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- 15-Watt Amp
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by the Editors of ELEMENTARY ELECTRONICS

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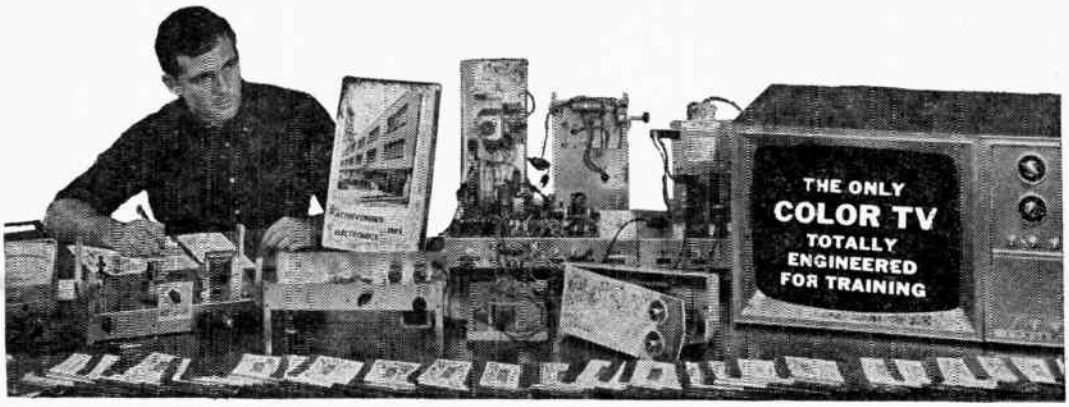

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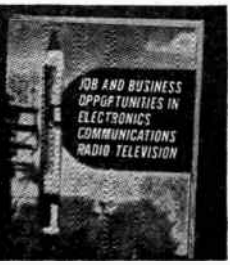


101

101 Electronic Projects for Under $15

1	Professional Burglar Alarm	26	Light-Controlled Switch
2	Solid Tach	27	Electronic Screamer
3	Automatic AC-DC Power Supply	28	Sideband Sideman
4	Power Megaphone	29	Budget Lamp Dimmer
5	Easy Auto Theft Alarm	30	RF Probe for VOM
6	Powerhouse Larynx	31	Super Mike Mixer
7	Speak-A-Mike Preamp	32	Mike Matcher
8	Fish Caller	33	Appliance Tester
9	Modulated 100 kHz Calibrator	34	Low Voltage Diode Tester
10	Open Circuit Burglar Alarm	35	Silicon Rectifier Tester
11	Stop Motion	36	RF Probe for VTVM
12	"Serutan" Crystal Rig	37	Dynamic Brake
13	Crystal Radio Amplifier	38	Budget 10V Swinger
14	FM Interference Filter	39	Multipurpose CB Oscillator
15	Flood Alarm	40	Portable CB Antenna
16	Stereo Balancer	41	Budget Mike Mixer
17	Slide Synchronizer	42	Headphone Limiter
18	Simple IF Signal Generator	43	CB Tuning Adapter
19	Enlarger Meter	44	Speech Snipper
20	Field Strength Meter	45	CB Modulation Lamp
21	No Parts BC Booster	46	CB Scope Stretcher
22	3-Way Tone Generator	47	CB Xmission Line Monitor
23	Square Shaper	48	Remote Flash
24	Treasure Locator	49	Mini-Drain Pilot Lamp
25	Latching Burglar Alarm	50	Wink and Blink

30 Integrated Circuit Projects

1	**Super 15 Amplifier**	9	**CB Booster**
2	**Current Swinger**	10	**Rock Spotter**
3	**Comm-press Log Amp**	11	**Spy-Sized Amplifier**
4	**Porta-Groove Amp**	12	**Far Out Gain Control**
5	**SCA Adaptor**	13	**Great Equalizer**
6	**Groove Booster**	14	**RPMeter**
7	**Hum Buster**	15	**Hot Lips**
8	**Silent Mike Preamp**	16	**Professional Remote Amplifier**

. . . and there's more!

ELECTRONIC PROJECTS FOR UNDER $15

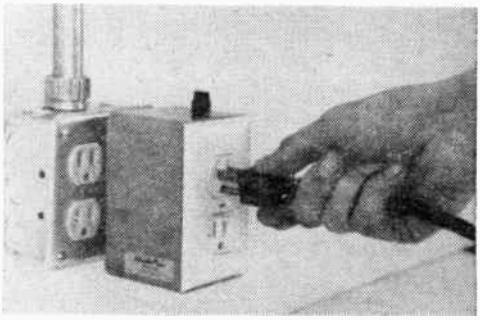
Pages 42-96

Pages 16-41

New

Down with Surges

A new plug-in AC Overvoltage Surge Suppressor prevents over-voltage burn-outs, erratic malfunctions, or inaccurate data from electronic equipment. The suppressor is designed for use in electronic test labs, medical and industrial electronics, or wherever electronic equipment is powered by AC lines. It offers protection against most voltage spikes caused by hookup, startup, shutdown, switching, stray pickup, lightning, etc. Designed to plug into any standard 50/60 cycle, three-



prong AC outlet, it provides two three-prong outlets which are fully protected against voltage surges. When a voltage surge exceeds the Suppressor's 200 volt trip point, a red light indicates the presence of the transient. The unit automatically turns on and immediately suppresses the voltage to an acceptable operating level. It then automatically turns off—ready for the next surge —while permitting continued, safe operation of equipment. Price is $39.50. Additional information is available by circling No. 46 on the Reader Service Coupon on page 7 or 109.

Nice Match Up

To fill the many mobile antenna requirements for all-frequency monitor radio coverage, New-Tronics announces the Hustler Monitor-Match, Model 5-M. A design of network isolation and impedance matching in the Monitor-Match is used in conjunction with your regular outside mounted or windshield antenna to give complete coverage on 25-50 MHz, high-band 140-175 MHz, and UHF 300-500 MHz. Installation is easy, requiring only plug-in connectors. Any desired number of outlets may be used. For further details

Products

circle No. 45 on the Reader Service Coupon on page 7 or 109.

Tuning Light

With its new CI-1020, Heath Company brings a completely self-contained solid-state timing light in kit form within easy dollar reach of professional and amateur alike for only $19.95. The unit features a special flash tube and solid-state circuitry to produce a high intensity flash that won't wash out even in direct sunlight. A high impact plastic focusing lens inside the barrel concentrates the beam into a clearly defined spot for increased accuracy. In operation, one of the unit's cables is connected to the car's battery terminals, and on to the number-one spark plug. A distributor cap adaptor also is provided. The slim-line housing is made of rugged high impact plastic that resists oil, gas and corrosion, protects against

electrical shock. Other features include circuit protection against damage from reverse polarity and a built-in calibrator. For additional information on the new Heathkit CI-1020 Solid-State Timing Light, circle No. 43 on the Reader Service Coupon on page 7 or 109.

Digit Midget

Weston Instruments has introduced a low cost, battery-operated portable digital multimeter, a "mini" package that can be carried anywhere. The new Model 4440 Digital Multimeter features seventeen ranges at 3½ digit resolution and weighs less than 2½ pounds. Designed specifically for field use, the Model 4440 can operate continuously for 8 to 12 hours on four rechargeable C cells. The Model 4440 Digital Multimeter is not just another multimeter. It has a full range coverage for most applications. Seventeen ranges cover 200 mv to 1000 volts AC/DC, 200 ohms to 2 megohms, plus AC and DC current. Accessory plug-in shunts are available to extend the AC and DC current ranges. To prevent the possibility of incorrect readings in the overrange condition (beyond 1999 on all ranges, except 999 on 1000 volt range), the Model 4440 circuitry is designed to blank all digits except a 1 in the thousands place plus the polarity sign and decimal, all

(Continued on page 110)

WHO'S WHO ON
101
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READERS SERVICE PAGE

101 ELECTRONIC PROJECTS

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• The Editor of 101 ELECTRONIC PROJECTS—1972 ISSUE offers readers an easy way to get additional information about products and services advertised in this issue. To become proficient in your hobby you must obtain the correct quality parts, knowledge, test gear, tools and many other items. Become a knowledgeable buyer by obtaining information on the products and services mentioned in this issue, and keyed with a Reader Service Number, it's yours for the asking. Just follow the instructions below and the literature you requested will be sent to you promptly and at no cost. It will be a pleasure to serve you.

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• Okay. I want some information and I want it fast. Please arrange to have the literature whose numbers I've circled at right sent to me as soon as possible. I understand this is a free service; however, I must limit the circled items to 20.

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	32	33	34	35
36	37	38	39	40	41	42
43	44	45	46	47	48	

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101 Electronic Projects 1972 Edition

More than two years ago 101 ELECTRONIC PROJECTS was conceived for the electronics experimenter whose first love was project building. At that time a subtitle was tacked onto the magazine —"for under $10." Well, we had to up the price $5 to $15 for reasons well known to us all. Our struggle to keep experimenting costs down failed —the economy was working against us. However, the price of the magazine remains the same mostly because you and thousands like you purchase copies from newsstands all over the continent (we have a large and active Canadian audience), and our advertisers continue to place their ads in this magazine. With this spirit in mind, the editors added new projects and updated many others to make our 101 projects the best reference source for low-priced projects you can find anywhere. Also, we've upped the number of IC projects from 21 to 30.

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.

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 a 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 wtih a voltage rating lower than that specified.

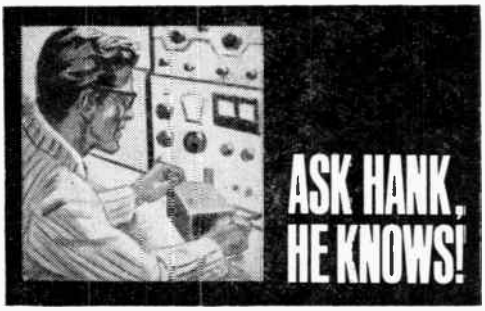
Potentiometers can be any taper unless a specific taper is specified. When batteries are specified do not use a smaller size than recommended. Current requirements for a project are taken into account for the battery type suggested in the Parts List.

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.

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 S. Martin

JULIAN S. MARTIN
Editor in Chief



Boom Boom Boom

The neighbor in the apartment above us has a pre-war RCA radio-phonograph combination which has so much bass that it sounds like jungle drums to us. He told me that if I can cut down the bass, it's OK with him. Fiddling with the tone control only cuts down the treble. What can I do?

—E. L., San Francisco CA

Give him a pair of headphones. Or, you can try any of the following. Replace the coupling capacitor from the volume control rotor to the first AF amplifier with one of much smaller capacitance. Or, replace the cathode bypass capacitor of one of the AF stages with one of a much smaller value. Or connect a pair of 40-*u*F electrolytic capacitors, back-to-back in series with one of the speaker leads.

Junk It

Some FM stations can be picked up on two places on the dial separated by a short quiet zone. This is part of a stereo multiplex system, isn't it? What I want to know is can I tune one FM set to one spot on the dial and another to the other spot and have stereo?

—J. B. T., Somewhere USA

In the first place, you've got a lousy FM receiver. No, you cannot get stereo the way you have described. You'll get mono-mono and what we've heard about "mono" (kissing disease), it can be contagious and debilitating. Your getting double reception because your FM receiver is a low-cost table-top job. Replace it.

Fluorescent Bulb Spotter

I replaced my CB ground plane base station

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

Ask Hank, He Knows

antenna with a beam on a rotator. It works great, but in some directions all signals are noisier than they were before. Why?

—R. G., New York NY

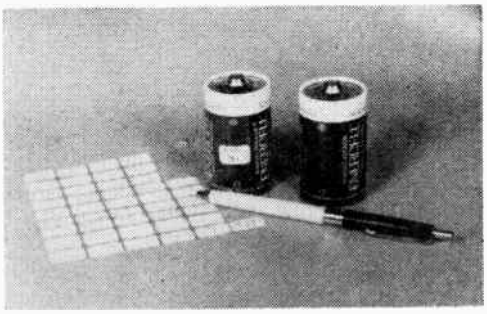
The beam provides gain and increases effective receiver sensitivity and effective radiated power. At the same time, it increases the noise level, particularly if the beam is aimed into an area where electrical noise is generated.

Dating Batteries

Why don't manufacturers place a use-before-date label on dry cells? I never know which ones on my bench to use first.

—D. R. H., Huntsville AL

Now that batteries are used in everything from toys to test equipment, it is becoming increasingly difficult to remember when a particular set was installed or new one purchased. One technique that seems to work well is to write the purchase date on self-adhesive labels and affix them to the cells. On test equipment using mercury cells, it helps to also put a label on the outside of the equipment case with the date the battery should be replaced.



Ghosts from Oil

I live in an area about one mile from a very large oil refinery. Due to my location, transmission from the TV stations is received on all television sets in the area with a very strong shadow due to the reflected signal bounced back from the many oil tanks. Some people in the area have improved their reception somewhat by using an external antenna. But even with this the reception is far from enjoyable. Perhaps you might know of some device on the market, or maybe you could tell me how to construct some device myself.

—M. P., Montreal, Quebec

Move. If it is not feasible, subscribe to a CATV service. If CATV is not available in your neighborhood, try a very high directional antenna and aim it at either the TV station or an oil tank so you will receive either the direct or reflected signal and nothing else!

Switch to Class D

I have a one-hundred milliwatt walkie-talkie which operates on CB channel 4. Range is only one-third of a mile and I would like it to be one mile. Can you suggest anything?

—M. B., Traer IO

You're getting pretty good range. If you're over 18, get a CB license and buy a 1-watt or more powerful walkie-talkie. There's not much that can be done to increase the range of a 100-mW unit unless you connect an external antenna to it, which is illegal when operated without a CB station license.

CB Sky Scratcher

What is the FCC antenna height limit for a CB antenna on a boat?

A. R., Miami Beach FA

As high as you can put it. The 20-foot antenna height limitation applies only to stations at fixed locations.

Year One VTVM

I have a Vomax Model 900 VTVM made by McMurdo Silver Co. Could you or any of your readers supply me with a schematic diagram or the present address of this company?

—G. B. L., Vancouver BC

Your VTVM belongs in a museum. McMurdo Silver, one of the big names in radio in the '20's and '30's, died long ago. So did his company. Why not spring for a new one?

Just Don't Ask the Police

Is there any place where I can write for the

(Continued on page 12)

"Four channel!"

LITERATURE LIBRARY

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

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

52. *Custom Alarms* reveals how inexpensive professional alarms can really be. Install one yourself. Circle 52 for exclusive catalog.

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

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

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

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

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

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

59. It's just off the press—*Lafayette*'s all-new 1972 illustrated catalog packed with CB gear, hi-fi components, test equipment, tools, ham rigs, and more—get your free copy!

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

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

62. Magnetic nutdrivers! They are new and exclusive with *Xcelite*, and come in ¼" and 5/16" sizes. They are water-coded, and have fixed handles in regular, extra long, and super long styles. They come in midget pocket clip types and interchangeable shanks for Series 99 handles.

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

64. For CB'ers and SWL's there is a free 12-page catalog from *Mosley Electronics*. Antennas for every need—base station verticals and beams, mobile, marine, SWL; also complete line of accessories is included.

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

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

67. *Heath*'s new 1972 full-color catalog is a shopper's dream. Its pages are full of gadgets and goodies everyone would want to own.

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

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

70. Free 1972 Catalog describes 100s of *Howard W. Sams* books for the hobbyist and technician. Includes books on projects, basic electronics and many related subjects.

71. 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.

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

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

74. Kit builder? Like wired products? *EICO*'s 1972 catalog takes care of both breeds of buyers at prices you will like. Now—discover *EICO*'s burglar alarm system products.

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

76. *H. H.* Scott has a parcel of pamphlets describing their entire 1972 line of quality hi-fi products. They have *Scottkits*, too!

77. *McGee Radio*'s 1972 catalog is free with bargains in hi-fi and general-use speakers. There are also a thousand-and-one other electronics products at low, low prices.

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

79. Want a deluxe CB base station? Then get the specs on *Tram*'s super CB rigs. Become a super CBer today.

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

81. Pep-up your CB rig's performance with *Turner's* M+3 mobile microphone.

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

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Not Valid After December 30, 1972

Ask Hank, He Knows...

frequency of my local police department? I have already tried asking them but they simply gave me the old wive's tale that it is illegal.

—D. R., Waseca MN

Call or write to Jim Hervey or Trav Marshall at E. F. Johnson Company in Waseca, Minn. They'll know. It isn't illegal to know the frequency nor is it unlawful (yet) to listen in. But, it is against the law to make use of what you hear and to tell anyone what you heard.

Who Said So?

I have on old RCA Victor radio. When I tried to have it fixed, I was told the transformer was shorted out and they did not make them anymore. Could you tell me where I could get one?

—M. F., Austin TX

If you took it to a radio repair shop, they should know how to select an equivalent transformer. It doesn't have to be an RCA part. Take it to a shop that knows how to repair *radios*. Surprisingly, some TV repairmen don't.

Bad Image

Why is it that I receive several local radio stations on other than their assigned frequencies with my 200 kHz to 30 mHz Brand "X" receiver? One operating on 1580 kHz, for example, can be heard at about 670 kHz and at other frequencies. I am told this is spurious radiation. Is this true?

—E.V., Jackson Miss.

It is unlikely that spurious radiation is the cause if more than one station can be heard at two or more frequencies. It is more likely due to inadequate "image" rejection in your receiver. If your receiver has a 455-kHz IF amplifier, the local oscillator is tuned to 1125 kHz when the tuning dial is set to 670 kHz. It is the 1590-kHz signal getting through to the mixer, beating with the 1125-kHz local oscillator signal, that causes a 455-kHz IF signal to be produced, just the same as when the dial is set to 1580 kHz and your local oscillator operates at 2045 kHz to produce a 455-kHz IF signal, except that the received signal is weaker.

Since you are experiencing this with several stations, a signal, fixed tuned wave trap at the antenna won't do. Try shortening your antenna in order to reduce pick-up of the strong broadcast signals. Your set has an antenna trimmer which you should be able to attenuate the unwanted image signal and accentuate signals at the frequency to which the dial is tuned.

Would You Believe—220th Harmonic

I can't hear the local FM weather station on 162.55 MHz because my local station WVLN, 740 on the dial, rides right in blocking the weather forecast.

—W.A.S., Olney IL

Your trouble may be one of location. I don't believe the 219th or 200th harmonic of WVLN will jam your FM hi-band receiver unless you are very close to the station's antenna. The Midland unit you are using, is a good one. Why not pull up stakes and test the rig at another site to prove to yourself the trouble is your location and not the rig.

Bags of Wind

Every now and then I come across a strange station on around 20.5 MHz and on about 13.5 MHz. The station monotonously plays a long interval signal which resembles bagpipes. At first I thought the station could have been an international broadcaster, but after playing the quick, cut-short music for almost 2 hours straight, I am convinced it could be some utility station. Could you help me?

—D.M.B., Eastchester NY

Clearly, it is a utility station, not an international broadcaster. But, frankly, I don't know its identity or location. My best guess is that it is an overseas telephone station, probably commercial and the "bagpipes" is a "marker" signal used to keep the circuit open when there's no traffic. If you asked about a similar type signal played on a horn, I'd say Paris. But "bagpipes" is a new one for me. I've caught something similar at times with weird

(Continued on page 14)

"Listen here, Gladys, you never argued eight hours with a solid-state computer!"

ANNOUNCING-

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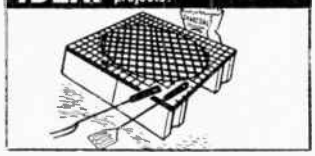

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Here is a partial list of the foremost experts who created the "Can't-go-wrong" projects: Bernard Gladstone, Home Improvement Editor, New York *Times*; Walter Fischman, "how-to" writer, New York *News* and *Popular Science*; Robert Hertzberg, famed electronics expert, Art Margolis, who conducts TV Repair Department of *Popular Science*, Fred Russell, dean of car experts—and hundreds of others!

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Ask Hank, He Knows...

collections of electronic tones, but I can't identify that either.

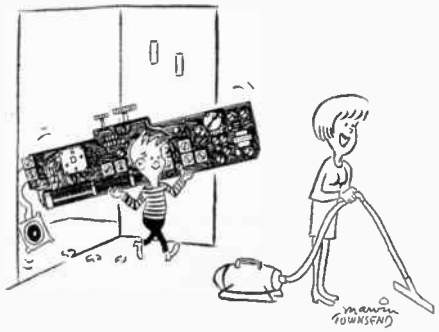
With some specific times mentioned I might at least speculated on the general area of the world, based on propagational factors. If anyone can help, please write.

Making Waves

Why do radio signals travel farther over water than land?

—M.K., Washington DC

If the world were a polished metal sphere and the air a perfect insulator, then a signal leaving an antenna would travel close to the surface of the sphere all the way around the surface with almost no loss of power. A radio signal traveling over water sees a low resistance surface. This resistance is much lower than the solid surface of earth. Hence, the signal will go farther over water than land. Land surface offers a high resistance and limits the distance a radio wave can travel before it is dissipated. Also, the irregular surface of land chops up the ground wave and breaks it up much the same way a hurricane is broken up over land.



"And what did mother's little boy learn to make at school today!"

Bonus Circuit—Rain Kicker

Next time a drizzle or light rain has your car's windshield wipers scraping away on dry glass, just think how much more convenient it would be to just "kick" the wipers every once in a while—when the glass gets really wet. The Rain Kicker will give your wipers just the kick it needs to clear the rain without grinding in the dirt. Fully adjustable from a once-in-a-while-kick to normal operation, it can be used on most all late model cars except Fords. The only requirement is that the car's wiper switch control the circuit from the motor to ground (car body). If the switch is between the car's battery and the wiper motor, the Rain Kicker cannot be used.

Though it might appear that the SCR will be turned on permanently, a running-switch built into the wiper motor assembly will cycle the SCR after each sweep.

Just about any layout can be used. You can build the unit in a small metal enclosure or directly into the dash. Potentiometer R2 adjusts the wipers from an occasional kick to normal.

PARTS LIST FOR THE RAIN KICKER

C1—50 uF, 15 VDC electrolytic capacitor
C2—20 uF, 15 VDC electrolytic capacitor
Q1—Unijunction transistor Motorola 2N4948
R1—220-ohms, ½ watt resistor
R2—250,000-ohm, ½ watt resistor
R3—100-ohm, ½ watt resistor
SCR1—Silicon rectifier, 75 PIV, 3 A. Motorola 2N4441

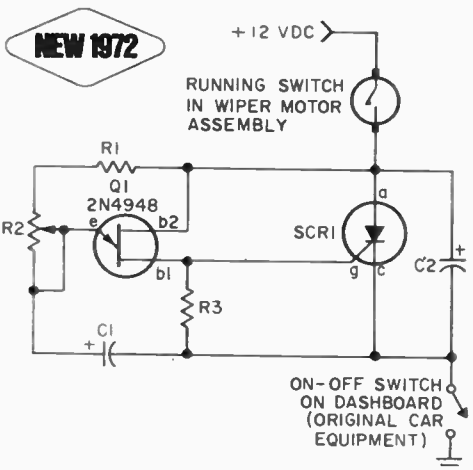
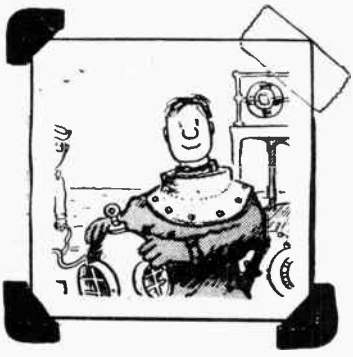


PHOTO PHLASHES

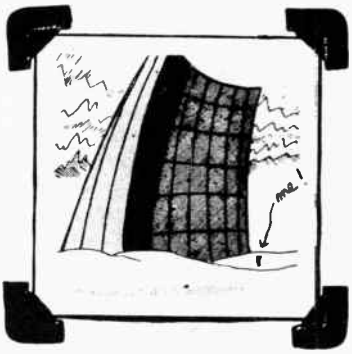
by Jack Schmidt

"This is Harrold when he got his first radio.'

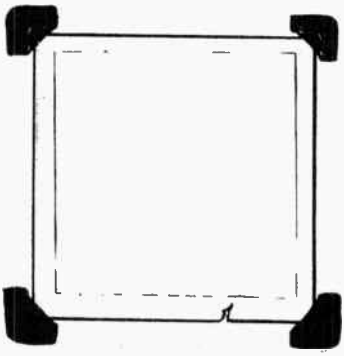
"This was the day he got stuck on the roof while fixing the antenna..."



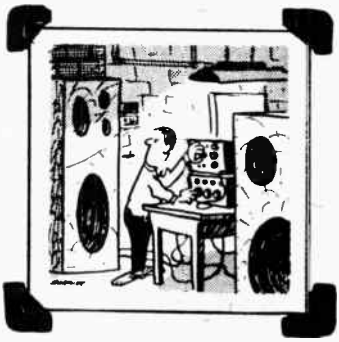
"He knew all about radio when he went into the Navy, but you know the service..."



"He took a repair job on the DEW line when he got out..."



"This is the first picture he took with his multi-head strobe flash..."



"This was our first stereo... the largest in the neighborhood."

30 INTEGRATED CIRCUIT PROJECTS

Integrated circuits are growing bigger every day—while growing smaller. What we mean of course is that industry, the government and the home are making bigger and better use of these micro-miniature marvels of the space age. Higher and higher orders of packing density now put major circuits in tiny packages. Consider for example our SCA adaptor project. A single little dual in-line package does the work that a rack of tube equipment did only a decade ago. In industry, precise automatic control and testing equipment becomes economically feasible as large scale integration (LSI) circuits are put to use.

To help introduce the newcomer—and delight the *old hand* as well—we've added nine new IC circuits and upgraded our original 21 to give you thirty big IC projects *in addition* to our regular 101 Projects section.

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 handful 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 function" 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

YOU CAN BUILD

sca adaptor	tape preamp	recorder preamp
auto tachometer	stereo phono preamp	dynamic mike preamp
frequency spotter	audio signal tracer	1-watt amplifier
spy-size amplifier	1 kHz oscillator	audio compressor
intercom	regulated 9v supply	stereo system balancer
phono amplifier	bi-polar-supply	100x instrument amp
cb booster	regulated variable supply	4-channel mike mixer
tape dubbing amp	ac millivoltmeter	silent mike preamp
comm-press log amp	ten meter dxer	far out gain control
super 15 amplifier	add-on product detector	pro remote amplifier

extreme bandwidth, just the length of the IC's power supply terminal can become a 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 Electronics, EDI, BA and others.

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 *T0-55* can (or a modified form of the T0-55), 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 configurations, by all means use it. Keep in mind, however, that the T0-55 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.)

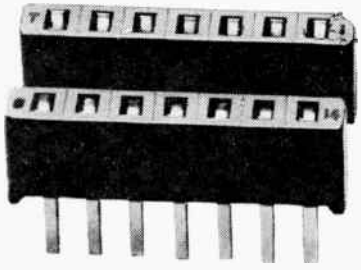
Though the ICs can be soldered directly into the circuit, they are extremely difficult to remove without damage. And, it generally takes special desoldering equipment to remove an IC from a printed circuit board. Although IC sockets cost just a few cents more, we suggest they be used at all times. Should there be a wiring error, the most you

30 INTEGRATED CIRCUITS

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



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; TO-55 type is to right of it. Both types are readily available from electronics supply houses.

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 TO-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 package 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 and you just position the notch to the left.

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 in-

put 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 T0-55 IC so they form a circle of approximately ¾" diameter. This will give you a little more room, and reduce the possibility of "solder bridges" across the connections.

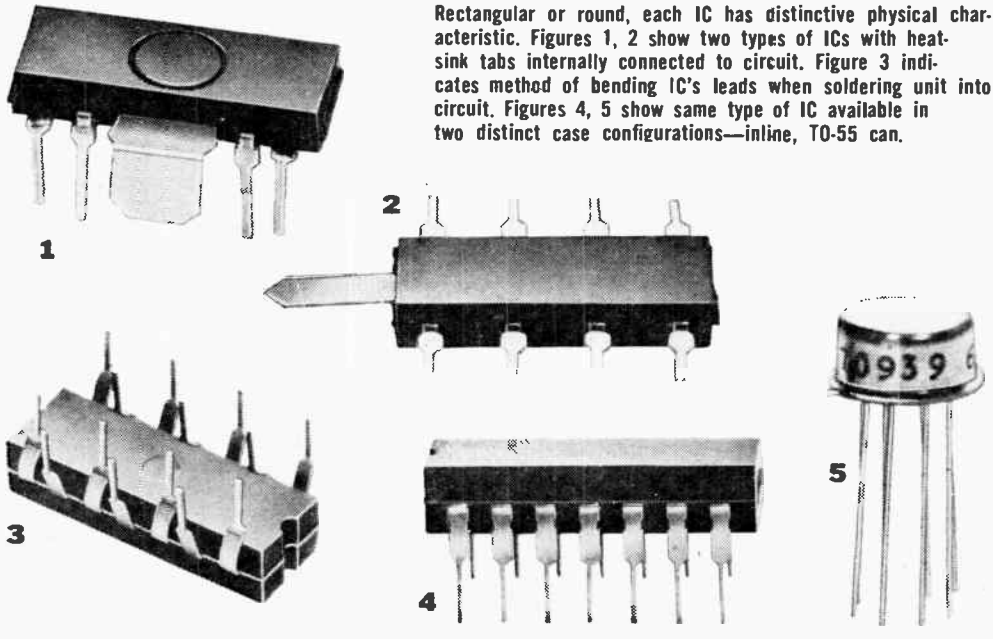
If you insist on soldering inline ICs directly into the circuit, offset every other terminal by gently bending the terminal outward and downward. Some ICs are factory offset especially for direct soldering: if you obtain such a unit do not suspect it is damaged because the terminals are offset. As previously 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.

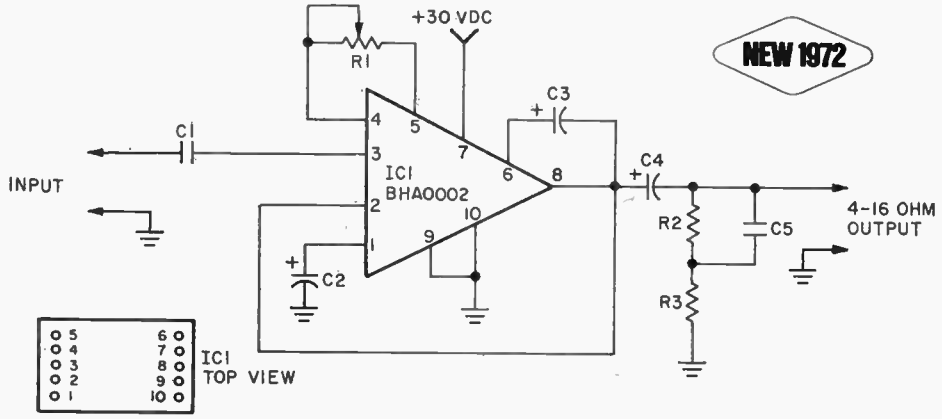
Unless you are skilled in working with linear ICs, it is best to make circuit modifications by building around our circuits. For example, if you decide you need more amplification provided by the signal tracer projects, add an additional input transistor amplifier. Do not try to squeeze extra gain out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



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 bending IC's leads when soldering unit into circuit. Figures 4, 5 show same type of IC available in two distinct case configurations—inline, T0-55 can.

IC 1 Super 15 Amplifier

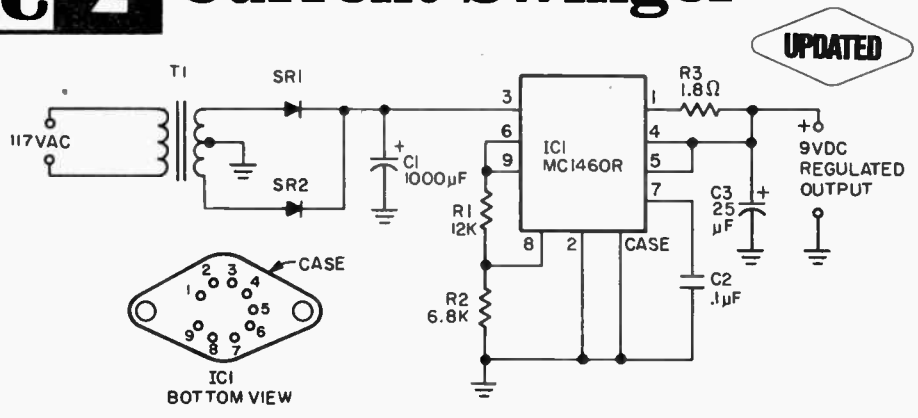


Just 350 millivolts input is all it takes for the Super 15 to push 15 watts output into a 4 ohm load or 10 watts into an 8 ohm load. Frequency response is better than +0/−3 dB 20 to 20,000 Hz and distortion at full power is a smidgen over 0.5% THD. The input impedance is about 20,000-ohms, and should be driven by a low impedance source such as a 600-ohm output transistor preamplifier. The power supply should be rated at least 1.2 amperes for mono and 2.5 amperes for a stereo pair. Bias adjust potentiometer R1 must be set in the following manner—set R1 so the full resistance is in the circuit, then connect a voltmeter (0-25 VDC) from pin 8 to ground. Adjust R1 so that the meter indicates exactly one half the supply voltage; for example, if the supply voltage at pin 7 is 30 volts there should be 15 volts from pin 8 to ground.

PARTS LIST FOR SUPER 15 AMPLIFIER

C1—0.22 uF, 75 VDC Mylar capacitor
C2—250 uF, 3 VDC electrolytic capacitor
C3—50 uF, 30 VDC electrolytic capacitor
C4—2000 uF, 30 VDC electrolytic capacitor
C5—0.05 uF, 75 VDC Mylar capacitor
IC1—Solitron BHA0002
R1—1000-ohm trimmer potentiometer
R2—470-ohm, ½ watt resistor
R3—22-ohm, ½ watt resistor

IC 2 Current Swinger



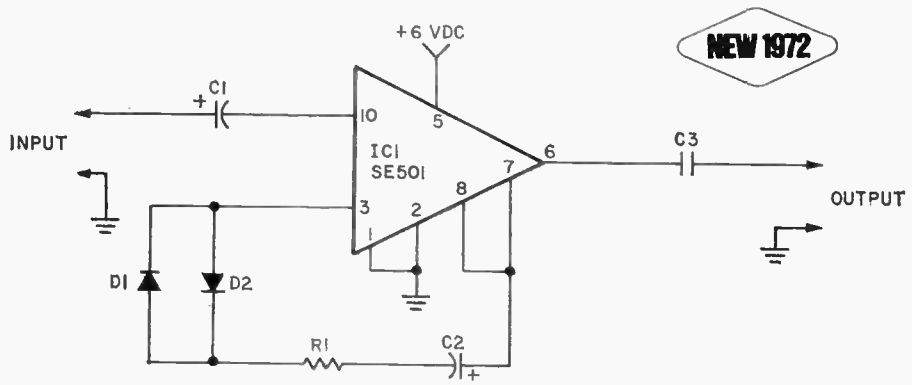
Supplying a precise 9V at currents up to 300 mA DC, the Current Swinger power supply features laboratory grade regulation and overcurrent protection. Whenever the device being powered attempts to draw more than 300 mA—such as caused by a short circuit—the IC voltage regulator section of Current Swinger 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 is used, 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.

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. (see text)
SR1, SR2—Silicon rectifier, 750 mA, 50 PIV

IC 3 Comm-press Log Amp

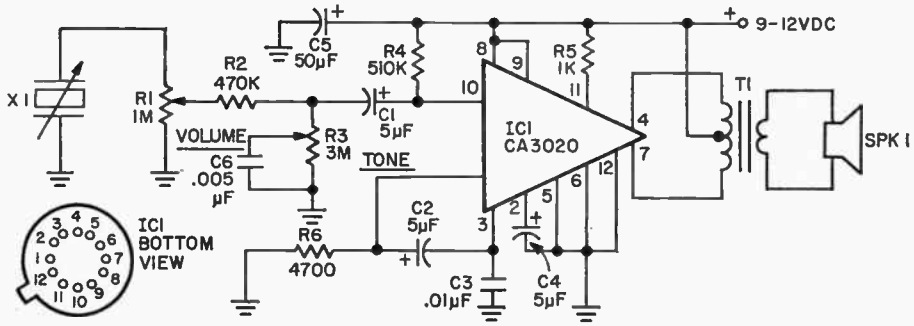


A log amplifier is a device that takes a large change in input signal and converts it to a small change in output. Hook one into a communications system and both low and loud sounds come out at almost the same level giving you a lot more talk power; it sounds just like the hard-sell commercials on TV. The input level should be about 0.1 volt peak for an output voltage of about 1 volt peak. Since this is a high frequency device, lead dress and good power supply bypassing at the power supply terminals are required. Keep the ground leads short. If a microphone preamplifier is used before the log amplifier, connect a volume control before the log amp's input. Some experimentation will be needed for optimum P.A. operation. Because of the much higher average voice power, a P.A. system using a log amp compressor might appear to be more sensitive to acoustic feedback (howling). Actually, you will have much more voice output before the howling starts.

PARTS LIST FOR THE COMM-PRESS LOG AMP

C1—1 uF, 6 VDC electrolytic capacitor
C2—10 uF, 6 VDC electrolytic capacitor
C3—0.1 uF, 75 VDC Mylor capacitor
D1, D2—Diode, Silicon, 1N914
IC1—Signetics SE501
R1—510-ohm, ½ watt resistor

IC 4 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 sub-miniature 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

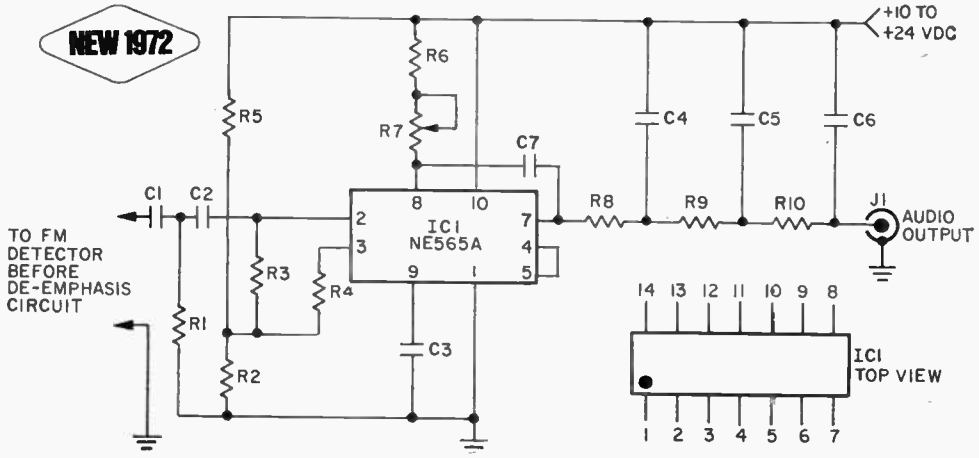
C1, C2, C4—5 uF, 6 VDC
C3—0.01 uF, 10 VDC
C5—50 uF, 15 VDC
C6—.005 uF, 15 VDC
R1—Potentiometer, 1 megohm audio taper
R2—470,000-ohms, ½-watt
R3—Potentiometer, 3 megohms
R4—510,000-ohms, ½-watt
R5—1,000-ohms, ½-watt
SPK1—Speaker, 3.2, 4 or 6-8 ohms
T1—Output transformer, 150 to 300 ohms center-tapped primary coil to speaker impedance (see text)
IC1—RCA CA3020 or CA 3020A
X1—Ceramic phono pickup (see text)

IC 5 SCA Adaptor

This simple but very effective SCA Adaptor can be assembled on a section of perf-board about 2-in. x 3-in. in size. All components should be firmly soldered to push-in terminals. The input *must* connect to the FM receiver's detector output before the de-emphasis network. The SCA output at J1 can be connected to any relatively high gain amplifier—the output level is about equal to that of a crystal microphone. The FM receiver must be tuned to a station you know has SCA programming. Then adjust potentiometer

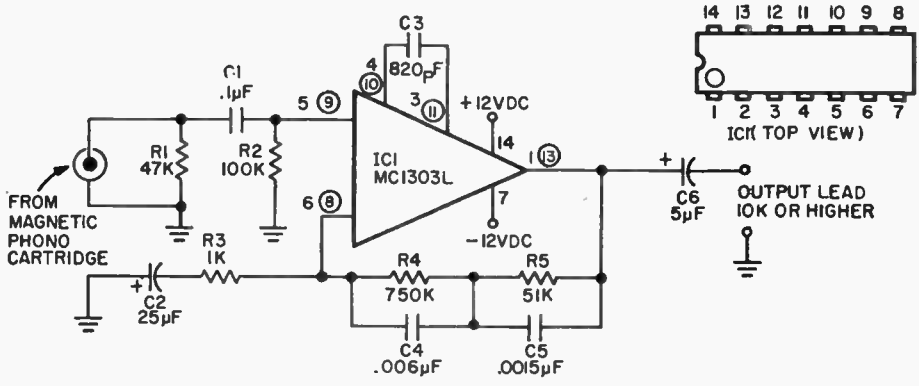
PARTS LIST FOR THE SCA ADAPTOR

C1, C2—510 pF, 500 VDC ceramic disc capacitor
C3, C7—0.001 uF, 75 V Mylar capacitor
C4, C6—0.018 uF, 500 VDC ceramic disc or Mylar capacitor
C5—0.047 uF, 75 VDC Mylar capacitor
IC1—Signetics NE565A (dual in-line package phase-locked loop)
J1—Phono jack
R1, R2, R3, R4—4700-ohm, ½ watt resistor
R5—10,000-ohm, ½ watt resistor
R6—1800-ohm, ½ watt resistor
R7—5000-ohm potentiometer
R8, R9, R10—1000-ohm, ½ watt resistor



R7 for a clean SCA audio output. Potentiometer R7's adjustment is not critical—the subcarrier is pulled in when R7's adjustment is near the correct setting. A metal cabinet is suggested. If desired, a pre de-emphasis output jack can be installed on the FM receiver or tuner so that the normal (after de-emphasis) output can feed the hi-fi system independent of the SCA output.

IC 6 Groove Booster

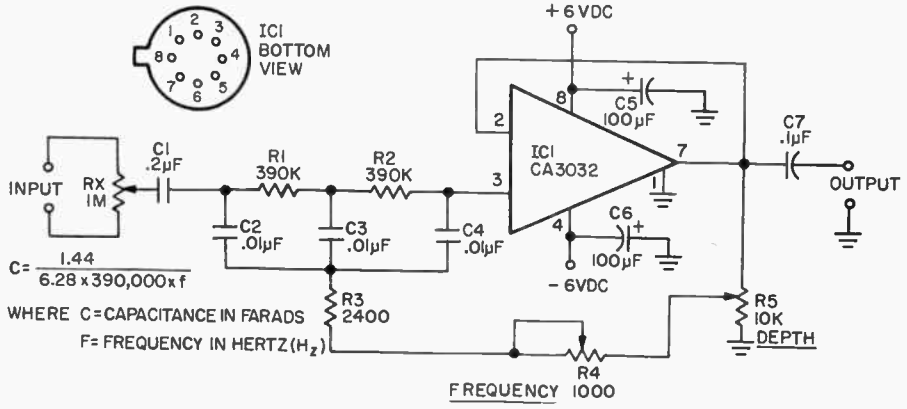


Using a dual operational amplifier IC, the Groove Booster will provide a fully equalized 1 V rms output from standard magnetic pickups. The terminal numbers which are circled on the schematic are the connections for one of the two independent amplifiers on the single IC chip. The uncircled numbers are 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 VDC disc
C4—0.006 uF, 100V VDC disc
C5—0.0015 uF, 100V VDC disc
C6—5 uF, 25 VDC
IC1—Motorola MC1303L
R1—47,000-ohms, ½-watt
R2—100,000-ohms, ½-watt
R3—1,000-ohms, ½-watt
R4—750,000-ohms, ½-watt
R5—51,000-ohms, ½-watt

IC 7 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.

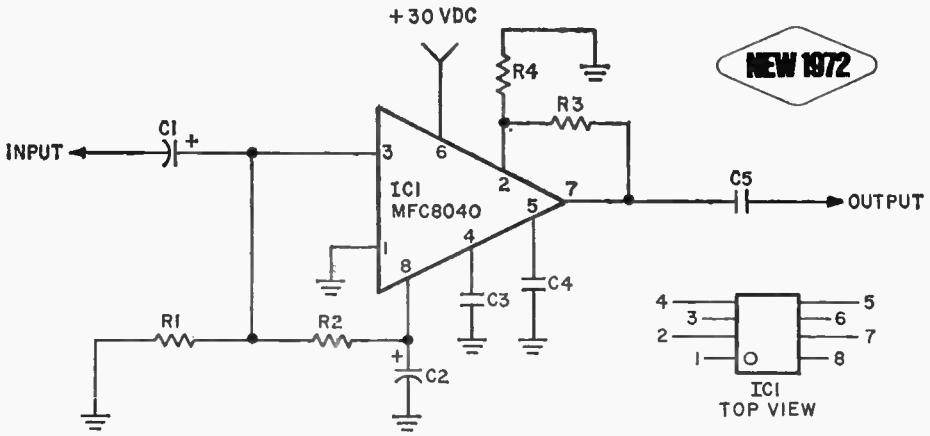
Potentiometer Rx is needed only if there is no way to control the level of the input signal to prevent overload. If the playback recorder has an output level control, Rx is not needed. The filter's input can be connected either to line level outputs or across speaker outputs. The filter's output should 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

IC 8 Silent Mike Preamp

Packing a walloping 60 dB gain with a 7 volt output, this mike preamp nevertheless is almost dead quiet. The input impedance is about 75,000-ohms; output

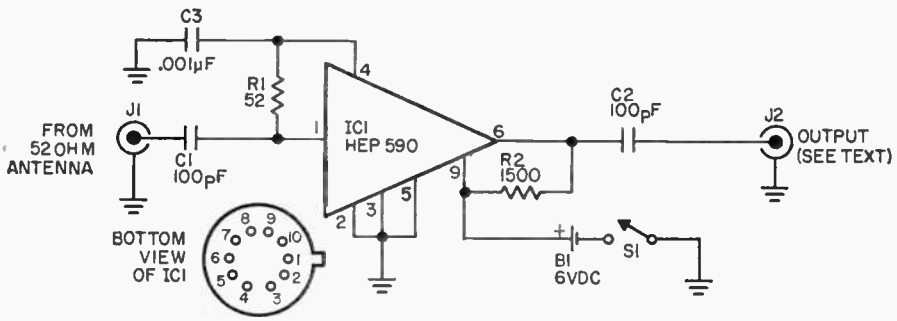


impedance about 100-ohms. Actual maximum output voltage depends upon the load resistance, ranging from 7 volts output into a 10,000-ohm load to 4 volts output into a 1000-ohm load. Parts layout is not critical and any type of assembly can be used. The power supply current is typically 8 mA, with a maximum of 12 mA.

PARTS LIST FOR THE SILENT MIKE PREAMP

C1—1 uF, 3 VDC electrolytic capacitor
C2—100 uF, 6 VDC electrolytic capacitor
C3—0.05 uF, 75 VDC Mylar cpacitor
C4, C5—0.1 uF, 75 VDC Mylar capacitor
IC1—Motorola MFC 8040
R1—75,000-ohm, ½ watt resistor
R2—270,000-ohm, ½ watt resistor
R3—110,000-ohm, ½ watt resistor
R4—100-ohm, ½ watt resistor

IC 9 BC Booster



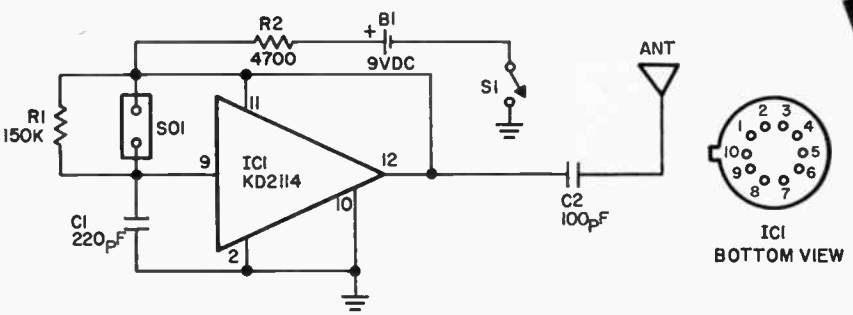
Connect CB Booster ahead of a low cost receiver, and you'll hear CB signals as if they were coming from your backyard. Using no tuned circuits, the CB Booster delivers approximately 15dB overall gain—that's about 3 S-units! Only restriction is that this little rf amplifier be used with a communications-type 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 units will sharply reduce the booster's gain.

PARTS LIST FOR CB BOOSTER

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

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.

IC 10 Rock Spotter



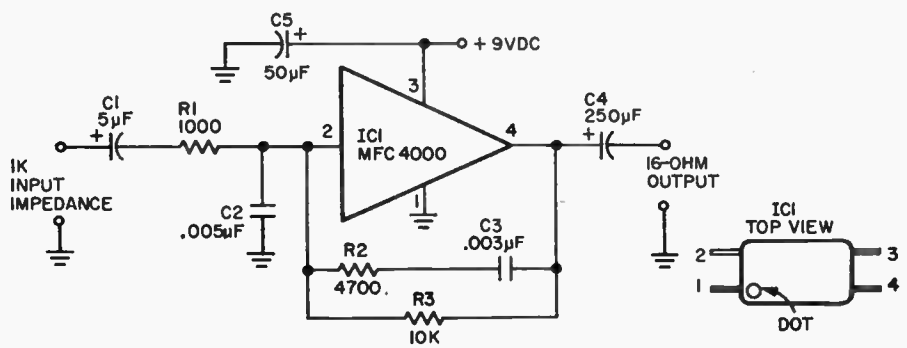
Ever try digging some QRP DX from under the pile up? It's a lot easier if you can get your receiver tuned smack dab on frequency to begin with. Pop a rock into this spotter and hold its antenna near the receiver's input. You'll have no problems pretuning your rig.

Frequency coverage is from 4 to 20 MHz, the heart of DX SWLing. Though Rock Spotter 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
R2—4,700-ohms, ½-watt
S1—SPST switch (see text)
SO1—Crystal socket

IC 11 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 impedance 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

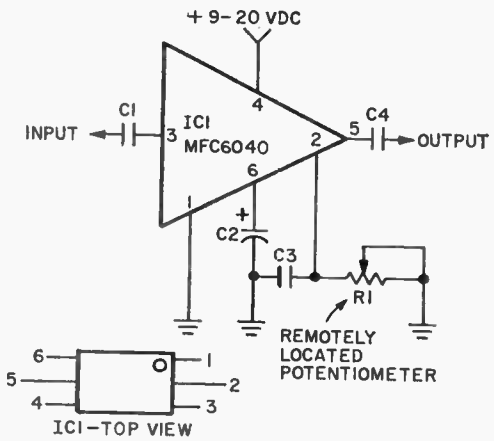
C1—5uF, 10 VDC
C2—0.005 uF, 10 VDC
C3—0.003 uF, 10 VDC
C4—250 uF, 10 VDC
C5—50 uF, 10 VDC
IC1—Motorola MFC 4000
R1—1,000-ohms, ½-watt
R2—4,700-ohms, ½-watt
R3—10,000-ohms, ½-watt

IC 12 Far Out Gain Control

PARTS LIST FOR THE FAR OUT GAIN CONTROL

C1—0.47 uF, 25 VDC capacitor
C2—50 uF, 25 VDC capacitor
C3—680 pF, 500 VDC ceramic disc capacitor
C4—0.1 uF, 75 VDC Mylar capacitor
IC1—Motorola MFC 6040
R1—50,000-ohm potentiometer

NEW 1972



One of the problems of locating a volume control in a remote location is that of hum and noise pickup; as a general rule, the greater the wire length the greater the hum and noise picked up. With an electronic attenuator the entire problem is eliminated, for the volume control wires carry only a DC control voltage which causes an integrated circuit amplifier's gain to vary by as much as 90 dB. Hum and noise picked up in the DC control wires are not impressed on the amplified audio signal. No layout precautions are required and any type of assembly can be used. If desired, the amplifier gain can be voltage controlled by eliminating potentiometer R1 and applying 3.5 to 6 volts DC directly to pin 2. With 3.5 VDC the amplifier works at full gain. The attenuation increases to a maximum of 90 dB as the control voltage is increased to 6 VDC.

IC 13 Great Equalizer

Pg 96.

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 3¾ IPS reel-to-reel tapes. Since the actual required equalization is deter-

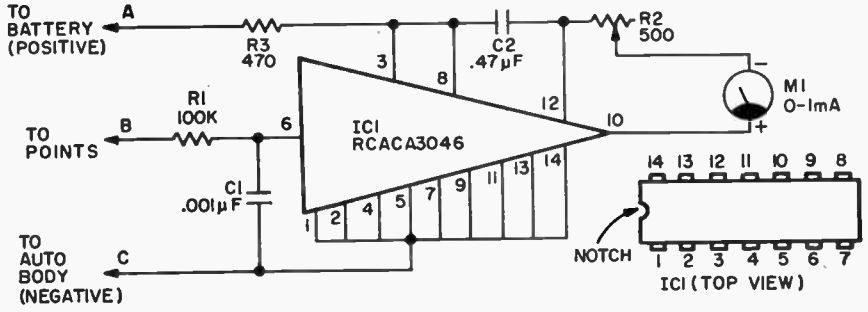
mined partially by the playback head characteristics, it might be necessary to modify or "tailor" the equalization; this is done by small changes in the value of capacitor C3 and resistor R5.

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 battery polarity.

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
R2—39,000-ohms, ½-watt
R3—560,000-ohms, ½-watt
R5—56,000-ohms, ½-watt

IC 14 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.

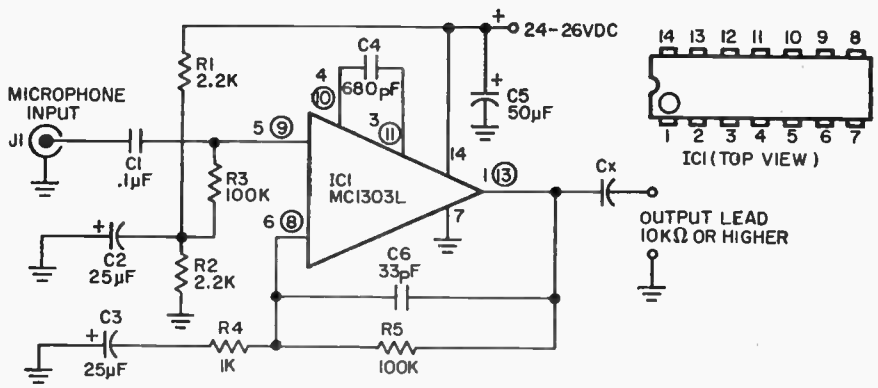
To use the tach, connect lead A to the car battery's positive terminal, lead C to the negative battery terminal or the car body and lead B to the distributor points. The distributor point connection is easily made at the high voltage coil terminal; one coil terminal connects to the battery, the other 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
R2—Potentiometer, 500 ohms linear taper
R3—470-ohms, ½-watt
M1—Meter, 0-1 mADC

IC 15 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 cen-



ter-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 correct 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.

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—2,200-ohms, 5%
R3, R5—100,000-ohms
R4—1,000-ohms

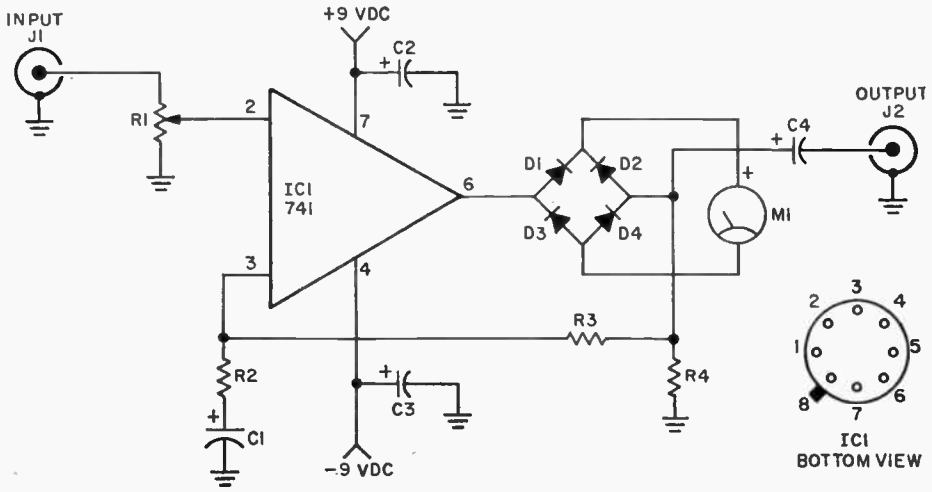
IC 16 Professional Remote Amplifier

NEW 1972

Here's a professional performance remote amplifier suitable for the hobbyist, amateur recordist or professional broadcast engineer. The input is any microphone with an output impedance up to 50,000 ohms, or for professional use, the input can be at line level. Output is 500-ohms at line level with a built in VU meter indicating output level. When the distance between the remote amplifier and its associated equipment is less than 25 feet the amplifier can be connected to any hi-fi type high impedance input (10,000-ohms or higher). For long line or professional applications, connect a 500/500 line matching transformer to output jack J2. Capacitor C4 is 0.1 uF for all applications except when used with a line matching transformer. When a transformer is used C4 is 25 uF. Better results can be obtained with a line matching transformer if the transformer primary *replaces* R4 (eliminating C4). M1 is a standard VU meter whose

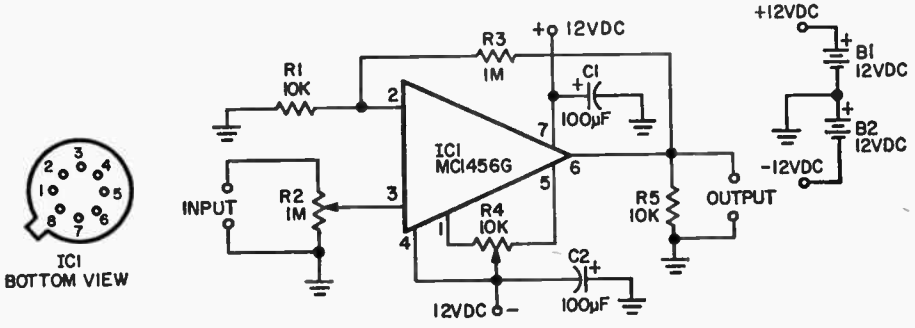
PARTS LIST FOR PROFESSIONAL REMOTE AMPLIFIER

C1—200 or 250 uF, 3 VDC electrolytic capacitor
C2, C3—50 uF, 12 VDC electrolytic capacitor
C4—0.1 uF or 25 uF, 12 VDC capacitor (see text)
IC1—Type 741 operational amplifier
J1, J2—Shielded jacks
M1—VU meter with internal rectifier removed
R1—50,000-ohm audio taper potentiometer
R2—100-ohm, ½ watt resistor
R3—15,000-ohm, ½ watt resistor
R4—560-ohm, ½ watt resistor



internal rectifier has been removed (open the case and unsolder the rectifier). Total current drain is less than 5 mA and the bi-polar power supply can consist of two transistor radio type 9 volt batteries.

IC 17 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 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 100 mV peak-to-peak. Naturally, higher input signals can be used because of the attenuation provided by sensitivity control R2.

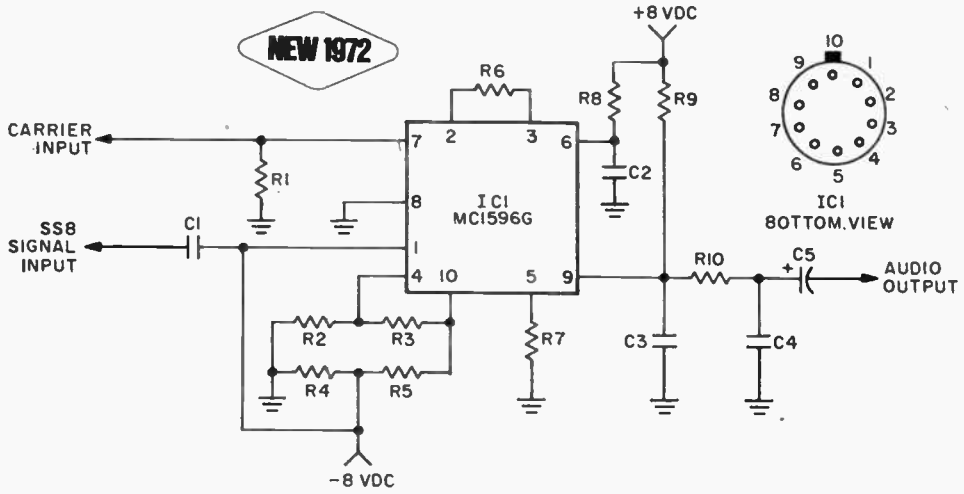
After you've completed the 100X Instrument Amplifier, connect a VTVM across

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

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 18 Add-on Product Detector



Many an old receiver is still a good receiver except for SSB reception. With a product detector, your old reliable can deliver good SSB reception on a par with many modern solid-state receivers. This product detector can be easily added to most old receivers; the only critical input requirements are an SSB signal input level of 5 to 500 mV and a carrier (BFO) input level of about 300 mV. The output is the demodulated audio. Best results are obtained from a crystal-controlled carrier oscillator, rather than a variable frequency oscillator. A rigid construction is suggested, either printed circuit or on a perf-board with push-in terminal connections. The power supply is bi-polar 8 volts, though a bi-polar 9 volt power source can be substituted. Since the current requirement is less than 5 mA, ordinary transistor radio 9 volt batteries can be used as the power source.

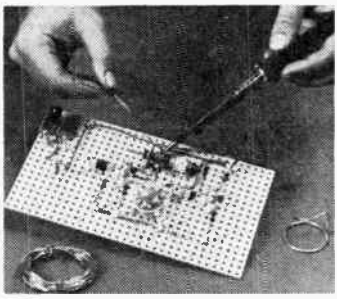
PARTS LIST FOR THE ADD-ON PRODUCT DETECTOR

C1—0.47 uF, 25 VDC Mylar capacitor
C2, C3, C4—0.005 uF, 500 VDC cermic disc capacitor
C5—1 uF, 10 VDC electrolytic capacitor
IC1—Motorola MC1596G
R1—51-ohm, ½ watt resistor
R2, R3, R4, R5, R6, R10—1000-ohm, ½ watt resistor
R7—6800-ohm, ½ watt resistor
R8, R9—3900-ohm, ½ watt resistor

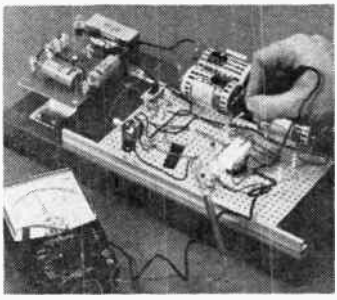
IC 19 Stereo See-Saw

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

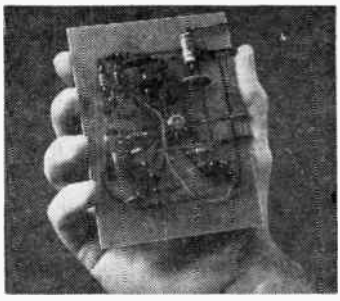
You get your own 161-piece electronics laboratory... with authentic electronic components used by industry!



You learn how to construct circuits and connect them with a soldering iron, which is part of your CIE laboratory equipment. This "hands on" experience is extremely valuable in applying what you learn.



Testing and troubleshooting are an important part of your learning experience. Included in your laboratory is a precision "multimeter" to diagnose electrical and electronic troubles quickly and accurately.



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Marvin Hutchens, Woodbridge, Virginia, says: "I was surprised at the relevancy of the CIE course to actual working conditions. I'm now servicing two-way radio systems in the Greater Washington area. My earnings have increased $3,000. I bought a new home for my family and I feel more financially secure than ever before."

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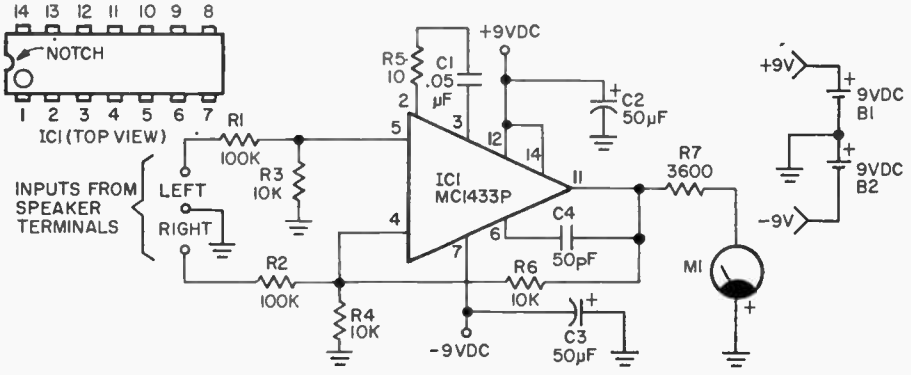
CIRCLE NO. 8 ON PAGE 7 OR 109

PARTS LIST FOR STEREO SEE-SAW

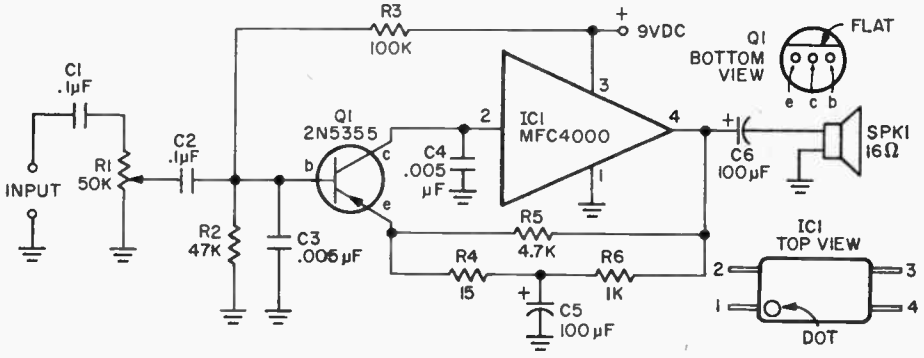
B1, B2—Battery, 9V, type 2U6
C1—0.05 uF, 10 VDC
C2, C3—50 uF, 10 VDC
C4—50 pF, 10 VDC
IC1—Motorola MC-1433P
M1—VU meter
R1, R2, R6—100,000-ohms, ½-watt
R3, R4—10,000-ohms, ½-watt
R5—10-ohms, ½-watt
R7—3,600 ohms (usually with VU meter)



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.

IC20 Mighty Mite

UPDATED

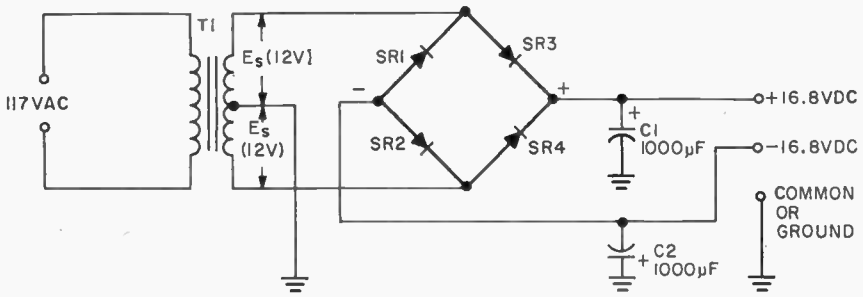


PARTS LIST FOR MIGHTY MITE SIGNAL TRACER

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 far better low-frequency response with large speakers)
IC1—Motorola MFC-4000
R1—Potentiometer, 50,000-ahms, audio taper
R2—47,000-ohms, ½-watt
R3—100,000-ahms, ½-watt
R4—15-ohms, ½-watt
R5—4,700-ahms, ½-watt
R6—1,000-ahms, ½-watt
Q1—PNP transistor, G.E. 2N5355 or equiv.
SPK1—16-ohm speaker (see text)

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.

IC 21 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.

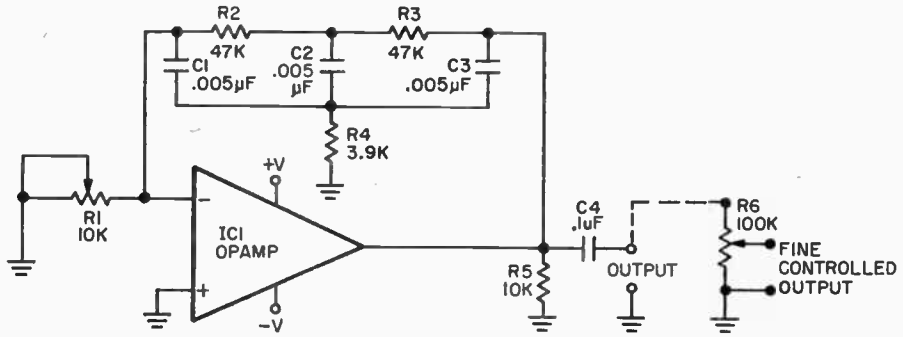
PARTS LIST FOR BI-POLAR POWER SUPPLY

SR1-SR4—Silicon rectifiers PIV roted to ot leost twice the supply's output voltoge
C1, C2—1000 or 2000 uF ot the supply's output voltage
T1—Power transformer with center-topped secondory

IC 22 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

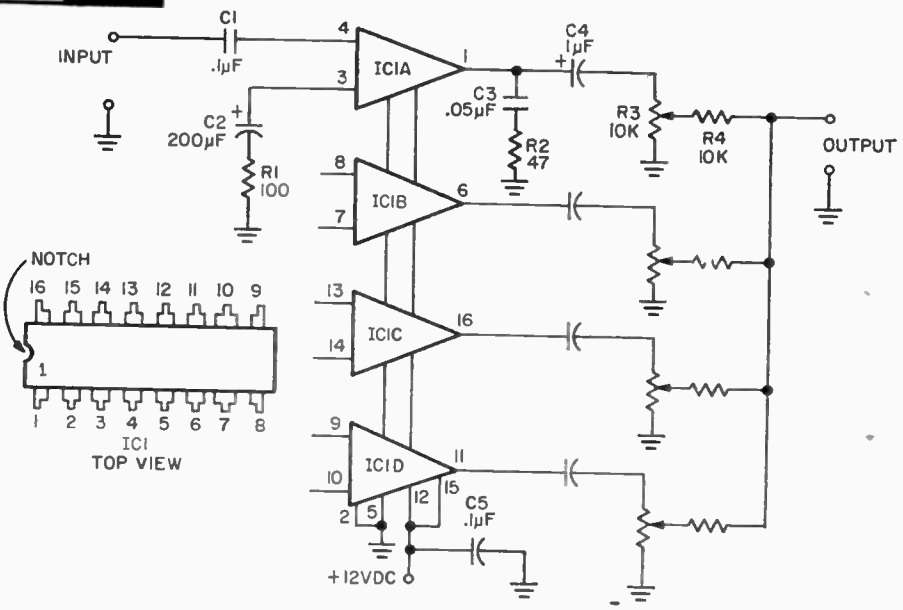


output level; its maximum value will approach the total power supply voltage. If fine output control is desired, add potentiometer R6. When your Notch Filter Oscillator is connected to a DC circuit, connect a DC blocking capacitor in series with R6's wiper arm. If the oscillator is to drive circuits of less than 10K ohm impedance, substitute a 1 uF non-polarized capacitor for C4, rated to the power supply's voltage.

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
R4—3,900-ohms, ½-watt
R5—10,000-ohms, ½-watt (see text)
R6—Potentiometer, 100,000-ohms, audio taper (see text)

IC 23 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. 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.

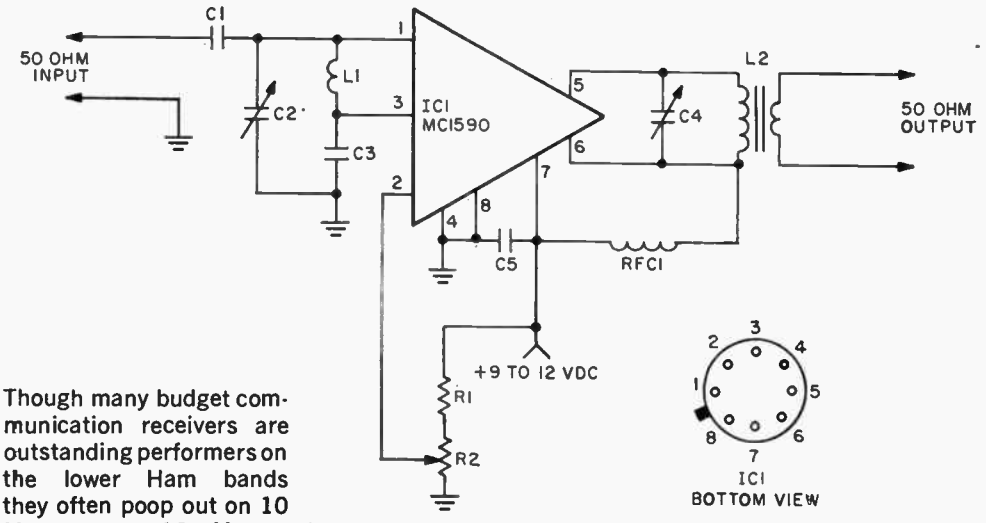
Any 50 to 50,000 ohm dynamic microphone can be used. However, crystal and ceramic mikes won't work with Pro-Mix; the medium impedance IC's medium input impedance will excessively load down a high impedance mike, resulting in sharp, low-frequency attentuation.

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
R2—47-ohms, ½-watt
R3—Potentiometer, 10,000-ohms audio toper
R4—10,000-ohms, ½-watt

IC 24 Ten Meter DX'er

NEW 1972



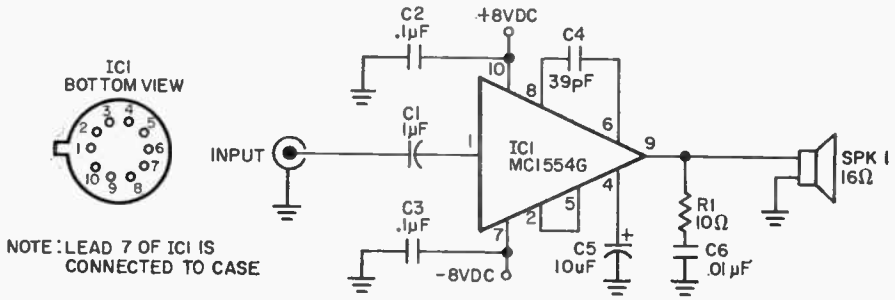
Though many budget communication receivers are outstanding performers on the lower Ham bands they often poop out on 10 Meters; yet 10 Meters is a real hot DX band with much of the action. To perk up reception, simply connect our Ten Meter DX'er between the antenna and receiver, and you'll hear signals you didn't know existed. With 50 dB of power gain in any 1 MHz segment, the Ten Meter DX'er will boost the 28 to 29 MHz or 29 to 30 MHz range with no extra tuning or attention. The unit must be constructed in a metal enclosure, and the input must be shielded from the output. Shielded input and output coaxial connectors are also suggested. Because of the very high gain, careful wiring and short ground leads are essential. Also, capacitor C5 must be connected directly at IC1's pin 7. Potentiometer R2 adjusts the DX'er's gain, and should be adjusted to just below the point where the DX'er overloads. To align, tune in a signal in the center of the desired frequency coverage and adjust trimmer capacitors C2 and C4 for maximum signal strength.

PARTS LIST FOR TEN METER DX'ER

C1—50 pF, 500 VDC cermic disc capacitor
C2, C4—50 pF trimmer capacitor
C3—0.002 uF silver mica capacitor
C5—0.002 uF, 500 VDC ceramic disc capacitor
IC1—Motorola MC1590G
L1—12 turns #22 enameled wire on Micro Metals T37-6 toroid core
L2—Primary, 17 turns #20 enameled wire on Micro Metals T44-6 toroid core. Secondary, 2 turns #20 enameled wire.
R1—10,000-ohm, ½ watt resistor
R2—10,000-ohm potentiometer
Misc—Metal cabinet, shielding material.

IC 25 Bi-Polar Amp

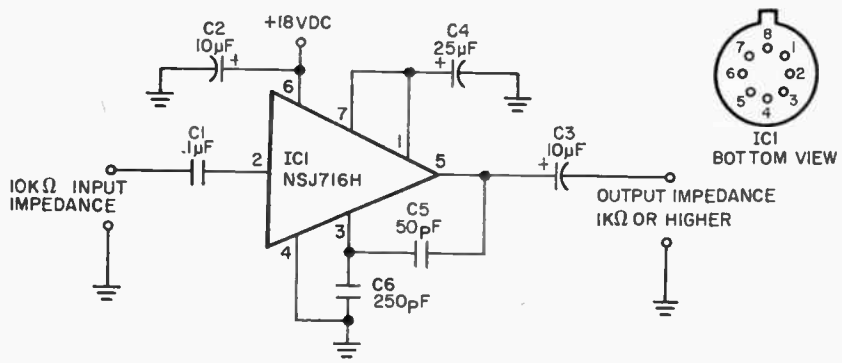
It is inconvenient when working with IC preamplifiers requiring bi-polar power sources to convert to a single-ended power source for the power amplifier. Our Bi-Polar Amp, however, can be driven from a bi-polar power supply. One of the benefits enjoyed by Bi-Polar Amp is that a large, expensive output 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 suggested. 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), disconnect 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—0.01 uF, 25 VDC
IC1—Motorola MC-1554G
R1—10-ohms, ½-watt
SPK1—16-ohm speaker

IC 26 Gabber Grabber



Gabber Grabber works best with the 10,000 ohm microphones and telephone pickup coils supplied with most solid-state recorders. It provides 26dB gain, and is ideal

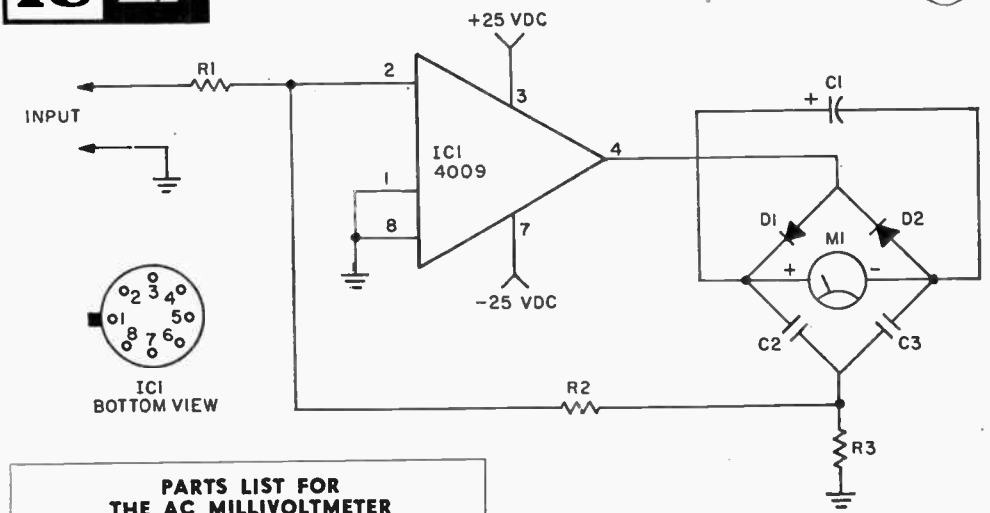
when a single microphone is used for conference recording or when remote telephone monitoring through a pickup coil is desired. The 18V power supply can be two series-connected 9V transistor radio batteries. Since the IC is a high frequency device, its leads should be kept as short as possible. A socket 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 27 AC Millivoltmeter

NEW 1972



PARTS LIST FOR THE AC MILLIVOLTMETER

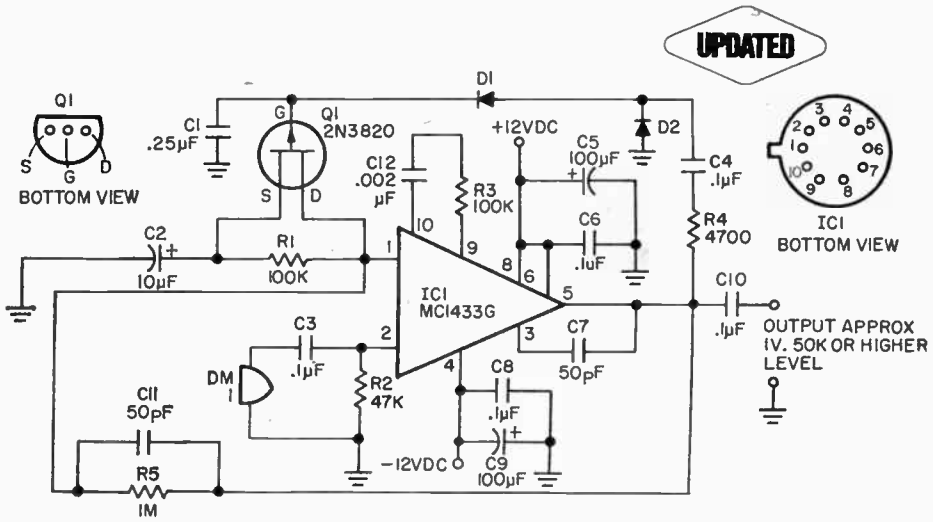
C1—500 uF, 3 VDC electrolytic capacitor
C2, C3—0.47 uF, 75 VDC Mylar capacitor
D1, D2—Diode, Germanium, 1N60
IC1—Opamp Labs 4009 (see text)
M1—Meter, 0-1 mA
R1, R2—100,000-ohm, ½ watt resistor
R3—10-ohm, ½ watt resistor

In this IC project, a single operational amplifier is all that's needed for an almost laboratory grade AC Millivoltmeter. The model shown uses any 0-1 mA DC meter. Only 10 mV of input produces a full scale reading. Higher ranges can be provided by connecting a switched 1 megohm total resistance voltage divider ahead of resistor R1. Or, simply increase R1's value to obtain the desired full-scale sensitivity. Just about any operational amplifier can be substituted for IC1, such as a 709 or 741. The pin connections, however, will be different, and wide-band ICs will require frequency compensation as detailed in the specifications for the substituted IC. A metal enclosure is suggested. The unit will work satisfactorily with a bi-polar power supply as low as 15 VDC (as low as 9 VDC with other opamps). Current drain is about 1 mA and a battery supply can be used.

IC 28 Squeeze Box

UPDATED

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

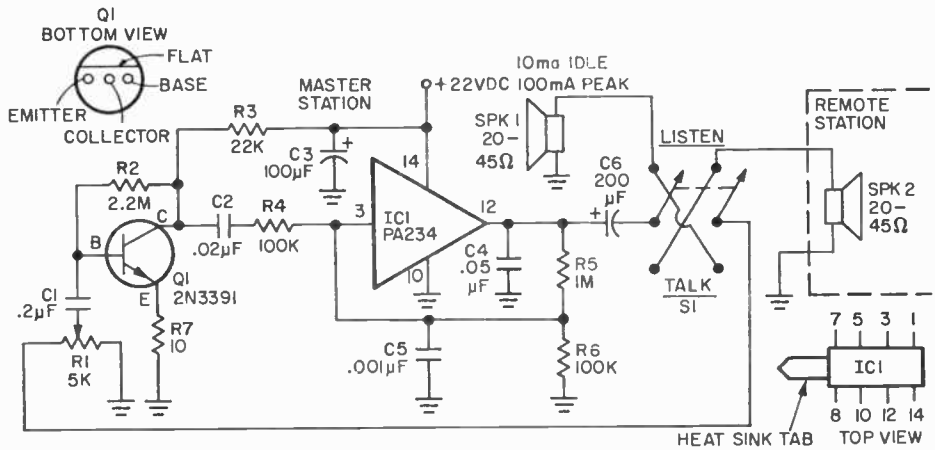
C1—0.25 uF, 10 VDC
C2—10 uF, 10 VDC
C3, C4, C6, C8, C10—0.1 uF, 75 VDC
C5, C9—100 uF, 15 VDC
C7, C11—50 pF, 75 VDC disc
C12—0.002 uF, 25 VDC
IC1—Motorola MC-1433G
R1—100,00-ohms, ½-watt
R2—47,000-ohms, ½-watt
R3—100-ohms, ½-watt
R4—4,700-ohms, ½-watt
R5—1 megohm, ½-watt
DM1—Dynamic microphone (see text)
D1,D2—Germanium diode, 1N60 or equiv.
Q1—FET transistor, type 2N3820

IC 29 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.

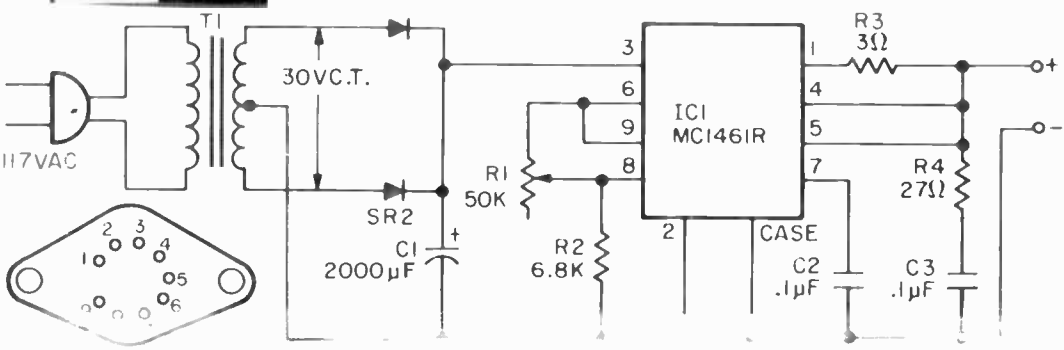
If an AC power supply is used, it must be rated for at least 100 mA drain. If a battery supply is used, figure the 10 mA idling current; the batteries will be able to deliver the 100 mA maximum output peak current. Solder a 1 inch square tin heat sink to IC1's tab during construction.



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
R3—22,000-ohms, ½-watt
R4, R6—100,000-ohms, ½-watt
R5—1 megohm, ½-watt
R7—10 ohms, ½-watt
SPK—Speaker, 20 to 45 ohms, (see text)
S1—Switch, DPDT (see text)

IC 30 Protect-A-Volt

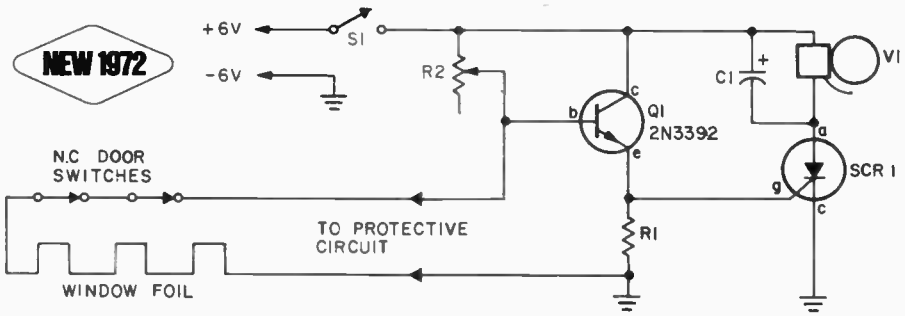


A simple turn of a knob sets Protect-a-Volt's output voltage anywhere in the 3 to 20 volt range—and with full short circuit protection! Should there be a wiring error in the powered project, this supply automatically shuts down the output voltage until the overload is removed. The maximum output current (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

(Continued on page 110)

101 ELECTRONIC PROJECTS FOR UNDER $15

1 Professional Burglar Alarm



This professional type burglar alarm can be used to protect windows or glass areas by using window foil that "breaks" a circuit as the glass is broken. It's an alarm that is triggered when the protective circuit is *opened*. All protective door and window circuits must be *normally closed* and series connected so that an opening of any protective device will trigger the alarm. Once the alarm is triggered it can be turned off only by opening master switch S1. The recommended power supply is an AC powered 6 VDC source or a lantern battery; standby current is about 100 *u*A. To adjust, connect a voltmeter (10 VDC range) across resistor R1, open the protective circuit and adjust potentiometer R2 so the meter indicates a voltage rising towards 1 volt. The alarm bell should ring before 1 volt is reached on the meter. If it does not, there is a wiring error. Finally, set R2 for the 1 volt meter reading, remove the meter and restore the protective circuit.

PARTS LIST FOR PROFESSIONAL BURGLAR ALARM

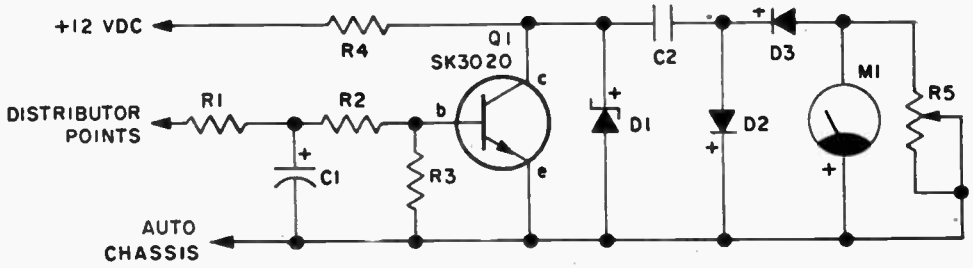
C1—50 uF, 6 VDC electrolytic capacitor
Q1—NPN transistor, 2N3393 or equiv.
R1—1000-ohm, ½ watt resistor
R2—250,000-ohm potentiometer
S1—SPST switch
SCR1—Silicon controlled rectifier rated 12 PIV or higher (General Electric C106 series)
V1—6 VDC alarm bell

2 Solid Tach

UPDATED

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.

PARTS LIST FOR SOLID TACH

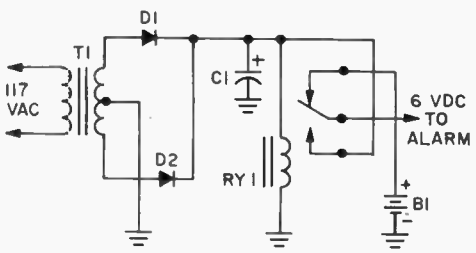
C1—1-uF, 100-VDC electrolytic capacitor
C2—0.47-uF, 15-VDC capacitor
D1—9.1-V. 250-mW Zener diode—Motorola HEP-104
D2, D3—100-mA, 50-PIV silicon rectifier —Motorola HEP-154
M1—0-1 mA DC meter
Q1—SK3020 npn transistor (RCA)
R1—200-ohm, ½-watt resistor
R2—220-ohm, ½-watt resistor
R3—1500-ohm, ½-watt resistor
R4—330-ohm, ½-watt resistor
R5—1000-ohm potentiometer

3 Automatic AC-DC Power Supply

NEW 1972

PARTS LIST FOR AUTOMATIC AC-DC POWER SUPPLY

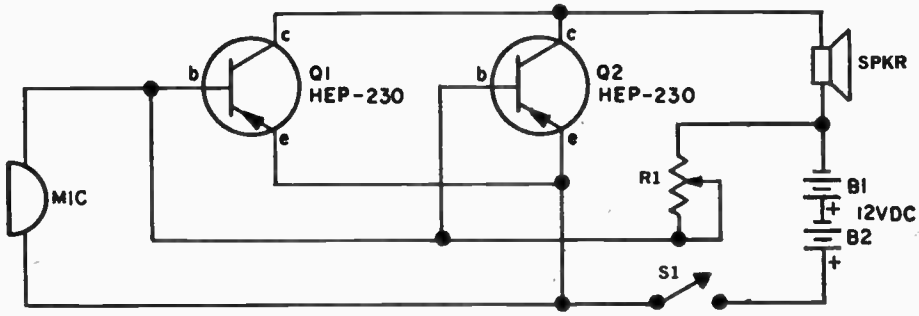
B1—6V lantern battery
C1—100 uF, 16 VDC electrolytic capacitor
D1, D2—Silicon rectifier rated 25 PIV at 1 A or higher
RY1—Relay, 6 VDC approximately 20 mA (Potter & Brumfield RS5D-6 or equiv.)
T1—12.6 volt center-tapped filament transformer rated 1 A or higher.



Both home-brew and battery operated burglar alarm kits are made fail-safe with this automatic AC power supply. Normally, power for the alarm comes from the line powered 6VDC power source; this prevents circuit alarm systems and signal lights from prematurely exhausting the battery. If the AC power line should fail for any reason, relay RY1 releases to switch in standby battery B1. As soon as the power line is restored, RY1 pulls in and again disconnects the battery. Relay RY1's contacts are shown in the power line off (battery on) position.

4 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.

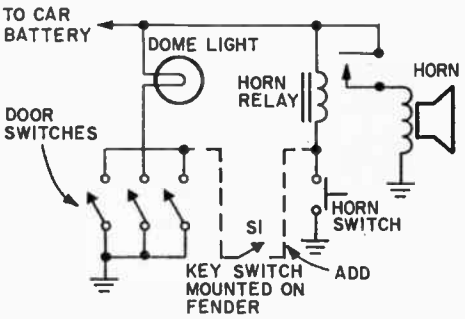
PARTS LIST FOR POWER MEGAPHONE

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

5 Easy Auto Theft Alarm

NEW 1972

A single fender-mounted key switch is all that's needed to turn your car's horn and courtesy lights into a burglar or theft alarm! Simply install keyswitch S1 on the fender, connect one terminal to the horn relay and the other to the courtesy-light door-switch wiring, as shown by the dotted lines. When S1 is on, anyone entering a car door equipped with a courtesy-light switch will automatically sound the car's horn. The sudden blast of the horn is usually enough to frighten off a potential burglar. If all the car doors are not equipped with switches you can easily install them; switches are available from local auto supply stores.



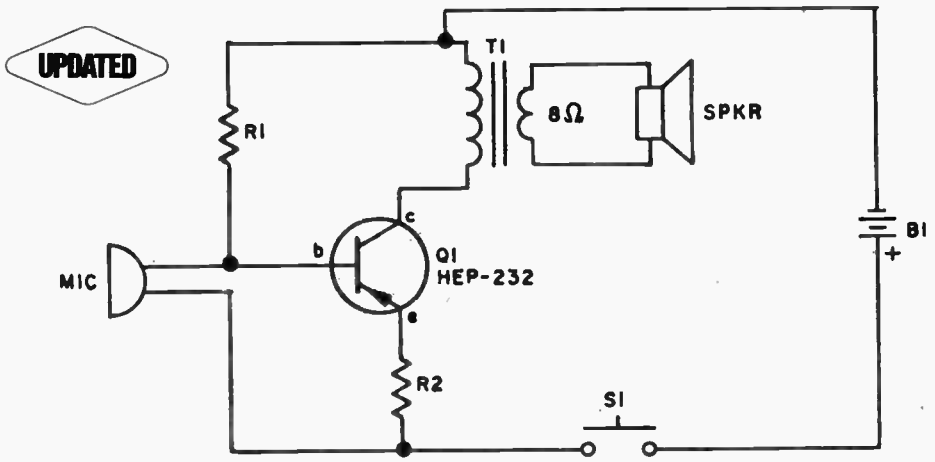
PARTS LIST FOR EASY AUTO THEFT ALARM

S1—Fender-mounted key switch.

6 Powerhouse Larynx

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 mounting kit.

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

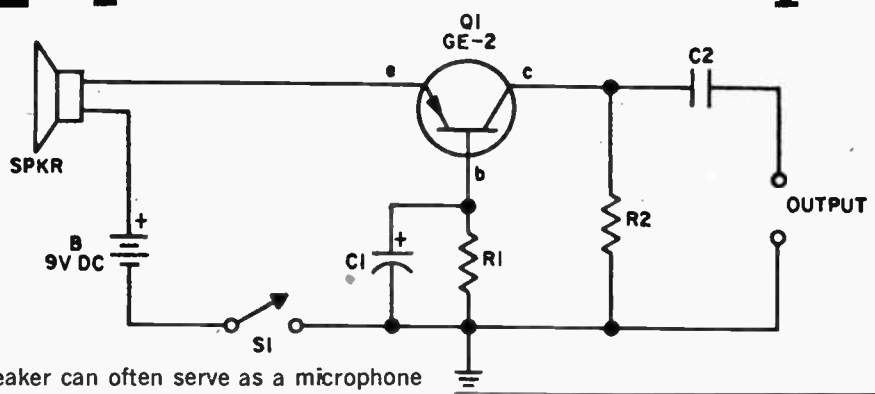
The entire unit can be assembled inside a speaker-trumpet if care is taken to acoustically isolate the microphone from the speaker to prevent howling feedback.

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

PARTS LIST FOR POWERHOUSE LARYNX

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 24-ohm, 5-watt audio output transformer—Lafayette 33-57011

7 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

PARTS LIST FOR SPEAK-A-MIKE PREAMP

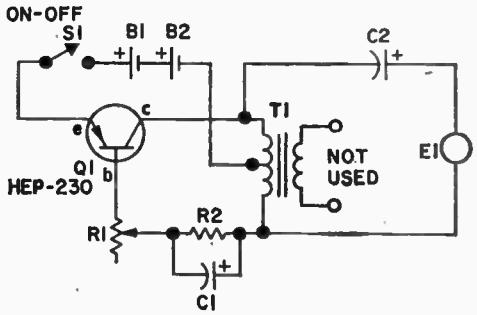
B1—9-V battery
C1—6-uF, 25-VDC electrolytic capacitor
C2—0.47-uF, 10-VDC capacitor
Q1—GE-2 pnp transistor
R1—270,000-ohm, ½-watt resistor
R2—27,000-ohm, ½-watt resistor
S1—Spst switch
SPKR—Any PM speaker, 4-10-ohms

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.

8 Fish Caller

UPDATED



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—Lafayette Radio 33-85580

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).

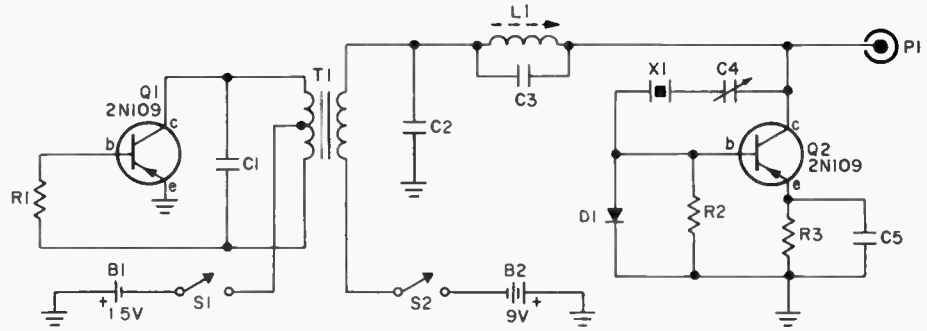
9 Modulated 100 kHz Calibrator

NEW 1972

If the part of the short wave band you like to monitor is so jammed with signals you can't find the markers from a standard 100 kHz calibrator, this modulated calibrator is the next best thing to a frequency meter. Just turn on the modulator with switch S1 and each marker will turn into a raucous growl that will stand out in any mass of heterodynes. Once you have the marker tuned in you can turn off the modulator for precise frequency alignment. The unit can be zero-beat to WWV by adjusting trimmer capacitor C4. For optimum performance the unit should be assembled in a metal enclosure with every part firmly tied down to terminal strips or perf-board. Normally, a clip lead attached to output binding post P1 will radiate a healthy signal into the receiver. If the signal is too weak at the higher frequencies simply connect the clip lead between binding post P1 and the reciever's antenna terminal. To adjust coil L1, temporarily connect a 0-10 mA DC meter between battery B2's positive terminal and ground. Using an insulated

PARTS LIST FOR MODULATED 100 KHZ CALIBRATOR

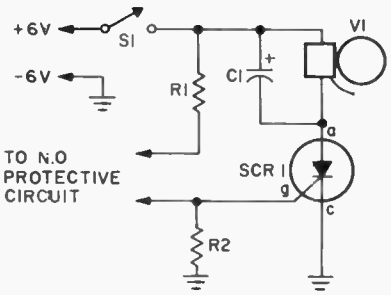
- B1—1.5 volt AA battery
- B2—9 volt battery type 2U6
- C1—0.1 uF, 25 VDC capacitor
- C2, C5—0.05 uF, 500 VDC ceramic disc capacitor
- C3—750 pF, 500 VDC silver mica capacitor
- C4—180 pF trimmer capacitor
- D1—Germanium diode, 1N60
- L1—2-18 mH width coil (J. W. Miller 6314)
- P1—Insulated 5-way binding post
- Q1, Q2—PNP transistor, 2N109 or equiv.
- R1—15,000-ohm, ½ watt resistor
- R2—100,000-ohm, ½ watt resistor
- R3—680-ohm, ½ watt resistor
- S1, S2—SPST switch
- T1—Transistor output transformer (Lafayette Radio TR-119)
- X1—100 kHz crystal



alignment screwdriver, adjust slug L1 for a peak meter indication of approximately 1.5 mA. Then remove the meter and reconnect the normal ground connection.

10 Open Circuit Burglar Alarm

NEW 1972



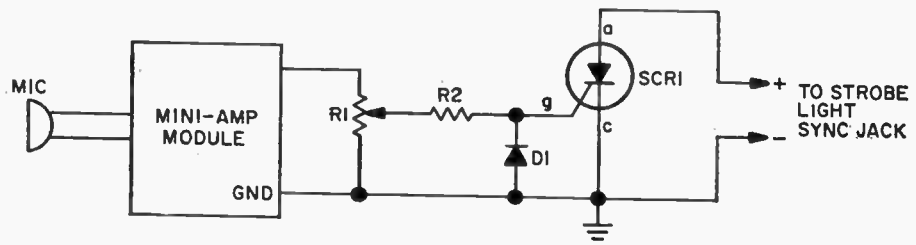
PARTS LIST FOR OPEN CIRCUIT BURGLAR ALARM

C1—50 uF, 6 VDC electrolytic capacitor
R1—4700-ohm, ½ watt resistor
R2—1000-ohm, ½ watt resistor
S1—SPST switch
SCR1—Silicon controlled rectifier, rated 12 PIV or higher (General Electric C106 series)
V1—6 VDC alarm bell

This simple electronic latch-up alarm circuit handles normally open protective devices such as concealed floor-mat switches. All protective devices are connected in parallel and the alarm is tripped as soon as any of the devices are closed. There is no standby current and a battery power source will last its shelf life. Either a line powered 6VDC supply or a 6V lantern battery is suggested. Once the alarm is tripped it can only be turned off by opening the master switch S1.

11 Stop Motion

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 tran-



sistor 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.

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

12 "Serutan" 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.

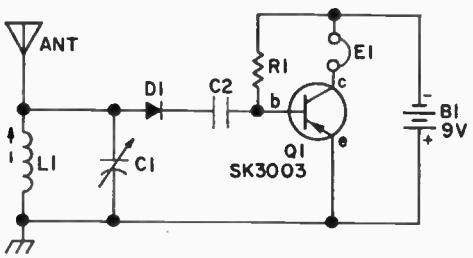
L1 is any ferrite antenna coil for the broadcast band, while E1 must be a magnetic headset for maximum output level. To align the receiver, set C1's dial to the known frequency of a strong local station and adjust L1's slug until you hear the station in the phones.

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 "SERUTAN" 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



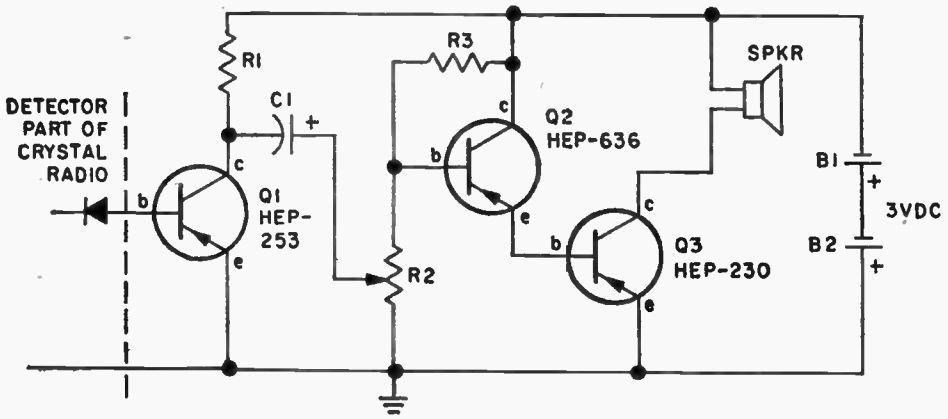
13 Crystal Radio Amplifier

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

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



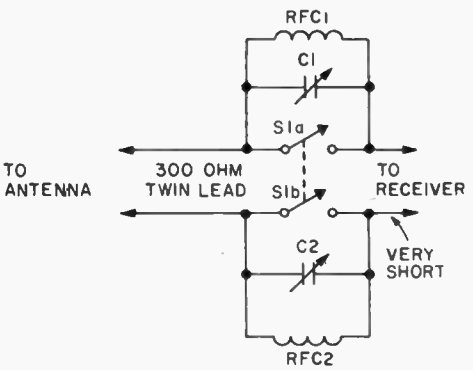
presently wired in the crystal radio so that the output is taken from the cathode end (marked "+"), reverse the diode's polarity. It will have no effect on the radio's operation. Any general-purpose transistors equivalent to those specified can be used.

14 FM Interference Filter

NEW 1972

PARTS LIST FOR THE INTERFERENCE FILTER

C1, C2—30 pF trimmer capacitor
Misc—300-ohm twinlead, metal cabinet
RFC1, RFC2—0.22 uH RF choke, any type
S1—DPST slide switch

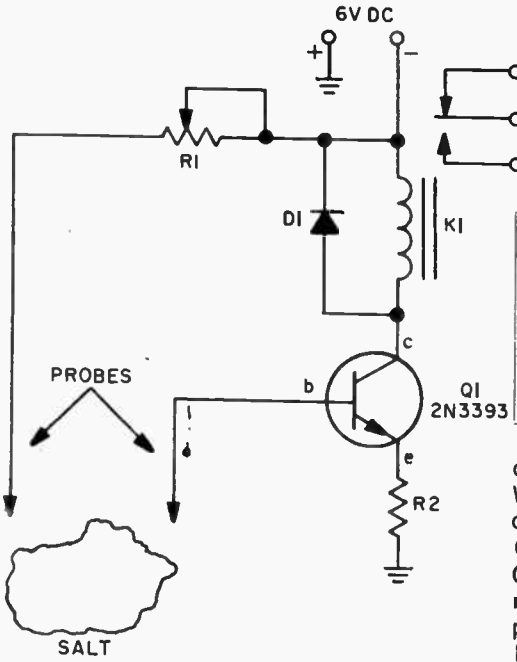


A simple filter is all it takes to remove a strong, local FM signal that is blocking or cross modulating other FM stations. The filter connects in series with the FM antenna's downlead. Just be sure to use the shortest possible length between the filter's output and the receiver. The filter *must* be assembled in a metal cabinet with ¼-in. access holes so you can adjust the trimmer tuning capacitors. The metal cabinet is grounded to the receiver's chassis. Switch S1 by-passes the filter for normal operation. If your antenna's downlead is coaxial cable, only one filter is installed—in series with the center (hot) conductor. To adjust, tune in the offending station and use an insulated alignment screwdriver to adjust trimmer capacitors C1 and C2 for *minimum* signal strength.

15 Flood Alarm

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



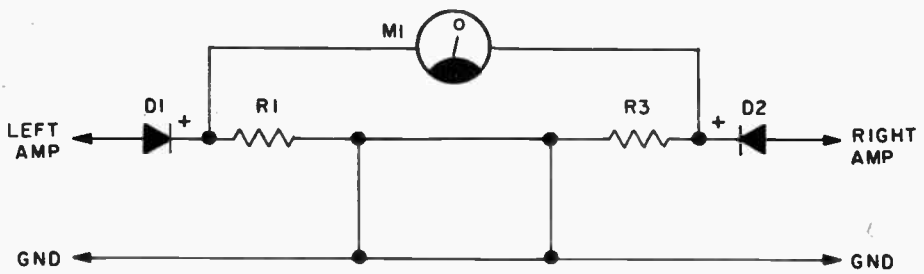
PARTS LIST FOR FLOOD ALARM

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

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 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 incorrect phasing by making certain the meter leads are connected to the amplifier "hot" terminals.

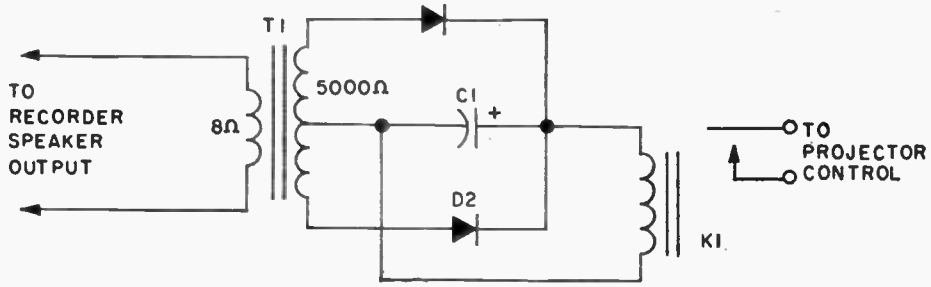
An ordinary 0-1 mA DC meter can be substituted. You adjust for zero reading, but keep in mind that the meter pointer can be driven in the reverse direction off-scale. Use only as much amplifier power as necessary for a visible meter indication. Those parallel wires on the schematic diagram show circuit symmetry. Only one wire is, of course, actually necessary.

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%

17 Slide Synchronizer

UPDATED



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.

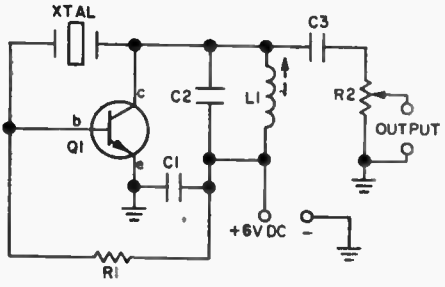
Record your commentary on the left track. At the instant you want slides to change, record a one-second noise or tone burst on the right track. Connect the programmer between the recorder's right speaker output and the projector's remote control cable. Make a test run to determine the right-track volume 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 SYNCHRONIZER

C1—25-uF, 50-VDC electrolytic capacitor
D1, D2—Motorola HEP-156
K1—2500-ohm coil plate-type relay
T1—5000-ohm CT audio output transformer

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.

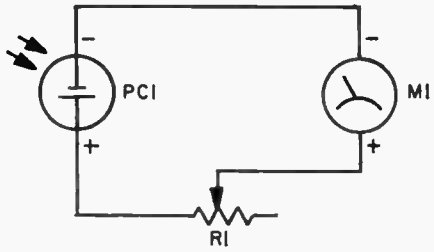
Turn the power supply on and off several times to make certain the oscillator starts consistently. If the oscillator fails to start every time, adjust L1's slug *slightly* until you obtain immediate and consistent starting each time the power is applied.

19 Enlarger Meter

UPDATED

PARTS LIST FOR ENLARGER METER

M1—100, 250, or 500-mA DC meter
PC1—Solar cell (Radio Shack 276-115)
R1—5000-ohm potentiometer linear taper



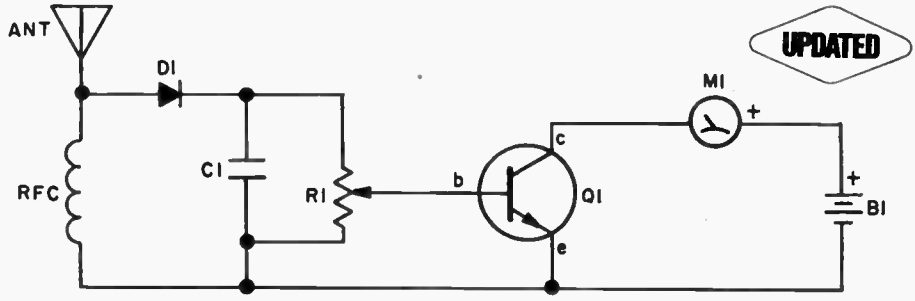
Every print a good print! That's what you get with the Enlarger Meter.

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.

20 Field Strength Meter



UPDATED

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.

PARTS LIST FOR FIELD STRENGTH METER

B1—1.5-V AA battery
C1—0.001-uF, 100-VDC capacitor
D1—1N60 diode
M1—0-1 mA DC meter
Q1—npn transistor—HEP-726
R1—50,000-ohm potentiometer
RFC—2.5-mH choke—J. W. Miller 6302

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.

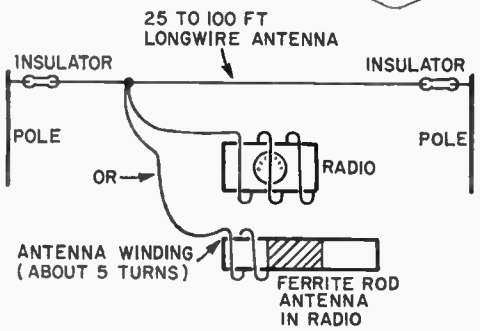
To operate the unit, sensitivity control

R1 is adjusted for ⅓ to ¾-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 No Parts BC Booster

NEW 1972

Just about any transister radio can be made a "DX hound" with the No Parts BC Booster. Simply bring in the end of an outdoor "longwire" antenna and wrap the end around the radio about 5 times. Even better reception is possible if you open the radio and wrap about 5 turns around the rod antenna immediately adjacent to the antenna coil mounted on the rod. Make certain the ends of the antenna are insulated with glass or ceramic insulators.



22 3-Way Tone Generator

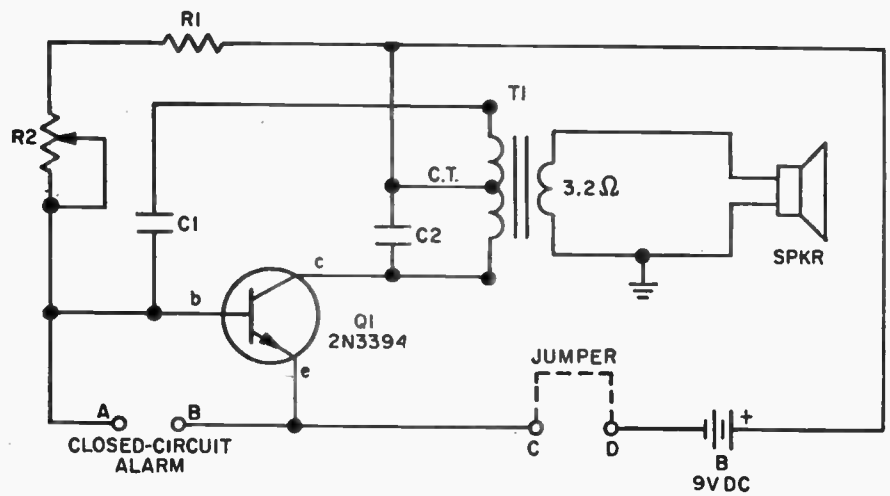
Add a terminal or two and an ordinary CPO (code practice oscillator) becomes a three-way threat, serving as a CPO, tone generator or intruder alarm.

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

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 primory to 3.2-ohm secondary (must *not* be miniature transistor type)—Lafayette Radio 33-75037



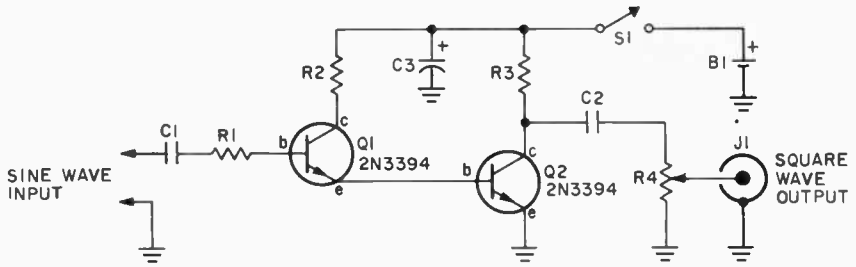
across points C and D. For a "make" intruder alarm, connect one or more normally open magnetic switches across points C and D. For a "break" intruder alarm connect a jumper across C and D and connect a series wire circuit across A and B, which disables the oscillator though power is applied. An intruder 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.

23 Square Shaper

NEW 1972

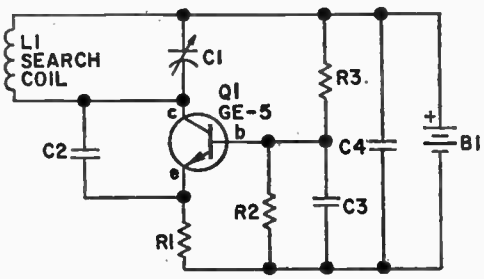


A quick-and-dirty square wave generator for audio amplifier tests can be fashioned from a standard signal generator and the Square Shaper. Simply drive the Square Shaper with about 1 volt from the generator; the maximum output at jack J1 will be a square wave of about 1 volt peak-to-peak. Just about any general purpose small-signal transistor can be used for Q1 and Q2, and any resistance value reasonably close to 470-ohms will be okay for R2 and R3. You can even substitute some surplus PNP transistors such as the 2N404 and 2N109 by simply reversing the polarity of battery B1.

PARTS LIST FOR THE SQUARE SHAPER

B1—1.5 V "C" battery
C1, C2—0.2 or 0.22 uF, 75 VDC Mylar capacitor
C3—50 uF, 3 VDC electrolytic capacitor
J1—Phono jack
Q1, Q2—NPN transistor, 2N3394
R1—100,000-ohm, ½ watt resistor
R2, R3—470-ohm, ½ watt resistor
R4—100,000-ohm audio taper potentiometer
S1—SPST switch

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

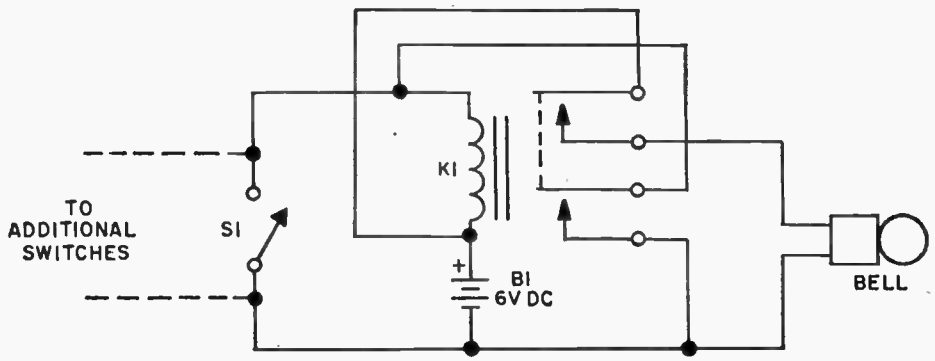
the search head passes over buried metal, the metal changes the inductance of L1, thereby changing the locator oscillator's frequency and changing the "beat tone" in the radio.

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. 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 Latching Burglar Alarm



PARTS LIST FOR LATCHING BURGLAR ALARM

B1—6-V lantern battery
BELL—6-VDC alarm bell
K1—6-VDC dpst relay—P & B KA11DY
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.

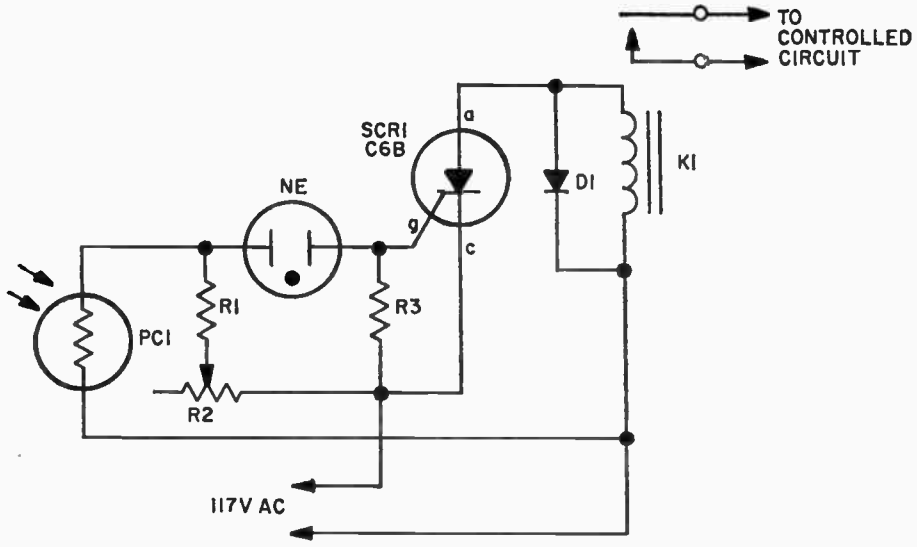
26 Light-Controlled Switch

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.

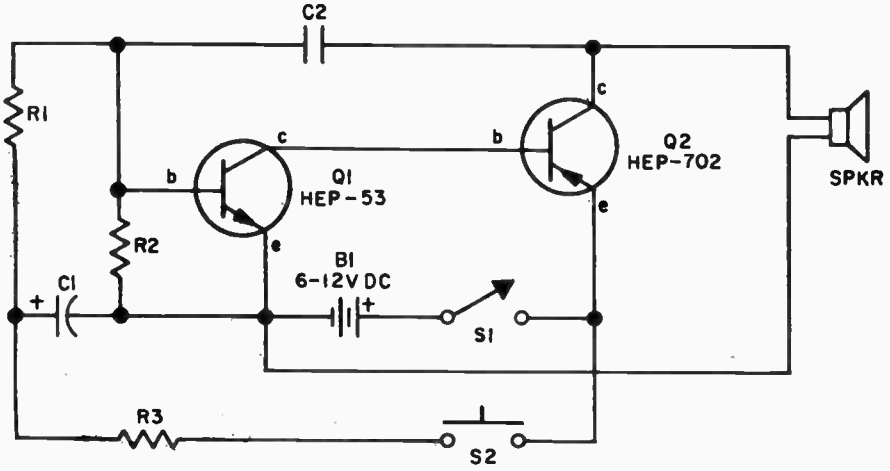
To prevent ambient light from tripping the photocell, it should be recessed at least an inch inside a metal or cardboard tube.



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

27 Electronic Screamer



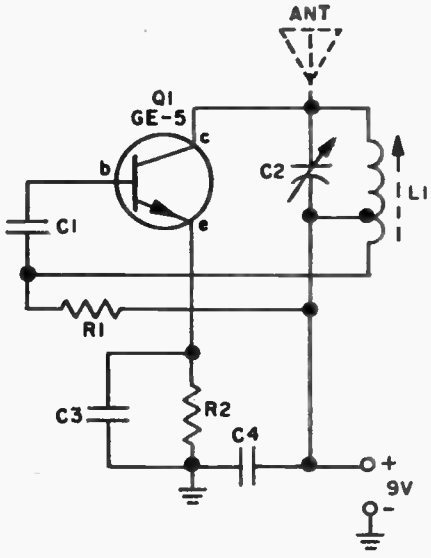
A real screamer! Use a public-address type horn under the hood of your car and you'll punch a hole in the tightest traffic jam. (Be certain, of course, that you hold a position

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 SCREAMER

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

28 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, ½-watt resistor
R2—68-ohm, ½-watt resistor

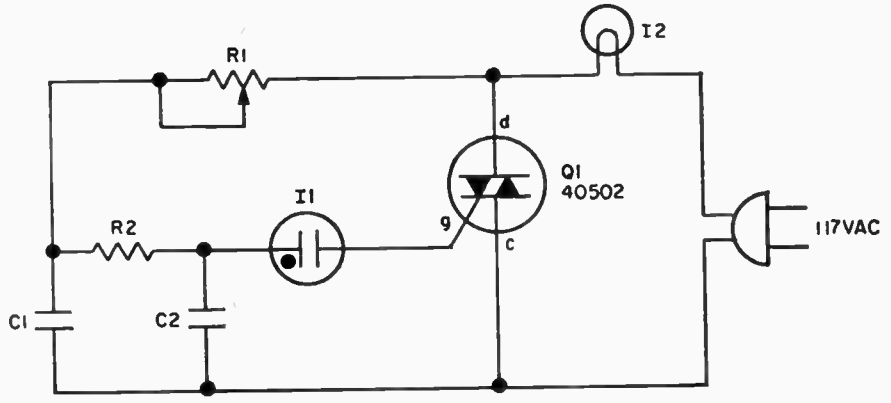
29 Budget Lamp Dimmer

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.)
Because the neon does not trip the gate until it conducts, the lamp turns on at me-

PARTS LIST FOR BUDGET LAMP DIMMER

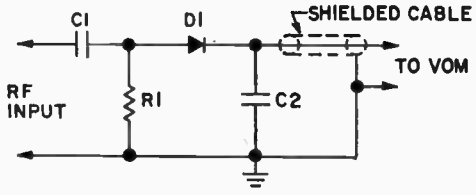
C1, C2—0.068-uF, 200-VDC capacitor
I1—NE-83 or NE-2 neon lamp
I2—External lamp not to exceed 400 watts
Q1—RCA 40502 Triac
R1—50,000-ohm, potentiometer
R2—15,000-ohm, ½-watt resistor

dium 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 RF Probe for VOM

UPDATED

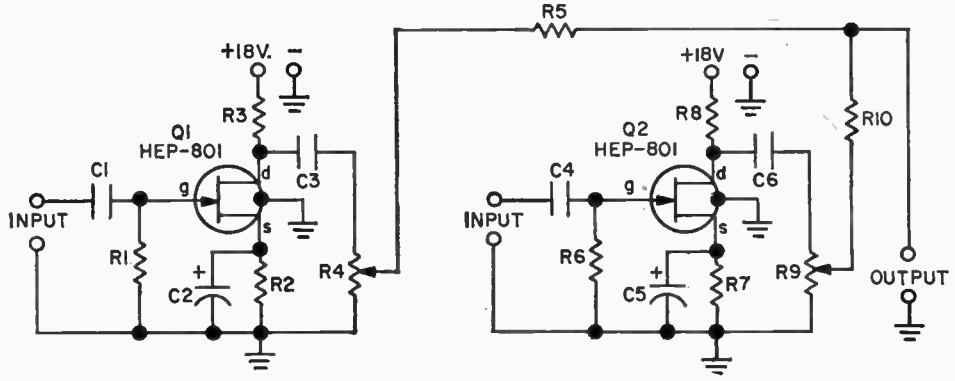


PARTS LIST FOR RF PROBE FOR VOM

C1—500-pF, 400-VDC capacitor
C2—0.001-uF, disc capacitor
D1—1N4149 diode
R1—15,000-ohm, ½-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 100V, the breakdown rating of the 1N4149.

31 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.

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

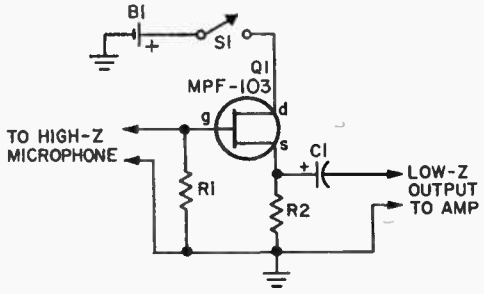
Using FET semiconductors with their *high input* impedance, this basic mixer can be used with high impedance crystal and ceramic microphones. It does not attenuate low frequency response whatsoever through low impedance loading of the microphone. The mixer's response is 10 to 20,000 Hertz.

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.

32 Mike Matcher

NEW 1972

Try to run a high impedance mike line for more than 25 feet and you're sure to get high frequency losses and hum pickup. But this simple junk-box project mounted in a small metal enclosure on the mike stand will convert the mike's output to a low impedance that can run for hundreds of feet without hum pickup or losses. The output can be run into any microphone input rated from 150-ohms up to high impedance. The circuit serves only to convert high to low impedance; it provides no amplification. A metal enclosure must be used. The Field Effect Transistor, Q1, can be just about any surplus N-channel type, such as the Motorola MPF-103.



PARTS LIST FOR MIKE MATCHER

B1—1.5 volt AA battery
C1—10 uF, 3 VDC electrolytic capacitor
Q1—Field effect transistor (see text)
R1—2-megohm, ½ watt resistor
R2—150-ohm, ½ watt resistor
S1—SPST switch

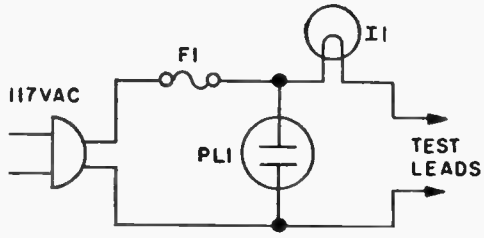
33 Appliance Tester

PARTS LIST FOR APPLIANCE TESTER

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

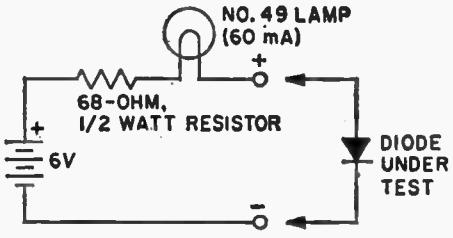
A simple circuit consisting of a 50 watt lamp, fuse and power outlet is all that's needed to check out appliances such as toasters and electric coffee pots.

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.

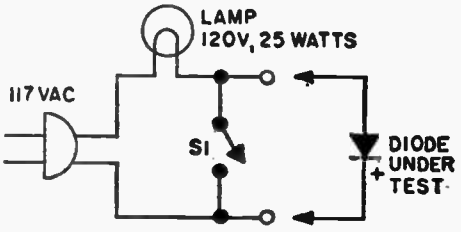
34 Low Voltage Diode Tester



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.



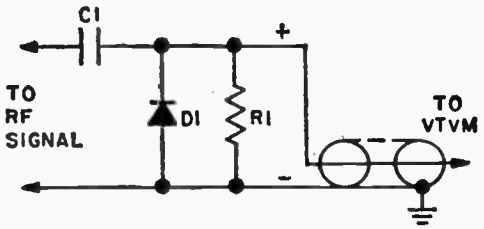
36 RF Probe for VTVM

PARTS LIST FOR RF PROBE FOR VTVM

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

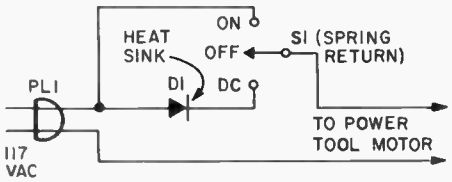
the metal can and solder if possible. The diode rectifies the RF voltage, while the capacity of the shielded cable provides filtering. The output of the probe is positive, with the VTVM indicating the peak value of the RF waveform. To determine the RMS value, multiply the VTVM reading by 0.707. The maximum 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 Dynamic Brake

NEW 1972

Give it a shot of direct current, and any AC power tool motor will instantly stop. No more free-running power saws or drills with the Dynamic Brake. The unit must be assembled in a metal enclosure as the enclosure provides the heat sink for silicon rectifier D1. This diode has only one solder terminal, the case is the second terminal. Place a single strip of plastic electrical tape on the bottom of SR1's case, thoroughly coat SR1's case with epoxy adhesive and cement SR1 to the enclosure (heat sink). When the adhesive is dry solder one connecting wire directly to SR1's case, the remaining wire connects to the terminal. Polarity is not important; any wire can go to any SR1 terminal.



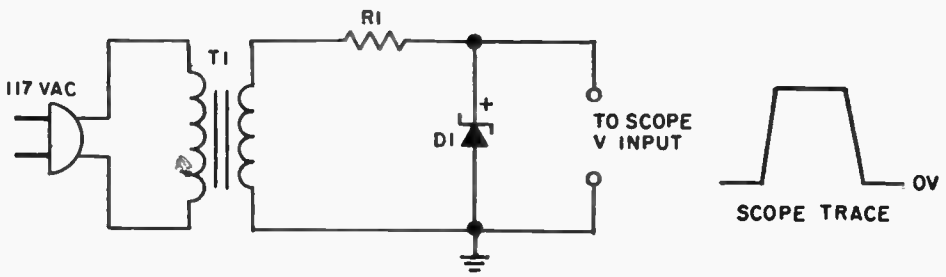
PARTS LIST FOR DYNAMIC BRAKE

PL1—AC plug
SR1—Silicon rectifier, 200 PIV, 20 A. (General Electric IN3210, A40B)
S1—SPDT switch. Center off, one side spring return
Misc—Metal cobinet

Switch S1 is a center-off, one side spring return. With S1 on, AC will be fed to the motor and the motor will run. To brake the motor, simply press S1 down and a quick shot of DC will instantly stop it. The switch returns to the center off position when released. This Dynamic Brake can only be used with AC motors; it will not brake universal (AC-DC) motors.

38 Budget 10V Swinger

UPDATED



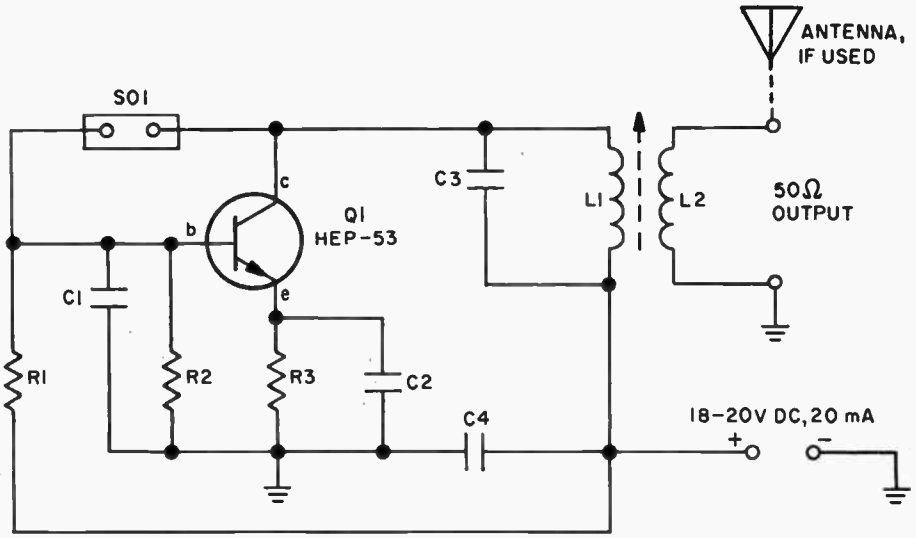
You can make accurate voltage measurements with your oscilloscope if you calibrate the vertical input with a Scope Calibrator. When the top of zener diode D1 goes negative it conducts and voltage across the diode is essentially zero. When the voltage at the top of the zener goes positive, it

builds until it reaches 10 V. At that point the diode conducts, dropping five volts across D1. The result is a square wave which varies from zero to 10 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 10 V peak-to-peak per division. The scope's vertical attenuator then provides multiples of the calibration such as 1 V/div., 10 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 10V SWINGER

D1—10V, 0.4-watt Zener diode—HEP-101
R1—270-ohm, ½-watt resistor
T1—177 to 12.6 VAC filament

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.

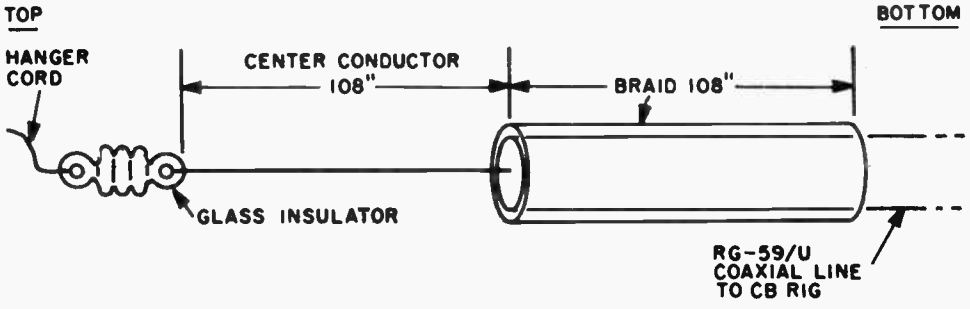
PARTS LIST FOR MULTIPURPOSE CB OSCILLATOR

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 ⅜-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, ½-watt resistor
R2—680-ohm, ½-watt resistor
R3—180-ohm, ½-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.



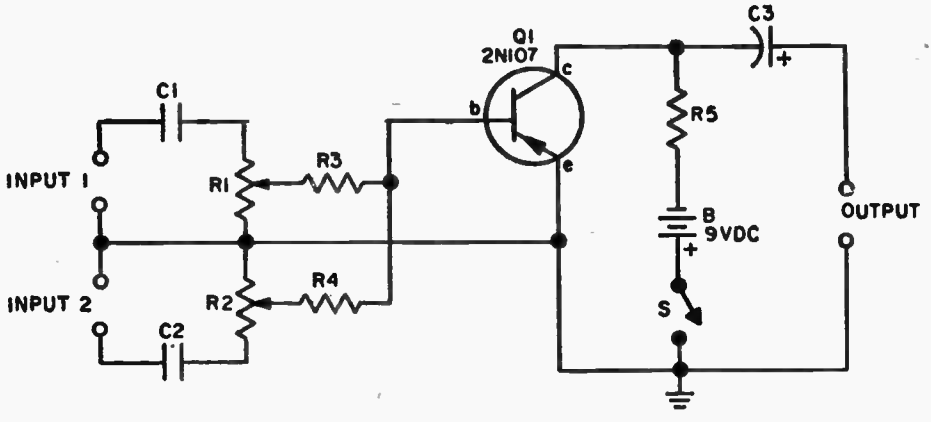
41 Budget Mike Mixer

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 BUDGET 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



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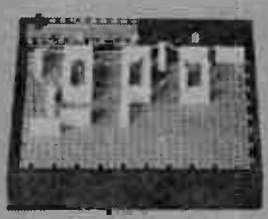

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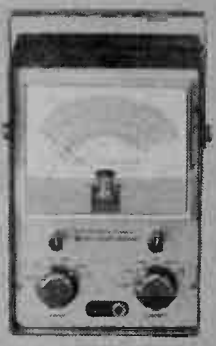

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321

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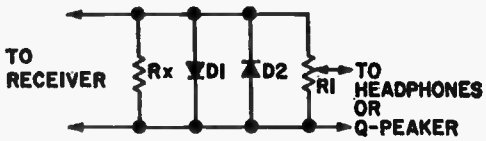
42 Headphone Limiter

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.



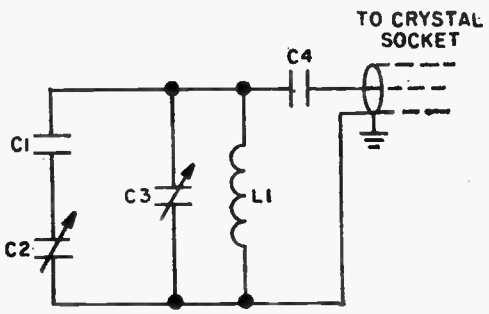
PARTS LIST FOR HEADPHONE LIMITER

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

43 CB 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.

44 Speech Snipper

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

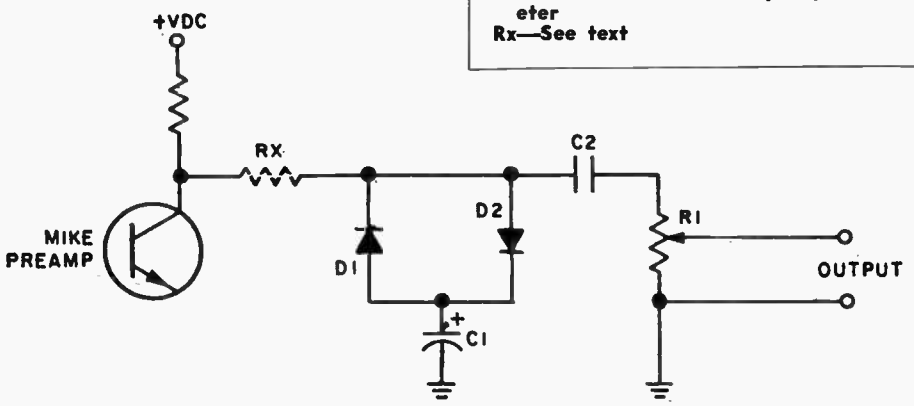
Connect the diodes to the collector of the microphone preamplifier, the stage with at least a 1V peak-to-peak audio output voltage. The diodes clip at approximately .2V, allowing overall amplifier gain to be increased without speech peaks producing overmodulation or excess peak power output.

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.

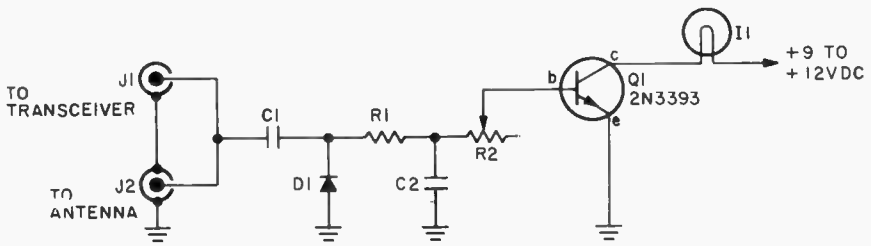
PARTS LIST FOR SPEECH SNIPPER

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



45 CB Modulation Lamp

NEW 1972



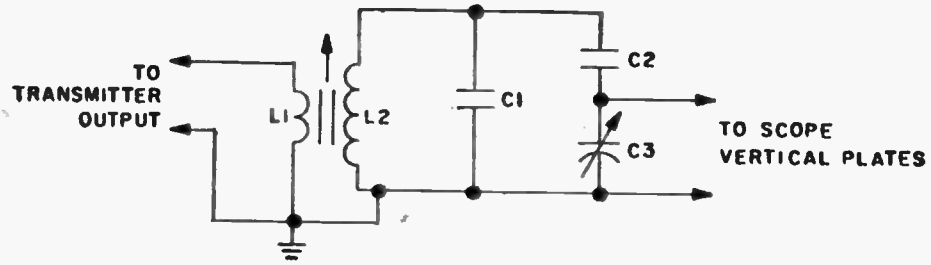
Less than a buck is all that's needed to be certain that what you put into the mike is really getting to your sky hook. Working directly from a minute sample of the transceiver's RF output, the Modulamp will glow only if there is a carrier output and modulation. So if no one replies to your call and the lamp glows in step with your modulation, you can at least be certain it's not the transceiver that's at fault. If the unit is built into a small metal box, jacks J1 and J2 should match the existing transmission line connectors. If you build the Modulamp directly into your transceiver, simply connect capacitor C1 to the RF output jack (and forget about J1 and J2). To adjust, simply talk into the mike in your normal voice and adjust trimmer potentiometer R2 until lamp I1 flashes in step with the modulation. If I1 will not flash regardless of R2's adjustment, substitute a higher gain transistor for Q1 (try a 2N3392). Just about any transistor rated 250 mW or more will work.

PARTS LIST FOR THE CB MODULATION LAMP

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

46 CB Scope Stretcher

UPDATED



PARTS LIST FOR CB SCOPE STRETCHER

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—⅜-in. RF slug-tuned coil form (J. W. Miller 4400-2)

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 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 ⅜-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.

47 CB Xmission Line Monitor

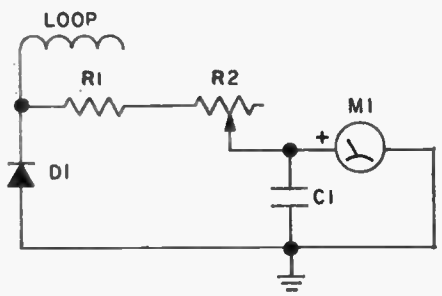
This monitor "steals" an insignificant amount of power, yet keeps constant watch on a CB rig's RF output. If a failing tube starts to drop the output, the line monitor immediately lets you know it.

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

PARTS LIST FOR CB TRANSMISSION LINE MONITOR

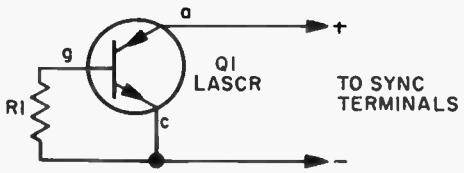
C1—0.001-uF, 100-VDC disc capacitor
D1—1N914 diode
M1—0-1 mA DC meter
R1—1500-ohm, ½-watt resistor
R2—10,000-ohm potentiometer



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 R2 serves as a coarse sensitivity control.

48 Remote Flash



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.

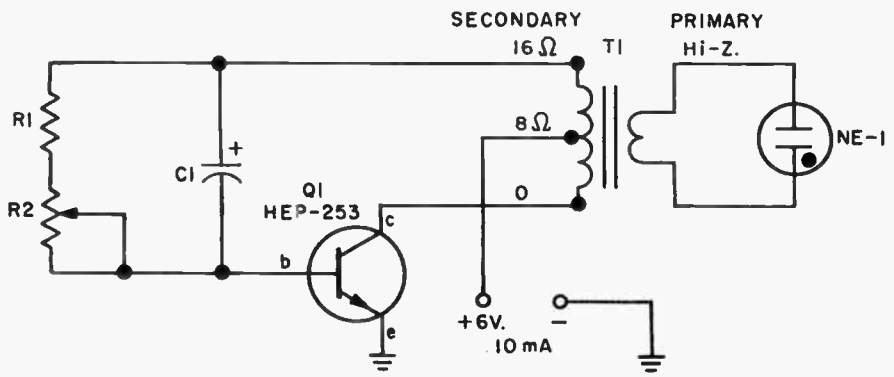
When using the device, bend the connecting wires so the LASCR lens faces the main flash. This will fire the remote unit.

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.

PARTS LIST FOR REMOTE FLASH

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

49 Mini-Drain Pilot Lamp



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.

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

50 Wink and Blink

UPDATED

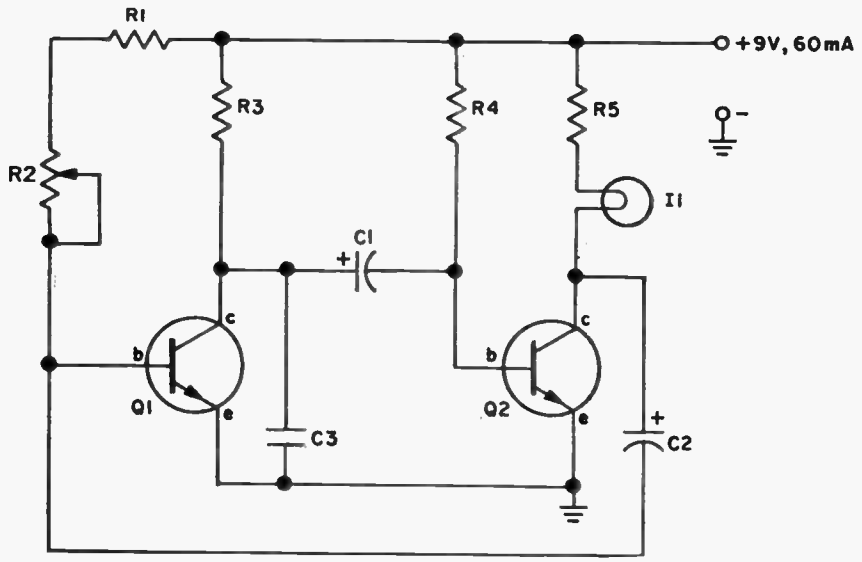
If a light blinks and winks someone will stop and look—and that's the purpose behind this attention-grabber.

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.

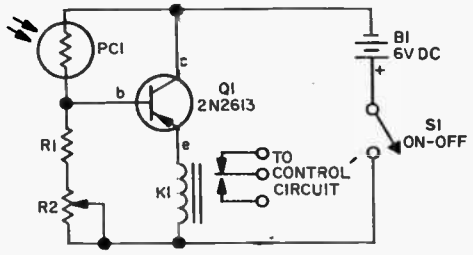
PARTS LIST FOR WINK AND BLINK

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—npn transistor—HEP-723
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

With only a handful of low-cost components this photo relay turns a light on or off ac-



cording 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.

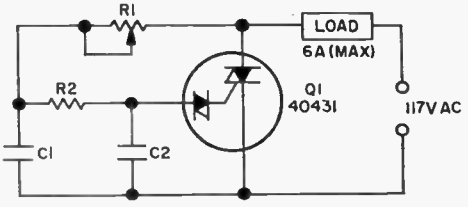
PARTS LIST FOR CANDLE POWER CONTROL

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

52 RPM Speed Control

PARTS LIST FOR RPM 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 Click Clack Timer

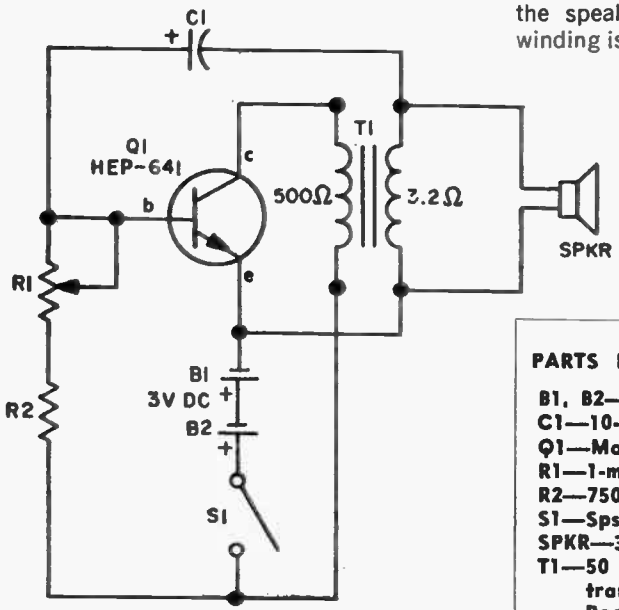
Providing equally spaced clicks from 3 to 300 per minute, this click generator is either an electronic metronome or an interval timer, say, for photo enlarging.

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.

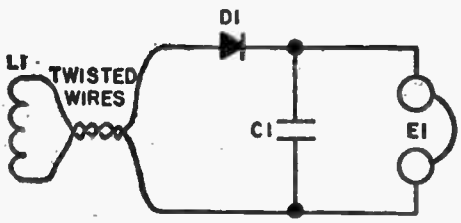
If the generator does not click when power is first applied, interchange the two leads from T1's secondary. Do not interchange the speaker leads! Note: T1's 3000-ohm winding is not used.



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, ½-watt resistor
S1—Spst switch
SPKR—3.2-ohm, 2½-in. dia. speaker
T1—50 to 3.2 ohm miniature audio transistor transformer—Lafayette Radio 99-61327

54 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—1N914 diode
E1—Magnetic headphone, 2000 ohms or better
L1—Coil, 3 turns on 1½-in. dia. form, use any thin gauge wire

55 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

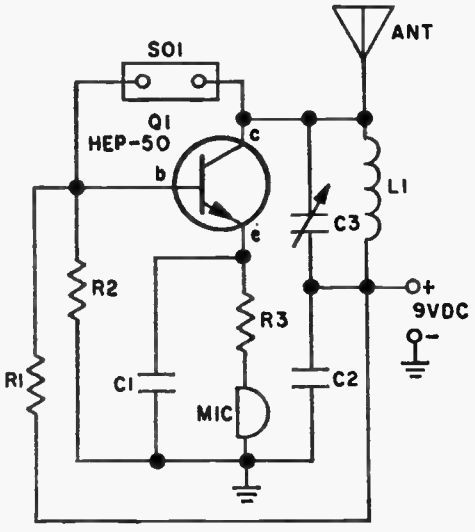
circuit. Salvage crystals from junked units. The whip antenna is a standard walkie-talkie three-section replacement type. The carbon microphone can be a telephone transmitter. You may want to use the portable CB antenna described in circuit 22 on page 26 or Extended CB Antenna in circuit 31 on page 31.

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

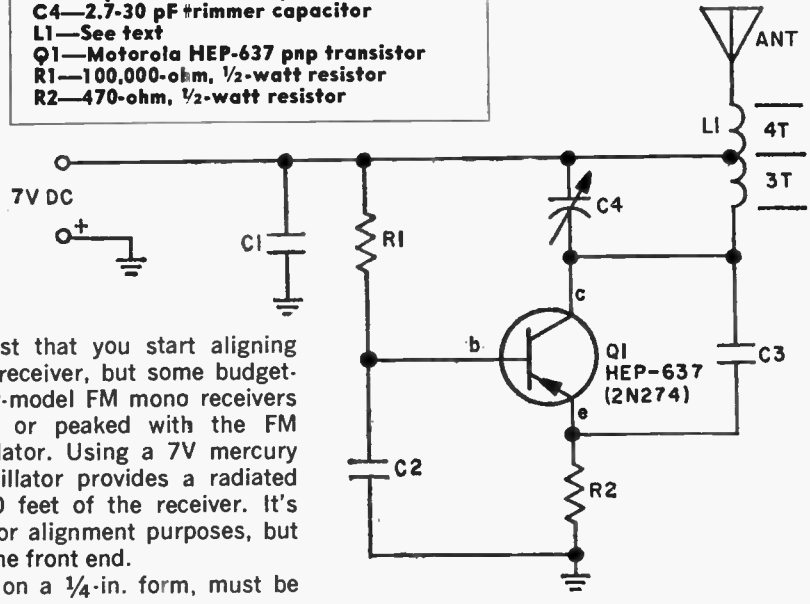
C1, C2—0.001-uF, 100-VDC disc capacitor
C3—50-pF trimmer capacitor
L1—10 turns #16 enameled wire wound on ⅜-in. form, spaced 1 in. end to end
MIC—Carbon microphone element
Q1—Motorola HEP-50 npn transistor
R1—47,000-ohm, ½-watt resistor
R2—10,000-ohm, ½-watt resistor
R3—330-ohm, ½-watt resistor
SO1—Crystal socket



56 FM Alignment Oscillator

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



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

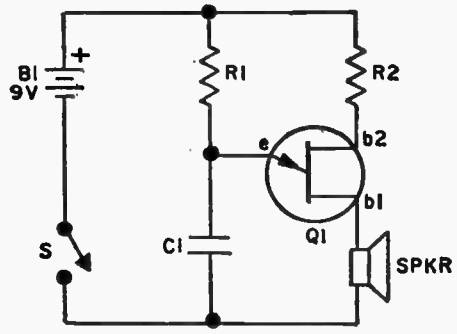
made with extra care. The 4-turn section is tight-wound, no spacing between turns. The 3-turn section is spaced—after winding—to a length of 3/8-in. from the tap to the end of the coil. The tap is made by scraping off some enamel, tinning the bare area, then soldering a solid bare wire to the tap. Frequency is preset by adjusting C4.

57 Mike Beeper

UPDATED

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.



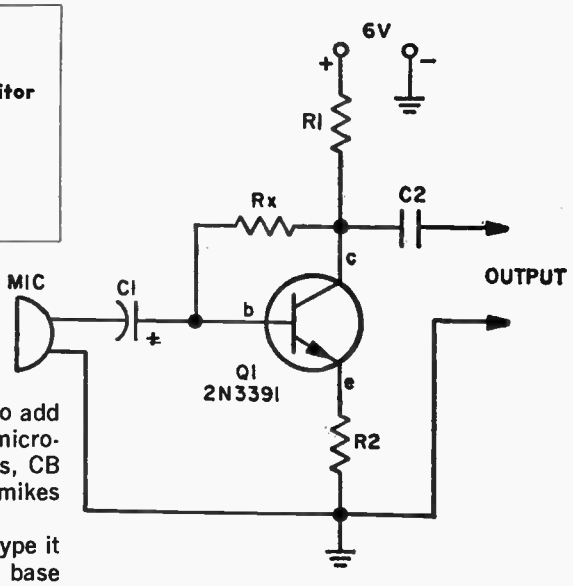
PARTS LIST FOR MIKE BEEPER

B1—Type 216 9-V battery
C1—0.1-uF, 10-VDC capacitor
Q1—unijunction transistor—HEP-310
R1—10,000-ohm, 1/2-watt resistor
R2—47-ohm, 1/2-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, 1/2-watt resistor
R2—15-ohm, 1/2-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 tail-

ored 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 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, ½-watt resistor

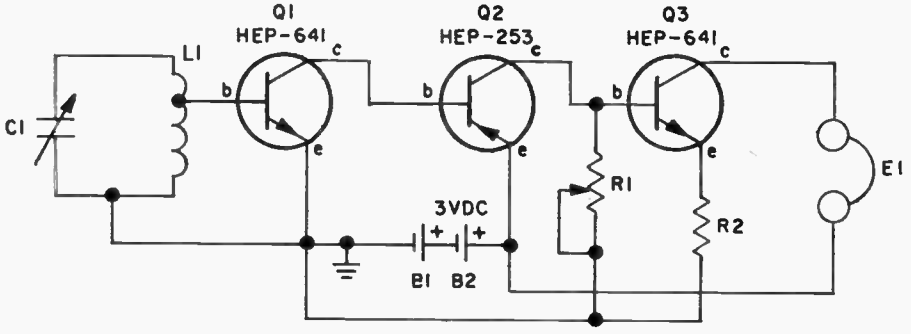
A shirt-pocket project, this direct-coupled radio uses transistor Q1 as a diode detector and first audio amplifier. Detection is across the base-emitter junction which operates as a diode. Normal base-emitter capacitance provides RF filtering. L1 can be a tapped (transistor type) ferrite antenna coil.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

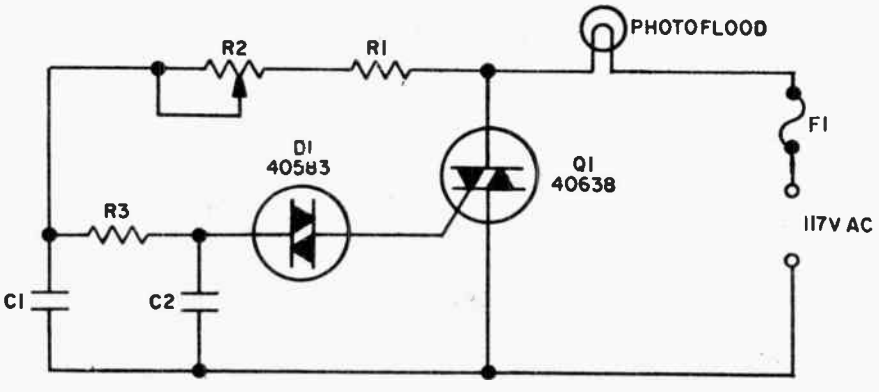
Control R1 is adjusted for best earphone sound—or least distortion consistent with maximum volume.

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.



60 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

61 CB Modulation Meter

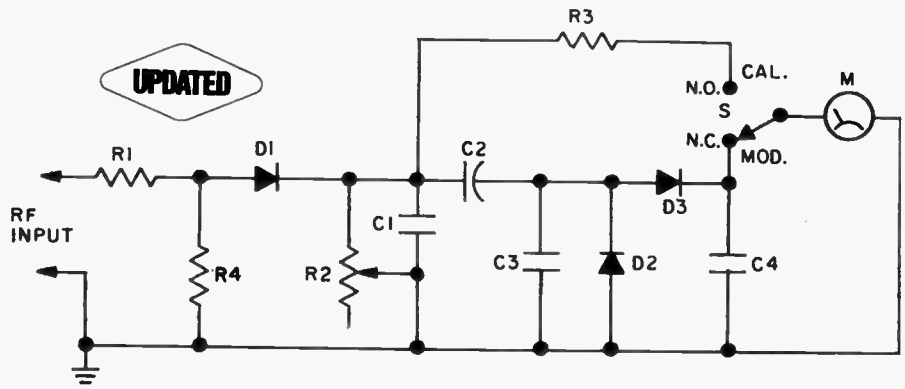
PARTS LIST FOR CB MODULATION METER

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, R4—1000-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.

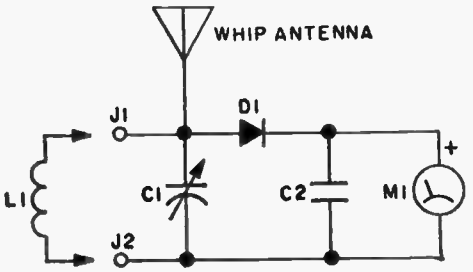


62 Budget FSM

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, de-

PARTS LIST FOR BUDGET 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

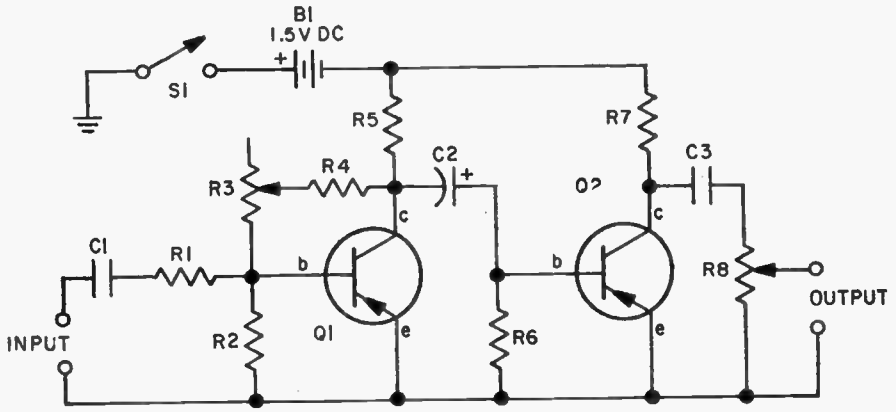


pending on the choice of coil L1. The coil can use phone tip jacks for a plug-in connection for band changing. Consult any coil table for L1's winding data since coil construction depends on the type of wire and frequency.

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.

63 Fancy Fuzzbox

UPDATED



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—pnp transistor—HEP-632
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

64 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-VIVM or a 20,000 ohms/volt VOM. Adjust the amplifier for the desired power output,

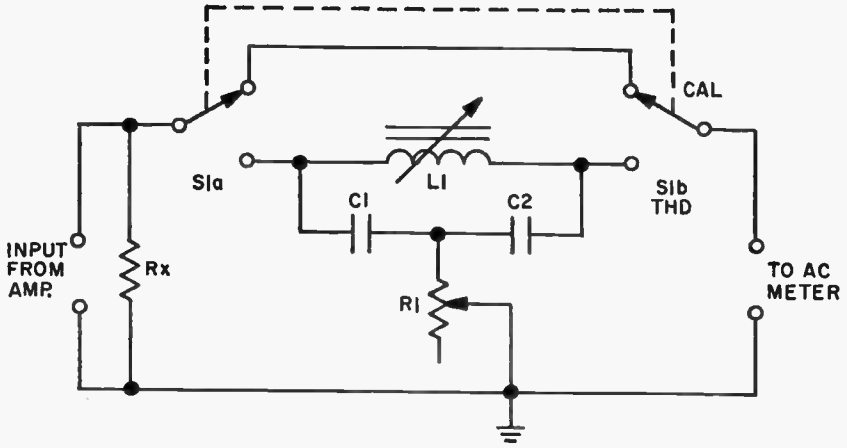
set switch S1 to the calibrate position and note the meter reading. Set S1 to the THD (Total Harmonic Distortion) position and adjust both coil L and resistor R for the *minimum* meter reading.

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



65 Shortwave Spotter

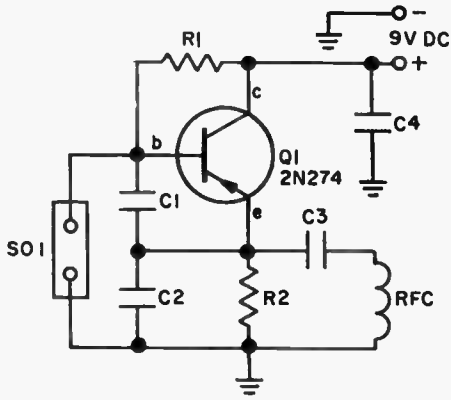
Can't find that rare, weak SW signal from Lower Slobbovia? You will if you use this SW frequency spotter. Obtain crystals on or near your favorite SW stations, plug 'em into the spotter and you'll transmit powerhouse markers on the shortwave bands. If your receiver has a BFO it will sound a loud *beep* 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

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

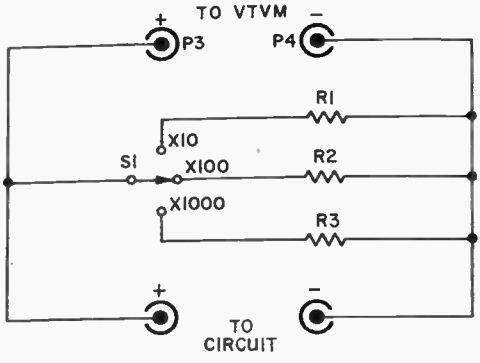


crystal will put you directly on frequency if you want the utmost accuracy.
A connection between the spotter and receiver is not needed. Simply position the spotter near the receiver antenna and start tuning until you find the marker signal.

66 Miladaptor

NEW 1972

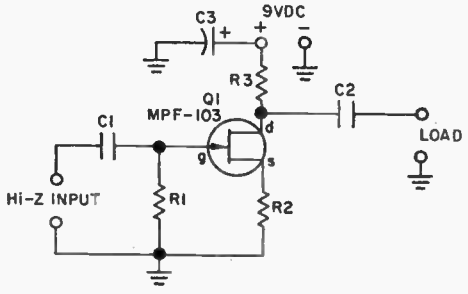
Less than $2 worth of parts is all it takes to convert your VTVM into a DC milliammeter. To use the Miladaptor you simply multiply the VTVM reading by X10, X100 or X1000 to obtain the DC current. For example, if the VTVM indicates 0.1 volt and S1 is set to X100, the current is 0.1 X100 or 10 milliamperes. If the VTVM indicates 0.25 volt and S1 is set to X1000, the current is 0.25 X 1000 or 250 milliamperes. The circuit under test connects to binding posts P1 and P2; the VTVM connects to binding posts P3 and P4. Switch S1 must be the make-before-break type. To avoid damage always start with S1 in the X1000 position and downrange until the VTVM indicates a convenient reading.



PARTS LIST FOR THE MILADAPTOR

P1, P2, P3, P4—Insulated 5-way binding post
R1—100-ohm, 1 watt, 5% resistor
R2—10-ohm, 1 watt, 5% resistor
R3—1-ohm, 1 watt, 5% resistor
S1—SP3T rotary switch (Mallory 5M1113, Centralab 1484 or equiv.)

67 Mike Powerhouse

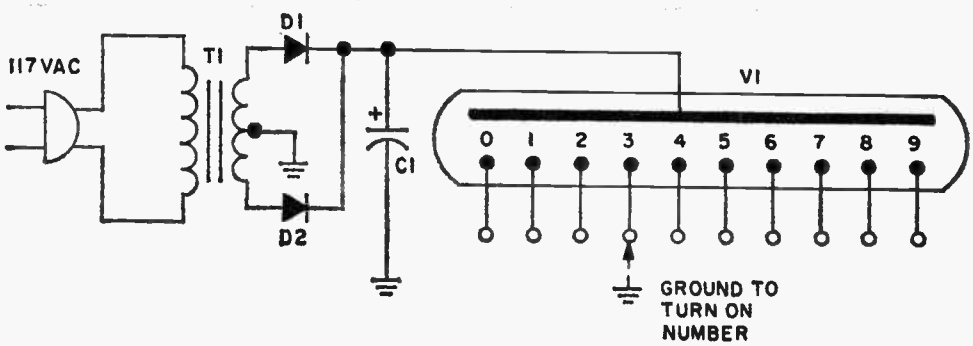


PARTS LIST FOR MIKE POWERHOUSE

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 micriphone 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.

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.

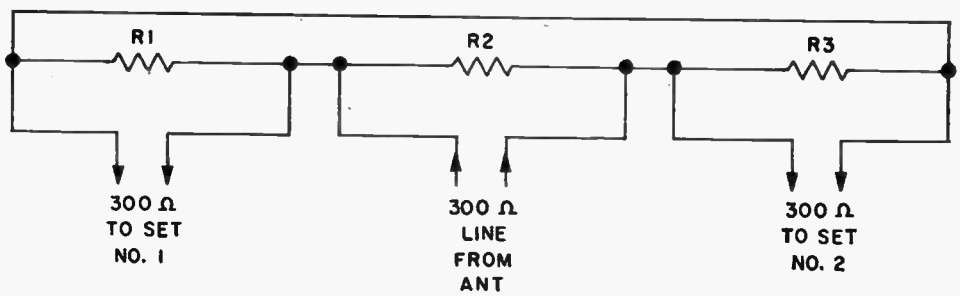
The same power supply can be used for additional *Nixies*, each connecting to the top of C1.

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 TV Coupler for Two



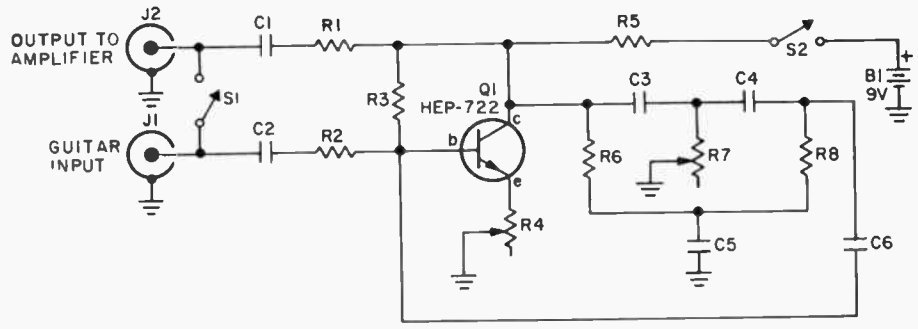
Direct connection of two TV sets to the same antenna can produce severe ghosting and color degradation. For best results, the two sets must have their inputs electrically isolated from each other. You can do it with this three-resistor two-set coupler. Since there's a small signal loss in the splitting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

PARTS LIST FOR TV COUPLER FOR TWO

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

70 Funk Box

NEW 1972



Fuzz, echo, reverb, big bass. They're all out! The new guitar sound is *funky*, and you'll get with it with the wide-range Funk Box. Just crank potentiometer R7 and you'll get an extra twang from way down low to way up high. Just about any construction can be used. If you build it in a metal box, use a push switch for switch S1 and you'll be able to key the effect in and out with your foot. To adjust the Funk Box simply adjust potentiometer R4 until you hear a whistle (oscillation); then back off R4 until the oscillation just ceases. Connect your guitar to jack J1 and twang away. The effect can be varied from bass to treble by adjusting potentiometer R7.

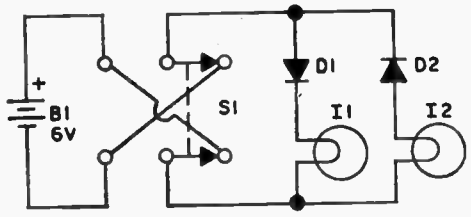
PARTS LIST FOR FUNK BOX

B1—9V type 2U6 battery
C1, C2—.1 uF Mylar capacitor
C3—.05 uF Mylar capacitor
C4—.02 uF Mylar capacitor
C5, C6—.01 uF Mylar capacitor
J1, J2—Phono jack
Q1—NPN transistor, HEP-722 or 723
R1, R2—22,000-ohm, ½ watt resistor
R3—470,000-ohm, ½ watt resistor
R4—2000 or 5000-ohm trimmer potentiometer
R5, R6, R8—56,000-ohm, ½ watt resistor
R7—10,000-ohm potentiometer
S1, S2—SPST switch

71 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)



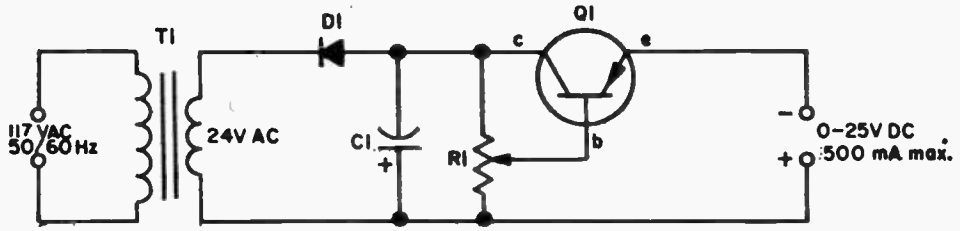
Using diode switching, a single pair of wires controls two circuits that normally require four wires. Though illustrated here with lamps, the same idea can be used for telephone circuits.

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.

72 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

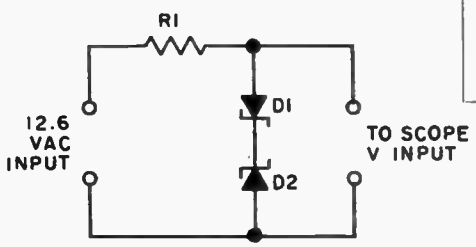
Providing an adjustable output voltage up to 35 VDC and maximum output current of 500 mA, this battery charger handles just about any NiCad battery used by experimenters and consumer equipment.
Transistor Q1 must be mounted on a heat sink (which can be a metal cabinet). Since Q1's case is also the collector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

73 Scope Calibrator

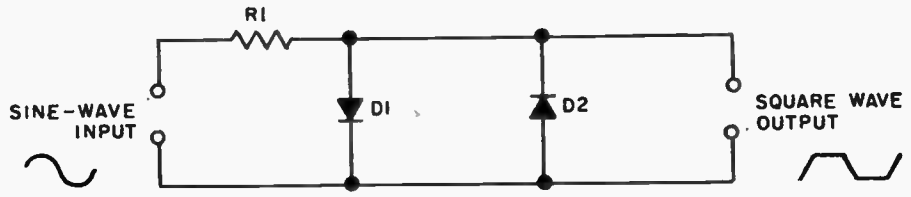
Back-to-back zener diodes provide a scope calibrator with a zero reference output. Whether the calibration voltage is fed to a scope's AC or DC input, the baseline will not have to be readjusted.
When the top of D1 goes positive D1 conducts current through to the D2 cathode. The voltage across D2 builds 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 CHEAPIE SCOPE CALIBRATOR

D1, D2—5-V, ¼-watt Zener diode
R1—270-ohm, ½-watt resistor



74 Sine Wave Squarer

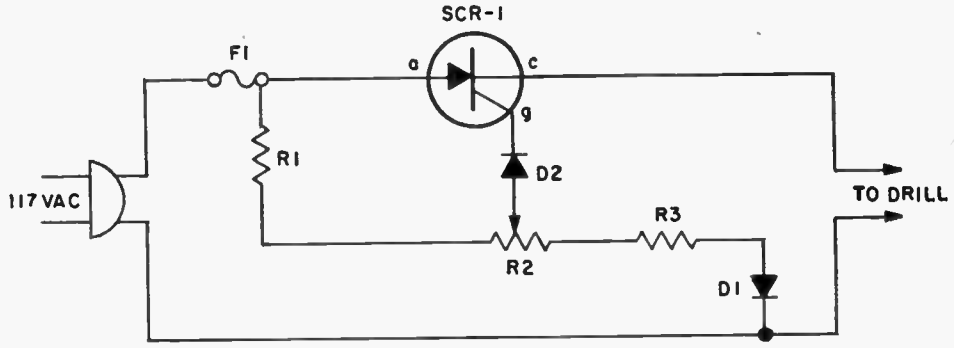


Two reverse-parallel diodes of the germanium type provide an emergency square wave generator. Since a germanium diode has an approximate 0.2 V breakover, any sine wave applied to the diodes will be clipped at 0.2 V. It provides a 0.4 peak-to-peak square wave. It's not perfect since the "rise" of the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

75 Uni-Torque Speed Control



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

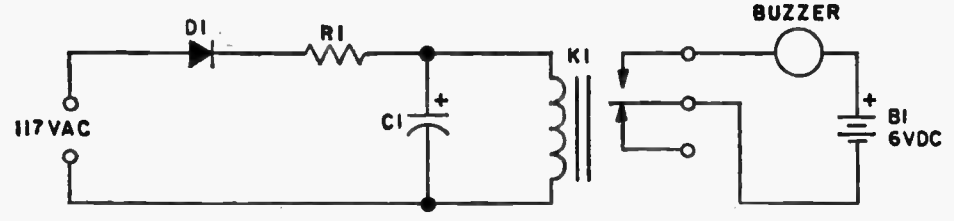
When the drill slows down, a back voltage developed across the motor—in series with the SCR cathode and gate—decreases. The SCR gate voltage therefore increases relatively as the back voltage is reduced. The "extra" gate voltage causes the SCR to conduct over a larger angle and more current is driven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

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

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

76 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 approx. 3 mA.

PARTS LIST FOR POWER FAILURE ALARM

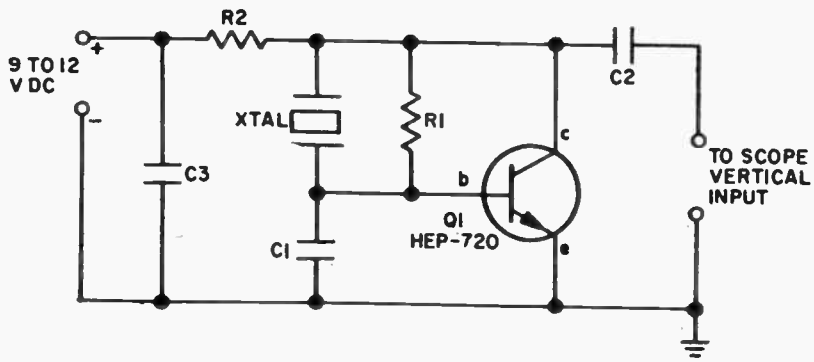
B1—6V dry-cell battery
C1—25-uF, 150-VDC capacitor
D1—500-mA, 200-PIV silicon diode
K1—3000-5000 ohm sensitive relay coil (see text)
R1—10,000-ohm, ½-watt resistor
1—6-VDC commercial home buzzer

77 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



78 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.

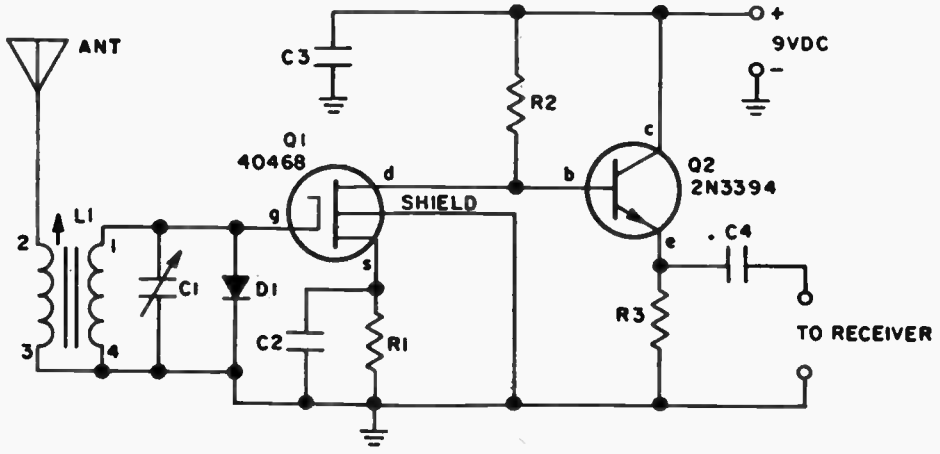
PARTS LIST FOR S-NINER FOR SWLS

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 tronsistor
R1—470-ohm, ½-watt resistor
R2—2400-ohm, ½-watt resistor
R3—4700-ohm, ½-wott resistor

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.



79 Tenna-Blitz Light

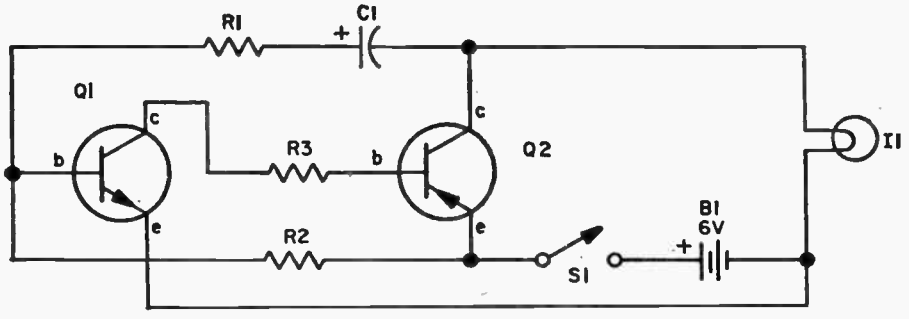
UPDATED

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.*

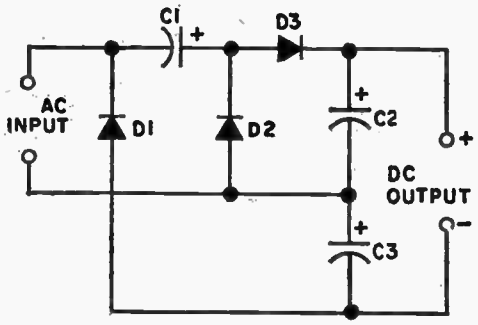
Mount the No. 49 lamp at the top of the antenna and run two wires down to the control unit inside the car. When switch S1 is turned on the multivibrator makes the lamp blink away. Changing the capacitor's value will vary the blink rate.

PARTS LIST FOR TENNA-BLITZ LIGHT

B1—6-V battery
C1—2-uF, 10-VDC electrolytic capacitor
I1—No. 49 pilot lamp
Q1—npn transistor—HEP-641
Q2—pnp transistor—HEP-739
R1—470-ohm, ½-watt resistor
R2—1-megohm, ½-watt resistor
R3—2700-ohm, ½-watt resistor
S1—Spst switch



80 Voltage Tripler

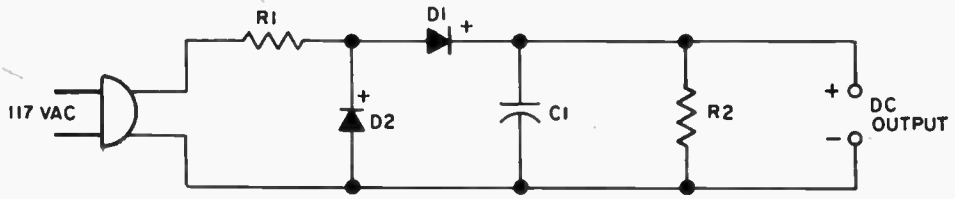


When you need high voltage but don't have a power transformer, a voltage tripler may work. It provides DC output approximately three times higher than the line voltage.
C1 is approximately 8 to 20 *u*F at 150VDC, and C2 and C3 should be a minimum of 100 *u*F at 300VDC. The larger the value for C2 and 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)

81 Preamp Low-Ripple Supply



PARTS LIST FOR LOW-RIPPLE SUPPLY FOR PREAMPS

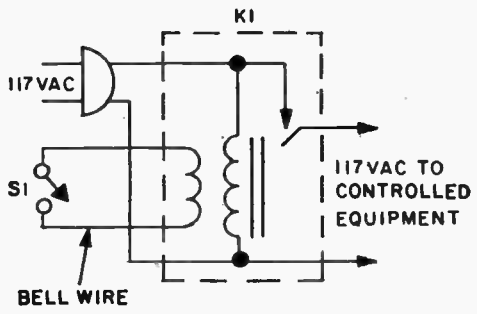
Output V	I max*	R1	C1	R2
12	1 mA	43,000-ohm, ½-watt	250-uF, 15-VDC	180,000-ohm, ½-watt
12	2 mA	22,000-ohm, ½-watt	250-uF, 15-VDC	100,000-ohm, ½-watt
25	2 mA	18,000-ohm, ½-watt	250-uF, 30-VDC	180,000-ohm, ½-watt

***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.

82 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

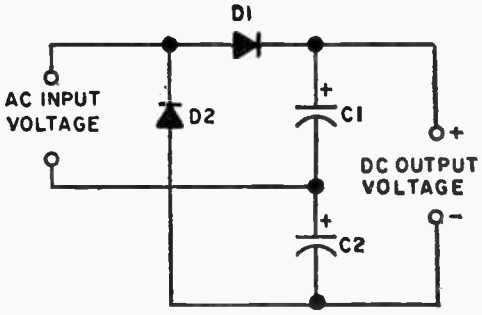


terminals from the hysteresis coil is approximately 30V. When S1 is closed, current through the hysteresis loop is almost unmeasurable. It's safe enough for ordinary bell wire to do the controlling.

PARTS LIST FOR LOW-VOLTAGE REMOTE CONTROL

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

83 Voltage Doubler



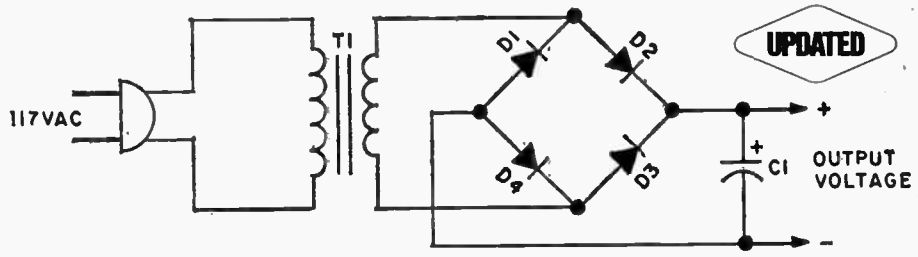
Found in many CB transceivers, the full-wave voltage doubler provides reasonably good regulation with DC output voltage twice the AC input. Capacitors C1 and C2 should be a minimum of 100 uF and rated at twice the DC output voltage. The larger the capacity, the greater will be the filtering.

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

84 Supply for SS Projects



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

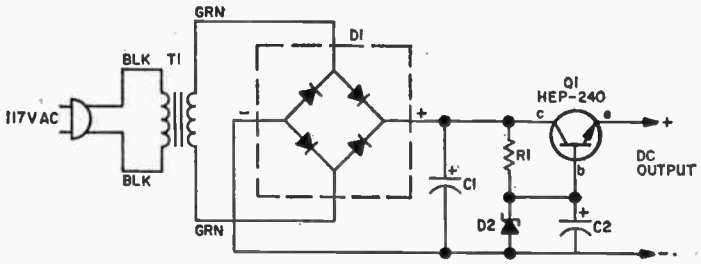
PARTS LIST FOR POWER SUPPLY FOR SS PROJECTS

C1—2500-uF electrolytic capacitor, voltage rating at least 1.5 times higher than output voltage
D1, D2, D3, D4—1A, 200-PIV silican rectifier—Radio Shack 276-1102
T1—Transformer; 117-VAC primary, secondary voltage equal to desired output voltage x 0.707

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.

85 Regulated 9-V Supply

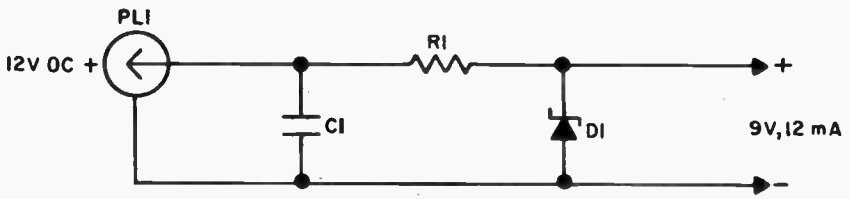


Providing 9 volts at approximately 250 mA, this lab-type power supply will handle many experimenter projects. Actually, T1 can be a 6.3-V *imported* filament transformer since they usually give approximately 12 V peak at less than 500 mA output. Change the Zener diode to 12 or 6 volts (and possibly the 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.

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)

86 Car Voltage for Q Radios



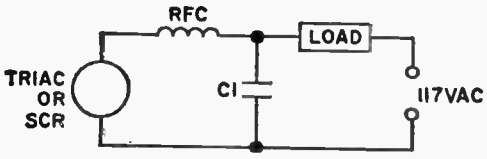
When your auto radio poops out, this regulated voltage adapter keeps you in music from a transistor portable until you're ready to climb under the dash to get at the trouble and fix it.
Power is taken from the 12-volt auto battery through a cigar lighter plug. The zener diode can be anything with an 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 is the cathode.
The adapter is rated for a current of 12

PARTS LIST FOR CAR VOLTAGE FOR Q RADIO

C1—0.05-uF, 400-VDC capacitor
D1—1-watt, 9.1-V Zener diode—HEP-104
PL1—Cigarette lighter plug
R1—150-ohm, ½-watt resistor

mA maximum. A good rule of thumb is that a radio powered by a Burgess type 2U6 battery can safely operate on the adapter.

87 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 ¼-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.

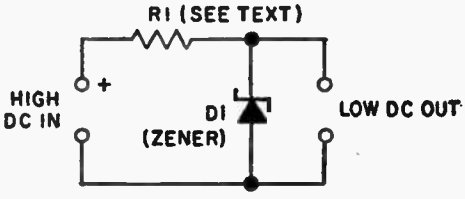
An RFI (Radio Frequency Interference) filter connected between the Triac or SCR and the load can hush the radio interference. Best results are obtained if the filter is located inside a metal box, or in a metal cabinet with the load being controlled.

88 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.

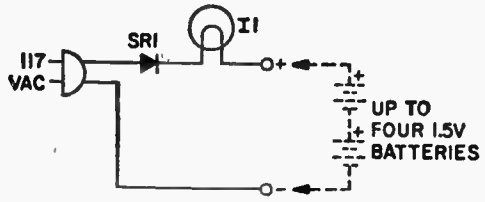
The power rating for the zener diode is determined by the voltage across the diode squared, divided by diode's nominal internal resistance. You can calculate the internal resistance by working backwards from the zener's power rating. As an example: a 9-volt, 1-watt zener would have a nominal internal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



89 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



PARTS LIST FOR DRY-CELL BATTERY CHARGER

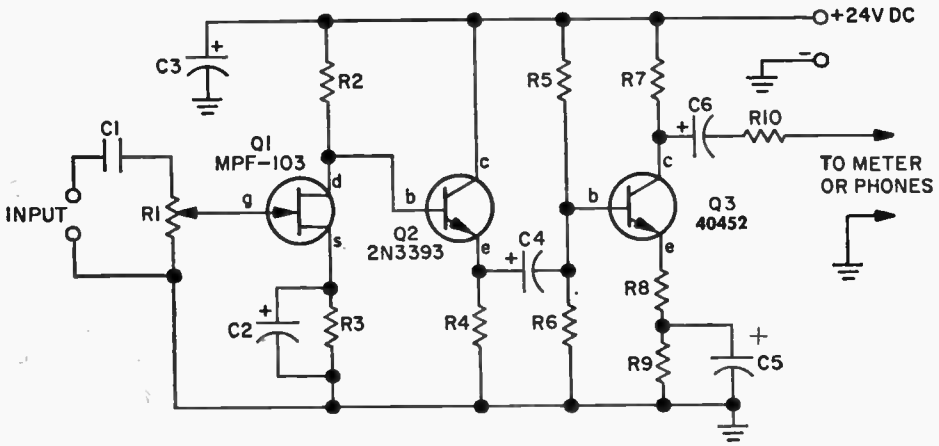
I1—No. S-6 6-watt candelabra lamp
SR1—200-PIV, 1A silicon rectifier—Radio Shack 276-1102

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.

90 Audio Signal Tracer

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.



PARTS LIST FOR AUDIO SIGNAL TRACER

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

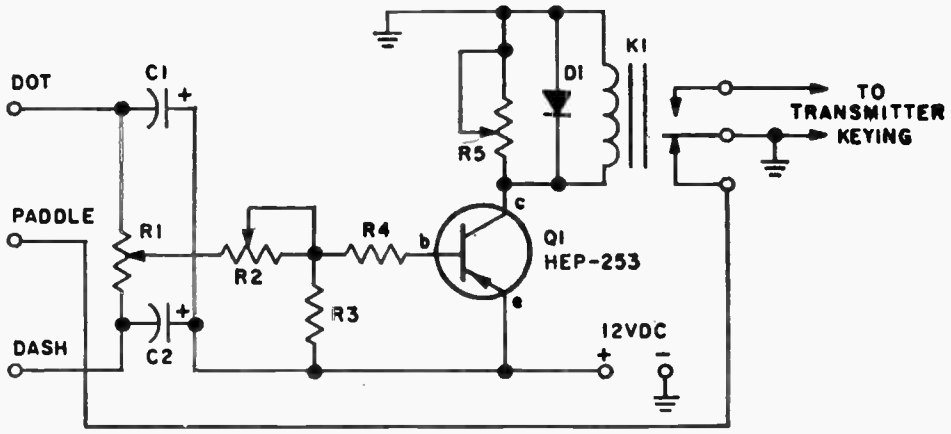
91 Electronic Keyer

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

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



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.

92 Headlight Minder

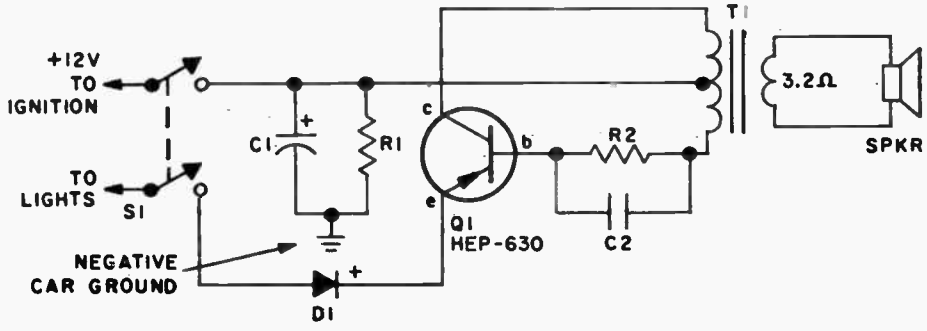
No more dead batteries in the morning; the Headlight Minder lets you know, loud and clear, if your lights are on when the ignition is off.

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.

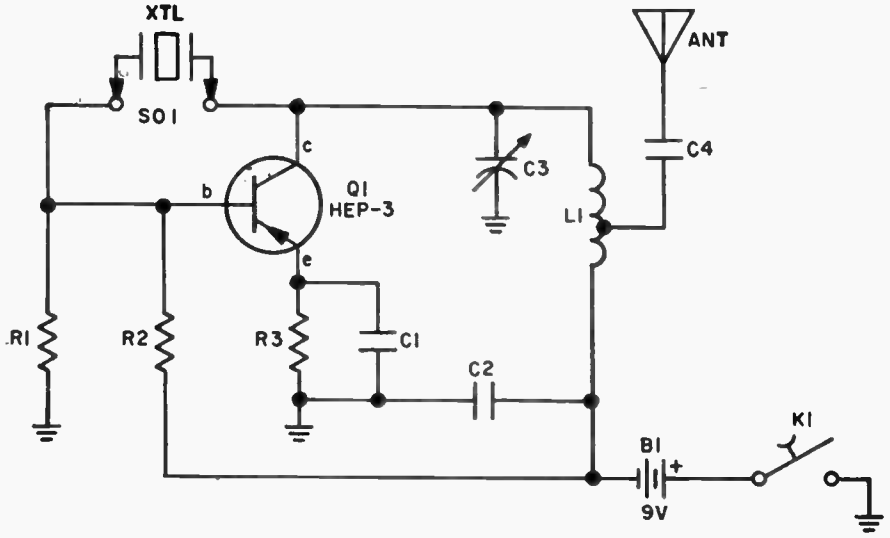
The unit can be built in a metal cabinet fastened to the car's dashboard so R1 is connected through the cabinet to the car's chassis, thereby completing a negative battery connection.

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



93 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.

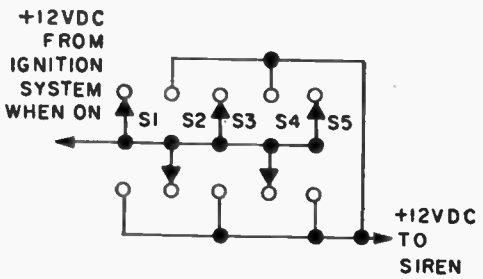
If the oscillator fails to start every time, change R2's value in slight increments until you obtain reliable crystal operation.

94 Electronic Combo Lock

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

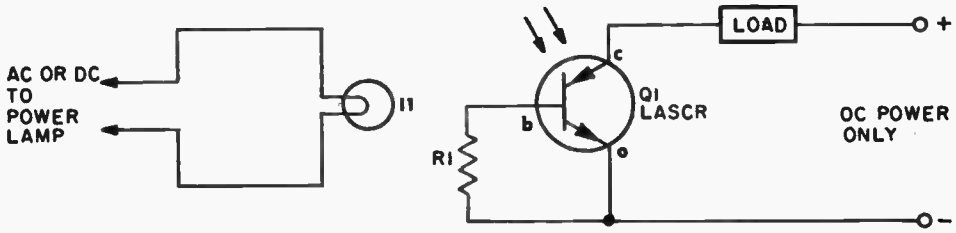
Switches S1 through S5 are spdt rather than spst only to keep all external switch markings the same. It would be a dead giveaway if two keying notches or lettering were reversed.

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."

95 Photo Light Control



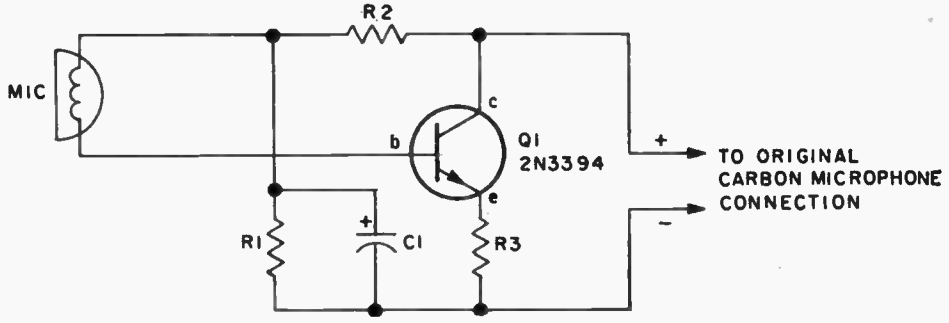
Heavy direct current or DC power is easily controlled without the use of massive power switches and wiring by using a LASCR (light activated silicon controlled rectifier) as an interface between the control and controlled circuits. The LASCR is similar to an SCR except that the gate is tripped by light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

96 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 be housed in the original microphone case.
To avoid destruction of Q1, the unit must be connected properly the first time. The

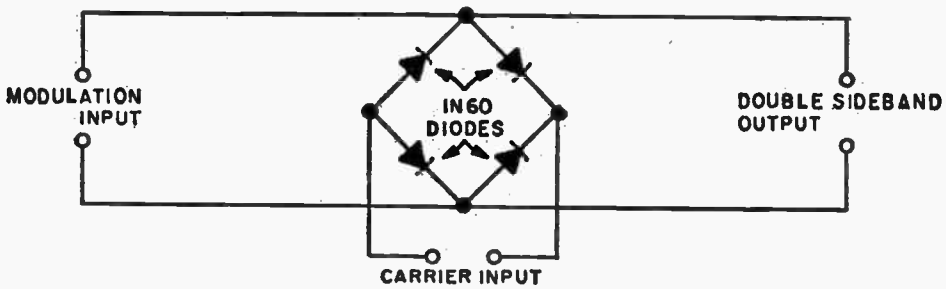


"+" lead, which goes to Q1's collector, connects to the carbon mike input that supplies a positive voltage.

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

97 Sideband Scrambler

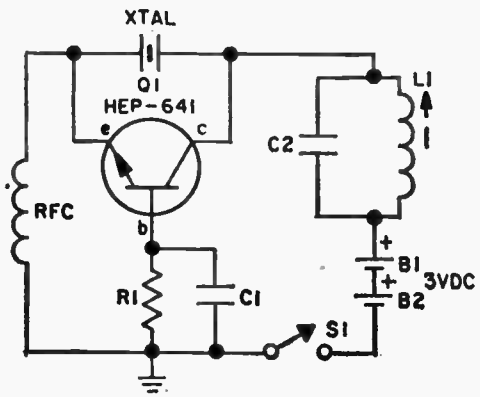


Feed audio modulation to one input, a carrier to another and the output of this sideband generator will be upper and lower sideband with supressed carrier. Where is it used? Try a sideband rig or a telephone speech scrambler. Work the scrambled signal into the modulation input to unscramble your speech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

98 100-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



PARTS LIST FOR 100-kHz FREQUENCY STANDARD

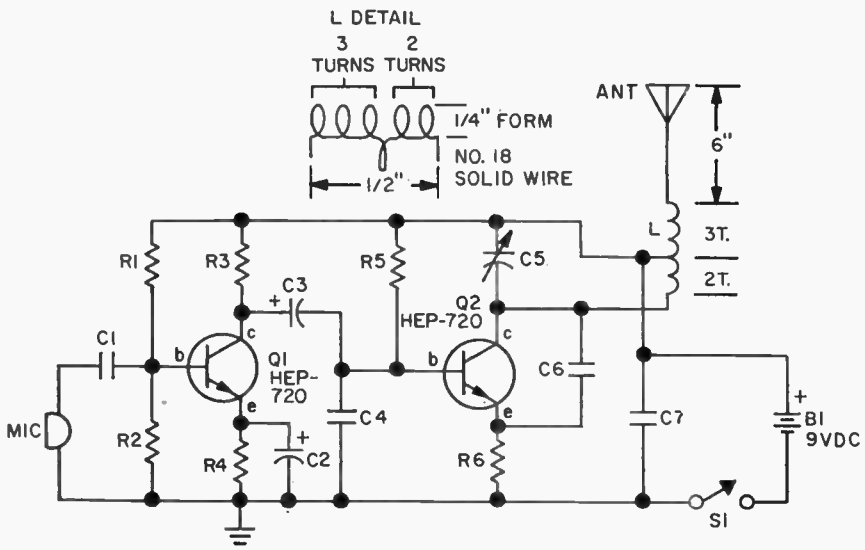
B1, B2—1.5-V AAA battery
C1—0.01-uF, 10-VDC capacitor
C2—200-pF silver mica capacitor
L1—Coil, 2-18 mH
Q1—HEP-641 npn transistor (Motorola)
R1—750,000-ohm, ½-watt resistor
RFC—2.5 mH RF choke
S1—Spst switch
XTAL—100-kHz crystal

have to be connected to the receiver antenna terminal.

Wiring is not critical and almost any layout will work. If the oscillator doesn't start, change R2's value by approximately 20% until you get consistent oscillator operation.

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

99 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

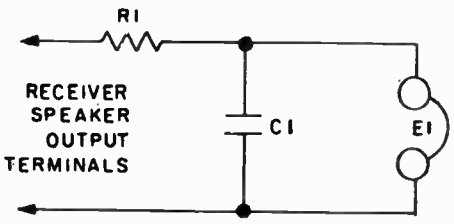
Just speak or play into the microphone and you'll broadcast to an FM receiver at distances up to 50 feet (maybe 100 feet if the wind is right). Use standard RF wiring precautions and make coil L1 exactly as shown. Best speech clarity is obtained by using a crystal or ceramic mike. For music reproduction,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

100 Headset Q-Peaker

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 mag-



netic 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.

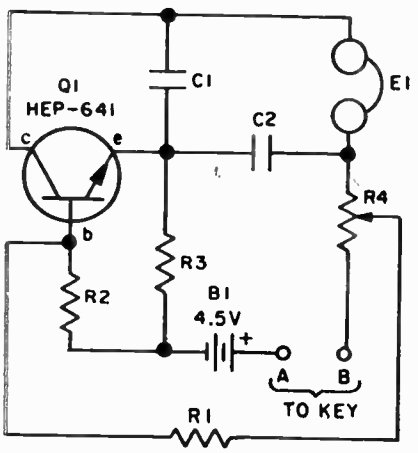
PARTS LIST FOR HEADSET Q-PEAKER

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

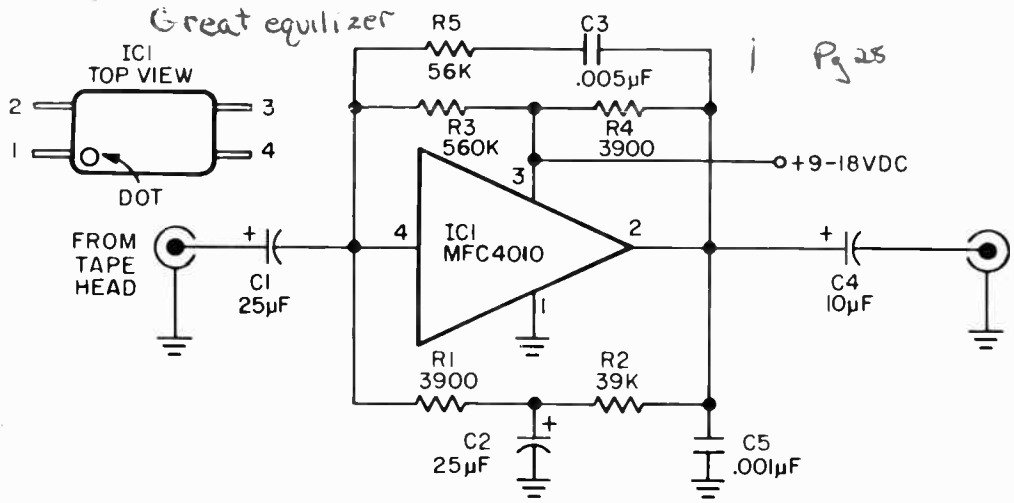
101 Budget CPO

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

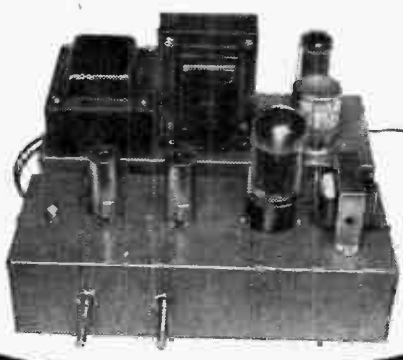


Components you have lying about might make this simple, budget CPO (code practice oscillator). Using component values given, the tone frequency is approximately 800 Hz. It can be changed by substituting different values for C1 and C2, but maintain the same capacity ratio. That is, C2 should always be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



BUILD TV amp

Donald A. Smith W3UZN



- adds pleasure to your viewing
- lets you enjoy TV's true hi-fi sound

WHO SAYS the radio-TV industry has removed the incentive to experiment with new circuits and devices? Just because the electronics manufacturers make such broad product lines is no reason there's little left for the experimenter to create or build. For proof, you're about to meet a project that presents real challenge—our *TV amp*. When you

Television Amp

listen to the average TV set, it's hard to believe that the sound coming out of its speaker is actually derived from high-quality FM normally associated with hi-fi reproduction. To be sure, most modern sets produce excellent pictures. Thing is, the sound portion of the program, as reproduced by many TVs, leaves much to be desired.

Odd as it may seem, if you take the sound off at the FM demodulator and feed it to a good quality amplifier and speaker system, you get quite acceptable sound quality. This really is easy to explain. Competition forces the TV manufacturer to cut corners, and this usually is done in the audio rather than the video section of the TV set. The push has been to please the viewer's eyes, maybe because many people have tin ears anyway. Besides, because viewers are still enthralled by getting pictures through the ether, why spend money for good audio in order to stimulate sales?

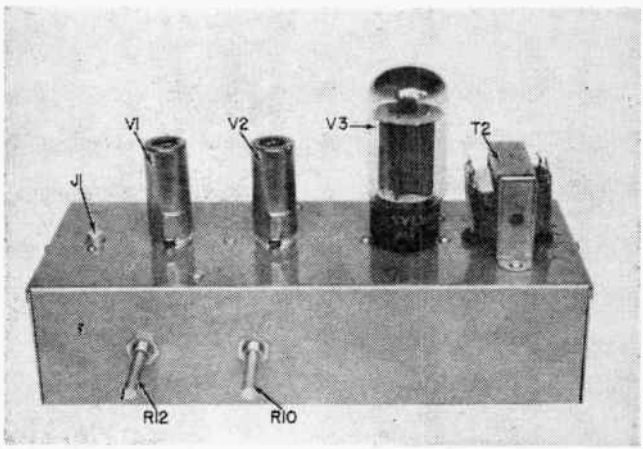
At best, the audio sections in TV sets are minimal. Just their 3½-in. speakers are evidence enough that they were never intended for full-range reproduction. Add to this the poor baffling for the speaker because of lack of proper acoustic design in the cabinet, and you have most of the elements contributing to the overall poor audio quality of the average TV set. If you raise the volume to approach that necessary for good orchestral reproduction, the distortion usually is so high you can't enjoy the music.

In some instances, feed the audio from the FM demodulator into a good-quality audio amplifier and speaker system, and you wish you'd left well enough alone. This certainly is true in the case of sets that have inadequate filtering in their power supply, resulting in much too high a hum level. And it's hard to tell if a set is in this category until tested because the limited range of both the audio amplifier and speaker in the TV set spell death to the lows. Only when you feed its output to audio equipment with extended range will the deficiency in filtering show up. Best thing to do in such a situation is to get rid of the TV set. It's cheaper in the long run than trying to improve its basic design.

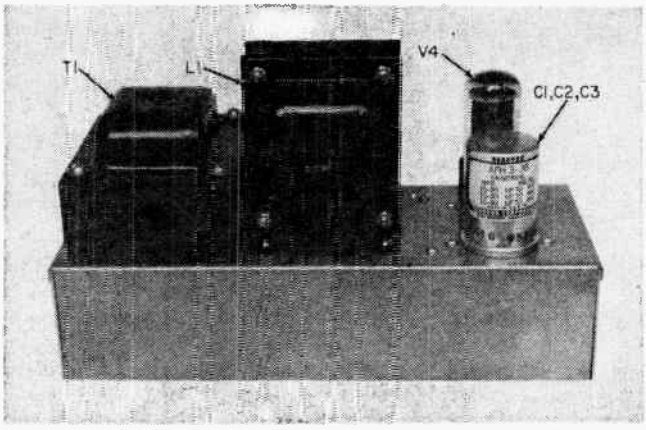
What Can Be Accomplished. If you're reasonably sure that your TV has adequate filtering and basically good design all the way through the FM demodulator to the audio, be venturesome, build our *TVamp* amplifier and add new dimensions to that TV. *TVamp* is a wide-range, low-distortion, medium-power amplifier especially designed to fit within the confines of the average TV set cabinet. In spite of its size, it has sufficient output to drive the popular bookshelf speaker systems (which are relatively inefficient).

In order to fit the *TVamp* into available space in the TV cabinet, the power supply is built on a separate chassis from the amplifier. Also. *TVamp* was designed so that it's possible to connect it to a TV with a minimum change in the TV's wiring. This permits quick restoration of the TV to its original state, in the event you dispose of the TV and want to keep the amplifier for another application.

How It Works. *TVamp* is a conventional class-A, beam-power output power amplifi-



Here's amplifier chassis in all its glory. We've identified all major parts and tubes that are on view when looking at top side of TVamp. You can't tell how good it works from how good it looks, so go ahead and build it.



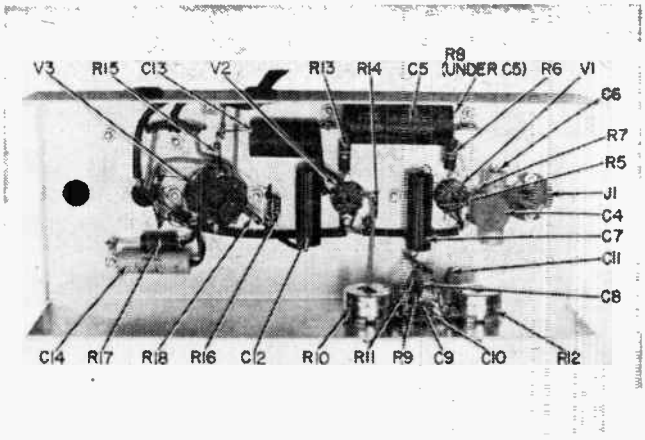
Separate power supply looks just as good as amplifier chassis and it produces hum-free high-voltage DC needed to excite tubes in amplifier. Husky components make it reliable.

er. Two 6AV6 tubes are connected in cascade as voltage amplifiers to drive a single 6L6 beam-power output stage. The 6AV6s were used because they are readily available, either from the average experimenter's inventory or from supply houses. Resistor R15 and capacitor C13 provide inverse feedback from the output stage to its driver, the second 6AV6. Separate bass and treble boost and cut controls are used to adjust the amplifier's response to the listener's taste.

A separate power supply is used for several reasons. You might ask why not use the TV's power supply? For one, in most cases the low-voltage B supply of the TV set isn't designed for the extra load *TVamp* would place on it. Another reason is that many TV sets have tube heaters connected in series across the 117-VAC power line and it would be necessary to redesign the series circuit to power the heaters of *TVamp* (unless, of course, a separate filament transformer were used). This would be costly since there are plenty of power transformers available at bargain prices that have both heater and high-voltage windings; in fact, you may even have one in your shop that would do the job. With such a transformer you can build a separate supply for both heater and plate power.

Since most TV cabinets are built to surround the chassis and picture tube, there is little unused space within the cabinet. By mounting *TVamp's* power supply on a separate chassis from the amplifier you have a better chance of locating each of the two smaller chassis in unused spaces in the cabinet than if the unit were mounted on a single large chassis. Also, since the name of the game is to improve the audio response of the TV with minimal changes in its original circuitry, and to maintain loading on the set's power supply so as not to disturb voltage limits designed into the set, it's wisest to use a separate power supply.

In fact, when you connect the new amplifier across the TV's volume control (described under the paragraph on connecting



Here's what important side of amplifier looks like if you use same parts we did and decided to follow our layout. Just stick to good wiring practices in hooking it up. There's nothing critical to need special precautions.

Television Amp

TVamp to the TV set), don't forget one important step. Even though you've removed the need for audio amplification in the TV, be sure to substitute a 3 to 5 ohm, 5-W resistor in place of the voice coil of the speaker. In other words, you disconnect the speaker but leave the audio tubes still operating. This is necessary to maintain the load on the power supply so the voltages required for the RF portion remain at their design levels for stable TV operation.

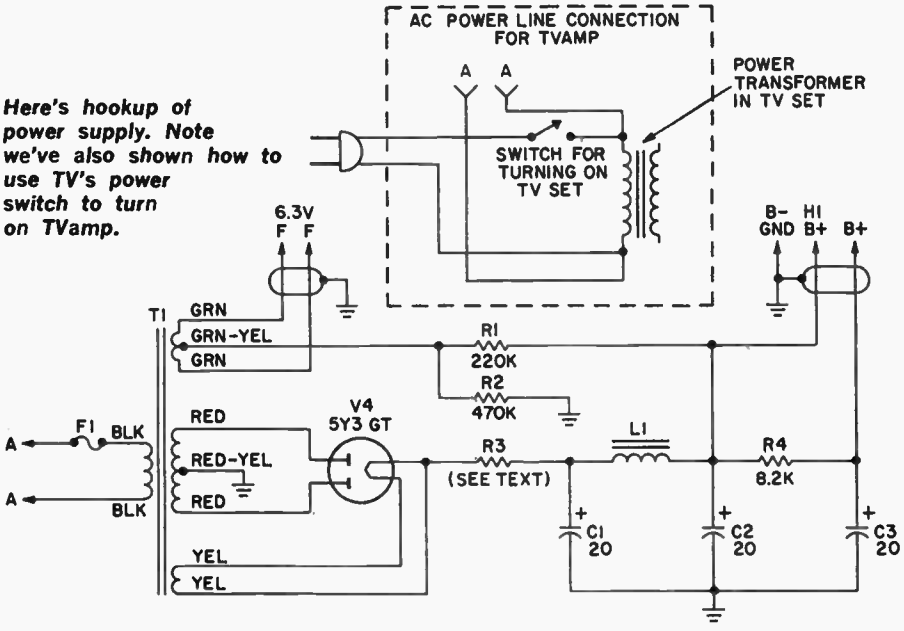
Building TVamp. We used two chassis. each 10 x 4 x 2½ in. Lay out all parts as shown in our photos and use a sharp, pointed awl to mark the centers of all holes. After center punching the holes, drill and deburr them. We purposely didn't include a pictorial layout since you have a wide choice of parts that could have different mounting dimensions.

Since the circuit isn't especially critical as to layout, we leave this to your discretion to suit the parts you purchase (or already have). Shielded 2-conductor cable is used to feed the heater voltage from the power-supply transformer windings to the amplifier chassis to reduce the possibility of stray induced hum from these leads. The value of R3 is based on the high voltage output of the particular power transformer you use. The transformer listed in the Parts List develops 300 VAC either side of the CT and we used a value of 50 ohms for R3. To calculate the value of R3 for higher volt-

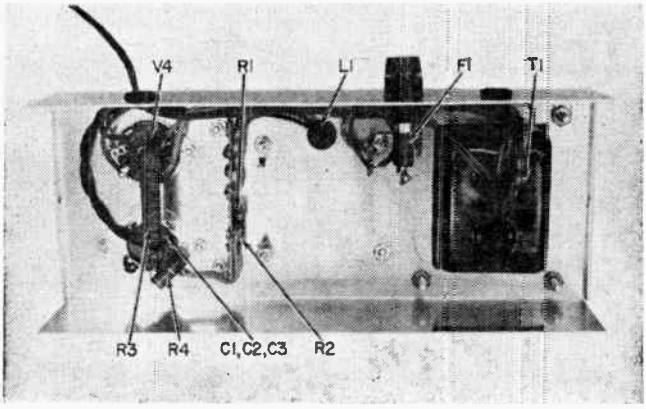
PARTS LIST FOR TVAMP

C1, C2, C3 20-20-20-uF, 450-V electrolytic capacitor (Lafayette 34E74236 or equiv.)
C4, C10 0.01-uF, 600-V tubular paper capacitor (Lafayette 34E82510 or equiv.)
C5 16-uF, 450-V electrolytic capacitor (Lafayette 34E55672 or equiv.)
C6, C14 25-uF, 25-V electrolytic capacitor (Lafayette 34E55210 or equiv.)
C7 0.1-uF, 600-V tubular paper capacitor (Lafayette 34E82700 or equiv.)
C8 470-pF, 1000-V ceramic disc capacitor (Lafayette 33E22997 or equiv.)
C9 0.001-uF, 600-V tubular paper capacitor (Lafayette 34E82312 or equiv.)
C11 0.005-uF, 600-V tubular paper capacitor (Lafayette 34E82445 or equiv.)
C12 0.05-uF, 600-V tubular paper capacitor (Lafayette 34E82643 or equiv.)
C13 4-uF, 450-V electrolytic capacitor (Lafayette 34E55631 or equiv.)
F1 Type 3AG-2 amp fuse in panel mount fuse holder (holder Lafayette 13E11-778, fuse Lafayette 13E10150 or equiv.)
L1 4.5-H, 200-mA filter choke (Stancor C1411 or equiv.)
R1, R9 220,000-ohm, ½-watt resistor

Here's hookup of power supply. Note we've also shown how to use TV's power switch to turn on TVamp.



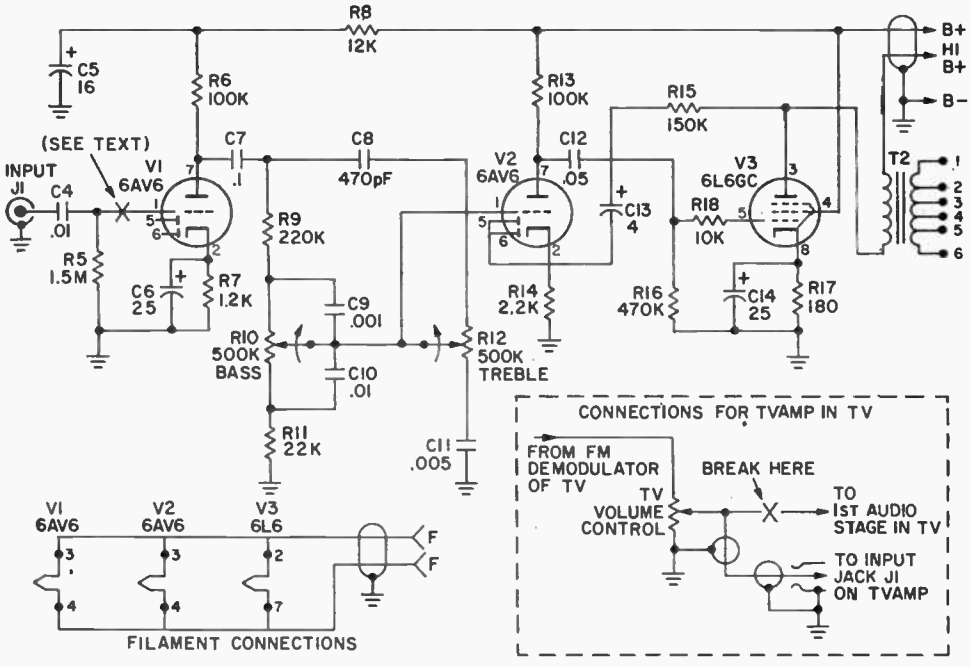
We showed you wiring side of amplifier on page 53, so here's what wiring side of power supply looks like. Simple, isn't it? With all that room under chassis you can do neat wiring job.



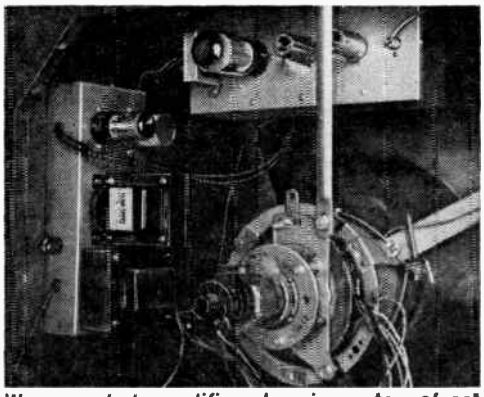
ages divide the amount of voltage in excess of 300 V by 0.075 (e.g. if voltage is 360 V the excess is 60 V so 60 V divided by 0.075=800 ohms). This is how you utilize

R2 47,000-ohm, ½-watt resistor
R3 10-W resistor (see text for resistance)
R4 8200-ohm, 2-watt resistor
R5 1,500,000-ohm, ½-watt resistor
R6, R13 100,000-ohm, ½-watt resistor
R7 1200-ohm, ½-watt resistor
R8 12,000-ohm, ½-watt resistor
R10, R12 500,000-ohm, linear taper potentiometer (Lafayette 33E11487 or equiv.)
R11 22,000-ohm, ½-watt resistor
R14 2200-ohm, ½-watt resistor
R15 150,000-ohm, ½-watt resistor
R16 470,000-ohm, ½-watt resistor
R17 180-ohm, 2-watt resistor
R18 10,000-ohm, ½-watt resistor
T1 Power transformer; 600-V CT @ 90 mA, 5-VAC @ 1 A, 6.3-VAC @ 3 A (Stancor PM 8409 or equiv.)
T2 Universal output transformer: primary, 1.5 to 10-K ohms; secondary to voice coils (Stancor A 3849 or equiv.)
V1, V2 6AV6 vacuum tube
V3 6L6GC vacuum tube

Misc. Two 10 x 4 x 2½-in. interlocking chassis (LMB 144 or equiv.), shielded cable Belden #8450 hookup wire, solder, knobs, hardware, screws, nuts, etc.



Television Amp



We mounted amplifier chassis on top of set so controls would be readily available. Power supply can go anywhere it fits.

whatever transformer is in your stock pile.

You may want to include a separate volume control on *TVamp* so you can use it as an auxiliary amp (say for playing records or handling the output of an AM/FM-stereo tuner in addition to the audio from the TV). Replace R5 with a 1.5-M pot. Connect its wiper to grid of V1 after breaking lead at X.

Installing TVamp. As mentioned previously, the purpose of mounting the amplifier and its power supply on separate chassis was to facilitate fitting it into available space within the TV cabinet. Our photo shows how we placed the units in an old model Philco set. We drilled holes in the top to let the controls extend outside the cabinet for ease in adjusting. The power supply was placed on the side of the cabinet, in a clear space near the top.

Again, the final choice of how you position your two chassis is left to you and is dependent on the available space in the particular TV you're using. The amplifier and power supply chassis are held in their respective locations in the cabinet by short bolts and nuts fastened through the chassis and the cabinet.

You will have to remove the TV chassis in order to make connections to its volume control and also to its power switch so that the amplifier will be turned *on* whenever the TV is *on*. Trace the power connections to the TV set's power transformer and connect the (primary) power leads of the *TVamp* transformer so that they will be connected to the power line in parallel with the power transformer of the TV through its switch. Use two different colors of hookup wire to connect the B+ and B− from the power supply to the amplifier chassis for easy identification.

Now that you have the modifications for using the TV's power switch to control power to *TVamp*, the only other change necessary to the TV while the chassis is out of the cabinet is to bring output from the FM demodulator to the input of *TVamp*. To do this, disconnect the wire or coupling capacitor now connected to the center contact of the TV's volume control; in its place connect the center lead of a piece of either coaxial cable or low-capacity shielded cable long enough to reach the input jack of *TVamp*. The shield of the cable is connected to the ground side of the volume control.

It's best to ground the lead removed from the volume control, thus removing the possibility of having stray signals induced into the audio portion of the TV. Danger is that they might be of sufficient magnitude to change the load on the TV's power supply and thus affect the overall operation of the set. Don't forget to disconnect the TV's speaker and substitute a 3 to 5 ohm resistor in its place.

When these connections have been made, the TV chassis can be put back in its cabinet. Remember, you need a pair of leads from the output transformer of *TVamp* to the external speaker system. And when locating this speaker system, remember to keep it near the picture tube so as not to ruin the illusion that the sound is coming from the picture. If you place the speaker across the room you won't affect the tone quality, but you'll most certainly ruin the illusion of the sound coming from the performer appearing on the picture tube.

Now that you've built the amplifier and tested it, sit back and really enjoy your TV. Look and listen to a musical group and find out what you've been missing. You'll be able to listen to it at reasonable volume and hear all of the instruments with little or no distortion; soloists will be more enjoyable because of the improvement in reproduction. You'll discover that what we said about the quality of sound available at the output of the FM demodulator is correct—it's truly high fidelity. Then, too, you've got a bonus if you decide to use this high-quality amplifier for a hi-fi phonograph. Why not take advantage of its excellence for this application too? ■

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.*

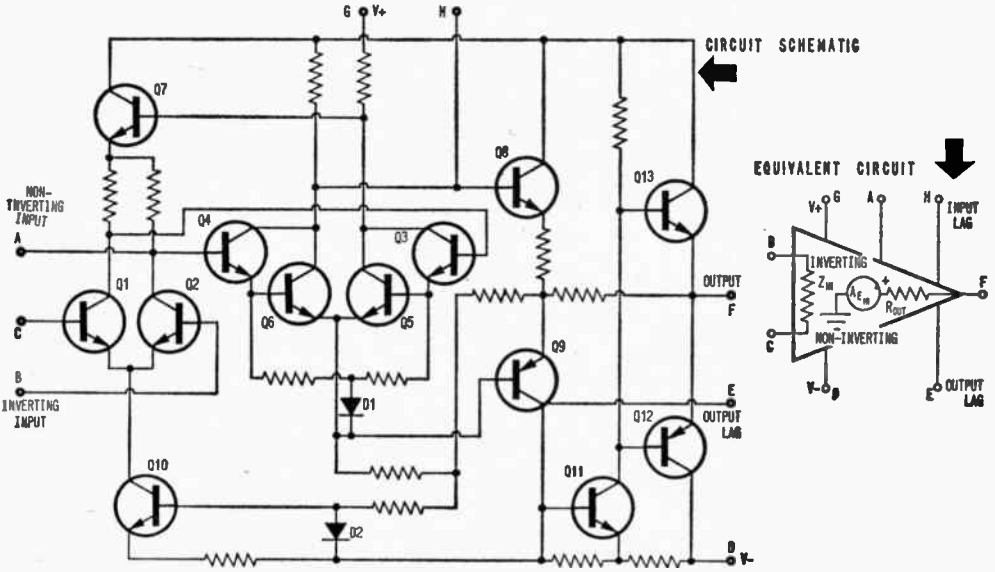


Fig. 1. Schematic and equivalent circuit of IC operational amplifier. Since device is DC coupled, it can be used for both AC and DC amplification. Output can be either in phase or out of phase with input signal.

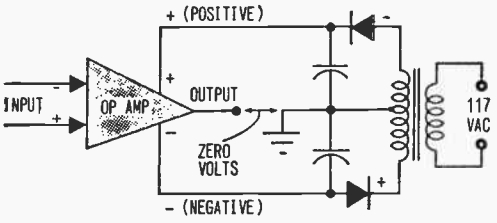
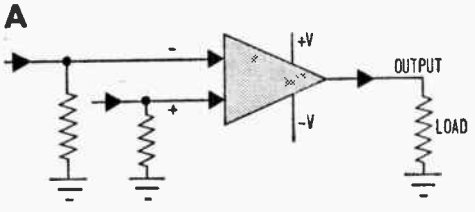


Fig. 2. OpAmp boasts two inputs: inverting input indicated as "—" and non-inverting input indicated as "+", DC output from power supply is half total supply voltage and of two differing polarities.

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



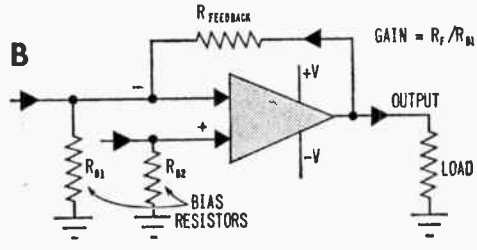


Fig. 3A. Open-loop gain results when amplifier is connected as shown and is maximum gain available. Fig. 3B. Closed-loop gain is device's gain after feedback has been applied; it's equal to Rf/Rb.

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-*u*V 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

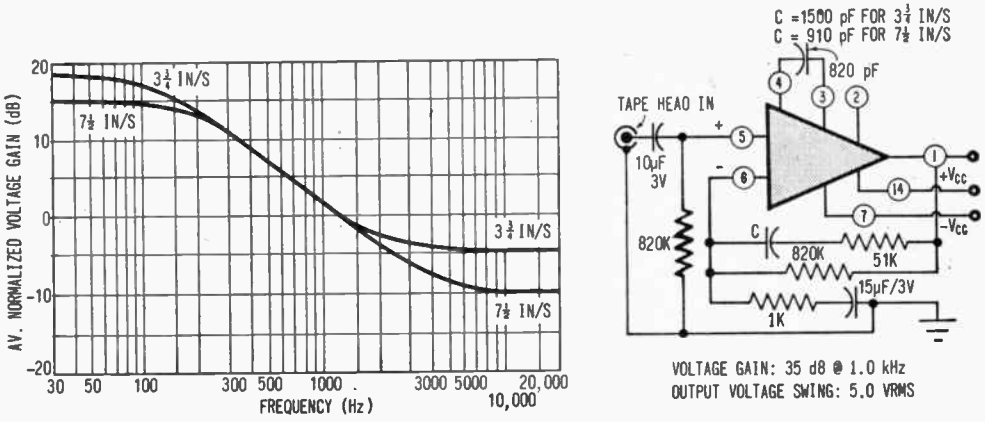


Fig. 4. Circuit for NAB-equalized tape-head preamp using Motorola MC1303L preamplifier. Only one channel is shown here—second channel utilizes other half of IC and is wired exactly the same.

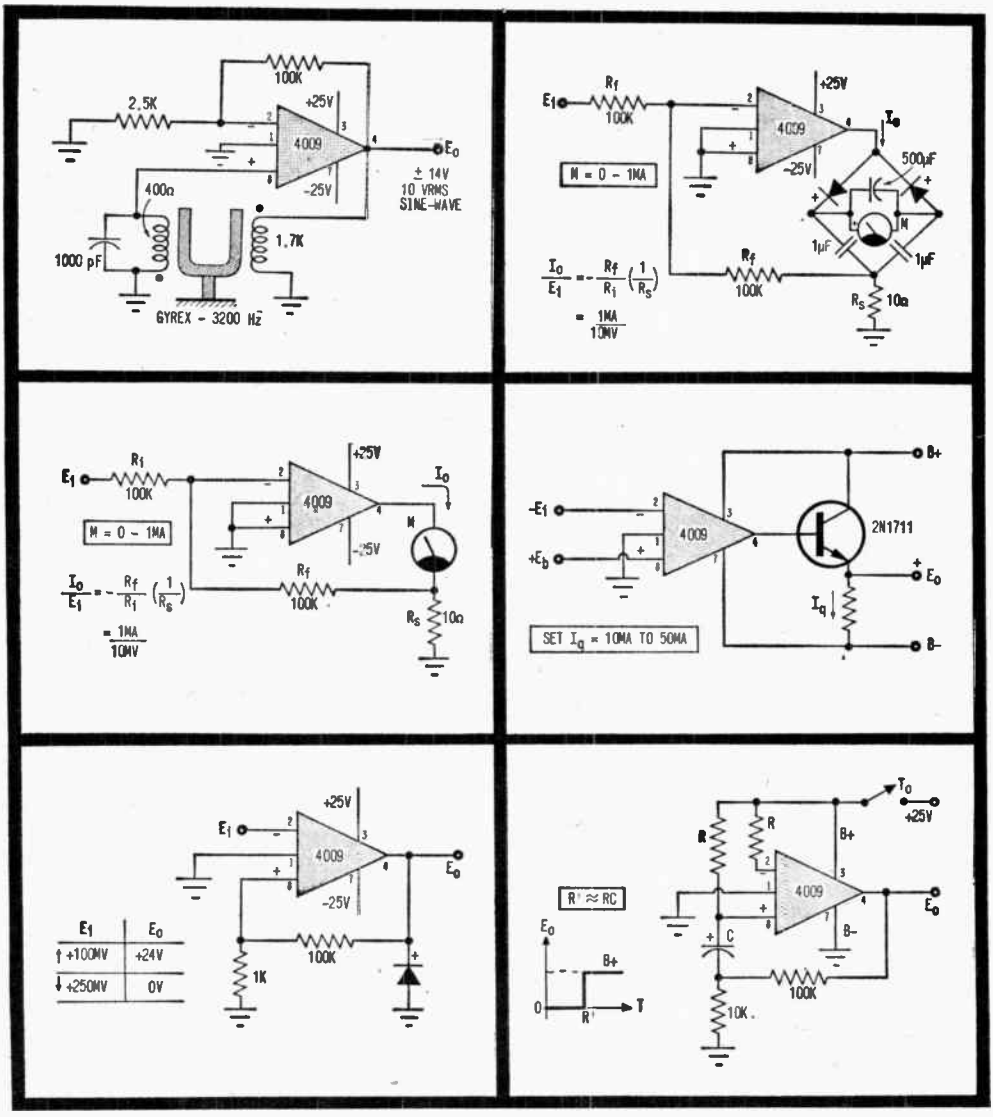


Fig. 5. Six circuits using 4009 OpAmp, available from OpAmp Labs, 172 S. Alta Vista Blvd., Los Angeles, Calif. 90036 for $10.00 ea., postpaid. Circuits, from left to right, are 1) tuning fork oscillator, 2) AC millivoltmeter, 3) DC millivoltmeter, 4) DC medium-power amplifier, 5) Schmitt trigger, 6)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

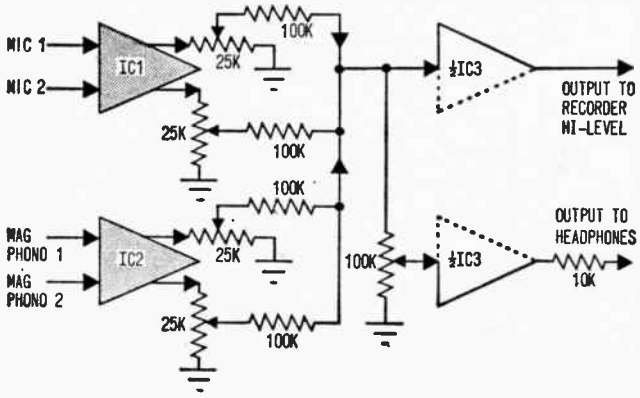


Fig. 6. Just for fun, try designing your own 4-channel mixer using Motorola's MC1303L stereo preamplifier IC. Block diagram gives basic info—you supply all details.

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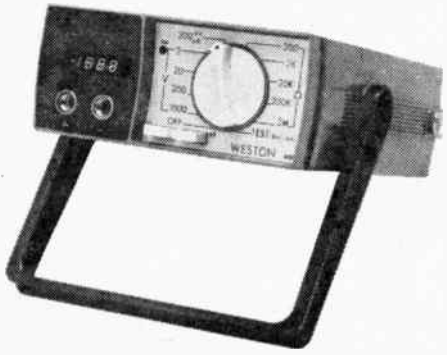
SR1, SR2—Silicon rectifier, 50 PIV, 500 mA
T1—Power transformer; 117 VAC primary, 30 VC.T.: 200 mA secondary (see text)

"Those creatures took my marbles!"

New Products

Continued from page 5



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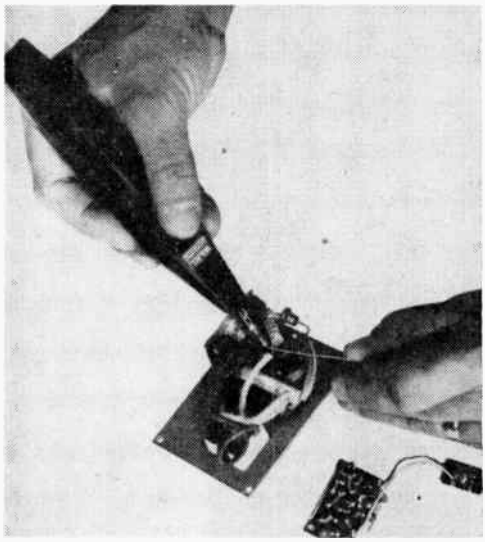

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Introducing OpAmps

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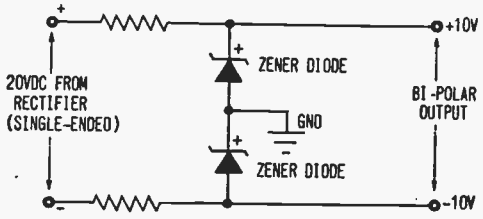

Fig. 7. Getting bi-polar output for OpAmp circuitry may pose problems, but solutions are easier than you might expect. One is to toss in a couple of Zeners: input is single-ended; output, bi-polar.

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.

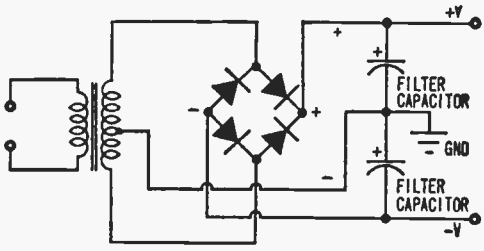

Fig. 8. Even cheaper way to achieve bi-polar output is to combine bridge rectifier with center-tapped power transformer. Full-wave output is easy to filter, ideal for most OpAmp circuits.

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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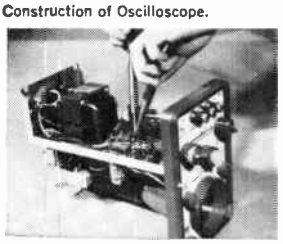
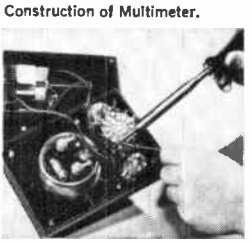


Construction of Multimeter.



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