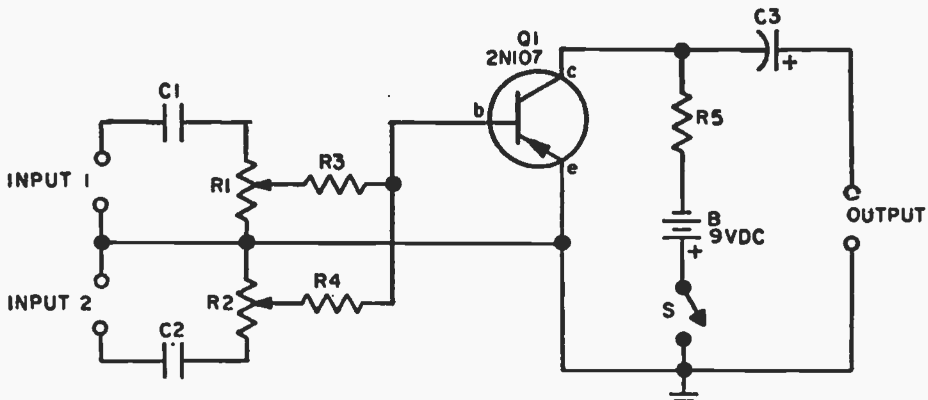
41 Junk Box Mike Mixer

Using components often found in an experimenter's junk box, this two-channel mike mixer handles high impedance or dynamic microphones. Level controls R1 and R2 should not be run wide open with hi-Z mikes since the input impedance then becomes the value of R3 and R4, or 100,000 ohms. If a hi-Z mike is loaded by less than 1 megohm, the low frequency response of the mike is attenuated.

Transistor Q1 can be almost any general purpose type such as the 2N107 or 2N217. However, the better the transistor, the better the signal-to-noise ratio. Top quality high-gain transistors should not be used since relatively high leakage current of experimenter-grade transistors provides the base bias current. Transistors with low leakage might produce high distortion because of low "internal" base bias.

PARTS LIST FOR JUNK BOX MIKE MIXER

B1—9-V battery
C1, C2—0.1-uF, 6-VDC capacitor
C3—10-uF, 15-VDC electrolytic capacitor
Q1—Pnp general purpose transistor, 2N107, 2N109, 2N217, etc.
R1, R2—2-megohm audio taper potentiometer
R3, R4—100,000-ohm, ½-watt resistor
R5—15,000-ohm, ½-watt resistor
S1—Spst switch

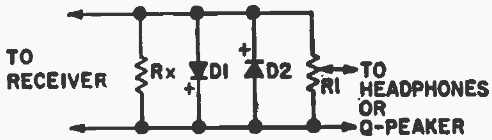


42 Headphone Limiter

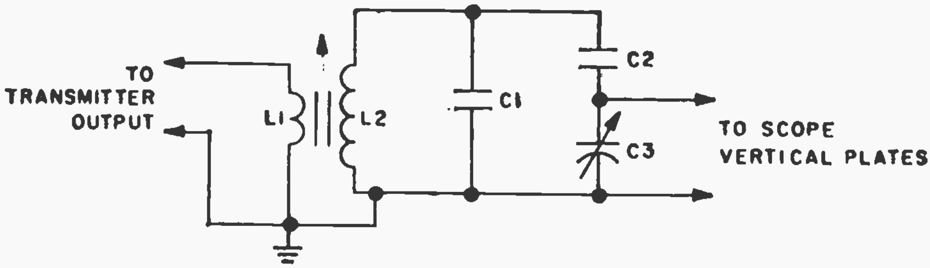
Most receivers don't provide automatic volume control on code reception. Thus a CW signal that blows your headphones off one moment might lie buried on the threshold of hearing the next. The Headphone Limiter chops those S9-100 signals down to size until they equalize with weaker signals, giving relatively constant headphone volume. Because the clipping action produces some distortion, the limiter should feed a headphone Q-peaker (described in another circuit). The value of Rx should match the existing speaker impedance and power. In most cases this will be equal to 4 ohms at 2-5 watts.

PARTS LIST FOR HEADPHONE LIMITER

D1, D2—1N60 diode
R1—5000-ohm audio taper potentiometer
Rx—See text



43 CB Imp Match



PARTS LIST FOR CB IMP MATCH

C1, C2—5pF silver mica capacitor
C3—45-pF trimmer capacitor
L1—3 turns #22 solid, plastic-insulated wire, adjacent to ground end of L2
L2—4 turns #18 enameled wire, centered on form
1—3/8-in. RF slug-tuned coil form (Lafayette 34E89135 or equiv.)

Critical inspection of a transmitter signal and accurate measurement of modulation is possible only with an oscilloscope. Unfortunately, a CB transmitter's RF output is so low the scope pattern is barely discernible—unless you use this booster. Since a scope's vertical plate connections operate at a high input voltage, it requires that a CB transmitter's output be fed to a parallel resonant circuit to step up to high RF voltage. The circuit shown will just about fill a 5-in. scope from edge to edge with virtually no loss at the transmitter.

First, wind L2 on the center of a 3/8-in. slug-tuned form. Then wind L1 adjacent to the ground end of L2. Connect L1 across the transmitter output with the CB antenna system also connected.

Adjust L1's slug for minimum standing-wave ratio (SWR). If the coil is correctly made, there should be no change in the antenna system's SWR Adjust C3 for the desired scope trace height; it may be necessary to reset L1 each time C3 is adjusted.

Note that you must use your scope's vertical *plate* connection. The RF signal can't travel through the vertical amplifier unless your scope happens to cost a kilobuck or more.

44 CB Xmission Line Monitor

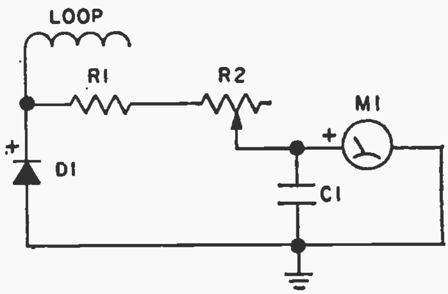
This monitor "steals" an insignificant amount of power, yet keeps constant watch on a CB rig's RF output. If a failing tube starts to drop the output, the line monitor immediaely lets you know it.

The device can be built in a separate metal cabinet or customized into the transceiver's cabinet.

Wiring between D1, R1, R2, and C1 must be as short as possible. The loop consists of four or five turns of insulated, solid hook-up wire wrapped around an exposed part of the output coax cable. Remove a part of the shield at a point near the RF output jack, for example. An alternate pickup is about 6 in. of wire slipped under the coax shield. If the shield is broken, solder a heavy copper wire to join the broken ends to avoid messing up your antenna's transmission line.
Vary the number of turns in the loop to secure approximately half-scale meter indication. Potentiometer R1 serves as a coarse sensitivity control.

PARTS LIST FOR CB TRANSMISSION LINE MONITOR

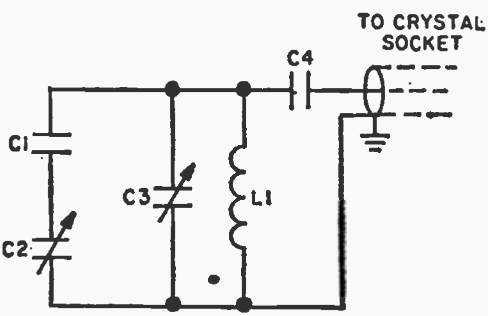
C1—0.001-uF, 100-VDC disc capacitor
D1—1N60 diode
M1—0-1 mA DC meter
R1—1500-ohm, ½-watt resistor
R2—10,000-ohm potentiometer



45 CB Tuning Adapter

PARTS LIST FOR CB TUNING ADAPTER

C1—10-pF silver mica capacitor
C2—17.5-pF trimmer capacitor
C3—30-pF variable capacitor
C4—47-pF, 100-VDC disc capacitor
L1—Coil, 5 turns #16 enameled wire wound on 1-in. dia. form. Spaced 1 in. end to end



A crystal-controlled CB rig with overtone crystals and an IF of 1300 to 1500 kHz can be converted to full 23-channel tuning with this adapter. It works on circuits where the crystal connects from oscillator grid to ground.
Use a 1-in. wood dowel for L1's form. Wind the coil as tightly as possible and stretch it to a length of 1 inch. Connection is made to the transceiver with the shortest possible length of RG-58A/U coaxial cable. The shield connects to the transceiver's chassis and to the bottom end of L1.
Set C3 so its plates are fully closed, then adjust C2 until channel 1 is received. Depending on the IF frequency, C3 might tune slightly more or less than the full band. If so, change C1's value very slightly to obtain only 23-channel coverage with C3. Making C1 smaller narrows the tuning range.

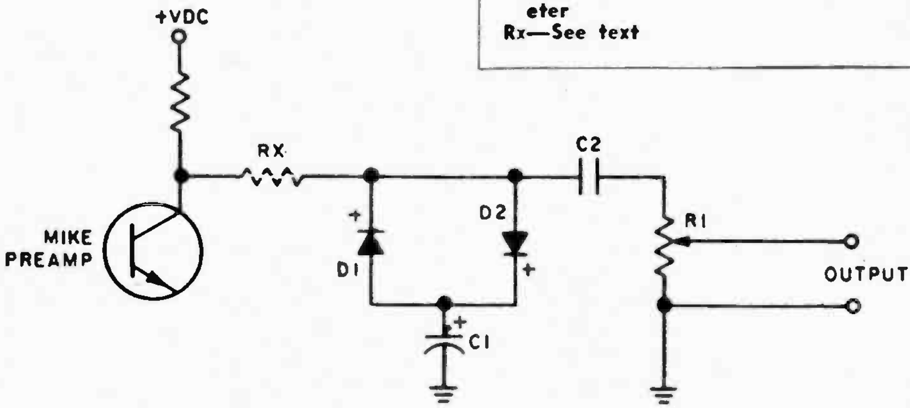
46 Speech Clipper

An effective speech 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 producing overmodulation 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

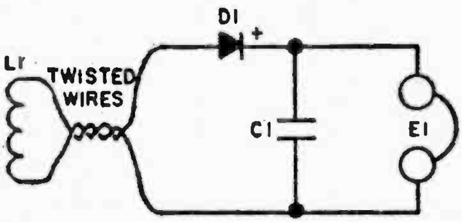
negative supply, reverse C1's polarity. The output level to the rest of the amplifier is determined by R1. If the diodes cause distortion in the preamplifier, add resistor Rx, as shown. Use the necessary value between 1000 and 10,000 ohms.

PARTS LIST FOR SPEECH CLIPPER

C1—100-uF electrolytic capacitor (see text)
C2—0.1-uF capacitor
D1, D2—1N60 diode
R1—25,000-ohm, audio taper potentiometer
Rx—See text



47 Modulation Monitor



This simple modulation 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.

PARTS LIST FOR MODULATION MONITOR

C1—100-pF disc capacitor
D1—1N60 diode
E1—Magnetic headphone, 2000 ohms or better
L1—Coil, 3 turns on 1½-in. dia. form, use any thin gauge wire

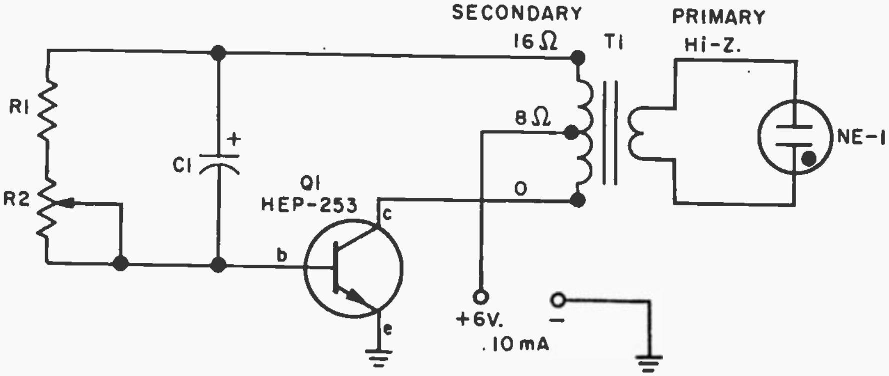
48 Mini-Drain Pilot Lamp

PARTS LIST FOR MINI-DRAIN PILOT LAMP

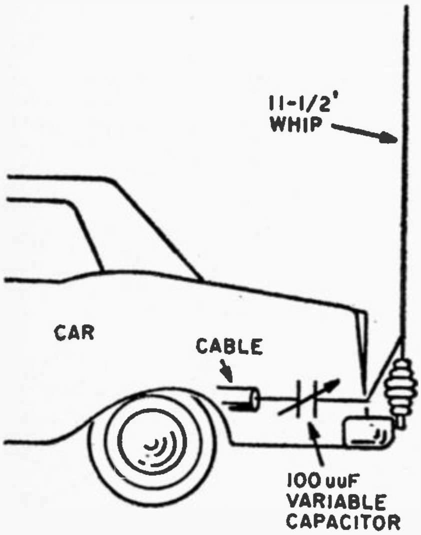
C1—3-uF, 25-VDC capacitor
I1—NE-2 neon lamp
Q1—Motorola HEP-253 pnp transistor
R1—100,000-ohm, ½-watt resistor
R2—250,000-ohm, potentiometer
T1—Miniature center-tapped transistor audio transformer; primary 4000-ohm to 8-16-ohm secondary

Need a pilot light for portable equipment that won't burn up batteries in minutes? Then try high frequency for the answer. Here's how it works: Q1 serves as a blocking oscillator with the frequency determined by R1-R2 and C1. The collector of Q1 connects to T1's common (O) terminal, the power source to the 8-ohm terminal and R1-C1 to the 16-ohm terminal. Note that in this circuit the usual primary and secondary transformer windings are shown in reverse position. It's because the transformer is being used backwards. The neon lamp connects to the high-impedance winding of T1. If the primary is center-tapped, ignore the tap.

As Q1 oscillates at AF frequency, voltage from Q1's collector to the power supply is stepped up many times and becomes a high-voltage low-current source for the neon lamp. Adjust R2 so the frequency is high enough to keep the lamp constantly lit. If you want a warning device, potentiometer R2 can be adjusted so the neon lamp blinks *on and off* at a rapid rate.



49 Zip Whip CB Antenna



The average 108-in. CB bumper or fender-mounted whip is nowhere near the desired 52 ohms impedance. An improved transmission line match and lower angle of radiation (and more gain) are obtained by using an 11½-ft. extended whip. The extended whip, however, isn't resonant on the CB band and must be electrically shortened. It's done by connecting a small variable capacitor between the bottom of the antenna and the coax cable center conductor. Adjust the capacitor for lowest SWR reading.

50 Light Flasher

If a light blinks and winks someone will stop and look—and that's the purpose behind this attention-grabber.

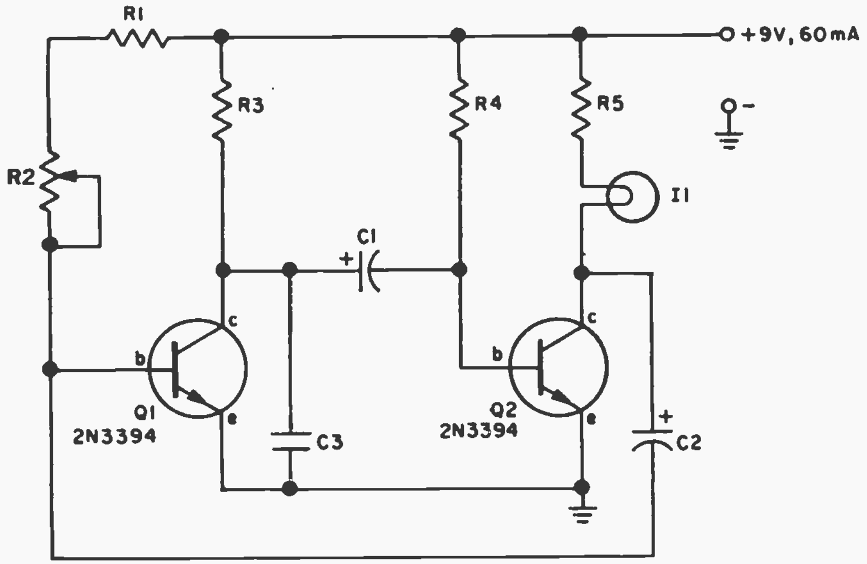
When power is first applied, current flows through Q2 and lamp L1 lights. Then, feedback through capacitor C2 causes Q1 to conduct. As C1 discharges through Q2's base, Q2 is turned off, thereby extinguishing the lamp. When C1's voltage equalizes, Q2 turns on again and the cycle is repeated

. . . flip-flop, flip-flop. Potentiometer R2 determines the flip-flop rate, hence, the blink rate.

"Junk box" pnp transistors (instead of npn types) can be substituted if polarity is reversed at the battery, C1 and C2.

PARTS LIST FOR LIGHT FLASHER

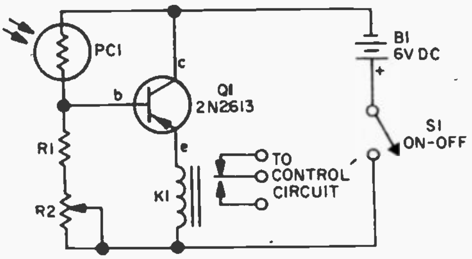
C1—10-uF, 15-VDC electrolytic capacitor
C2—30-uF, 15-VDC electrolytic capacitor
C3—0.2-uF, 25-VDC capacitor
I1—No. 49 panel lamp
Q1, Q2—2N3394 npn transistor
R1—4700-ohm, ½-watt resistor
R2—1-megohm potentiometer
R3, R4—10,000-ohm, ½-watt resistor
R5—120-ohm, ½-watt resistor



51 Candle Power Control

PARTS LIST FOR CANDLE POWER CONTROL

B1—6-V battery
K1—1000-ohm, 2-3 mA sensitive relay
PC1—RCA 4425 photocell
Q1—2N2613 pnp transistor
R1—120-ohm, ½-watt resistor
R2—5000-ohm potentiometer
S1—Spst switch



With only a handful of low-cost components this photo relay turns a light on or off according general room illumination.

Q1 can be any general purpose pnp transistor of the 2N109 or 2N217 variety, though greater sensitivity is obtained with the 2N2613 type. Relay K1 is a high-sensitivity type like the Sigmas used by model radio control hobbyists.

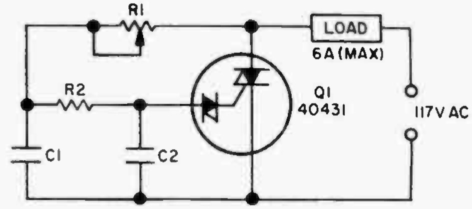
Potentiometer R2, part of a voltage divider consisting of photocell PC1, R1 and R2, is set so that with normal illumination falling on PC1 the base bias current (through PC1) is just below the value needed to generate the collector-emitter current required to activate relay K1. When additional light falls on PC1, photocell resistance decreases, thereby increasing the base bias, which causes greater collector current to flow and the relay closes.

This circuit can be controlled by sunlight so K1 drops out at dusk to turn on a night light. Or use a flashlight to trip K1 for "killing" TV commercials by shorting the TV speaker connections.

52 Motor Speed Control

PARTS LIST FOR MOTOR SPEED CONTROL

C1, C2—0.1-uF, 200-VDC capacitor
G1—RCA 40431 Triac-Diac
R1—100,000-ohm linear taper potentiometer
R2—10,000-ohm, 1-watt resistor



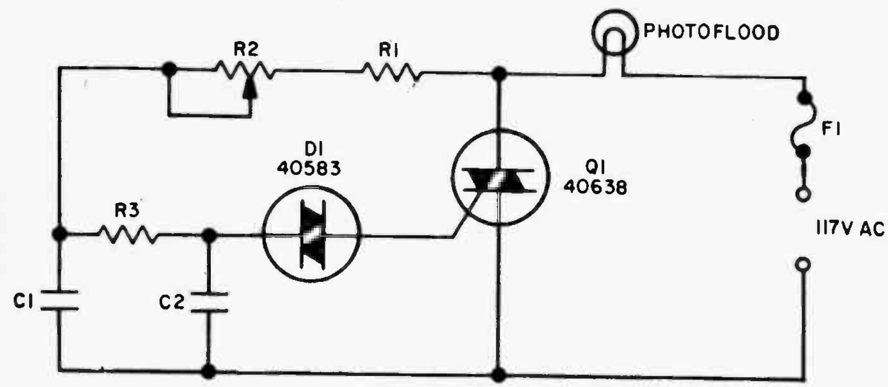
Old universal appliance motors and shaded-pole induction motors salvaged from inexpensive turntables can be easily converted to slow-speed hobby drills, chemical stirrers, vari-speed turntables movable display drives, etc. It's done with a full-wave Triac speed controller.

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 provided with a heat sink, which can be the metal cabinet. Build up a marble-size 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*.

53 Photoflood Dimmer



All the flexibility of a professional photo studio's variable lighting can be yours with this 500-watt lamp dimmer.

Triac Q1 is supplied with a heat sink which must, in turn, be connected to a larger heat sink. The entire unit is assembled in a metal cabinet with Q1's heat sink epoxy-cemented to the cabinet for heat dissipation.

Fusing must be employed. Otherwise, the surge current when 500-watt photo lamps burn out will instantly destroy Q1. Connect an 8AG (fast-action) 5-ampere fuse in series with the lamp or any other fuse of equal action, or faster. In this circuit 3AG fuses cannot be used. Potentiometer R2 will adjust the lamp's intensity from full *off* to essentially 100% full *on*.

PARTS LIST FOR PHOTOFLOOD DIMMER

C1, C2—0.01-uF, 300-VDC capacitor
D1—RCA 40583 Diac
F1—Fuse, type 8AG, 5A
Q1—RCA 40638 Triac
R1—1000-ohm, ½-watt resistor
R2—100,000-ohm linear taper potentiometer
R3—15,000-ohm, ½-watt resistor

54 VU Meter with Boost

PARTS LIST FOR VU METER WITH BOOST

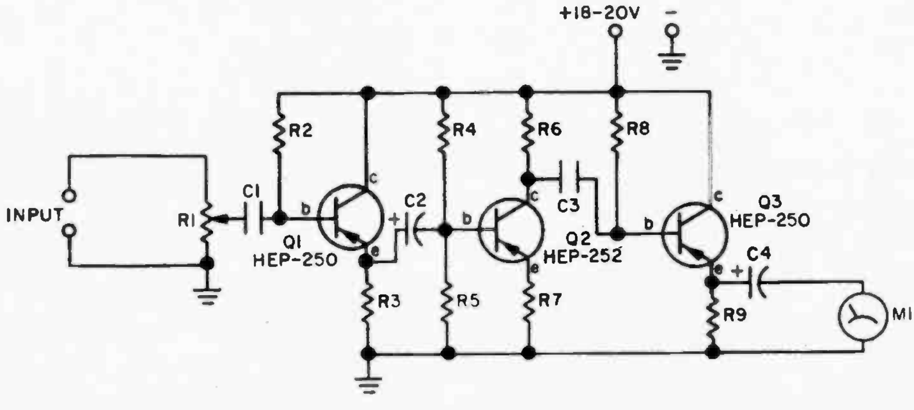
C1, C3—0.1-uF, 25-V capacitor
C2—10-uF, 15-V electrolytic capacitor
C4—30-uF, 15-V electrolytic capacitor
M1—VU meter
Q1, Q3—Motorola HEP-250 pnp transistor
Q2—Motorola HEP-252 pnp transistor
R1—1-megohm, audio taper potentiometer
R2, R8—470,000-ohm, ½-watt resistor
R3, R9—4700-ohm, ½-watt resistor
R4—120,000-ohm, ½-watt resistor
R5, R6—10,000-ohm, ½-watt resistor
R7—1500-ohm, ½-watt resistor

You can ride gain on audio signals, just as the *pros* do, with an amplified VU (Volume Unit) meter.

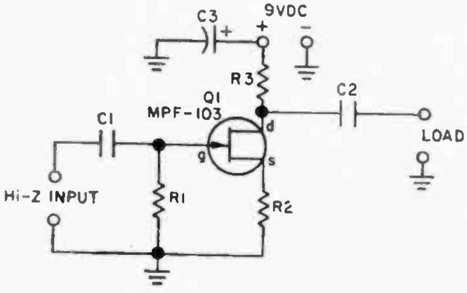
The circuit shown can produce VU readings almost down to microphone levels. Input level (sensitivity) control R1 allows the meter to be used, too, with high level audio signals.

Transistor Q1 is an emitter follower that presents a high impedance to the input terminals (through R1). Q2 is a voltage amplifier and Q3 is an emitter follower to match Q2's medium collector impedance to the relatively low meter impedance. Meter M1 can be any VU meter; an inexpensive miniature or a professional model. It's powered by two series-connected 2U6 type 9V batteries.

The amplified meter can also serve as a test instrument. Its high sensitivity can trace audio signals from the output of a magnetic pickup to an amplifier's power output or speaker terminals. It can also be used to plot the effects of tone control and equalizer circuits.



55 Mike Power



PARTS LIST FOR MIKE POWER

C1, C2—0.05-uF, 25-VDC capacitor
C3—100-uF, 15-VDC electrolytic capacitor
Q1—Motorola MPF-103 FET transistor
R1—2-megohm, ½-watt resistor
R2—3300-ohm, ½-watt resistor
R3—10,000-ohm, ½-watt resistor

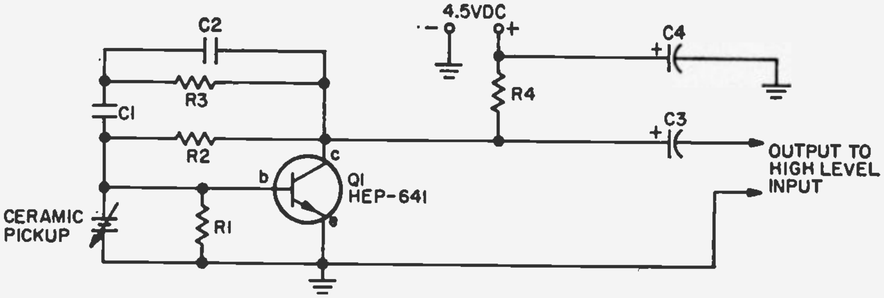
Approximately 10 dB of extra microphone amplification for CB and ham transmitters, tape recorders and PA amplifiers is provided by the field effect transistor. Since an FET's input is many megohms, the amplifier's input impedance is determined by gate resistor R1, which is 2 megohms. It's a suitable load for high impedance crystal and ceramic microphones.

The amplifier is "flat" from 20 to 20,000 Hz. Low frequency response can be attenuated for communications use by reducing the value of C2 to one half.

Power supply by-pass capacitor C4 must be used regardless of whether the voltage supply is a rectifier or battery. If C4 is not used there might be severe low frequency attenuation, sharply reduced gain or instability.

The amplifier's output can be connected to any load of 50,000 ohms or greater, which includes just about every piece of equipment except those specifically designed for low impedance microphones.

56 Ceramic Pickup Preamp



Because of record equalization and the characteristics of a ceramic pickup, its sound, when fed to a "flat" amplifier, can be lacking in lows. Some sort of equalization is needed when feeding the pickup to, say, a PA or tape recorder auxiliary amplifier.

This one-transistor preamp provides proper equalization for modern ceramic pickups and amplification to allow direct connection to all high level inputs on amplifiers or tape recorders. Equalization is accomplished through low impedance loading of the pickup by R1 and Q1's input impedance, and the C1/C2/R3 equalizer. Changes in equalization are obtained by adjustment of the C1/C2/R3 network. Do not change R2 for equalization, but it can be varied for a bias adjustment to accommodate other transistor types.

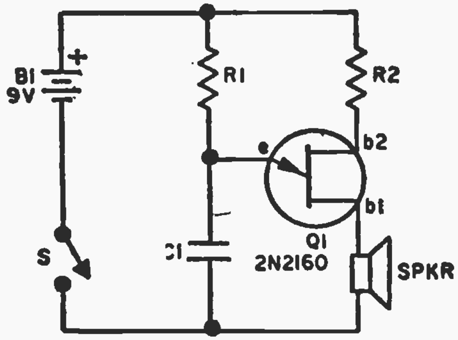
PARTS LIST FOR CERAMIC PICKUP PREAMP

- C1—0.01-uF, 10-VDC capacitor
- C2—3300-pF, 100-VDC capacitor
- C3—0.05-uF for tube amp; 10-uF, 10-VDC electrolytic capacitor for transistor amp
- C4—30-uF, 6-VDC capacitor
- Q1—Motorola HEP-641 npn transistor
- R1—10,000-ohm, ½-watt resistor
- R2—220,000-ohm, ½-watt resistor
- R3—33,000-ohm, ½-watt resistor
- R4—4700-ohm, ½-watt resistor

57 Mike Beeper

You can always feed an audio generator into a mike input to check an AF system, but how do you check the mike? Saying "woof, woof, *hello, test*" gets mighty tiring. Instead, clamp the Mike Beeper to the front of the mike with a rubber band and you'll send continuous tone *through the mike*. It lets you take your time checking the mike, connecting cable, jacks, amplifiers, etc.

The beeper can be built in a small plastic case—nothing is critical. The speaker may be any size from one to three inches.



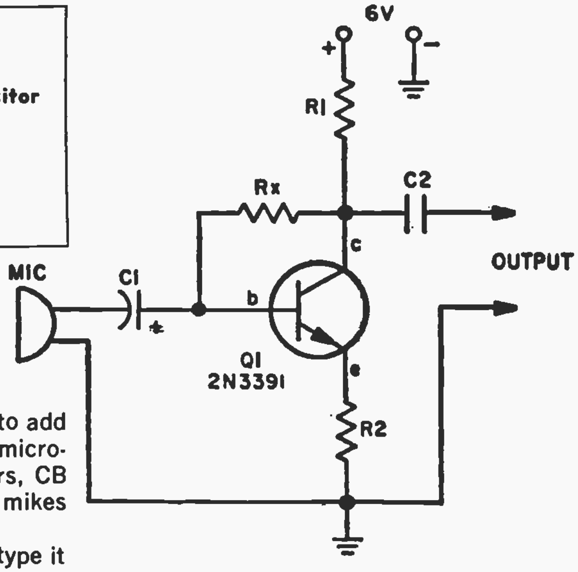
PARTS LIST FOR MIKE BEEPER

B1—Type 216 9-V battery
C1—0.1-uF, 10-VDC capacitor
Q1—2N2160 unijunction transistor
R1—10,000-ohm, ½-watt resistor
R2—47-ohm, ½-watt resistor
S1—Spst switch
Spkr—3.2 or 8-ohm miniature speaker

58 Low-Z Mike Preamp

PARTS LIST FOR LOW-Z MIKE PREAMP

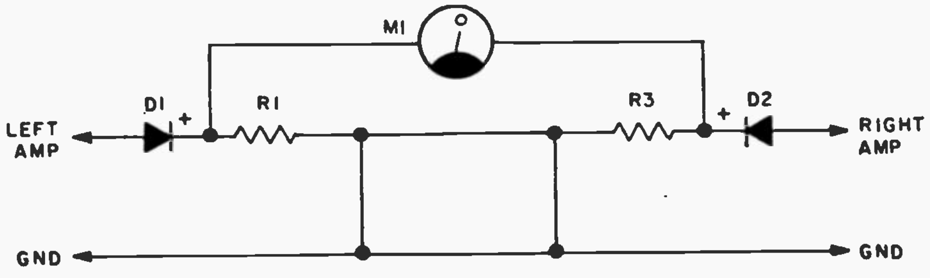
C1—10-uF, 15-VDC electrolytic capacitor
C2—0.47-uF capacitor
Q1—2N3391 npn transistor
R1—10,000-ohm, ½-watt resistor
R2—15-ohm, ½-watt resistor
RX—See text



Just a handful of parts is all it takes to add up to 30 db gain for low-impedance microphone inputs found on tape recorders, CB rigs, etc. The circuit is suitable for mikes in the 50- to 1000-ohm range.

Because transistor Q1 is a high-gain type it is very sensitive to slight changes in base bias. Hence, bias resistor Rx must be tailored for each transistor. Temporarily connect a 2 megohm potentiometer in place of Rx and adjust the pot until the collector to ground voltage is 3V. Measure the pot's resistance and substitute a fixed resistor(s) within 10% of the measured value.

59 Stereo Balancer



It looks ridiculously simple, but this instrument will give you precise volume and tone control balance between left and right stereo amplifiers.

For maximum convenience, the meter is a zero-center type. Resistors should be at least five percent and the diodes a matched pair. Note that the lead for each side that goes directly to the meter is connected, between the junctions of D1/R1 and D2/R3.

Optimum stereo level and phase balance occurs for matched speakers when the meter indicates "0". If the meter indicates either side of zero, the levels are not matched or the wires are incorrectly phased. Check in correct phasing by making certain the meter leads are connected to the amplifier "hot" terminals.

An ordinary 0-1 mA DC meter can be substituted. You adjust for zero reading, but keep in mind that the meter pointer can be driven in the reverse direction off-scale. Use only as much amplifier power as necessary for a visible meter indication.

PARTS LIST FOR STEREO BALANCER

D1, D2—1N60 diode
M1—1-0-1 mA DC meter, zero center
R1, R3—560-ohm, ½-watt resistor, 5%

60 CB Modulation Meter

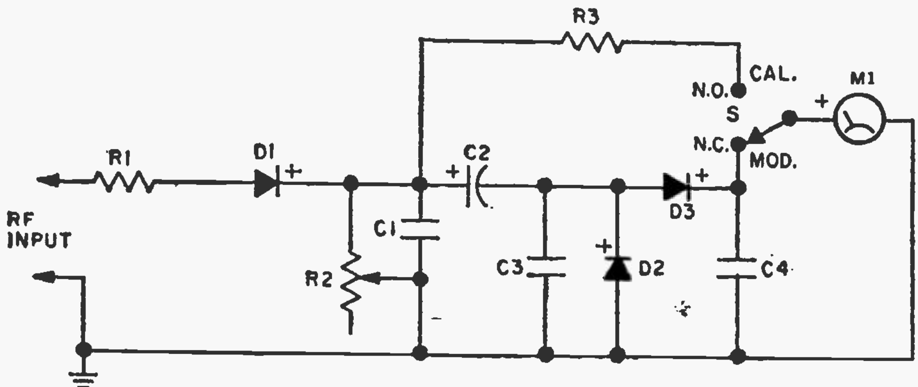
PARTS LIST FOR CB MODULATION METER

C1—500-pF, 100-VDC capacitor
C2—10-uF, 10-VDC electrolytic capacitor
C3—200-pF, 100-VDC capacitor
C4—300-pF, 100-VDC capacitor
D1, D2, D3—1N60 diode
M1—0-1 mA DC high-speed meter
R1—560-ohm, ½-watt resistor
R2—1000-ohm potentiometer
R3—910-ohm, ½-watt resistor, 5%
S1—Spdt spring-return switch

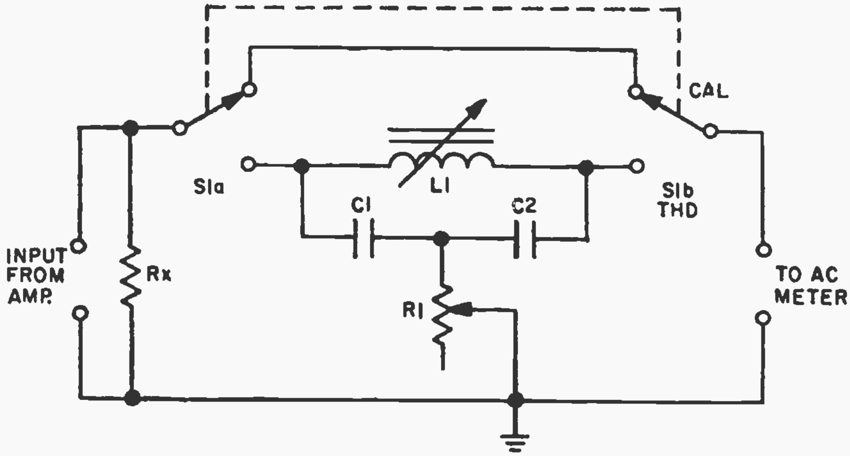
You can measure CB audio modulation percentage with the accuracy of the local broadcast station—'cause you'll be using the same type system.

In building the circuit, keep R1, D1 and R2's leads as short as possible. Meter M1 must be a high-speed model, such as the Alco P-1000 series. Connect the meter across the transceiver's RF output with a coaxial T-connector in the transmission line. As you key the transmitter, set switch S1 to *calibrate* and adjust R2 for a full scale reading. Accuracy will be within 10%.

Better accuracy is assured if R2's adjustment and meter calibrating point is compared against a scope modulation pattern. Don't compare this meter against commercial CB modulation meters. On a tone signal, this one is less accurate, but on speech modulation, the commercial models are not as accurate as a circuit of this type.



61 Audio Distortion Meter



This 1-kHz distortion meter is extremely accurate and is handy for measuring the distortion of power amplifiers.

Resistor Rx is the load resistor for the amplifier; 4, 8 or 16 ohms at the appropriate power rating. The AC meter can be an AC-VTVM or a 20,000 ohms volt VOM. Adjust the amplifier for the desired power output, set switch S1 to the calibrate position and note the meter reading. Set S1 to the THD (Total Harmonic Distortion) position and adjust both coil L and resistor R for the *minimum* meter reading.

The percent harmonic distortion is equal to the *minimum* reading divided by the *calibrate* reading x 100.

The circuit works by filtering out the 1-kHz fundamental signal with the L1/C1/C2/R1 T-notch filter. What's left is the harmonic content.

PARTS LIST FOR AUDIO DISTORTION METER

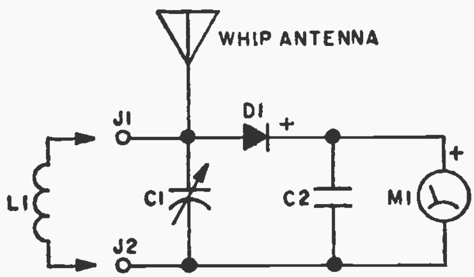
C1, C2—0.01-uF, 100-VDC capacitor, 5%
L1—UTC VC-15 variable inductor
R1—250,000-ohm potentiometer
Rx—Amplifier load resistor (see text)
S1—Dpdt switch

62 Field Strength Meter

High sensitivity without amplification is obtained when a field strength meter (FSM) is tuned to its operating frequency. With a *poly*-type miniature capacitor for C1, the FSM can be built in a pocket-size cabinet.

Tuning range is from 1.5 to 144 MHz, depending on the choice of coil L1. The coil can use phone tip jacks for a plug-in connection for band changing. Consult any coil table for L1's winding data since coil construction depends on the type of wire and frequency.

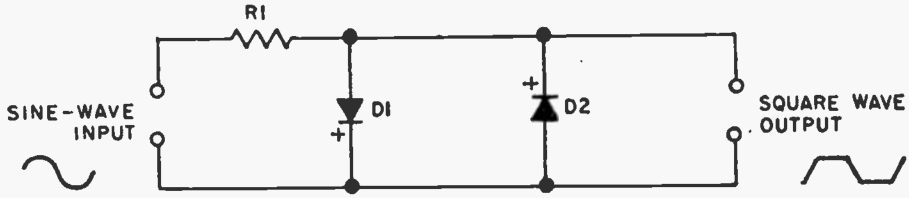
Even greater sensitivity is obtained if a more sensitive meter is used. A 50-uA meter, M1, provides maximum sensitivity combined with reasonably rugged construction.



PARTS LIST FOR FSM

C1—365-pF variable capacitor
C2—.005-uF, 100-VDC capacitor
D1—1N60 diode
J1, J2—Phone tip jack
J1—Coil (see text)
M1—0-1 mA DC meter

63 Sine Wave Squarer



Two reverse-parallel diodes of the germanium type provide an emergency square wave generator. Since a germanium diode has an approximate 0.2 V breakover, any sine wave applied to the diodes will be clipped at 0.2 V. It provides a 0.4 peak-to-peak square wave. It's not perfect since the "rise" of the original sine-wave is still present, as shown in the waveform.

To prevent loading and possible distortion of the sine wave input a 1000-ohm resistor should be connected between the squarer and the generator.

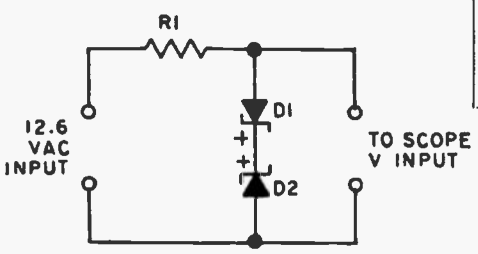
PARTS LIST FOR SINE WAVE SQUARER
D1, D2—Germanium diode (almost any type)
R1—1000-ohm, ½-watt resistor

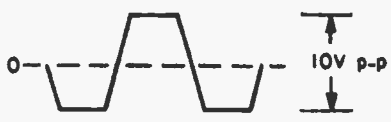
64 Scope Calibrator

Back-to-back zener diodes provide a scope calibrator with a zero reference output. Whether the calibration voltage is fed to a scope's AC or DC input, the baseline will not have to be readjusted.

When the top of D1 goes positive D1 conducts current through to the D2 cathode. The voltage across D2 builds until 5 V is reached and the output waveform is 5 V positive. The reverse action takes place when the top of D1 goes negative, providing an output waveform of 5 V negative. The total result is a 10 V peak-to-peak square wave to calibrate the scope face.

PARTS LIST FOR ZERO REFERENCE SCOPE CALIBRATOR
D1, D2—5-V, ¼-watt Zener diode
R1—270-ohm, ½-watt resistor





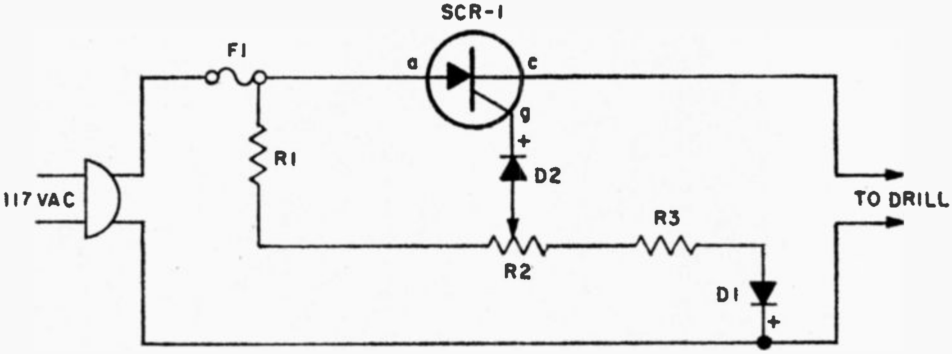
65 Uni-Torque Speed Control

PARTS LIST FOR UNI-TORQUE SPEED CONTROL
D1, D2—500-mA, 200 PIV silicon rectifier
F1—3-A "Slo-blo" fuse
R1—2500-ohm, 5-watt resistor
R2—250-ohm, 4-watt potentiometer
R3—33-ohm, ½-watt resistor
SCR1—3-A, 200-PIV silicon controlled rectifier

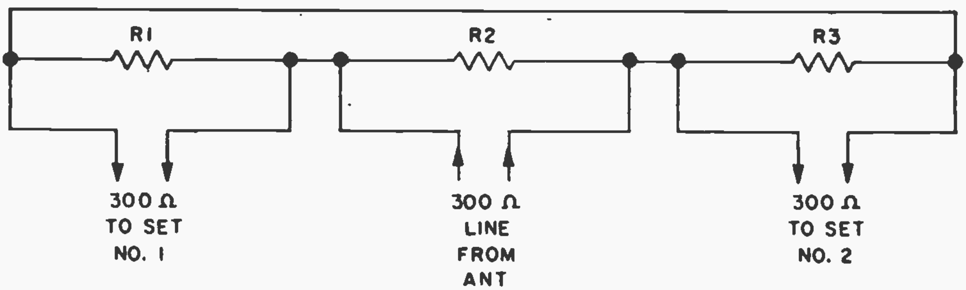
As the speed of an electric drill is decreased by loading, its torque also drops. A compensating speed control like this one puts the oomph back into the motor.

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.



66 Two-Set TV Coupler



Direct connection of two TV sets to the same antenna can produce severe ghosting and color degradation. For best results, the two sets must have their inputs electrically isolated from each other. You can do it with this three-resistor two-set coupler. Since there's a small signal loss in the splitting process, signals should be moderately strong, with little or no snow visible.

PARTS LIST FOR TWO-SET TV COUPLER

R1, R2, R3—910-ohm, ½-watt resistor
Misc.—Lengths of 300-ohm twinlead, perfboard

67 OTL Amplifier

OTL means "Output Transformer-Less." So right off the bat you save $3 on the cost of this 2-watt amplifier. Not to mention wide frequency response since there's no transformer to lop off lows and highs.

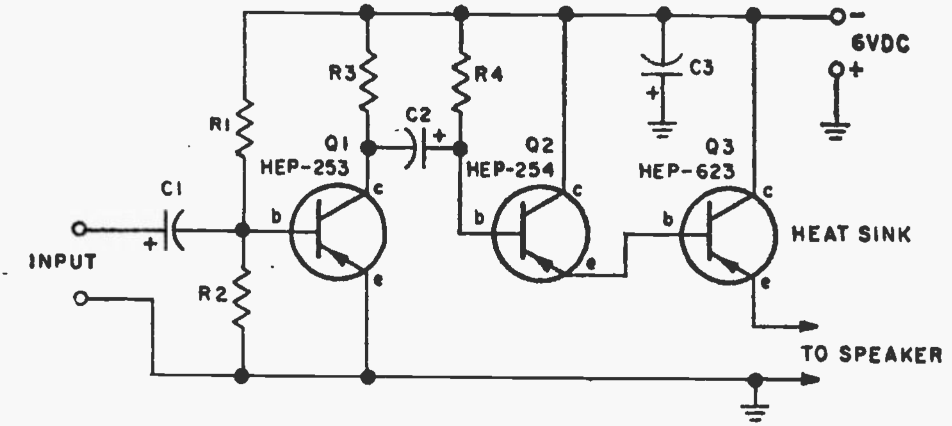
The amplifier should be mounted in a metal cabinet with the cabinet serving as Q3's heat sink. Make certain an insulator is used between transistor Q3's case—the collector connection—and the cabinet. Insure proper heat transfer through the insulator by smearing a bit of silicon transistor grease on both sides of the insulator. You can use a 4-, 8-, or 16-ohm speaker with the amplifier, though the power output will be lower as the impedance increases.

Because of transistor differences there might be excessive distortion. If this occurs, alter R4's value slightly (not more than 50,000 ohms) until distortion is reduced.

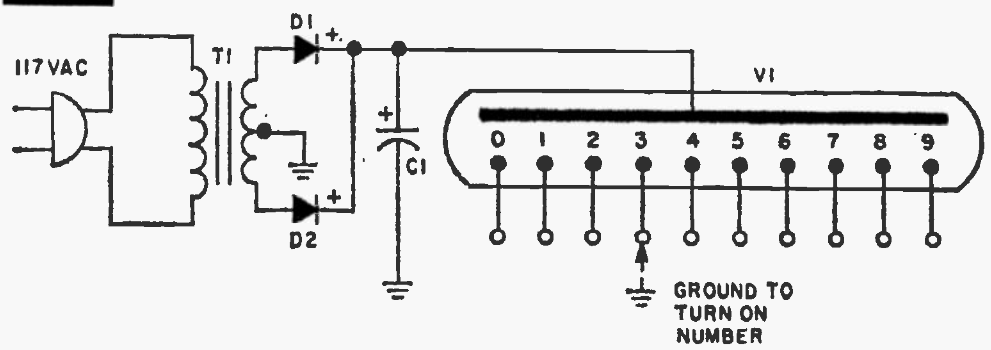
If a volume control is needed, connect a potentiometer of 10,000 ohms or higher between the input terminals and C1.

PARTS LIST FOR OTL AMPLIFIER

C1, C2—10-uF, 6-VDC electrolytic capacitor
C3—50-uF, 6-VDC electrolytic capacitor
Q1—Motorola HEP-253 pnp transistor
Q2—Motorola HEP-254 pnp transistor
Q3—Motorola HEP-623 pnp transistor
R1—100,000-ohm, 1/2-watt resistor
R2—15,000-ohm, 1/2-watt resistor
R3—1000-ohm, 1/2-watt resistor
R4—200,000-ohm, 1/2-watt resistor



68 Nixie Numbers



Using *Nixie* tubes you can transmit numerical signals or even ball scores over long distances.

The Nixie—actually a peanut-size tube—has 10 numerical-shaped neon lamps (0 through 9). By shorting the appropriate lead to ground, an internal neon lamp corresponding to that number is illuminated.

Transformer T1 is 250V center-tapped, providing an output voltage (peak DC) of approximately 200. Though current requirements are very low, D1 and D2 should be line-voltage type silicon rectifiers of 200 mA minimum.

The same power supply can be used for additional *Nixies*, each connecting to the top of C1.

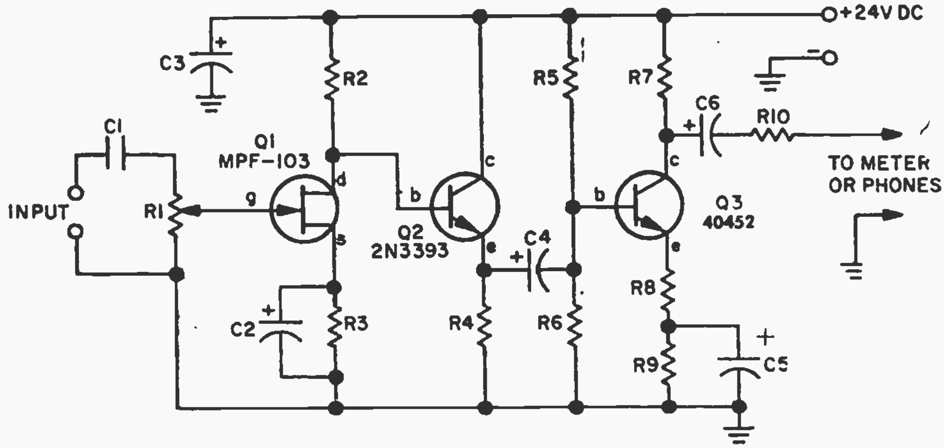
The neon numbers can be turned on either through an 11-position (one position for off) rotary switch or individual toggle switches.

PARTS LIST FOR NIXIE NUMBERS

C1—30-uF, 250-VDC electrolytic capacitor
D1, D2—200-mA, 400-PIV silicon rectifier
T1—117-V primary, 250-V secondary, 25-mA center-tapped power transformer
V1—Neon readout tube (National Electronics NL840)

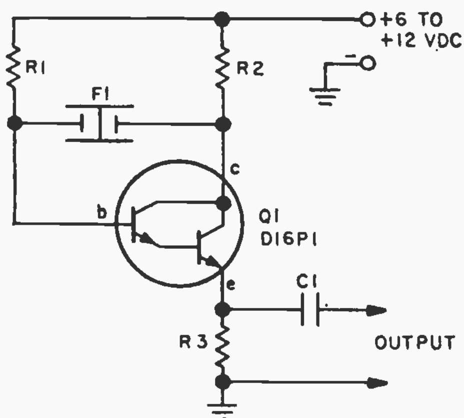
69 Audio Signal Tracer

PARTS LIST FOR AUDIO SIGNAL TRACER	
C1—.01-uF, 400-VDC capacitor	R1—2-megohm potentiometer
C2—100-uF, 6-VDC electrolytic capacitor	R2—33,000-ohm, ½-watt resistor
C3—250-uF, 50-VDC electrolytic capacitor	R3, R7—2200-ohm, ½-watt resistor
C4, C6—10-uF, 25-VDC electrolytic capacitor	R4, R 10—4700-ohm, ½-watt resistor
C5—200-uF, 6-VDC capacitor	R5—68,000-ohm, ½-watt resistor
Q1—Motorola MPF-103 FET transistor	R6—22,000-ohm, ½-watt resistor
Q2—2N3393 npn transistor	R8—18-ohm, ½-watt resistor
Q3—40452 npn transistor	R9—1000-ohm, ½-watt resistor



Got servicing problems on audio equipment? Then sniff them out quickly with an audio signal tracer. This tracer has enough gain to fill headphones with a thundering roar on the output from a microphone or magnetic pickup. Substitute a VU meter for the headphones and you can make relative level measurements starting at the pickup through the power amplifier. See plans for VU Meter with Boost project.

70 Precision Freq. Oscillator



If you need a precise, frequency-controlled signal source for remote triggering of a telephone "snooper" or other selective device, you might try an electromechanical resonator. The frequency of resonator F1 in the transmitter unit should match the frequency of reed relays in the receiving unit. A switch would allow several different resonator frequencies in the transmitter. A small amplifier with a speaker connects to the output of the *Darlington amplifier* (Q1). In operation, the resonator passes only the *tuned* frequency as positive feedback, causing the amplifier to oscillate at the resonant frequency.

PARTS LIST FOR PRECISION FREQUENCY OSCILLATOR

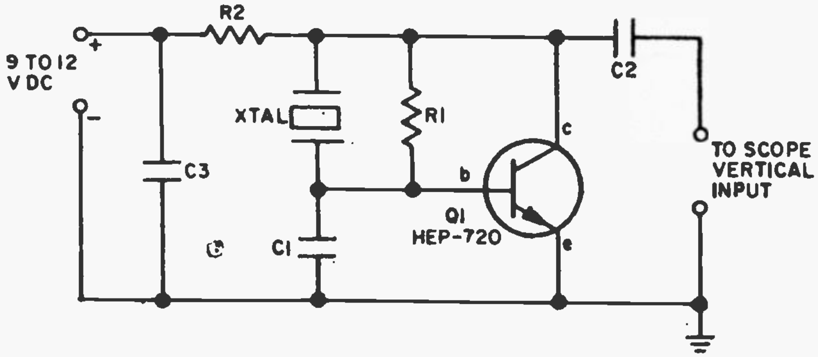
C1—0.2-uF, 10-VDC capacitor
F1—Twintron resonator (H.B. Engineering Corp., 1101 Ripley St., Silver Spring, Md. 20910)
Q1—GE D16P1 Darlington amplifier
R1—4.7-megohm, ½-watt resistor
R2—2000-ohm, ½-watt resistor
R3—560-ohm, ½-watt resistor

71 Scope Calibrator

Operating on exactly 100 kHz, the Scope Calibrator provides a reference for calibrating the variable time base oscillator of general purpose scopes. If the scope is set, for example, so one cycle of the signal fills exactly 10 graticule divisions, each division represents 1 MHz, or 1 microsecond. If the scope is adjusted for 10 cycles on 10 graticule divisions, or 1 cycle per division, each division represents 100 kHz or 10 microseconds. Now if the scope's time base oscillator is sufficiently stable so it doesn't drift too far off, you can make precise measurements of an unknown pulse width, length and frequency.

PARTS LIST FOR SCOPE CALIBRATOR

C1, C3—0.01-uF, 25-VDC capacitor
C2—0.002-uF, 25-VDC capacitor
Q1—HEP-720 npn transistor
R1—100,000-ohm, ½-watt resistor
R2—1000-ohm, ½-watt resistor
Xtal—100-kHz crystal



72 Signal Injector

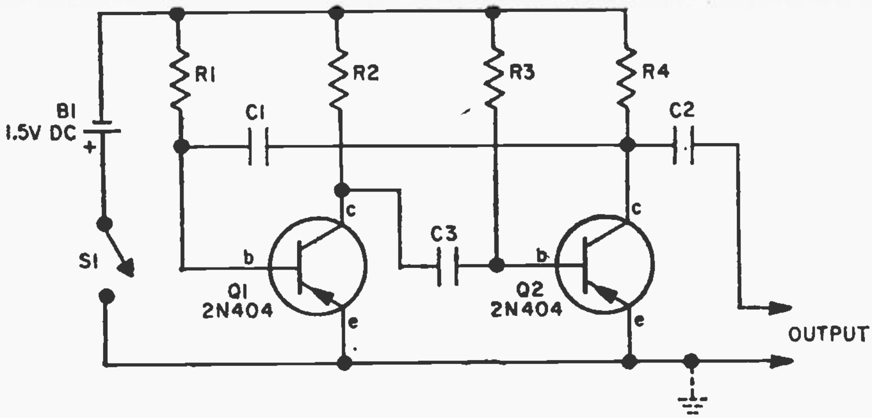
Producing harmonically rich 1-kHz pulses, this multivibrator generates an output signal from 1 KHz to almost 14 MHz. It's useful for servicing audio and RF receiving equipment.

The device is a *signal injector;* you work back from the speaker. At the point where you no longer hear a signal in the speaker you have localized the difficulty.

A precaution: signal level is quite high and it could destroy an RF transistor. So when working on low-level amplifiers or IF circuits, and the connection is to a transistor base, make an inductive hookup. Insulate the test probe with a layer of tape and rest it against the base connection. There's no problem with tube circuits.

PARTS LIST FOR SIGNAL INJECTOR

B1—1.5-V or AAA battery
C1, C2, C3—0.01—uF, 500-VDC disc capacitor
Q1, Q2—2N404 pnp transistor
R1, R3—100,000-ohm, ½-watt resistor
R2, R4—10,000-ohm, ½-watt resistor
S1—Spst switch



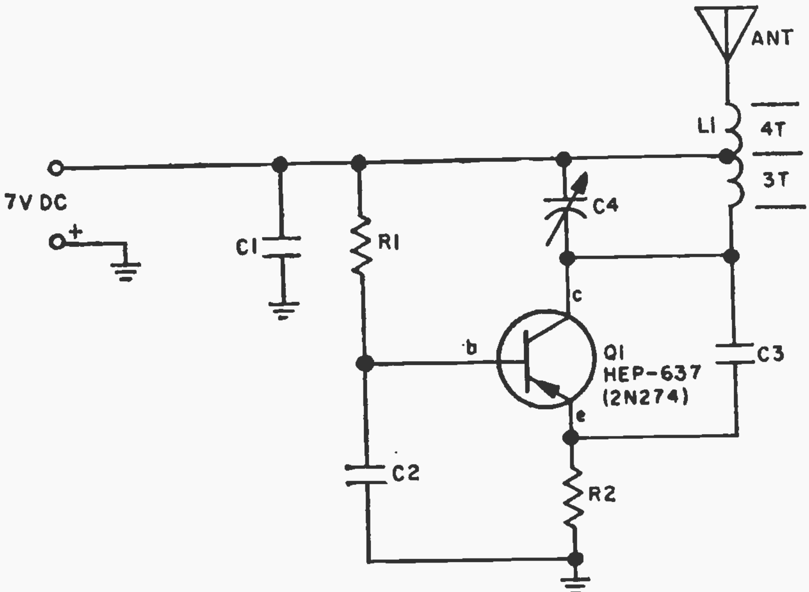
73 FM Alignment Oscillator

We don't suggest that you start aligning your stereo FM receiver, but some budget-priced and early-model FM mono receivers can be aligned or peaked with the FM Alignment Oscillator. Using a 7V mercury battery, the oscillator provides a radiated signal within 10 feet of the receiver. It's strong enough for alignment purposes, but won't overload the front end.

Coil L1, wound on a ¼-in. form, must be made with extra care. The 4-turn section is tight-wound, no spacing between turns. The 3-turn section is spaced—after winding—to a length of ⅜-in. from the tap to the end of the coil. The tap is made by scraping off some enamel, tinning the bare area, then soldering a solid bare wire to the tap. Frequency is preset by adjusting capacitor C4.

PARTS LIST FOR FM ALIGNMENT OSCILLATOR

C1, C2—500-pF, 100-VDC capacitor
C3—5-pF silver mica capacitor
C4—2.7-30 pF trimmer capacitor
L1—See text
Q1—Motorola HEP-637 pnp transistor
R1—100,000-ohm, ½-watt resistor
R2—470-ohm, ½-watt resistor



74 Power Failure Alarm

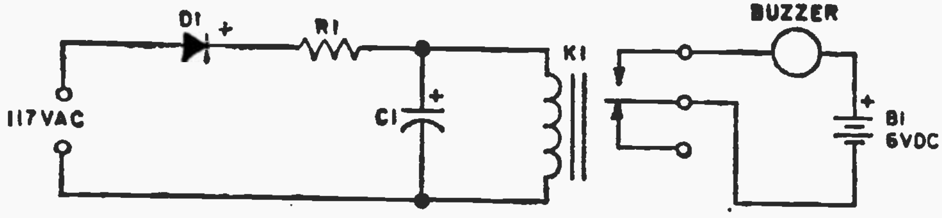
Never fear again that a power failure will knock out your electric alarm clock. The instant the juice fails, the Power Failure Alarm's raucous buzz let's you know about it, even in the wee hours of the morning.

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 activated and the buzzer contacts are held open. When power fails, K1's contact springs back, completing the battery connection to the buzzer.

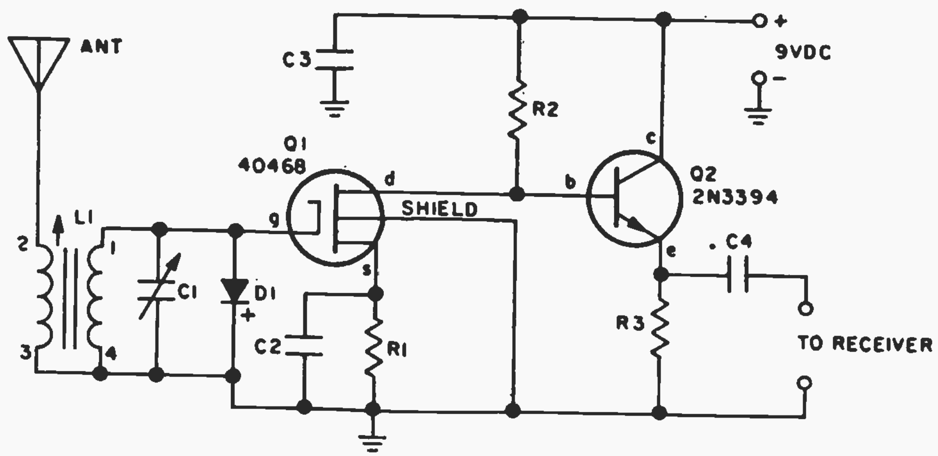
K1 is a "model radio-control" type relay with a pull-in current of approximately 3 mA.

PARTS LIST FOR POWER FAILURE ALARM

B1—6V dry-cell battery
C1—25-uF, 150-VDC capacitor
D1—500-mA, 200-PIV silicon diode
K1—3000-5000 ohm sensitive relay coil (see text)
R1—10,000-ohm, ½-watt resistor
1—6-VDC commercial home buzzer



75 S-9er for SWLs



Super sensitivity is the feature of this two-transistor shortwave preselector. It provides overall gain as high as 40 dB from 3.5-30 MHz.

Diode D1 protects against excess gate voltage caused by nearby transmitters, while Q1 serves as an emitter follower to match the medium output impedance of the FET transistor to the low input impedance of the receiver.

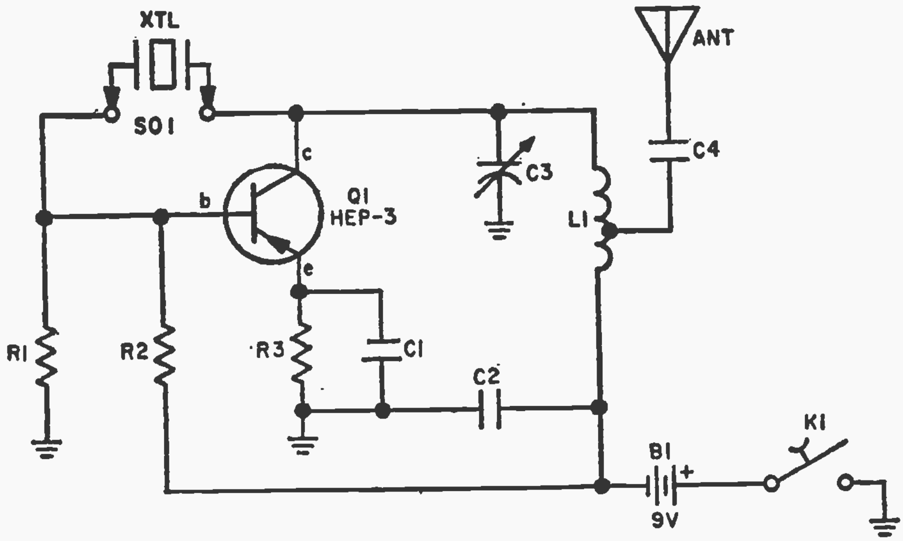
Since Q1 is a MOSFET type with a gate that's very sensitive to static changes, Q1 must be handled with a short-circuit across all leads until just before power is applied. Also, a soldering iron must not be applied to Q1's leads unless they are shorted.

L1's connections are specified in the instructions supplied with the coil. An RG-174U coaxial cable should serve for the output.

PARTS LIST FOR S-NINER FOR SWLS

C1—365-pF tuning capacitor
C2, C3—0.05-uF, 25-VDC capacitor
C4—500-pF, 25-VDC capacitor
D1—1N914 diode
L1—Antenna coil: 1.7-5.5 KHz use Miller B-5495A, 5.5-15 MHz use Miller C-5495A, 12-36 MHz use Miller D-5495-A
Q1—RCA 40468 FET transistor
Q2—2N3394 npn transistor
R1—470-ohm, ½-watt resistor
R2—2400-ohm, ½-watt resistor
R3—4700-ohm, ½-watt resistor

76 QRP Transmitter



PARTS LIST FOR QRP TRANSMITTER

B1—9-V battery, Type 912
C1—0.001-uF, 10-VDC capacitor
C2—0.005-uF, 10-VDC capacitor
C3—30-pF variable or trimmer capacitor
C4—0.005-uF, 100-VDC capacitor
K1—Telegraph key
L1—17 turns of B&W #3007 miniductor tapped at 8 turns from battery end
Q1—Motorola HEP-3 pnp transistor
R1—10,000-ohm, ½-watt resistor
R2—51,000-ohm, ½-watt resistor
R3—470-ohm, ½-watt resistor
SO1—Crystal socket
Xtal—21-MHz fundamental crystal

Any ham can work the world with a California Kilowatt. But working out with 100 milliwatts on 15 meters is the real challenge. Use a metal chassis and good RF wiring techniques to build the rig. Socket SO1 should match the crystal, generally an FT-243 type. The crystal should be the fundamental type. When cutting the Miniductor to length, cut through the plastic supports first—don't try to tear the wire through the supports.

If the oscillator fails to start every time, change R2's value in slight increments until you obtain reliable crystal operation.

77 Tenna-Blitz

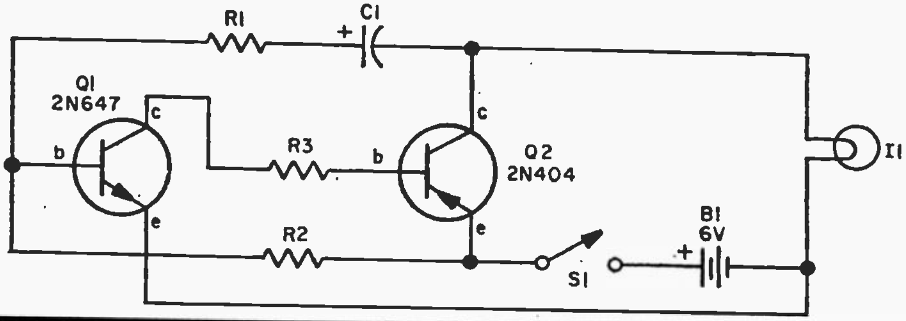
The ballgame is over and your car is buried in the parking lot along with two thousand other cars of the same color. Only yours isn't lost. Sticking above acres of metal is a little lamp going *blink-blink-blink.*

Mount the No. 49 lamp at the top of the an-

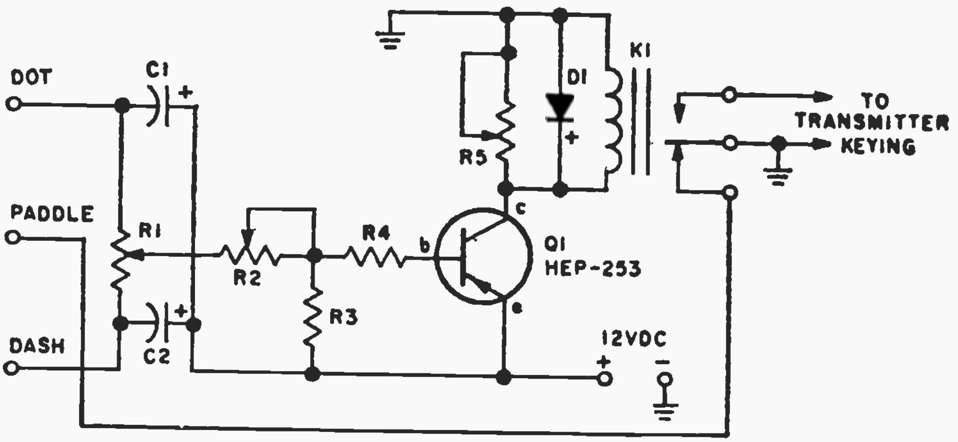
PARTS LIST FOR TENNA-BLITZ

B1—6-V battery
C1—2-uF, 10-VDC electrolytic capacitor
I1—No. 49 pilot lamp
Q1—2N647 npn transistor
Q2—2N404 pnp transistor
R1—470-ohm, ½-watt resistor
R2—1-megohm, ½-watt resistor
R3—2700-ohm, ½-watt resistor
S1—Spst switch

tenna and run two wires down to the control unit inside the car. When switch S1 is turned on the multivibrator makes the lamp blink away. Changing the capacitor's value will vary the blink rate.



78 Electronic Keyer



PARTS LIST FOR ELECTRONIC KEYER

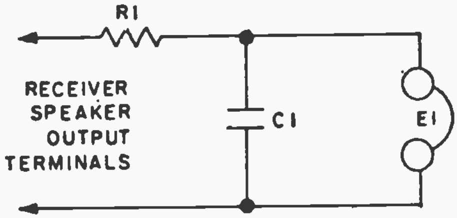
C1—3-uF, 6-VDC electrolytic capacitor
C2—10-uF, 6-VDC electrolytic capacitor
D1—1N60 diode
K1—12-VDC relay (P&B RS-5D)
Q1—Motorola HEP-253 pnp transistor
R1—10,000-ohm linear potentiometer
R2—50,000-ohm potentiometer
R3—1200-ohm, ½-watt resistor
R4—560-ohm, ½-watt resistor
R5—2,500-ohm potentiometer

This is not the equal of a $50 electronic keyer, but it's a lot easier to use than an ordinary hand key.

When the paddle terminal connects to the dot terminal, C1 starts to charge. When C1's voltage causes Q1 to conduct, collector current pulls in relay K1, thereby keying the transmitter. When K1 grounds the paddle terminal, C1 discharges, causing Q1 to stop conducting and dropping out the relay. When K1's paddle connection is restored to ground the cycle repeats until the paddle is released.

Dashes work in similar fashion. Potentiometer R1 sets the dot-dash ratio, potentiometer R2 sets the speed. Potentiometer R5 drops out the relay just before Q1 stops conducting and has a slight effect on the dot-space ratio.

79 Headset Q-Peaker



PARTS LIST FOR HEADSET Q-PEAKER

C1—0.005-.05 uF capacitor (see text)
E1—2000-ohm magnetic headset
R1—100,000-ohm, ½-watt resistor

If you're tired of copying CW signals through the grind without a Q-multiplier on your receiver, the 29¢ Headset Q-Peaker is the next best answer. It's the cheapest route to greater selectivity.

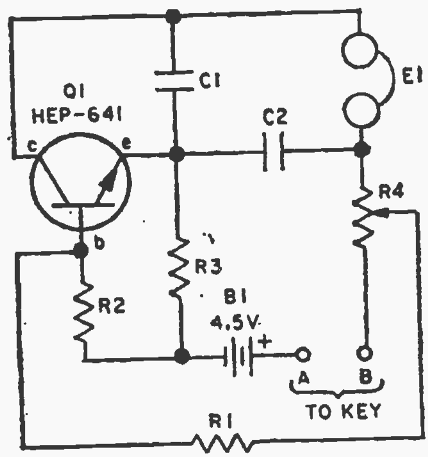
Capacitor C1 plus the inductance of a magnetic headset form a parallel resonant circuit at approximately 1 kHz. All other signals are sharply attenuated so you hear mainly the signal you want. Resistor R1 isolates the resonant circuit to prevent a receiver's low output impedance from reducing the "Q" of the headset circuit.

The exact value of C1 depends on the particular headset. Try different values in the range shown until the desired resonant frequency or peaking action is obtained.

80 Budget CPO

PARTS LIST FOR BUDGET CPO

B1—4.5-V battery
C1—0.02-uF, 10-VDC capacitor
C2—0.22-uF, 10-VDC capacitor
E1—2000-ohm magnetic earphone
Q1—HEP-641 npn transistor (Motorola)
R1—2700-ohm, ½-watt resistor
R2—1500-ohm, ½-watt resistor
R3—27,000-ohm, ½-watt resistor
R4—50,000-ohm potentiometer



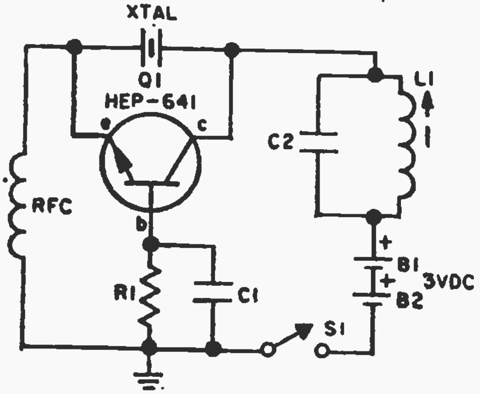
Components you have lying about might make this simple, budget CPO (code practice oscillator). Using component values given, the tone frequency is approximately 800 Hz. It can be changed by substituting different values for C1 and C2, but maintain the same capacity ratio. That is, C2 should always be about 10 times larger than C1. Battery current drain is only about 1 milliampere.

81 100-kHz Freq. Standard

Few shortwave receivers below the deluxe class have really accurate dial calibration. But with a 100-kHz frequency standard you'll know with great precision where the receiver is tuned.

The calibrator 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 nave 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.

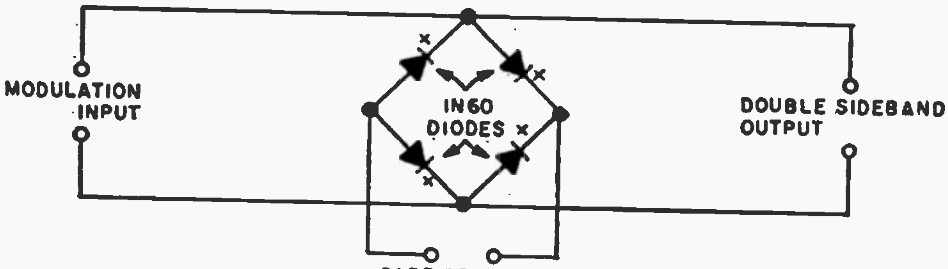


If you want to zero beat the crystal against station WWV, install a 50-pF trimmer in series or in parallel with the crystal. Use whichever connection works since the specific crystal type determines the series or parallel connection.

PARTS LIST FOR 100-kHz FREQUENCY STANDARD

B1, B2—1.5-V AAA battery
C1—0.01-uF, 10-VDC capacitor
C2—200-pF silver mica capacitor
L1—Coil, 2-18 mH
Q1—HEP-641 npn transistor (Motorola)
R1—750,000-ohm, ½-watt resistor
RFC—2.5 mH RF choke
S1—Spst switch
XTAL—100-kHz crystal

82 Sideband Scrambler



Feed audio modulation to one input, a carrier to another and the output of this sideband generator will be upper and lower sideband with supressed carrier. Where is it used? Try a sideband rig or a telephone speech scrambler. Work the scrambled signal into the modulation input to unscramble your speech scrambler output.

83 Carbon Mike Converter

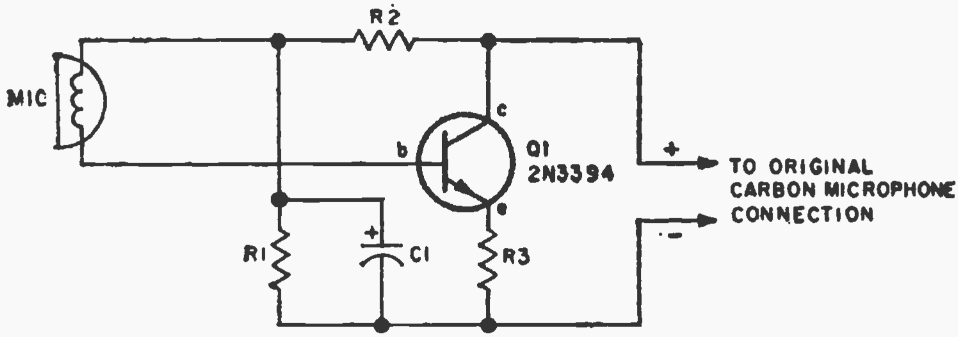
Good pitching beats good hitting—and a good magnetic mike beats a good carbon mike. This one-transistor carbon microphone converter takes a carbon mike input and converts it to the magnetic variety.

Note that no ground connection is used, even if the circuit is built in a metal cabinet. MIC is a replacement-type magnetic element that is substituted for the original carbon element. Using miniature components the entire converter amplifier can also

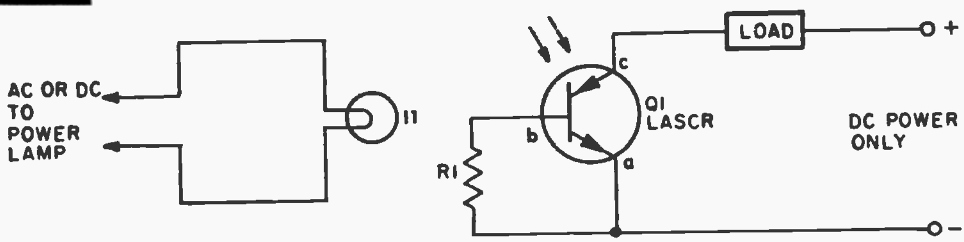
PARTS LIST FOR CARBON MIKE CONVERTER

C1—10-uF, 10-VDC electrolytic capacitor
MIC—Microphone magnetic replacement element
Q1—2N3394 npn transistor
R1—2200-ohm, ½-watt resistor
R2—6800-ohm, ½-watt resistor
R3—240-ohm, ½-watt resistor

be housed in the original microphone case. To avoid destruction of Q1, the unit must be connected properly the first time. The "+" lead, which goes to Q1's collector, connects to the carbon mike input that supplies a positive voltage.



84 Photo Light Control



Heavy direct current or DC power is easily controlled without the use of massive power switches and wiring by using a LASCR (light activated silicon controlled rectifier) as an interface between the control and controlled circuits. The LASCR is similar to an SCR except that the gate is tripped by light rather than voltage/current.

The triplamp can be any ordinary flashlight bulb powered by two D cells. When the lamp is turned on the LASCR gate is closed, causing current to flow through the load and the LASCR anode (a) cathode (c) circuit.

A suitable LASCR is one from GE's L8B series. Use one with the appropriate PIV rating. Inexpensive LASCRs are occasionally available from "surplus dealers"; though you must make certain the "surplus" unit has the required PIV rating.

PARTS LIST FOR PHOTO LIGHT CONTROL

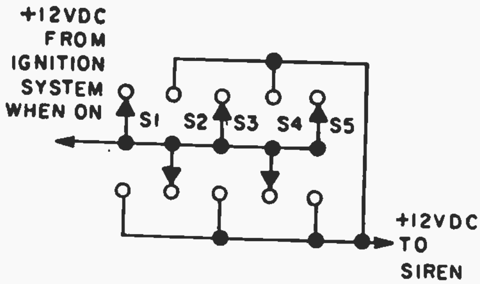
I1—Flashlight bulb or pilot lamp (see text)
Q1—Light-activated-silicon-controlled rectifier (LASCR, GE—see text)
R1—47,000-ohm, ½-watt resistor

85 Electronic Combo Lock

Install an electronic combination lock on your car's dashboard and a thief would have a better chance playing Russian roulette.

Switches S1 through S5 are spdt rather than spst only to keep all external switch markings the same. It would be a dead giveaway if two keying notches or lettering were reversed.

Tracing the circuit will show that only if switches S2 and S4 are down is the siren disabled. The siren sounds if any other switch is down or if S2 or S4 is up when the ignition is turned on. A simple wiring

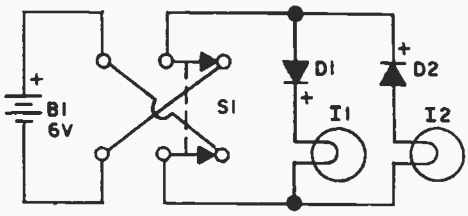


change lets you set any combination.
The switches can be "sporty" auto accessory switches sold individually or in switch banks. Provide labels such as "Carburetor Heater," "Window Washer," etc. and no-one will know the car is wired for "sound."

86 Two-Way Signaller

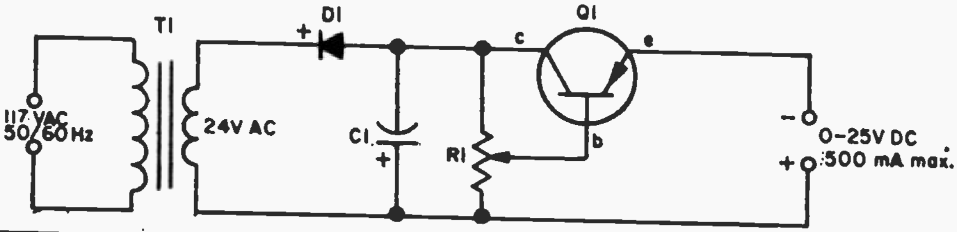
PARTS LIST FOR TWO-WAY SIGNALLER

- B1—6-V battery, 4 D cells in series
- D1, D2—50-PIV 1 A silicon diode, HEP-154(S)
- I1, I2—6.3-V, 0.15-A, miniature bayonet base pilot lamp
- S1—Dpdt toggle switch (Cutler Hammer 7591-KP)



Using diode switching, a single pair of wires controls two circuits that normally require four wires. Though illustrated here with lamps, the same idea can be used for telephone circuits.
When polarity-reversing switch S1 is set so the positive battery terminal feeds the top wire, the D1/I1 circuit is operative and only lamp I1 lights up. Lamp I2 remains off because diode D2 blocks the flow of DC to the lamp.
When battery polarity is reversed, so the top wire is negative, only D2 conducts, illuminating I2. D1 blocks the current flow and I1 is off.
If a carbon mike is connected in series with the battery and the lamps are replaced with headphones, switch S1 determines which of two headphones receives the transmitted signal.

87 NiCad Battery Charger



PARTS LIST FOR NICAD BATTERY CHARGER

- C1—100-uF, 50-V capacitor
- D1—500-mA, 100-PIV silicon rectifier
- Q1—40-W, pnp power transistor
- R1—2000-ohm potentiometer
- T1—24-VAC, 117-VAC primary filament transformer

Providing an adjustable output voltage up to 35 VDC and maximum output current of 500 mA, this battery charger handles just about any NiCad battery used by experimenters and consumer equipment.
Transistor Q1 must be mounted on a heat sink (which can be a metal cabinet). Since Q1's case is also the collector connection it *must* be insulated from the cabinet with

the insulating hardware provided in a transistor mounting kit. For best heat dissipation place a layer of silicone transistor mounting grease on both sides of the mica insulator.

When charging one or a string of series-connected NiCads, connect an ammeter in series with the charger and adjust the current to that specified for the batteries. Never attempt a rapid charge of NiCads (unless so designed) since excess charging current can permanently damage these cells.

88 Electrolysis Detector

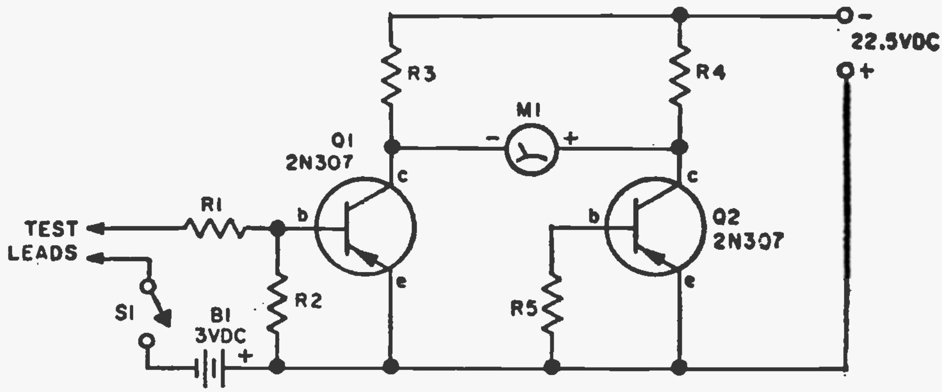
Two transistors and a meter are all it takes a boat owner to keep track of metal-eating electrolysis.

Resistors R3 and R4, transistors Q1 and Q2 and meter M1 form a balanced-bridge meter, with the meter normally indicating zero. The test leads are attached to the boat's submerged metal. As electrolysis takes place, a current flows through the battery circuit, applying base bias to Q1. This unbalances the circuit, causing meter M1 to indicate a reading of other than zero.

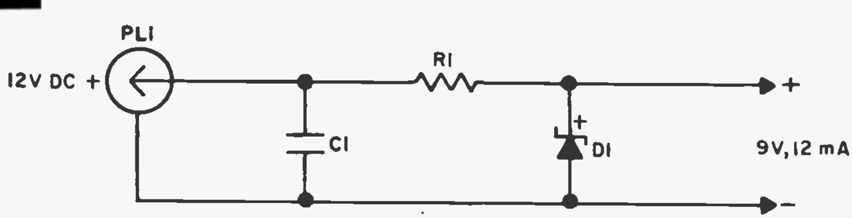
If the meter reverses and reads off-scale, interchange the meter connections.

PARTS LIST FOR ELECTROLYSIS DETECTOR

- B1—3-V battery
- M1—0-15 mA DC meter
- Q1, Q2—2N307 pnp transistor
- R1, R2, R5—220-ohm, ½-watt resistor
- R3, R4—1000-ohm, ½-watt resistor
- S1—Spst switch



89 Car Voltage for Q Radios



When your auto radio poops out, this regulated voltage adapter keeps you in music from a transistor portable until you're ready to climb under the dash to get at the trouble and fix it.

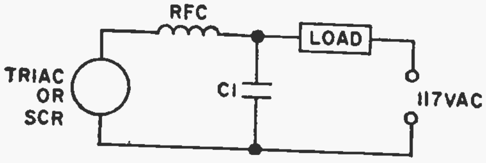
Power is taken from the 12-volt auto battery through a cigar lighter plug. The zener diode can be anything with an approximate rating of 9 volts. For example, you can use a 9.1-volt unit (common in Zener kits), or even one rated at 8.6 volts. Make certain the Zener is correctly installed; the end

marked with a band (cathode) connects to the resistor.
The adapter is rated for a current of 12 mA maximum. A good rule of thumb is that a radio powered by a Burgess type 2U6 battery can safely operate on the adapter.

PARTS LIST FOR CAR VOLTAGE FOR Q RADIO

C1—0.05-uF, 400-VDC capacitor
D1—1-watt, 9-V Zener diode
PL1—Cigarette lighter plug
R1—150-ohm, 1/2-watt resistor

90 Triac & SCR Hash Filter



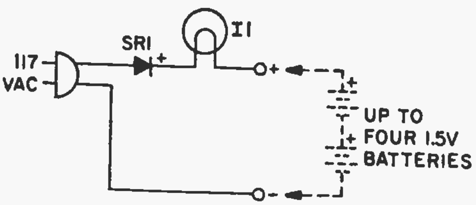
PARTS LIST FOR TRIAC & SCR HASH FILTER

C1—0.1-uF, 200-VDC capacitor
RFC—60-mH coil, 65 turns #18 AWG magnet wire, 2 layers, on 3 x 1/4-in. ferrite rod for AM broadcast-band frequencies

Triacs and SCRs used by experimenters in light and motor speed controls generate a considerable amount of electrical "hash". It can cause severe interference to BCB and SW radios located within 50 to 100 feet. The noise is generated when AC line current is regulated into sharp pulses by the SCR or Triac.
An RFI (Radio Frequency Interference) filter connected between the Triac or SCR and the load can hush the radio interference. Best results are obtained if the filter is located inside a metal box, or in a metal cabinet with the load being controlled.

91 Dry-Cell Charger

This circuit in a fancy commercial package will cost you about $5. Build a lamp bulb charger yourself and 50¢ may just about do it.
The lamp maintains constant charging of approximately 20 mA through one to four 1.5-volt batteries. But you can go as high as 22.5 volts for either batteries in series or a single battery.
Give small penlight batteries about 10 hours charge, the C and D cells about 20 hours. Yes, you can recharge NICads stamped with a charge rate of approximately 20 to 25 mA.



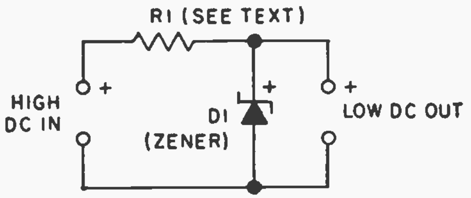
PARTS LIST FOR DRY-CELL BATTERY CHARGER

I1—No. S-6 6-watt candelabra lamp
SR1—200-PIV, 100-mA minimum silicon rectifier

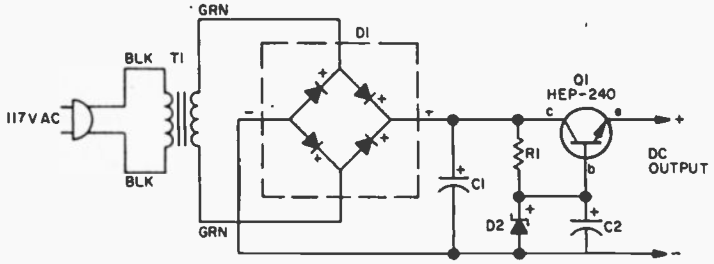
92 Zener Regulator

When the output from an AC power supply is too high for a solid-state project, chop it down to size with a zener diode voltage regulator and keep it on the button.
To calculate R, first add the load current and 1/20 of the load current for the zener's idling current. Then use Ohm's Law (R=E/I to calculate R. The resistor's power rating should be twice the calculated power dissipated by R.

The power rating for the zener diode is determined by the voltage across the diode squared, divided by diode's nominal internal resistance. You can calculate the internal resistance by working backwards from the zener's power rating. As an example: a 9-volt, 1-watt zener would have a nominal internal resistance of $R=E^2/W$, 81/1, or 81 ohms. It's not precisely accurate but close enough. (No parts list)



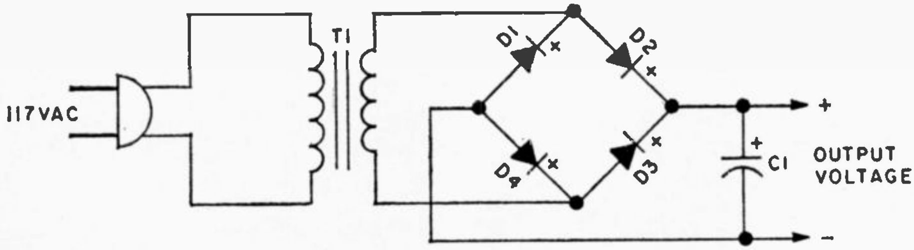
93 Regulated 9-V Supply



PARTS LIST FOR REGULATED 9-V POWER SUPPLY
C1—500-uF, 25-VDC electrolytic capacitor
C2—100-uF, 15-VDC electrolytic capacitor
D1—Motorola HEP-175 50-PIV diode bridge rectifier
D2—Motorola HEP-104, 9.1-V Zener diode
Q1—Motorola HEP-240, 10-watt npn transistor
R1—560-ohm, ½-watt resistor
T1—12-V filament transformer (see text)

Providing 9 volts at approximately 250 mA, this lab-type power supply will handle many experimenter projects. Actually, T1 can be a 6.3-V *imported* filament transformer since they usually give approximately 12 V peak at less than 500 mA output. Change the Zener diode to 12 or 6 volts (and possibly the value of R1) and you get a regulated 12- or 6-volt supply. For 12 volts you must use a 12-V filament transformer. Filtering is very good since the *electrical* filter capacitor equals the value of C2 times the gain of Q1. It can add up to thousands of μF.

94 Supply for SS Projects



PARTS LIST FOR POWER SUPPLY FOR SS PROJECTS

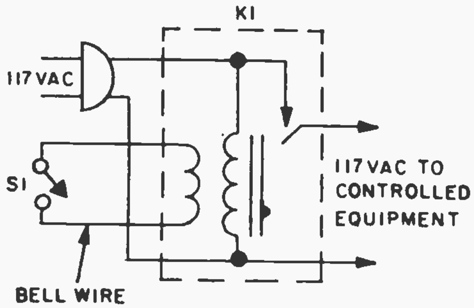
C1—2500-uF electrolytic capacitor, voltage rating at least 1.5 times higher than output voltage
D1, D2, D3, D4—500-mA, 100-PIV silicon rectifier (see text)
T1—Transformer; 117-VAC primary, secondary voltage equal to desired output voltage x 0.707

Though the transformer isn't center-tapped in this circuit, the bridge rectifier provides full-wave rectification with an easy-to-filter DC output. It forms a handy supply for solid-state projects.

The output voltage is equal to the secondary voltage multiplied by 1.4. Or, working backwards, the secondary voltage must be 0.707 times the desired output voltage. Silicon rectifiers D1 through D4 must have a PIV rating equal to at least the DC output voltage. Their current rating must at least equal the current requirements of the project being powered by the supply.

95 Low-V Remote Control

Using ordinary bell wire you can safely control a remote 117 VAC power source. Secret behind it all is a unique hysteresis relay, K1. Normally, K1's coil represents a high impedance; no current flows through the coil so the relay contacts stay open. When S1 closes the loop on the hysteresis coil, the impedance of the main coil drops. Current flows and the contacts close.

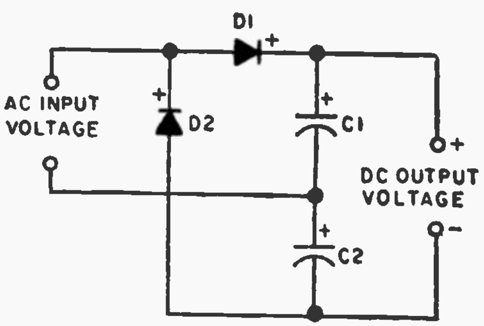


When S1 is open, the voltage across its terminals from the hysteresis coil is approximately 30V. When S1 is closed, current through the hysteresis loop is almost unmeasurable. It's safe enough for ordinary bell wire to do the controlling.

PARTS LIST FOR LOW-VOLTAGE REMOTE CONTROL

K1—Hysteresis relay (Alco)
S1—Spst switch
Misc.—Bell wire

96 Voltage Doubler



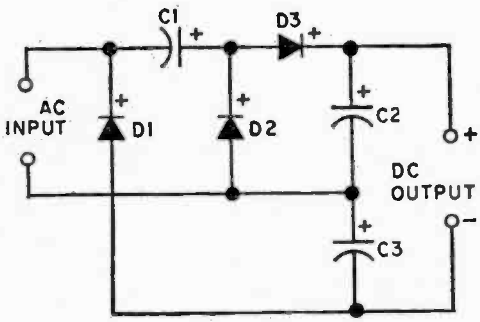
Found in many CB transceivers, the full-wave voltage doubler provides reasonably good regulation with DC output voltage twice the AC input. Capacitors C1 and C2 should be a minimum of 100 uF and rated at twice the DC output voltage. The larger the capacity, the greater will be the filtering.

On the positive half-cycle, C1 is charged through silicon diode D1. On the negative half-cycle, C2 is charged through D2. The DC output voltage is the sum of the charge across C1 and C2.

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 PIV at least twice DC output voltage

97 Voltage Tripler



When you need high voltage but don't have a power transformer, a voltage tripler may work. It provides DC output approximately three times higher than the line voltage.

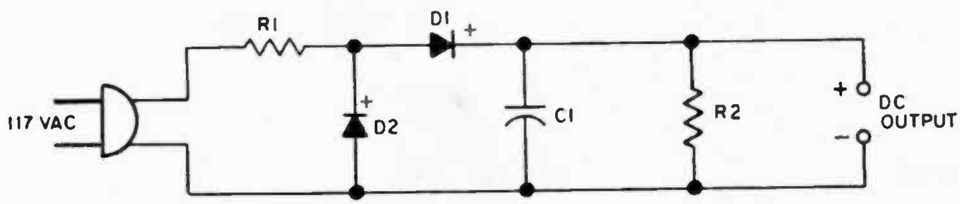
C1 is approximately 8 to 20 uF at 150VDC, and C2 and C3 should be a minimum of 100 uF at 300VDC. The larger the value for C2 and C3, the better the filtering.

On the negative half-cycle, C1 charges through diode D2, while C3 charges through D1. On the positive-half cycle, C1's charge, plus the line voltage, charges C2 through D3. The output is the voltage across C2, which is the line voltage plus the charge from C1, plus the added voltage of C3. The total is almost three times the line voltage.

PARTS LIST FOR VOLTAGE TRIPLER

C1—16-uF, 150-VDC electrolytic capacitor
C2, C3—140-uF, 300-VDC electrolytic capacitor
D1, D2, D3—HEP-160(S) 1000-PIV, 1-A diode (Motorola)

98 Preamp Low-Ripple Supply



PARTS LIST FOR LOW-RIPPLE SUPPLY FOR PREAMPS

Output V	I max*	R1	C1	R2
12	1 mA	43,000-ohm, ½-watt	250-uF, 15-VDC	180,000-ohm, ½-watt
12	2 mA	22,000-ohm, ½-watt	250-uF, 15-VDC	100,000-ohm, ½-watt
25	2 mA	18,000-ohm, ½-watt	250-uF, 30-VDC	180,000-ohm, ½-watt

***For lower current, decrease value of R2**

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.

99 Shortwave Spotter

Can't find that rare, weak SW signal from Lower Slobbovia? You will if you use this SW frequency spotter. 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.

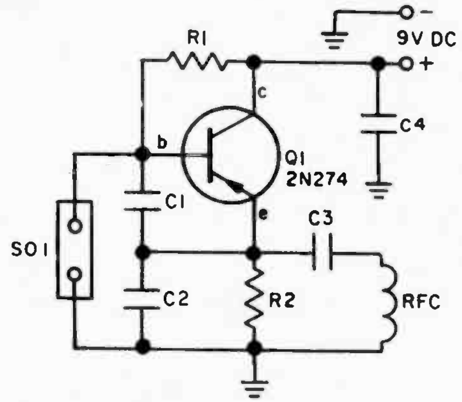
The spotter can be assembled on a small section of perfboard with flea clips for tie points. For good performance, all components must be firmly mounted and well soldered. A common 2U6 9-volt battery in the circuit will last for months, if not for its total shelf life.

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, 25¢ 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.

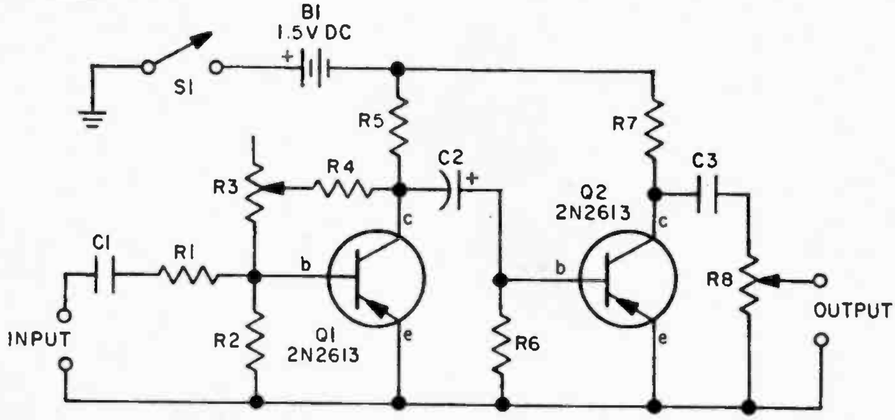
A connection between the spotter and receiver is not needed. Simply position the spotter near the receiver antenna and start tuning until you find the marker signal.

PARTS LIST FOR SHORTWAVE SPOTTER

C1—1200-pF silver mica capacitor
C2—75-pF silver mica capacitor
C3—250-pF, 100-V disc capacitor
C4—0.01-uF, 25-VDC capacitor
Q1—RCA 2N274 pnp transistor
R1—220,000-ohm, ½-watt resistor
R2—1000-ohm, ½-watt resistor
RFC—1-mH RF choke
SO1—Crystal socket



100 Fancy Fuzzbox



Add that 'way-out NOW sound to any electric guitar by connecting the Fuzzbox between your guitar and amplifier. Potentiometer R3 sets the degree of fuzz, R8 the output level.

Since the fuzz effect cannot be completely eliminated by R3, fuzzy-free sound requires a bypass switch from the input to output terminals. The switch should completely disconnect the fuzzbox output; the input can remain in parallel with the bypass switch.

PARTS LIST FOR FANCY FUZZBOX

B1—1.5-V AA battery
C1, C3—0.1-uF, 3-VDC capacitor
C2—5-uF, 3-VDC electrolytic capacitor
Q1, Q2—2N2613 pnp transistor
R1, R6—22,000-ohm, ½-watt resistor
R2—18,000-ohm, ½-watt resistor
R3—1-megohm potentiometer
R4—100,000-ohm, ½-watt resistor
R5, R7—10,000-ohm, ½-watt resistor
R8—50,000-ohm, audio-taper potentiometer
S1—Spst switch

101 Headlight Minder

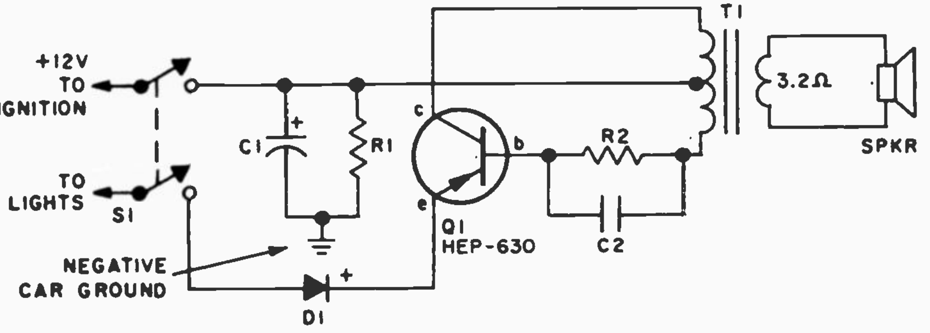
No more dead batteries in the morning; the Headlight Minder lets you know, loud and clear, if your lights are on when the ignition is off.

When the ignition only is on, the tone circuit is off since there is no complete power path for Q1. Diode D1 prevents positive battery voltage from flowing through Q1 to the lights. When lights and ignition are on, Q1's collector and emitter are positive and the tone generator remains off. When the lights are on and the ignition is off, Q1's (ground) terminal through R1 and the generator sounds off. You'll know you left the lights switched on.

The unit can be built in a metal cabinet fastened to the car's dashboard so R1 is connected through the cabinet to the car's chassis, thereby completing a negative battery connection.

PARTS LIST FOR HEADLIGHT MINDER

C1—30-uF, 25-VDC capacitor
C2—0.2-uF, 25-VDC capacitor
D1—500-mA, 50-PIV silicon rectifier
Q1—HEP-630 pnp transistor
R1—15,000-ohm, ½-watt resistor
R2—680-ohm, ½-watt resistor
S1—Dpst switch
SPKR—3.2-ohm speaker
T1—500-ohm CT primary to 3.2-ohm secondary audio output transformer



What's your favorite circuit?

If you have a circuit that you honestly believe should be in this projects magazine, please let us know about it. Just pencil in the schematic diagram complete with parts identification. Mail to the Editor, 101 Electronic Projects, 229 Park Avenue South, New York, New York 10003.

ASK HANK, HE KNOWS!

Hank Scott, our Workshop Editor, wants to share his project tips with you. Got a question or a problem with a project you're building—ask Hank! Please remember that Hank's column is limited to answering specific electronic project questions that you send to him. Sorry, he isn't offering a circuit design service. Write to:

Hank Scott, Workshop Editor
101 Electronic Projects
229 Park Avenue South
New York NY 10003

Buzzzz

For troubleshooting portable transistor radios, what other piece of test equipment do I need besides a VOM?

—C. M., Folsom, CA

Frankly, we can't think of any piece of test gear more versatile than a voltohmmeter. Yet, there are moments for the experimenter when a VOM is really not the most suitable test instrument for the job at hand. Doctoring portable transistor radios is one case in point. A handy-dandy tester for troubleshooting any kind of mini-sized receiver is a pen-shaped signal injector. Made by EICO and Knight (Allied Radio Shack), this type of signal injector contains a multivibrator whose output signal is rich in harmonics. The instrument injects AF or RF signals and no tuning of circuits is required to hear the injector's output. Just touch its probe to the radio's circuit, and you should hear a loud beep in the radio's speaker if the circuit is functioning properly. When you no longer hear the beep, you've isolated the faulty circuit. Remember to start probing the radio's innards at the speaker terminals, eventually working your way backwards toward the antenna terminal.

Rating System For Cannibalized Parts?

Most hobbyists have quite a collection of parts cannibalized from old TVs and radio sets. Many of these items can be identified easily. But others, such as various types of chokes, transformers, capacitors, and even resistors present a problem to the hobbyist trying to determine their rating values. I think electronic parts manufacturers could perform a real service to the service technician and hobbyist if they identify the value of all parts they produce. It seems to me that some sort of an identifying code could be stamped or printed on the item so the part could be easily identified. Is there any way these salvaged items can be checked on a VTVM or other piece of test equipment in the absence of a circuit diagram?

—K. M. W., Noblesville, IN

Years ago, electronic components were identified more completely than the ones made today. In today's electronics marketplace, if it costs the equipment manufacturer two cents more for each item to be ticketed, it would add much more to the price of the finished equipment. Manufacturers of consumer products tell us that every penny counts in the price of a TV or radio. If you still need to measure the electrical characteristics of unlabelled parts, get your hands on an R-C-L bridge and inductance comparator.

Reed Switch Lowdown

A project I want to build calls for a reed switch. What is a reed switch?

—J. B., Carmel, CA

Reed switches are becoming very popular in hobbyist circles. A magnetic reed switch is a type of relay consisting of two ferromagnetic reeds sealed into a glass tube. Inside this tube is a controlled atmosphere. The reeds are insulated from each other by a small air gap. When placed inside a coil of wire which is series connected to a battery, the reeds become magnetized in opposite polarity and they make contact. By energising the coil you have an SPST switch. There are various ways to control the reeds. The advantage of magnetic reed relays lies in their high speed switching capability. Also, the contacts are highly reliable because they are hermetically sealed from the contact-killing oxidants found in the air we breathe.

VOM Sorts Out uF Mystery

The only test equipment I have is a Volt-Ohmmeter. Can I test capacitors with it?

—S. C., St. Albans, NY

Yes, you can easily check many fixed-value capacitors with your VOM. First, set the instrument to its highest "ohms" position (the R x 10,000-ohms position on most VOMs is a good starting point). Then connect the VOM's leads to the capacitor. The meter needle should rapidly flick over towards the "zero"-ohms side of the meter and then drop back towards "infinite"-ohms. But if you're testing a polarity-sensitive capacitor—like an electrolytic job—the meter needle probably won't give you an open-circuit reading even after you hang your VOM across the electrolytic for a few minutes. The theory behind your meter's capacitor-

Continued on page 105

By Lars Jorgensen

introducing... OpAmp

A ready-to-go amp with a zillion applications the little OpAmp can fill most any bill you have in mind

Just as a child builds houses and castles by adding one toy block to another, so too will the electronic engineer in the 1970s design all types of electronic equipment by adding one block to another. But he won't be using toy blocks—he will use operational amplifiers—the basic building blocks of electronics.

The operational amplifier, or OpAmp, is considered a basic electronic circuit building block because, just as is the case with the child's block, the OpAmp becomes whatever the designer wants it to be in a circuit. For example, the OpAmp in the triangle above serves as a low- or high-gain AF amplifier. a line amplifier, a preamplifier, an oscillator, a mixer, a modulator, a multivibrator, a detector, etc. You name it and the OpAmp can do it within the limitations of the device's bandwidth.

Certainly you can always arrange a group of discrete components to do any of the above-mentioned jobs, but what makes the OpAmp unique and important is that in addition to the OpAmp itself, just a few additional components are required to fabricate a complete module. Circuit functions are changed by changing the value of just some of the external components or the way they are connected.

Goodies Do Come in Small Packages. When the OpAmp is an IC, rather than discrete components, the entire OpAmp is in a small package (as in the photo above), and the external associated components for a given circuit may number four or five. Changing the value or connection of only one or two of these components completely changes the OpAmp's function. The OpAmp is not a new development that has evolved from the availability of ICs. OpAmps, predating these new IC types, were wired packages of discrete components that afforded no savings in cost. However, the IC OpAmp certainly has tipped the scales the other way. These new units cost but a fraction of what the older ones did, both in dollars and in space requirements. Progress surely pays dividends—collect yours by using OpAmp.

Easy Does It. Another advantage of OpAmp is that without having to make yards and yards of calculations you can be fairly certain of the end results, within broad limits. As an example, suppose you wanted to construct a microphone preamplifier having 60 dB of gain (1000 ×). You would have to calculate all the constants of many discrete components associated with two or three transistors and/or FETs—and you'd still have to breadboard the circuit to iron out the bugs. But, using an OpAmp the only calculation would be:

$$Gain = R1/R2$$

and since R2 would be known, your total effort would be to calculate the proper value for R1 and connect it into the circuit.

Does it all sound too easy? If we were to delve deeply into OpAmp theory you'd have another 100 pages or so to read. But OpAmps are available predesigned with cer-

OpAmps

tain characteristics, such as input impedance, gain, bandwidth, overload voltage, etc., clearly specified. All that is required of the experimenter is for him to select the few components needed for his particular application. Particularly for the newcomer to electronics, practical application of the OpAmp can be easily handled. As long as you know what result to expect from your connections of the components, you can get started on OpAmp applications immediately. The how and why can come later.

AC, DC or Both. The schematic of a typical OpAmp is shown in Fig. 1. We could go into differential inputs, constant current sinks, split outputs and all the other technical terms that are impressive. But, in all probability most of this terminology would be meaningless to the experimenter and hobbyist. What is important, as noted in Fig. 1, is the absence of coupling capacitors. The OpAmp is DC coupled, and its output is self-center tapped. The OpAmp can handle either AC, DC or both simultaneously, and the output is normally at DC ground potential. As it is usually powered by a bi-voltage power supply as shown in Fig. 2, the OpAmp's output can be set to the center tap or ground potential and usually is in experimenter's applications.

Input Polarity Controls Output. Observe in Fig. 2 that the OpAmp has separate inputs indicated as positive (+) and negative (−) respectively. The input impedance of the device is the internal impedance between these two inputs. The input polarity determines what the polarity will be at the output when a voltage is applied to the input. The positive input is non-inverting, and the output voltage will have the same polarity as the input voltage. The negative input is inverting, therefore, the output voltage will be 180° out of phase with the input voltage. Keep this point in mind, as we'll come back to it later. Knowing this fact at this point will help you to understand the workings of the OpAmp.

Differential input is a term that you will run across frequently as you work with OpAmps. It means that the amplifier responds to the *difference* in voltage between the input terminals which may be either AC or DC. If a 1.5-V battery is connected across the input terminals the difference voltage is 1.5 V. It doesn't matter to which input the positive battery terminal is applied, the difference voltage will still be 1.5 V. The output voltage of the amplifier, the voltage between the amplifier output terminal and ground, is equal to the open loop gain of the amplifier times the differential voltage. If the open loop gain is 1000, and the differential input voltage is 1 millivolt, the output voltage is 1 *mV × 1000 or 1 volt.*

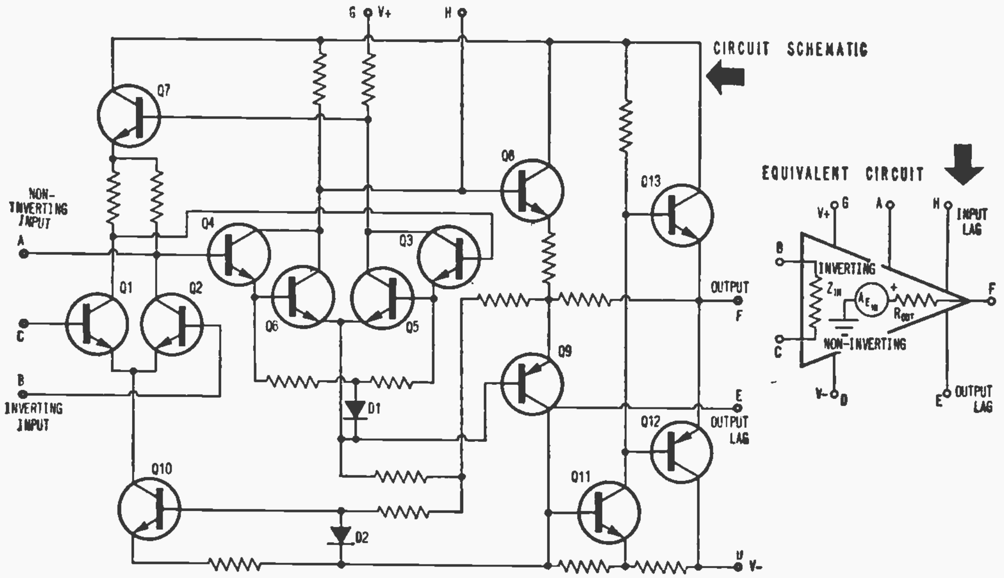


Fig. 1. Schematic and equivalent circuit of IC operational amplifier. Since device is DC coupled, it can be used for both AC and DC amplification. Output can be either in phase or out of phase with input signal.

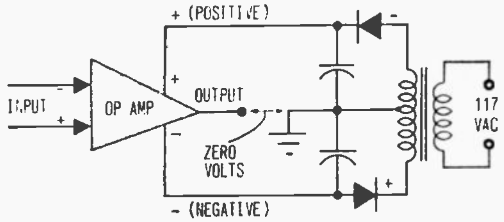


Fig. 2. OpAmp boasts two inputs: inverting input indicated as "—" and non-inverting input indicated as "+", DC output from power supply is half total supply voltage and of two differing polarities.

Open Loop—Closed Loop. Open loop gain refers to the gain of the OpAmp, or any amplifier, as rated by the manufacturer. Open loop gain or maximum gain, is achieved by connecting the amplifier as shown in Fig. 3A. Closed loop gain refers to the gain of the amplifier after a feedback network has been connected from its output to its input. Fig. 3B indicates how negative feedback is derived by connecting amplifier output to the inverting (−) input. If the amplifier should include both negative and positive feedback, which is unusual in experimenter's circuits, the closed loop gain will be the total resultant gain of the device. It is easy to calculate the closed loop gain. Essentially, it is derived by dividing Rf by Rb1 (where Rf = feedback resistance and Rb1 = its associated bias resistance—see Fig. 3B).

When the loop is closed, which occurs

A

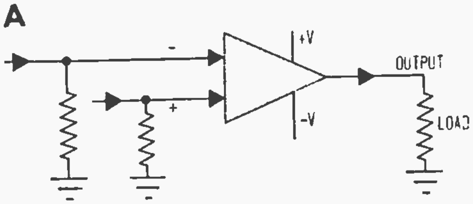
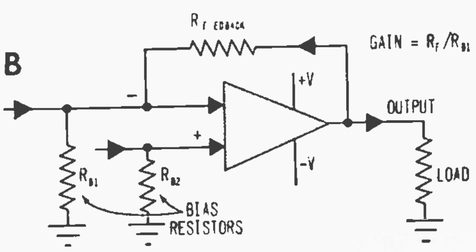


Fig. 3A. Open-loop gain results when amplifier is connected as shown and is maximum gain available. Fig. 3 B. Closed-loop gain is device's gain after feedback has been applied; it's equal to Rf/Rb.

B



when feedback is applied, the inverting (−) input bias resistor becomes part of a feedback voltage divider consisting of Rf in series with Rb1. It can be shown mathematically that, when the input signal is applied between the inverting input and ground, the closed loop gain equals Rf/Rb. When the input signal is applied between the non-inverting (+) input and ground, the closed loop gain equals Rf/Rb+1. Since the factor of +1 is generally insignificant, we can consider that, for experimental use, the closed loop gain is as previously stated. If Rb is 1000 ohms, and Rf 1 megohm, as shown in Fig. 3B, the closed loop gain will be equal to 1 megohm/1000 ohms or 1000. This is equivalent to gain of 60 dB, since gain in dB equals 20 log voltage gain. Regardless of the linear OpAmp used, resistors having these values will always produce the same gain if the amplifier's open loop gain is greater than the closed loop gain. It is not possible to get a closed loop gain higher than open loop gain. For example, an Rf/Rb ratio that produces total gain of 60 dB for one amplifier will not produce 60 dB gain in another amplifier if the latter has a gain of only 50 dB.

Bear in mind that regardless of whether it is an open or closed loop unit, the OpAmp output voltage will be in phase with the non-inverting (+) input and out of phase with the inverting (−) input. For example, assuming the OpAmp in Fig. 3B has a gain of 1000, if 1 millivolt is applied across the input, with the positive voltage connected to the non-inverting (+) input, the output voltage to ground will be +1 volt. If we reverse the input (−) the output voltage to ground will be −1 volt.

Offset Voltage.—What Is It? An important consideration is the offset voltage, which usually refers to the inherent differential voltage, but can also mean a desired DC input voltage difference.

In normal operation, if both inputs are grounded through a resistor, and no input voltage is applied, theoretically the output voltage should be equal to the ground voltage. In actual practice there is a small inherent difference voltage, called the offset voltage, which naturally produces a slight output voltage. If you specifically wanted a quiescent output voltage other than zero you would apply a DC potential to the inputs through a bias resistor and this voltage would be called the operating offset voltage.

(Continued overleaf)

OpAmps

We will spend some time on offset voltage since understanding it will help you trouble shoot experimental projects. In normal linear amplifier operation a zero offset voltage is essential so that output voltage to ground will be zero. This affords the most flexibility in audio and RF circuits. If the output voltage is at zero, the output signal can swing equally to both positive and negative sides of the power supply. For example, if the supply is a +15 V, −15 V (total 30 V) unit, the signal could swing 15 V peak either side of ground (zero output voltage) or 30 V peak-to-peak. But if an offset voltage caused the output voltage to be +10 V under no-signal conditions, the output voltage could only swing +5 V before overload. So for most operations the offset voltage should be as close to zero voltage as is possible.

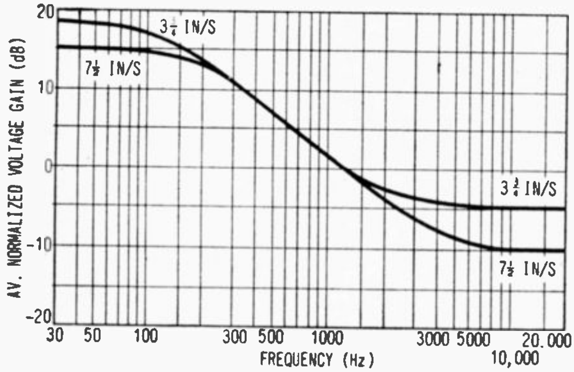
Taking Advantage Of Offset Voltage. However, for specific applications, offset voltage can be applied deliberately. For example, assume a 30-millivolt peak pulse must be amplified to 30 volts peak. Obviously, this can't be accomplished with zero output voltage and a +15 V, −15 V supply, as the maximum possible swing is only 15 V in either direction. Therefore, by applying an offset voltage that drives the output voltage to −15 V, this leaves a full 30 volts available for a 30-V output voltage swing, and when the 3-μV peak signal is applied the output voltage can swing the full 30 V from −15 through zero to +15 volts.

Therefore, you can see the offset voltage can be an advantage or disadvantage, depending on the type of signal with which you are working.

Beware Of Offset Voltage. An important point to keep in mind about offset voltage is, that for zero output voltage the DC resistance path from both inputs to ground must be identical. An OpAmp's input is a transistor, and as all transistors require a bias current, which, though quite small (measured in microamperes), nevertheless does exist. Since the bias current flows through the bias resistor it produces a voltage drop across the resistor. If the resistance paths to ground for the two inputs differ, the voltage drop across the resistors will differ, and the voltage at the OpAmp's inputs will be different. You will have an offset voltage condition. So, as a general rule, the DC path from both inputs to ground must be identical to avoid an unwanted offset voltage.

OpAmp As An AC Amplifier. Bear in mind that the resistance for the OpAmp's inputs includes the entire resistance associated with each input. For example, in Fig. 3B the 1-megohm Rf resistance in series with the output circuit resistance is also in parallel with the 1000-ohm bias resistor. Since feedback resistor Rf alone is greater than 10 times the bias resistor it can be ignored but you will run across many circuits where Rf is an appreciable part, or all, of the DC resistance, and it must be taken into account.

A practical example of the Rf factor is in the tape-head equalized preamp shown in Fig. 4. Since the amplifier is intended for a relatively high input impedance, an 820 k resistor is used for the positive input bias



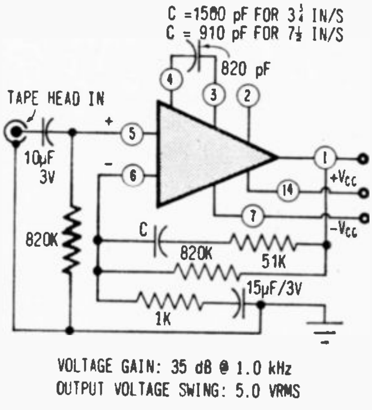


Fig. 4. Circuit for NAB-equalized tape-head preamp using Motorola MC1303L preamplifier. Only one channel is shown here—second channel utilizes other half of IC and is wired exactly the same.

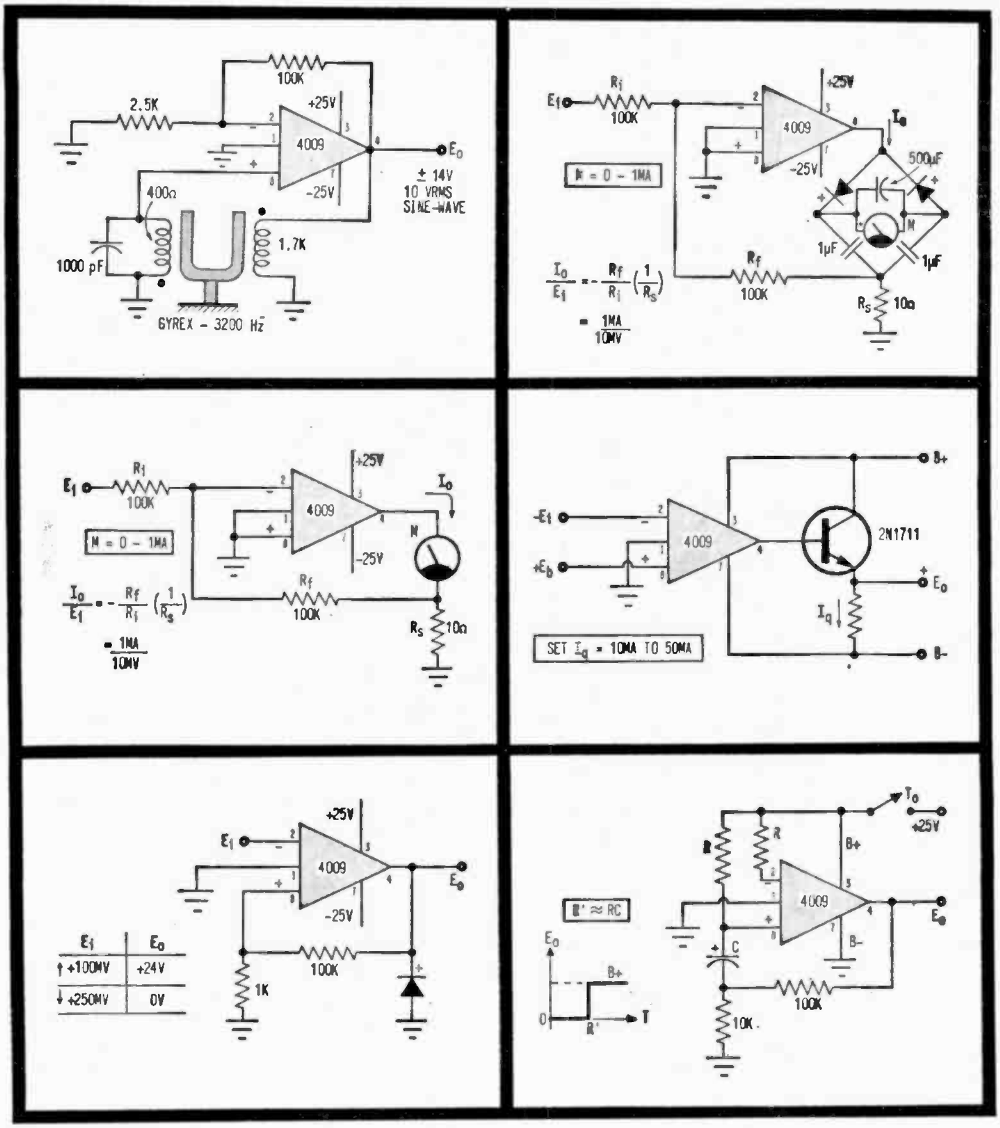


Fig. 5. Six circuits using 4009 OpAmp, available from OpAmp Labs, 172 S. Alta Vista Blvd., Los Angeles, Calif. 90036 for $10.00 ea., postpaid. Circuits, from left to right, are 1) tuning fork oscillator, 2) AC millivoltmeter, 3) DC millivoltmeter, 4) DC medium-power amplifier, 5) Schmitt trigger, 6) fast turn-on timer.

resistor. Now an identical 820,000-ohm resistor in the negative input, which will be used for frequency equalization, is going to result in extremely large feedback resistors. Instead, we use a 1000-ohm negative input load (no longer bias) resistor and isolate it from ground with a 15-uF capacitor. While there is no DC path to ground, the capacitor provides an AC path so that the 1000-ohm resistor can be used for the AC feedback. To provide the equal negative input bias resistance we then connect an 820,000-ohm resistor between the negative input and the output. Since the output is at ground potential both inputs "see" the same resistance value to "ground" and there is no offset voltage. The 820,000-ohm input resistor, in combination with the parallel RC series circuit, produces the proper equalization.

OpAmp As A DC Amplifier. In the previous example you have seen the application of the OpAmp as an AC amplifier. If you go through the calculations you will find

OpAmps

that the AC gain at mid-frequency is determined by the 820,000-ohm resistor and it is identical to the DC gain, again from the formula: Gain = Rf/R bias. By the way, the Motorola MC1303L used in the previous example has a slightly different configuration from the usual OpAmp but is one of the best devices available for the experimenter as it behaves like an OpAmp and with reasonable care is indestructible.

So now we have two practical uses for the OpAmp: a) as a DC amplifier and b) an AC amplifier. By connecting the OpAmp to eliminate the input-blocking and negative input capacitor, the OpAmp can be used for simultaneous DC and AC amplification if you allow for a developed offset voltage.

You're Just Getting Your Feet Wet. This article should provide enough information to get you started on your own experiments, and enough help to get you started building and servicing OpAmp circuits. You must keep in mind that an offset voltage determines the output DC voltage and only AC requires DC isolation of the feedback path bias resistor. Then you should not have too much difficulty calculating and building your own circuits. The only problem you may have is with stability, and you should take precautions to prevent the entire circuit from oscillating. Many OpAmps have a frequency response that extends well into RF, and, just as in any RF circuit, sloppy wiring will cause self-oscillation. Use standard RF wiring techniques, a lot of point-to-point grounds and a 0.1-uF bypass capacitor from each side of the power supply to ground, connected directly at the OpAmp leads, and you'll greatly reduce the possibility of instability.

Going Beyond AC and DC. Once you get beyond the audio and DC experiments why not give some oddball circuits a try? In Fig. 5 we show a number of useful circuits that are easy to build and easy to understand. All circuits are designed around an OpAmp Labs type 4009—but you can try them with any OpAmp, though you may have to change a few parts values to get them going. One tip to help you when working with oscillator circuits is to concentrate on feedback to the positive (+) input, as shown in the Wein bridge oscillator. If you remember your basic theory you will recall that negative feedback reduces gain while positive feedback drives the amplifier towards oscillation until there is sufficient positive feedback to sustain oscillation (same idea as in a receiver Q-multiplier). So, if you can't get an oscillator to start oscillating, make certain you have sufficient positive feedback. Quite often, the same OpAmp circuit will combine both negative and positive feedback, as in the Wein bridge oscillator, and too much feedback will prevent oscillation. The solution then is to increase positive feedback. If this isn't always possible, try decreasing negative feedback.

Why Is OpAmp a Building Block? This is a question you should know the answer to at this point. The reason for its being called a building block is that a complete operating entity can be assembled by stacking together several OpAmps. Let's look at a receiver as a practical example. Long before OpAmps were available, receiver design often required several engineers. One designed the front end, another an IF amplifier to match the front end output, perhaps another for the audio amplifier and finally a technician to connect them all together and iron out the bugs. More modern components generally required one engineer and a technician to de-bug the set. Again the design was circuit-to-circuit, so that one circuit matched another.

(Continued on page 112)

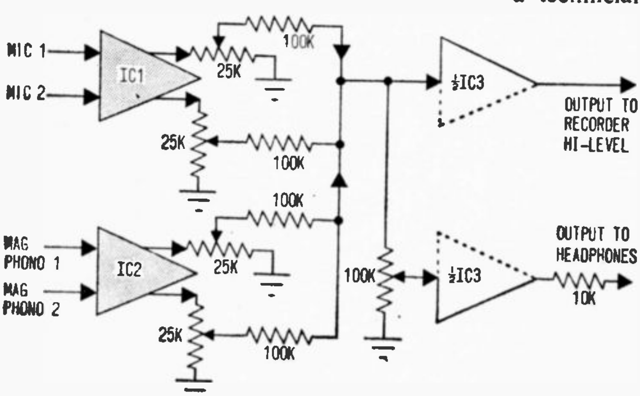
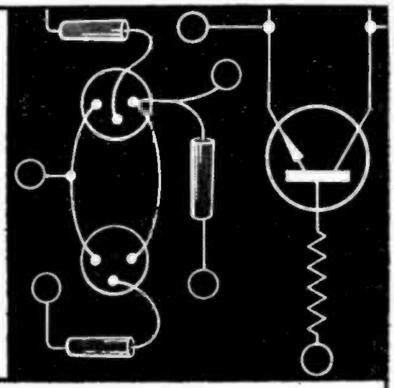


Fig. 6. Just for fun, try designing your own 4-channel mixer using Motorola's MC1303L stereo preamplifier IC. Block diagram gives basic info—you supply all details.

A simple circuit using only five parts is a basic building block for thinking machines. Here are all the details.



Some experiments with....

THE UNIVERSAL LOGIC CIRCUIT

by Jack Brayton

■ It's no news that digital computers are here to stay. The jargon of computer designers and programmers is rapidly becoming a part of our electronics language, as well. "Flip-flop" is an everyday term, and "binary" doesn't leave very many of us cold any more (even if we may not know how to use it).

But it may come as something of a shock to learn that many modern computers are based on a simple circuit which has only five components, and which you can build for under $1 even if you buy all parts new (a little bargain-counter shopping can bring the price down below 40¢). This basic circuit performs all the decision-making functions, and by using several of the basic circuits connected together properly you can also produce flip-flops, latches, and "adders" (circuit arrangements which add two numbers and provide their sum).

This is no "textbook" possibility, either. The identical circuit makes up one half of one of the most popular integrated-circuit modules in current production (the module consists of two such circuits, electrically isolated from each other) and is the heart of many "state-of-the-art" computer designs. In fact, the circuit didn't gain extreme popularity until IC's came along, but is now probably the most widely used type of "logic element."

Logic Elements. Before we get into the universal circuit, let's take a brief detour to examine the whole field of logic elements. If you already know all about them, stick with us anyway, because this is a field in which the same words may mean different things to different people—and different words may end up meaning the same!

In "computerese," a logic element is a circuit or arrangement of parts which performs some "logic function." While the experts list 16 different possible logic functions, only three are used widely enough to warrant discussion. These three are the *and* function, the *or* function, and *negation* or *inverter* action.

An *and* function indicates that *all input signals* must be present in order for an output signal to be produced. The simplest example of this is the pair of switches shown in Fig. 1. If we define "switch closed" as meaning "signal present," then the lamp cannot light until both signals are present (both switches, S1 and S2, closed). If either sig-

LOGIC CIRCUIT

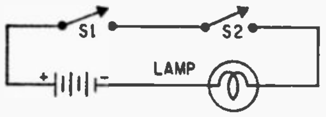


Fig. 1. The basic AND circuit is easily demonstrated with switches in series—S1 and S2 must close before indicator lamp will light.

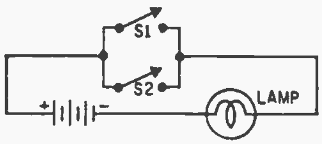


Fig. 2. Switches in parallel are used to demonstrate basic OR logic —either S1 or S2 will light the indicator lamp in this circuit.

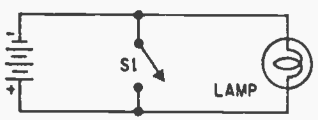


Fig. 3. This logic circuit for a demonstration of NEGATION or INVERSION is simple but not very practical — battery is shorted.

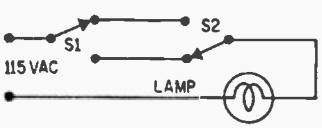


Fig. 4. Demonstration circuit for INVERTER logic—S2 changes condition set by S1. If lamp is on S2 turns it off—off, to on.

nal is absent (its switch open) no current can flow and the bulb remains dark. Implicit here, of course, is the assumption that the bulb being lit represents the output signal.

The *or* function indicates that presence of *any input signal* is sufficient to produce an output. Fig. 2 shows this arrangement with switches S1 and S2 in parallel. Either signal being present allows current to flow and the bulb lights; if both switches are closed it makes no difference, for the bulb requires only one closed circuit to come on.

Negation or *inversion* means that the *presence* of the signal causes the *absence* of output; when the input signal is *not* present the output is there. Fig. 3 shows this arrangement with the switches—but don't try this circuit out, because the dead short would run down the batteries in a hurry. You can see that closing the switch to indicate presence of the signal puts a dead short across the bulb, turning it off so long as the switch is closed.

In case you're wondering why all the emphasis was put on defining the meaning of each event (switch closed = signal present, light on = output present, etc.) it's because the same circuits can represent different functions if signal definitions are changed.

For example, if we re-define the meaning of the switch position so that a *closed* switch means the signal is *absent*, and also re-define the meaning of the lamp so that its being out indicates an output signal, what happens to the circuit of Fig. 1?

With the signals absent, both switches must be closed; this allows the lamp to be on, indicating that no output signal is present. When either input signal is made present (by opening its switch), the lamp goes out, indicating output. But this is the definition of the *or* function, while Fig. 1 was presented originally as an example of an *and* type circuit.

There's no mixup. Any circuit which is an *or* for a given set of signal conditions becomes an *and* when all signal definitions are changed to their opposite meanings, and the old *and* becomes an *or*.

Inverters don't change, because they act on only a single signal rather than on two or more inputs as *or's* and *and's* do; they still produce an output which is the opposite of the input—Fig. 4 is more practical circuit.

Actual logic elements seldom use switches; instead, diode matrices or transistor circuits are usually employed because of speed (although some early logic devices were based on the use of multi-pole relays). If we define a signal's presence as a positive voltage, and its absence as zero volts (or a dead short to ground), Fig. 5 shows some typical logic elements in current use. Those at *A* and *B* are "diode logic," those at *C* and *D* are "RT logic," while those at *E* through *G* are "DCT logic."

These elements may be cascaded one on another, although diode logic requires amplifiers in between logic elements to restore the losses (the other types include the amplification in the elements). Thus if we

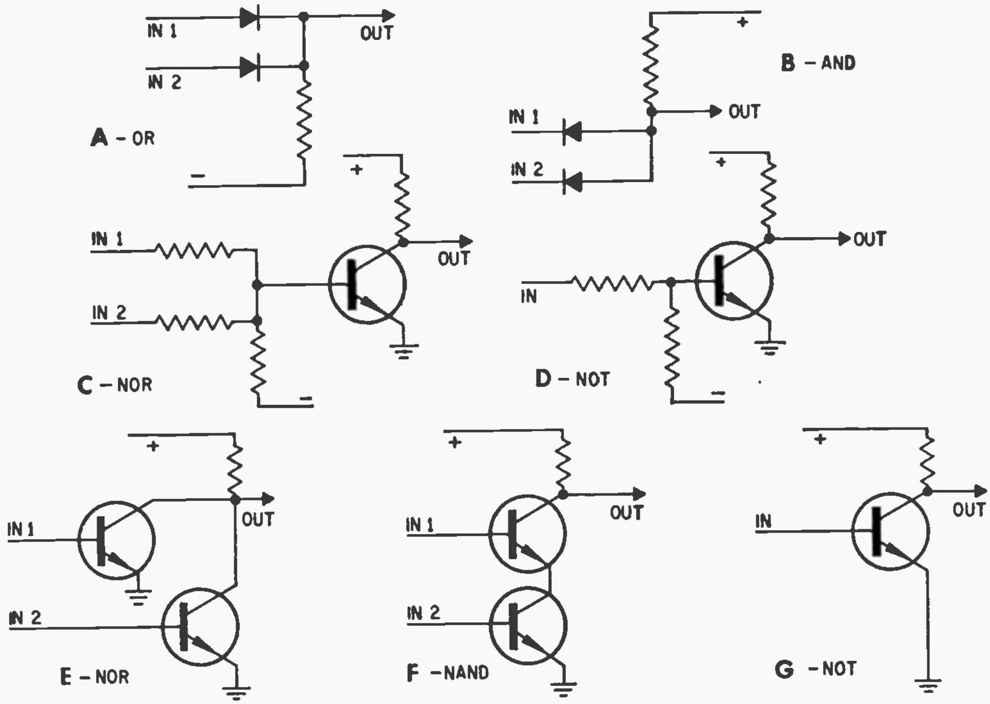


Fig. 5. Circuits A and B are called DL—for Diode Logic. The resistors limit current and provide IR drop for an output. Abbreviated RTL (Resistor-Transistor Logic), C and D have resistance network in base circuit to change base bias (signal). The three remaining circuits (E, F, and G) are DCTL—Direct-Coupled Transistor Logic.

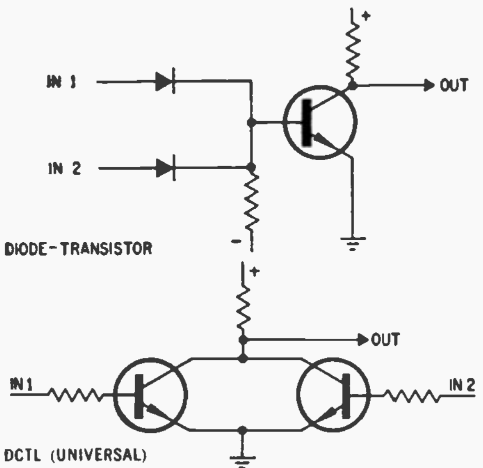


Fig. 6. Diode-Transistor Logic (DTL), top, is combination of circuits in Figs. 5A and 5G. Diodes give input isolation (high resistance) and little signal attenuation (low resistance). The DCTL circuit is Fig. 5E redrawn—resistors in base circuit limit current.

should happen to want an inverted or function, we could first *or* two signals together, then invert the output of this element. If we use DCT logic, the resulting circuit would look like Fig. 6.

The Universal Logic Circuit. And strange as it may seem, we have just developed the *Universal Logic Circuit.* That's it in Fig. 6. Computer designers know it as the *nor* (Not *Or*) *gate.*

Here's how it works: When both inputs are at ground level, both transistors are "off" because neither has any base bias. Current flow through the transistors is very small, typically less than 0.1 ma. Almost the entire supply voltage appears at the output terminal as a result.

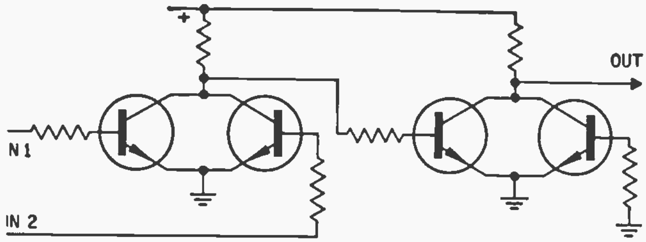
Raising either input to a voltage greater than about .75 volt positive turns on the associated transistor, and the output voltage immediately drops almost to zero since an "on" transistor is virtually a short circuit.

The two resistors in the base leads provide protection for the transistors: the resistor in the collector lead develops the output.

Since we defined a "true" input signal as a positive voltage, this circuit gives us a "false" output if either input is "true." It also, as you can verify, gives us a "true" output any time both inputs are "false." By redefining "true" and "false" voltage levels, we change it from a "not or" to a "not and" or "nand" circuit.

UNIVERSAL LOGIC CIRCUIT

Fig. 7. Interconnecting DCTL circuits produces an OR INVERTER. A signal applied to either IN 1 or IN 2 causes transistor to conduct—effectively grounding transistor base in next DCTL—which switches it off.



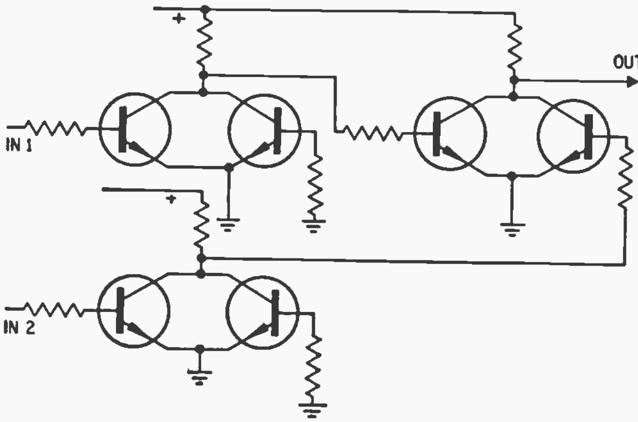
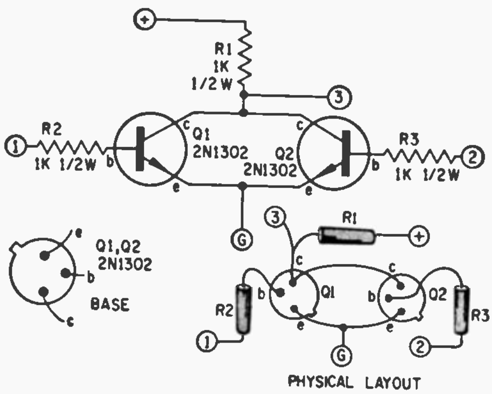


Fig. 8. Three DCTL circuits are interconnected with inverters in the input. This AND logic circuit requires signals at both IN 1 and IN 2 to cutoff both transistors in output DCTL to get a positive-voltage output.

Fig. 9. A practical DCTL circuit is used as the Universal Logic Circuit. Schematic and pictorial diagrams, below, give all needed information to make ULC's needed for experiments demonstrating computer action.



Thus to fully describe the circuit to a computer engineer, you would call it a "positive nor"; if you said "negative nand" you would be equally correct.

If we were to permanently ground one of the input terminals and apply the signal only to the other input, we would have an inverter. To make the circuit into a true "positive or" arrangement, all we need do is take the original circuit and add a second one, modified into an inverter, in the output lead. Fig. 7 shows how this is done. Now with either input "true," the intermediate output is "false." This "false" level is inverted by the second stage to become "true" again, so the output is "true" if either input is "true"—and we have a true "positive or."

It's a little more complicated to develop a true "positive and" function, since the inverters must be placed in the input leads rather than the output. Fig. 8 shows the arrangement; this required three instead of the two needed for "positive or" but produces the true function.

By similarly arranged interconnections between several of these circuits, any logic requirements may be met. We'll perform some experiments to verify this, but first let's build the circuit. Since they're relatively inexpensive, it's best to build about six of them all at the same time.

Building the Universal Logic Circuit. Circuit requirements are not particularly critical, and resistor values can vary 50% either way with little effect on performance. While the diagrams and all the experiments assume the use of *npn* transistors (See Fig. 9), you can substitute *pnp* varieties by reversing all polarities (including those of "true" and "false" in the experiment instructions).

The best components to use are those designed for switching service; a good transistor for the purpose which is also inexpensive is the type 2N1302. The 2N1304 or 2N1306 can be substituted easily. New, these transistors cost about 40¢ each. They are widely available in "manufacturers' surplus" however at prices ranging down to 10¢ each, from firms which advertise in most electronics magazines.

Construction is simplest if you use a separate small piece of perforated board for each circuit. The perforation pattern termed "pattern G" by the makers of Vectorbord allows transistor leads to be threaded directly through the holes without need for clips or eyelets. The resistors mount next to the transistors. Use sturdy terminals for the input, output, power, and ground connections to allow easy changing of interconnecting wires during the experiments.

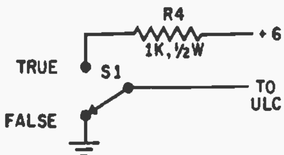


Fig. 10. Simple circuit is I/O SWITCH used to feed data to ULC's. Arm of the switch goes to ULC IN 1 or IN 2.

For a power source, a 6-volt lantern battery is recommended. The current drain is a bit heavy for extended experimentation using flashlight cells, and an AC-powered supply is cumbersome. However, any source of 6 VDC is suitable.

Input and Output Devices. While you can supply input signals by using a resistor and jumper wires, and can determine output levels with a voltmeter, it's more fun to use the I/O (input/output) panel. This consists of a number of s.p.d.t. slide switches, each wired as shown in Fig. 10. Mark the "true" and "false" positions on the panel. The

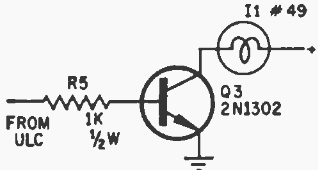


Fig. 11. Circuit for the I/O INDICATOR is easy to wire on a small square of perforated board. R5 connects to ULC output, isolating base and collector.

"true" position is the one which connects the output lead to the resistor and power source. Incidentally, if you use the I/O panel do *not* reverse "true" and "false" meanings when using pnp transistors; the wiring of the panel does the transposition for you so long as its power lead is connected to the same source used for the logic circuits.

The "output" indicators of the I/O panel are No. 49 (brown-bead) pilot lamps, connected to switching transistors as shown in Fig. 11. The 2N1302 is suitable for this purpose also; if you're using pnp's, use a 2N404 or a 2N1303 here. Other pilot bulbs may require too much current for the transistor, so be sure of your bulb type. And note

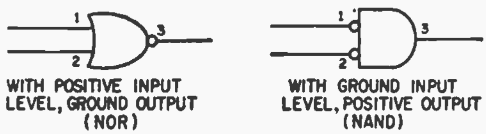


Fig. 12. Block-diagram form of computer elements are in accordance with MIL-STD 806B used to layout many of the computer systems before wiring is begun.

that the supply voltage for this circuit is only —3 VDC. A pair of flashlight cells will suffice since each bulb draws only 60 ma, and current drain when all bulbs are off is almost zero.

The Experiments. We'll go through four experiments, to introduce you to the principles of operation of the *Universal Logic Circuit* and the results it produces. From there, you're on your own. In all these experiments, we'll use the symbols defined in Fig. 12 to indicate each logic block and the manner in which it is connected. The "shield" and "bullet" symbols are those used in military-oriented logic diagrams (as specified by MIL-STD-806B) and are the closest thing to an industry standard symbol in existence today. The tiny "bubble" indicates that the signal at that point is normally "low" (ground), and lack of bubble indicates that signal is "high" (positive) when "true."

Experiment No. 1: Inversion. We've mentioned earlier that the *Universal Logic Circuit (ULC)* may be used to invert a signal. Let's prove it by cascading two *ULC* modules to first invert a signal, then re-invert it back to its original condition.

The hookup is shown in Fig. 13. One input of each ULC module is grounded. The other input of *ULC* No. 1 is connected to the *I/O* panel switch output; the output of *ULC* No. 1 connects to the remaining input of *ULC* No. 2. This output also connects to the input lead of I/O panel indicator No. 1. The output of *ULC* No. 2 connects to *I/O* panel indicator No. 2.

With all interconnections made by clip leads, apply power and operate the *I/O* switch to "false." Indicator No. 1 should

UNIVERSAL LOGIC CIRCUIT

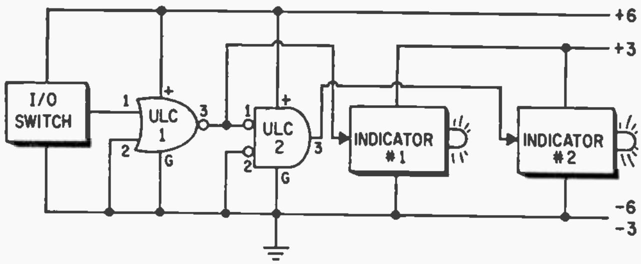


Fig. 13. Block diagrams are more practical for computer circuits. The circuits of modules would have to be repeated over and over, with some changes, to make different types of logic elements. These are the connections for Experiment No. 1.

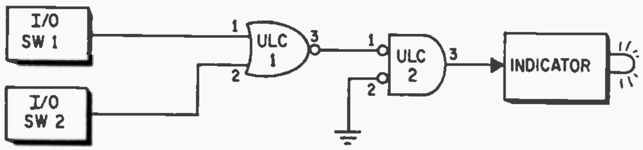


Fig. 14. Experiment No. 2 shows two inputs, one indicator in block diagram while Experiment No. 1, above, has but one input switch for two indicators. Diagram duplicates circuit in Fig. 7—less I/O units.

light, showing that the "false" input has become "true" at the output of *ULC* No. 1. Indicator No. 2 should remain dark, showing that the intermediate "true" output has been re-inverted to its original "false" condition.

Operate the switch to "true"; the two lights should switch conditions. No. 1 goes dark, and No. 2 lights.

A circuit of this sort would never be employed in any actual equipment, since it simply converts a signal state and makes no decisions. However, it shows how the level of a signal at any particular terminal can be set at will, by adding inverters if necessary to reverse the original condition of the signal. We'll be using this property in both the following experiments.

Experiment No. 2: Positive OR Gating. An immediate use of the inversion hookup is to produce a positive *or* element, which generates a "true" output whenever either input is "true". Experiment No. 2 demonstrates this arrangement.

Fig. 14 shows the connections. The inputs of *ULC* module No. 1 connect to two *I/O* panel switches. The output of *ULC* No. 1 connects to one input of *ULC* No. 2, while the second input to *ULC* No. 2 is grounded. The output of *ULC* No. 2 connects to the *I/O* panel indicator.

After all interconnections are made, place both *I/O* switches in "false" position and apply power. Observe that the light stays out, indicating a "false" output. Operate first one switch, then the other, and note that

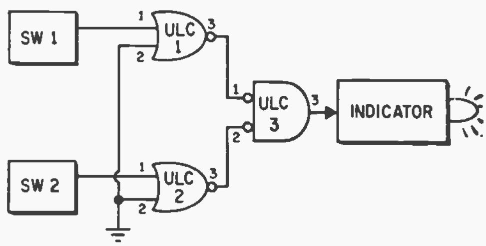


Fig. 15. The block diagram for Experiment No. 3 uses circuit in Fig. 8—just add indicator circuitry and I/O switches. Note simplicity of block diagram layout.

either switch turns on the light. With both switches in "true" position, light remains on.

This circuit is widely used to allow either of two, or more, isolated signals to produce the same output. The inversion stage may be omitted, if the following stage is to perform an *and* function, for reasons which we'll see by comparing the next experiment and the previous one.

Experiment No. 3: Positive AND Gating. Another use of inversion is to obtain the positive *and* function from the *ULC*; this produces a "true" output when, and only when, all input signals are true. A single false input signal holds the output false.

Fig. 15 shows the connections. *ULC*'s No. 1 and No. 2 are used as inverters between the *I/O* panel switches and *ULC* No. 3. The output of *ULC* No. 3 connects directly to the indicator.

Place both switches in "false" position before applying power. Operate each switch separately and note that the light stays out.

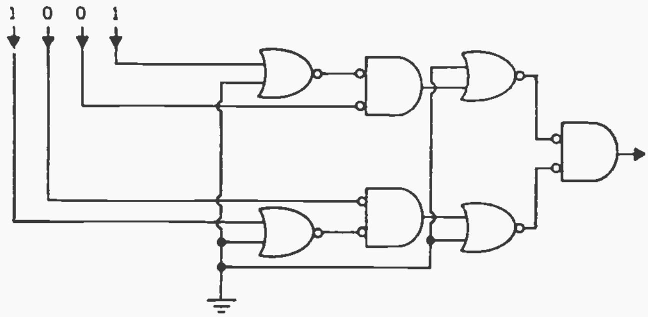


Fig. 16. With four I/O switches feeding in the binary equivalent of decimal 9 this program gives an output. For any other input signal (binary number) there is no output. Binary numbering is used in many computers because the off and on conditions of a switch, and other electronic components, are easy to translate into the two number, 0 and 1, binary system.

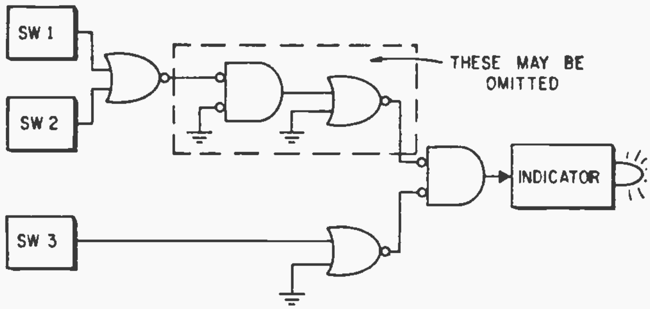


Fig. 17. Even in computers two negatives (inverters or negation) make a positive. Output indication will be the same if the two inverters in the dotted-line box are skipped over and a jumper connected in place of them.

When both switches are operated at the same time, the light indicates a true output.

This circuit is used to detect bit patterns which represent letters, numbers, or instructions for a computer. The value of each bit is taken either direct (if response to a "0" is desired) or inverted (if desired response is to a "1") and applied to the *and* gate input. Sufficient *ULC*'s are used to allow the required number of input signals. The output remains false until each bit value is that required by the gate circuits (either 1 or 0), and at that time becomes true. Fig. 16 shows such a detecting gate arrangement which responds to the binary number 1001 (equal to decimal 9) at its inputs. Typical computer circuits provide for as many as 48 inputs to such gates, to decode a single 24-bit pattern.

If a positive *and* circuit is to be driven by the positive *or* of Experiment No. 2, both the output inverter of the *or* and the input inverter on that input of the *and* may be omitted as shown by the dotted box in Fig. 17. Remember from Experiment No. 1 that two inverters cascaded gave results equal to no inverter at all; since this particular hookup puts two inverters in cascade, both can be omitted. Thus the circuit of Fig. 17 will give a true output if input 1 and input 3 are both true, or if input 2 and input 3 are both true, or if all three inputs are true. Output will be false if either input 3 is false, or both inputs 1 and 2 are false. Try it and see for yourself.

PARTS LIST

ULC MODULES (Each Module)
Q1, Q2—npn transistor, 2N1302, 2N1304, 2N1306 or equivalent.
R1, R2, R3—1000-ohm ½-watt resistor
Perforated board approx 1" x 1½" for chassis; 5 terminals.

I/O SWITCH (Each Unit)
R4—1000-ohm ½ watt resistor
S1—SPDT slide switch

I/O INDICATORS (Each Unit)
I1—Pilot lamp, 2-volt 0.06 amp, type 49 or equiv.
Q3—npn transistor, 2N1302 or equiv.
R5—1000-ohm ½-watt resistor

Misc.—Utility box enclosure if desired; sockets for pilot lamps; machine screws; wire; solder; etc.; 6-volt lantern battery; 3-volt battery.

Estimated construction cost: 96¢ per ULC, 24¢ per I/O switch, and 65¢ per I/O indicator
Estimated construction time: 5 hours including experiments

Experiment No. 4: R-S Flip-Flop. The preceding three experiments have demonstrated all the basic gating circuitry; more complex arrangements are simply combinations of those three, as illustrated by Fig. 16. Now it's time to see how the *ULC* is used to construct flip-flops, which can provide

UNIVERSAL LOGIC CIRCUIT

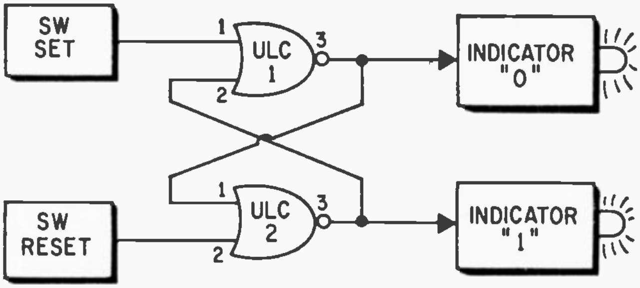


Fig. 18. Using two ULC modules, two I/O switches and two indicators you can hook up and R-S flip-flop in a few seconds. Actually only a single indicator is needed since no light can be used as indication of binary O. The lighted lamp indicates binary 1.

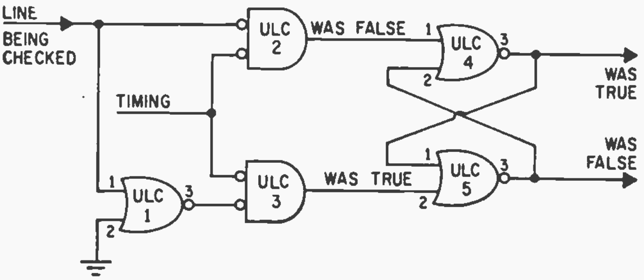


Fig. 19. Explanations for some computer programs become complex so best explanation is the actual operation of circuit. Note circuit action with line input open, shorted and grounded while periodically feeding a pulse into the timing input. Two I/O indicators are needed for demonstration.

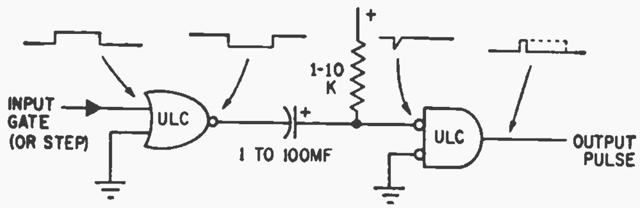


Fig. 20A. The ULC modules can also be used to shape pulses to be fed to other circuits. Here a square wave is inverted, integrated and then formed into a smaller square wave than original.

memory and thus make the circuit truly "universal".

Flip-flops used in today's computers are of several general types, while those usually described at the beginning level are actually all members of one of these types only. The major types are known as *R-S*, *J-K*, and *T*.

The R-S flip-flop is a "reset-set" unit, with two input leads and two output leads. A true signal on the "set" input lead results in a signal on the "1" output, which remains even after the input is removed, until a true signal is applied to the "reset" input. This makes the "1" output false and the "0" output true.

If true input signals are applied to both inputs of a *R-S* flip-flop at the same time, anything can happen. This unit is primarily a *memory* device, and is used only in places where both inputs can never be true at the same time.

A *J-K* flip-flop is similar to the *R-S* type except that its output signals "swap states" if both inputs are made true at the same time. Thus it can count as well as remember.

The *T* flip-flop is similar to a *J-K* except that both input leads are connected together internally; thus this unit can count only!

The connections to build a *R-S* flip-flop from two *ULC* modules are shown in Fig. 18. The output of each *ULC* cross-connects to one input of the other module, as well as driving an *I/O* indicator. The other input of each module connects to an *I/O* switch.

Start the experiment with both switches in "false" position before applying power. One of the two indicators will light; it's purely a matter of chance which one comes on initially. Operate the "set" switch to turn out the "0" light, and the "reset" to turn out the "1" indicator. After operating the switch, return it to "false" position and note that the lights remain in their new position. The circuit is effectively *remembering* the switch position, even after it has been changed.

Keep in mind that the inputs to the *R-S*

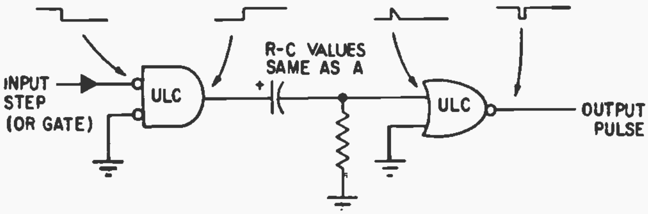


Fig. 20B. Resistor connected to ground in this one-shot multivibrator circuit gives a negative-going pulse from the leading edge of the square wave input signal. Circuit in Fig. 20A has positive pulse.

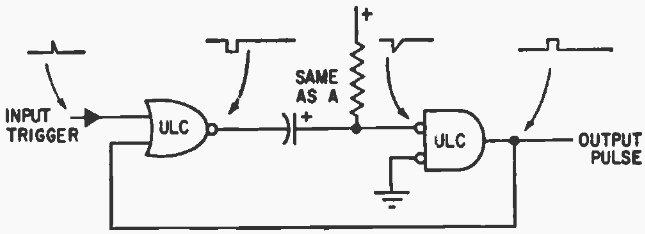


Fig. 20C. Adding feedback loop to one-shot multivibrator circuit allows short-duration positive pulse to generate positive-going square wave at the output.

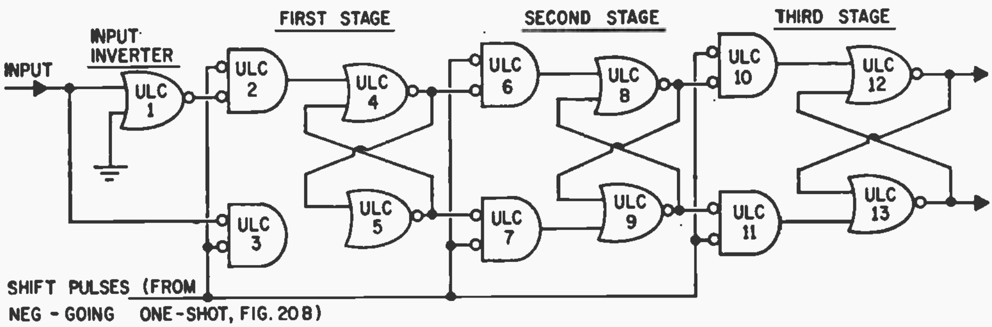


Fig. 21. This 3-stage Shift Register used more than a dozen ULC modules interconnected and with feedback. Shift pulses should be as short as possible. Indicators connect to outputs 4 and 5, 8 and 9, 12 and 13.

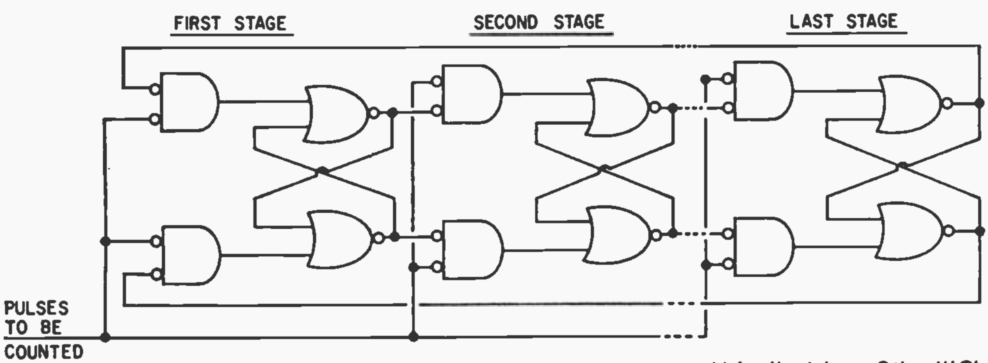


Fig. 22. Ring Counter can be made from Shift Register. Leave out inverter; add feedback loop. Other ULC's can be connected between second and last stages. Binary-1 output advances while all others are O.

flip-flop could have been taken from outputs of either *and* or *or* circuits. Similarly, the flip-flop output can drive gating circuits as well as indicators. For instance, should you want to know the condition on one signal line at a specific time, and have available a second signal which is true at all times *except* the specific time in which you're interested, then a circuit such as that in Fig. 19 would do the trick. (See page 74, top.)

Here's how it works, as a guide to designing your own: *ULC* 1 is used as an inverter to provide the opposite of the signal we're checking, as well as the signal itself (if the timing signal were reversed, true during the time to be checked, an extra *ULC* could have been used to invert it also). *ULC*'s 2 and 3 are separate *NAND* arrangements,

LOGIC CIRCUIT

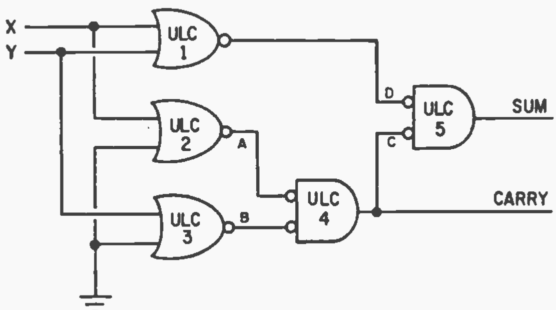
providing a true output only when both the timing signal and the other gate input are both false. The output of *ULC* 2, when true, indicates that the signal being checked was false at the timing point. The output of *ULC* 3, because of the inversion, indicates that the signal being checked was true.

ULC's 4 and 5 form an *R-S* flip-flop which remembers whether *ULC* 2 or *ULC* 3 provided the true output signal at checking time, and maintains the record until the next checking time occurs. If the signal was true, providing true output from *ULC* 3, then the output of *ULC* 5 is made false. This in turn provides one input to *ULC* 4, and the false output from *ULC* 2 provides the second input. With both inputs false, *ULC* 4 produces a true output level. This is applied to *ULC* 5 as its second input, maintaining *ULC* 5's output false, thus closing the loop to hold both *ULC* 4 and *ULC* 5 outputs constant until a new input signal arrives.

ULC's 2 and 3 both provide false output until the timing signal goes false again, so that the only time at which the flip-flop condition can be changed is that determined by a false level on the timing line.

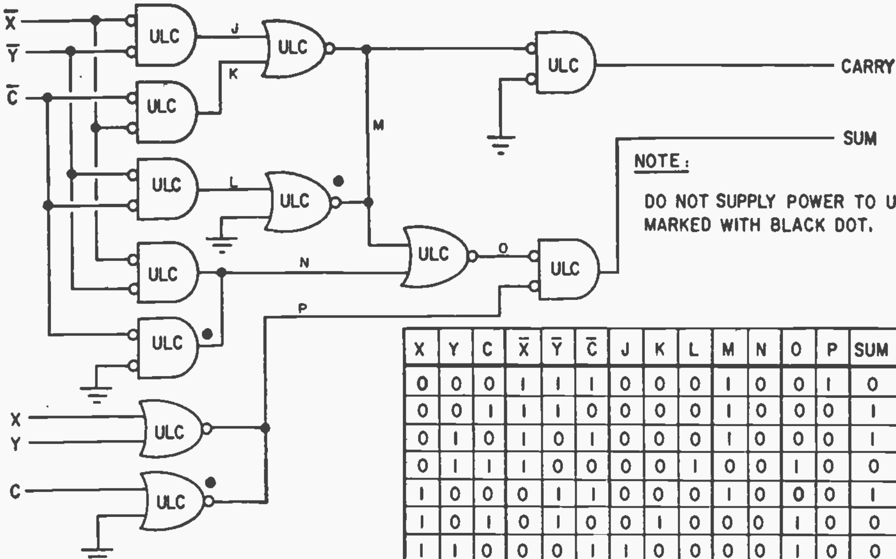
These circuits switch in only a few mil-

(Continued on page 110)



X	Y	A	B	C	D	SUM	CARRY
0	0	1	1	0	1	0	0
0	1	1	0	0	0	1	0
1	0	0	1	0	0	1	0
1	1	0	0	1	0	0	1

Fig. 23. Half-Adder performs binary addition for two bits (X and Y signal inputs). In this program binary 1 is a positive-going input pulse while binary O is ground or the absence of a pulse at inputs X or Y.



X	Y	C	$\overline{X}$	$\overline{Y}$	$\overline{C}$	J	K	L	M	N	O	P	SUM	CARRY
0	0	0	1	1	1	0	0	0	1	0	0	1	0	0
0	0	1	1	1	0	0	0	0	1	0	0	0	1	0
0	1	0	1	0	1	0	0	0	1	0	0	0	1	0
0	1	1	1	0	0	0	0	1	0	0	1	0	0	1
1	0	0	0	1	1	0	0	0	1	0	0	0	1	0
1	0	1	0	1	0	0	1	0	0	0	1	0	0	1
1	1	0	0	0	1	1	0	0	0	0	1	0	0	1
1	1	1	0	0	0	1	1	1	0	1	0	0	1	1

Fig. 24. Full Adder includes carry-bit inputs (C and $\overline{C}$) but requires double inputs. DC power connections are not in these block diagrams—it is very important to note power isn't applied to ULC's marked.

ASK HANK, HE KNOWS!

Continued from page 88

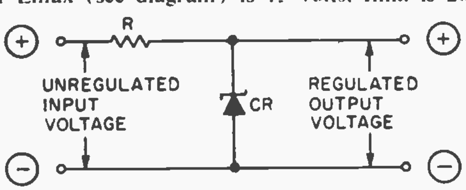
checking ability lies within the capacitor, itself. When you first connect the VOM across a discharged capacitor, the inrush of electrons into the capacitor's dielectric from the VOM's internal battery supply causes current to seemingly flow through the capacitor. This current "flow" is seen by your VOM's needle as a change in dielectric resistance; that is, until the capacitor's dielectric can absorb no more electrons. Current flow now dwindles off to a mere dribble; your VOM sees this as a very high resistance. All of this dancing-meter action takes place almost in the time it takes you to connect your VOM's leads to the capacitor under test. So you'll need a sharp eye and steady hand to see your meter needle jump! In the case of electrolytic capacitors, though, the dielectric charges in a considerably greater span of time. You should see the needle leap over to the zero ohms reading, and slowwwly slide back to the infinite ohms side of the meter's face. Reason is an electrolytic capacitor's dielectric is composed of material that sops up a charge over a greater time span. And don't wait for your VOM's needle to completely swing over to its zero ohms position, either. With an electrolytic connected across your VOM, you'll wait for some switched-on, tuned-in messiah to appear before that capacitor reaches its fully-charged state!

Zapped by a Zene-R

What value of resistor should I use with a zener diode in a voltage regulator circuit?

—*L. M., Baltimore, Md.*

It depends upon the maximum input voltage (Emax), the minimum load current (I) and the regulated output voltage (Eout). For example, if Emax (see diagram) is 15 volts, Imin is 20



mA and Eout is 9.1 volts, you need a 9.1 volt zener diode (CR) and a 5.78-ohm resistor (R). First calculate the voltage drop across R which is 15-9.1=5.9 volts. If the zener diode is a 10-watt type, its zener current will be approximately 1 ampere. Thus the current through R will be 1 + 0.02 or 1.02 amperes. The value of R, therefore, should be 5.78 ohms since R=E/I, or, 5.9/1.02. Also, it will dissipate 6.018 watts. Since a 5.78-ohm resistor is not standard, parallel a 10-watt 7.5-ohm and a 5-watt 25-ohm, resistor. Now, if load current rises to 1 ampere, zener current would fall to 20 mA. Or, if input voltage dropped to 13 volts with load current at 20 mA, the voltage drop across R would be only 3.9 volts, and the zener current would drop to approximately 656 mA. Now, with reduced input voltage, if load current rises to 500 mA, the voltage drop across R would remain at 3.9 volts, and the zener current will drop to 156 mA.

Games That Switching Transistors Play

Could you set me straight on switching transistors (like those on surplus computer boards). Do they work at audio frequencies or can these transistors be rigged up in RF oscillator circuits?

—*E. J. A., Bronx, NY*

Depending upon the age, type, and original use of the surplus-variety switching transistor, it may be plugged into small-signal or power circuits, and can generally be used for most low-frequency applications. Some switching transistors will work at RF, especially those manufactured within the past couple of years.

Wrist-Watch-Sized Meters For Sale

Could you please tell me where I could get a meter that is at least 2% accurate, and has the physical size of a wrist watch? Is there a company that makes a line of meters this small, or would they have to be specially made?

—*J. G. H., Cottonwood, CA*

Try Phaostron Instrument & Electronics Co., 151 Pasadena Ave., South Pasadena, CA. They make one-inch diameter meters rated at 2% full-scale accuracy.

Caught by a Pre-amp Propheteer

I bought a pre-amp chassis and need a power supply to operate it. The place where I bought this unit said I would need a power supply capable of delivering 150 VDC @ 30 milliamps. I hope you can give me a diagram for this supply.

—*V. D., Joliet, IL*

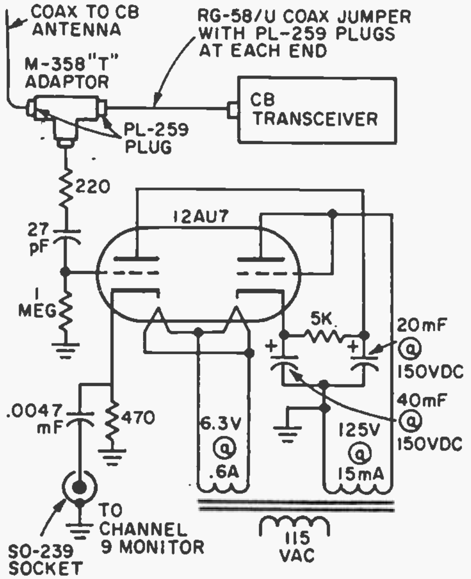
Judging by the schematic of the pre-amp you sent with your letter, a much wiser alternative would be to send the unit back where it came from. As an audiophile-turned-philosopher of note once remarked: "Garbage gear is garbage gear is garbage gear . . . ad nauseum."

Extra Ears For Channel 9

Now that CB Channel 9 has been officially made an emergency channel, many CBers would like to build a very inexpensive receiver for monitoring this channel while listening for their regular calls on other channels. Please print a diagram showing an inexpensive monitoring receiver setup for this purpose.

—*J. P. R., St. Louis, MO*

You could build an inexpensive—no, downright cheap!—superregen rig that does nothing but listen for distressing yelps on Channel 9. But if rolling your own doesn't hack it in your head, buy a used CB base station transceiver and connect it to your regular CB rig through an isolator. You can probably pick up a used rig for a song and a dance. After you waltz the



rig home, disable its transmitter by disconnecting the mike and PTT switch. Your normal CB set is connected to the antenna through a coaxial "T" adapter. Follow our diagram for proper hookup. Whenever you transmit with your normal CB rig, the isolator will electronically separate the Channel 9 receiver from your transceiver.

Loopstick Eye Opener

Where can I buy ferrite loop antennas other than those listed in Lafayette Radio Electronics' catalog?

—J.B.W., Staten Island, NY

Scrounge and ye shall find, quoteth your Workshop Editor. If you look westward, you'll find that one of the niftiest electronics parts houses catering to the Order of the Ohm devotee is none other than Burstein-Applebee Co., 3199 Mercier St., Kansas City, MO 64111. Drop them a postcard.

Carefully Coax The Coaxial Cable

How do you run a coaxial cable through a window without drilling a hole? Can the cable be jammed under the sash at the window sill? Will flattening the coax affect its operation?

—S. M., Northampton, PA

Squashing even a small length of coaxial cable will definitely alter its impedance. Don't try mashing it down. Instead, drill an undersized hole under the window sash. Snake the cable through this hole. Then seal the outside with caulking compound. It would also be a good idea to loop the outside portion of the cable so that it forms a natural rain gutter. This way rain water won't seep into the sash.

Sock-et To Your Transistors

Instead of soldering and unsoldering transistors each time I use them, how can various types of transistors be plugged into a circuit with the same ease of a tube?

—E. L. M., Sudbury, MA

Plug-in transistors are not as available as they used to be. The alternative is to solder lead-type transistors to an Amphenol octal plug. This assembly can be plugged into an octal tube socket. Be careful to observe transistor polarity.

Aesop's Electronic Fable?

I received a package of 200 transistors as a gift. I have never seen any of them ever used in any magazine. And, the catalogs I have give me no info to go by. I wonder if you can help me.

—F.M.C., Medical Lake, WA

A gift, huh. Seems to us that 200 transistors tied together would make for a groovy strand of love beads.

Letter S Louse-up

I am strictly an amateur at the art of radio and electronics, and am now at your mercy for information about a transistor (Toshiba type 25A93). Please tell me where I can buy this transistor type, how much it costs, and what it does.

—H. K., Hamilton, Ont.

What you are really at the mercy of is an improper designation! We looked in Toshiba's catalog of transistor types, and found a type 2SA93 listed. The transistor type you wrote to us asking info for doesn't exist; a simple little problem like substituting an S for a 5 makes all the difference! To answer your last question, the 2SA93 is a pnp-type transistor, useful in BCB circuits. There are several replacement types for this transistor; try a 2N500, 2N1500, or 2N2180 if you can't find the 2SA93. You can buy the Toshiba transistor, or any of its equivalents, at any well-stocked electronics supply house.

Dis Depth Finder Done Died

I recently constructed a depth finder kit. It works OK up to 15 feet, but beyond that depth it indicates nothing. My power supply consists of two 6-volt lantern batteries. Under load, they deliver 11.5 volts. Must I add a pre-amp, or should I change transistor types?

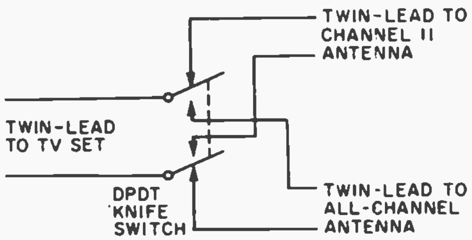
—K. W., Sheboygen, WI

What would you add a pre-amp to, we ask. And don't bother changing transistor types, either—the kit manufacturer likes to have his depth finder kits put together with the widgets supplied. Chances are the underwater probe is defective. But if both your depth finder kit and probe check out okay, find yourself a landlubber sport.

Strike Three on Eleven

I want to watch the New York Yankee baseball games being televised on channel 11 (New York City). My antenna is 42 feet above the ground, and it's feeding a signal booster. I am located in a valley west of Newton which is about 60 air miles from New York City. How do I get better reception on channel 11?

—F.A.E., Newton, NJ



We don't answer letters from non-Mets fans. Seriously though, you need to install a separate stacked-beam antenna cut to channel 11. Connect it to your TV set through a switch as shown in the diagram. And, as you found out with your other antenna, the higher you mount it, the stronger the signal will be at your TV's antenna terminals.

Humdinger of a Rig

I bought a short wave receiver and I am quite happy with it. My problem is the receiver has developed a hum that drives me crazy. The hum isn't always present. Sometimes it doesn't appear, and then sometimes it does. If I turn my radio off, and then back on again, it might go away. But then it comes right back on again in a little while. Sometimes when the hum is there and I turn my receiver volume up high, it goes away and when a loud noise (it sounds like static) comes in, the hum goes away. As you can see, the problem isn't easy to explain. My buddy had the receiver over at his house and he couldn't get the receiver to hum at all. Is the problem in the rig or my location? There are no high tension wires near me.

—T.A., Bedford, OH

It sounds as if the problem lies with your receiver. Perhaps it's a tube with an intermittent short circuit, or a bad case of inter-electrode leakage, playing havoc with your rig. Check your tube's electronic health on a tube tester that has the capability of checking for inter-electrode leakage and grid emission. A drug store, or cheap, cathode-emission type tube tester might not detect a subtle tube fault. Try a new set of tubes even if the tube tester reveals no faults. If that doesn't work, buy a bottle of tranquilizers.

Body Talk For a Color Organ

I have a color organ which has two input wires and want to connect it to my stereo rig. How do I hook it up for best results? I don't want it to interfere with speaker performance.

—E.V., Edgewater, MD

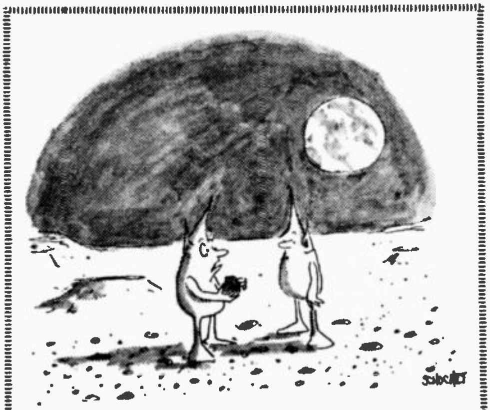
The input impedance of your color organ should not present any unusual loading hassles to the stereo amp. Generally, the color organ's input impedance is several times that of the stereo amplifier's output impedance. It's a perfectly safe procedure to connect the color organ's input wires to the stereo amp's output terminals. Unless the color organ manufacturer warns you otherwise, connect the input wires to the 16-ohm and Common (or Ground) amplifier terminals. Set the input level controls of the color organ so that the lights are activated on musical passages of normal volume. If you're planning to connect one color organ to your stereo, then buy a "hybrid" transformer having three separate windings. Two of the transformer windings match the amplifier's output impedance: the third winding matches the color organ's input impedance. When properly connected, the color organ will simultaneously respond to both channels.

Hole in Zero

I plan to install a police band 150-174 MHz monitor receiver in my car. But, my wife doesn't want me to drill an extra hole in the car top for an 18-inch whip antenna. Can I use my AM auto radio antenna?

—D. C., New York City

Replace your AM auto radio antenna with a Hy-Gain 712 disguise antenna. Any mobile radio or CB dealer, or radio parts store can order one for you. It lists at $22.50. This antenna provides 3 dB of gain on the VHF band and it's junction box has a jack for your AM auto radio. You can use this antenna for both BCB and VHF. ■



"It must be very valuable. Why else would they spend 24 billion dollars and travel 238,800 miles for this?"

New Products

(Continued from page 9)

advantages of high input impedance and sensitivity of the vacuum-tube voltmeter, while adding stability and portability. A symmetry circuit protects FETs from over-voltage transients and provides balanced temperature compensation. Calibration of plus and minus voltages is identical. Voltage regulation maintains constant voltage for the life of the batteries. The 176 has true peak-to-peak AC measuring, high AC frequency response (to 3 MHz), fuse and diode protected against accidental overloads. 4½-in. sensitivity meter with convenient zero scale for special applications. RF accessory probe which extends frequency range to 250 MHz, and a high-voltage accessory probe that brings the voltage range to 60 kV with input impedance greater than 1000 megohms. The B & K Model 176 FET/VOM is priced at $99.95. Optional probes are: RF, $11.95; high voltage, $15.95.

Circle No. 19 on Page 8

Buried Treasure Seeker

EICO TH-30 Treasure Hunter

Both ferrous metals (iron, steel, tin) and non-ferrous (gold, silver, copper)—to a depth of up to 6 inches—are ferreted out by EICO's new model TH-30 Solid-State Detector Kit, $29.95. As the "Treasure Hunter" approaches the search area, the presence of burried coins, underground and building pipes, etc., heightens the pitch of the audio-frequency beat note heard through the built-in speaker. Engineered for long-term trouble-free performance, the EICO TH-30 comprises an all-solid-state circuit design, powered by a single 9-volt battery.

Circle No. 20 on Page 8

Fast Count

The new Heathkit IB-101 frequency counter uses computer-type integrated circuitry to provide accurate counting from 1 Hz to over 15 MHz without any special test gear adjustment. An overrange indicator and Hz/kHz switch give the IB-101's five cold-cathode display tubes the same capability as a much more expensive *eight-digit counter.* Readings to the nearest kHz are made with the range switch in the kHz position. Pushing the range switch to the Hz position allows reading figures down

Heathkit IB-101 Frequency Counter

to the last Hz. The overrange & Hz/kHz indicators light up to give error-free frequency measurement and correct range at all times. And it's only $199.95 in kit form.

Circle No. 21 on Page 8

Safety First

Kalimar has just introduced a new safety device that should be in every room in your home, office, and factory; and should also be

Kalimar Fire Alarm

carried with you on those out-of-town trips. No batteries or springs are needed. Just plug into any 110-volt AC outlet. When room temperature reaches 140°F., a loud *BUZZ* will alert you to take action. Sells for $9.95.

Circle No. 22 on Page 8

This Beep is Clean

Two head cleaners that signal "enough" when they have done their work, and a versatile five-way test-and-clean unit are available for the increasingly popular eight-track cartridge players. All three products by Robins are actually housed in standard eight-track cartridges to make it easy to get the best possible results. Model THC-9, listing at $2.50, is a head-and-capstan cleaner cartridge, with pre-recorded "beep" tones. Its specially formulated cleaning tape is permitted to run, removing accumulated oxide, grime anjd dust particles, until four beeps are heard. The recommended usage frequency is every 20 hours of player operation. Model THC-10, listing at $3.00, employs a special non-abrasive polyester tape to clean cartridge player heads for optimum sound fidelity. It talks with clicks, and is permitted to run until four clicks are heard. Then the cleaning job is done. The five-way "Test-N-Clean" cartridge is Model THC-11, listing at $5.30. To

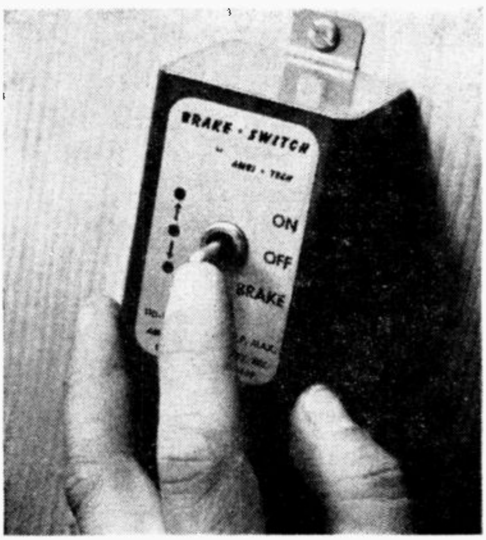
Robins New Cartridge Head Cleaners

help keep equipment trouble-free, it performs these vital functions: testing track selector, testing stereo channel balance, testing speaker phasing and testing head alignment to assure full fidelity playback without crosstalk. THC-11's fifth task is to clean player heads while it is testing. Robins, whose home office plant is in College Point NY 11356, is a major single-source manufacturer of cassettes, cartridges, reel-to-reel tape and cassette, cartridge and phon accessories. Look for them on racks at your favorite hi-fi dealer.

Circle No. 23 on Page 8

Brake-Switch For Safety

Home craftsmen and industrial users can now improve shop safety as well as production effi-



Ambi-Tech Brake-Switch

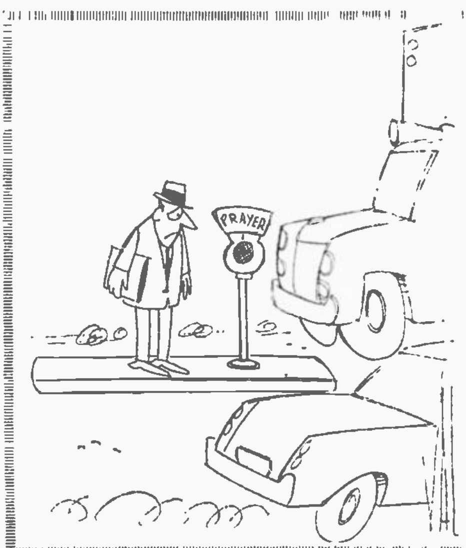
ciency by stopping motor-driven equipment with remarkable speed. Brake-Switch, a novel solid-state device, made by Ambitech Industries, features ON, OFF, and BRAKE switch positions, with an automatic return to OFF when BRAKE position is released. Installation is simple requiring no rewiring or mechanical attachments. The unit comes complete with an integral grounded receptacle and 9-ft. heavy-duty power cord. The switch can be mounted anywhere, permitting remote control if desired. Brake-Switch is ideal for controlling AC motor operated tools such as radial arm and table saws, lathes, grinders, etc. Slowdown time is eliminated, resulting in quicker setups and increased production speed. Long life is assured by solid-state construction and all units are guaranteed for 1 year. Standard unit, rated at ¾ HP or 10 A., sells for $14.95, plus postage.

Circle No. 24 on Page 8

Pegboard Hangers

Every practical handyman and fix-it shop knows that the right way to efficient operations is to have a clean, uncluttered work area with facilities to keep all disassembled parts where they won't roll away, get lost or mislaid or gather dust and dirt, with tools at your fingertips. All Handy-Hanger pieces are made of high-impact plastic, structurally sturdy to take abuse, snap into ⅛-in. pegboard, provide a convenient place for tools, parts, and supplies. Two different 9-in. long tool holders accommodate screw drivers, pliers, wrenches and other hand tools. A 9-in. shelf will hold all kinds of loose, boxed, bottled, or canned items. Three sizes of parts bins, 7, 5, and 3 in. are just the thing to hold parts and supplies. Individual units are priced from 20¢ to $1.00, depending on item. A trial kit consisting of one of all 6 items is available for $3.50. ■

Circle No. 25 on Page 8



Logic Circuit

Continued from page 104

lionths of a second, yet will hold their conditions as long as power is supplied. Thus the circuit of Fig. 19 provides a means for determining the level on a line at an almost-instantaneous point in time, and retaining the record as long as desired.

Miscellaneous Circuits. These four experiments only scratch the surface of the possibilities open with *ULC*'s. Figs. 20 through 25 illustrate additional circuit arrangements possible with the units. For additional ideas, try the chapters on "Logic" and "Digital Circuitry" (chapters 5 and 7 respectively) in *General Electric's Transistor Manual, Seventh Edition*—or make your own by trial and error. One of the major advantages of the *ULC* is that it is almost indestructible: the only precaution to take is to see that the "output" terminal is never shorted to the power source. ■

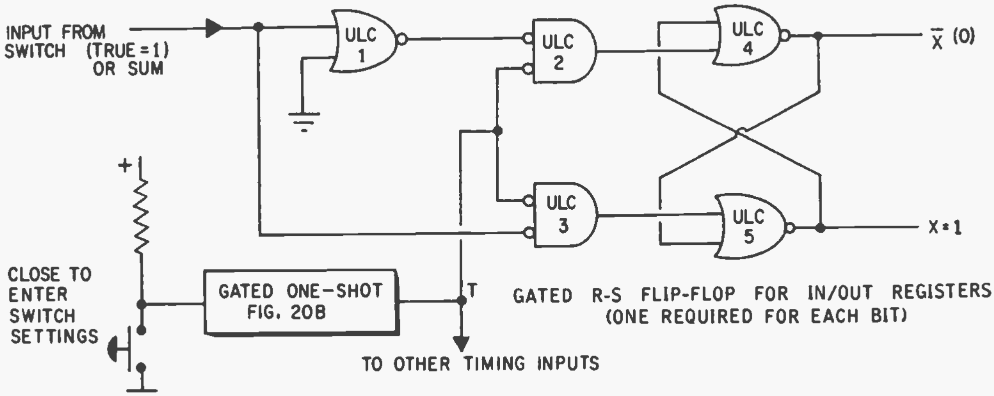


Fig. 25A. A gated R-S flip-flop, for in/out registers, is needed for each binary bit needed in computer program.

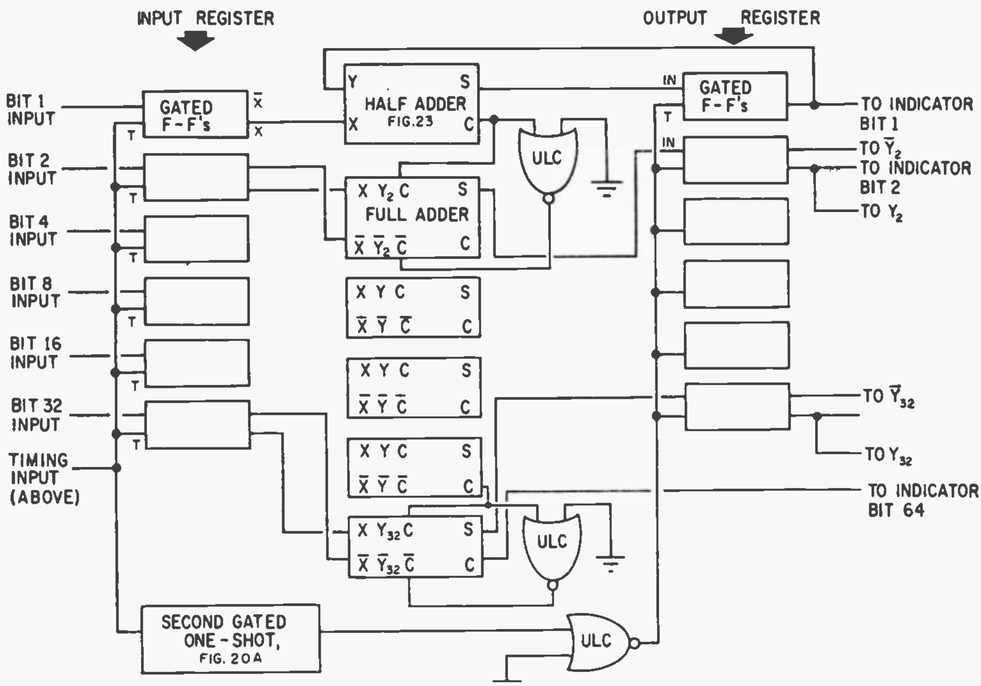


Fig. 25B. Great computers grow from little modules. This adding machine adds totals up to 127 using scores of ULC modules. All connections are not shown—those for bits 4, 8 and 16 are the same as for bits 2 and 32 and would make the block diagram harder to understand. Since 135 ULC modules makes construction expensive.

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Continued from page 94

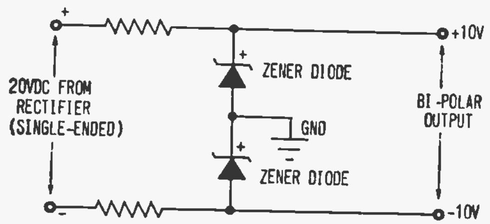

Fig. 7. Getting bi-polar output for OpAmp circuitry may pose problems, but solutions are easier than you might expect. One is to toss in a couple of Zeners: input is single-ended; output, bi-polar.

But with OpAmp design each circuit becomes a separate building block that will mate with any other block—just as toy blocks can be mated. Let's assume you build a front end for a receiver, you know the desired output voltage and the required matching impedance. You then select an off-the-shelf OpAmp for the IF amplifier having the required input impedance (no matching problem), add a tuned circuit and a resistor in the feedback loop to establish the circuit's resonant frequency and gain, and once again, before the circuit is built, you know the output voltage and impedance. For the AF amplifier you select an OpAmp having the required impedance, add the correct feedback resistor for the desired gain and your amplifier is complete. This is possible because an OpAmp can produce either high or low power out, and a single OpAmp can provide the entire voltage gain and power output stages of the AF section of your receiver.

You can take the same building block approach with other circuits. Each circuit function can be designed as a building block, the entire circuit being achieved when they are all connected together.

Let's Experiment. Here's a useful building block project you may want to try. Starting with a Motorola MC1303L stereo preamplifier, in building block fashion, design a 4-channel mixer/amplifier in which: two channels are for mikes, two for magnetic phono or tape head inputs, and having a high level output. Try this approach, one MC1303L will be used for the two mike channels, one for the two equalized channels for magnetic phono pickup or tape head, and one half of an MC1303L as the output amplifier, with the half remaining as an amplifier for a VU meter or headphone monitor amplifier. Fig. 6 is a block diagram to get you started—from there on you're on your own. However, because locating a bi-polar power supply can be an Excedrin headache, we'll help you out with the power supply.

Bi-Polar or Single-Ended. A bi-polar supply is, as we have previously discussed, a power supply that produces an equal voltage either side of the center tap or ground, since the center tap is generally grounded. Using a power transformer single-ended secondary, as in Fig. 7, you can provide a zero voltage point, or phantom-ground by connecting two Zener diodes across the rectified output of the supply. The junction of the two Zeners serves as the ground, or center tap. The major problem with this arrangement is that you must select the correct series resistor and each half of the supply will be a half-wave rectifier. Also, this requires a fair amount of filtering, achieved either through large, expensive capacitors or a capacity-multiplied transistor regulator.

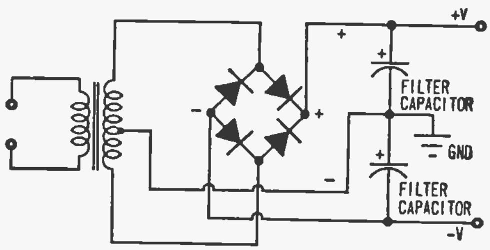

Fig. 8. Even cheaper way to achieve bi-polar output is to combine bridge rectifier with center-tapped power transformer. Full-wave output is easy to filter, ideal for most OpAmp circuits.

An alternative approach is shown in Fig. 8 above. Using a power transformer having a split-secondary (center tapped) and a bridge rectifier, you produce a center-tapped supply with full-wave rectification on both sides, which requires much smaller filter capacitors.

The more popular power source is a single-ended power supply having positive and negative output leads—generally either side may be grounded. By connecting two 4700-ohm resistors across the supply, the junction of the resistors becomes the center tap (ground) and each side of the supply will provide output voltages of opposite polarity with respect to the center tap or ground. ■

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