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[Also see page 6]
It's easy and inexpensive to build an
ELECTRONIC TIMER
with RAYTHEON CK722 TRANSISTORS

Yes, and it gives you a chance to experiment with the latest in electronics. Raytheon will supply you with complete information free. Just write to Department P.

*Raytheon — pioneers in large scale production of transistors.

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If you are unable to locate any of these products at your local radio parts jobber, write direct to the manufacturer.

COVER PHOTO: This young experimenter, shown testing the Heathkit A-7B audio ampli-
 fier, is not only acquiring valuable "know-
 how" by assembling and testing such a unit but is adding to his hi-fi system at low cost. This is only one of a wide variety of kits available to experimenters. Such kits offer the twin benefits of practical experience with electronic circuitry and a carefully-engineered unit which makes a professional addition to the workshop or home music system. See article on page 30 for details of this amplifier.

(Enlarged by John Dejeans)

RAYTHEON MFG. CO.
Receiving and Cathode Ray Tube Operations
Newton 58, Massachusetts
RELIABLE SUBMINIATURE AND MINIATURE TUBES
SEMICONDUCTOR DIODES AND TRANSISTORS
NUCLEONIC TUBES
RECEIVING AND PICTURE TUBES — MICROWAVE TUBES
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Raytheon Transistors are neither expensive nor hard to get. As a matter of fact for the price of a tube you can use this newest electronic development in your rigs. And Raytheon Transistors are so practical and popular you'll find many transistorized circuits available.

Your nearest Raytheon Tube Supplier has Raytheon Transistors in stock. For a free characteristics chart, write to Department P.

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Receiving and Cathode Ray Tube Operations
Newton 98, Massachusetts
RELIABLE SUBMINIATURE AND MINIATURE TUBES
SEMICONDUCTOR DIODES AND TRANSISTORS
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Miniature Lighted Christmas Tree
"Detective's Special" Amplifier
A Photoelectric Rifle Range
Transmitter for Model Control
Train Speed Controller
Plus More On
High-Fidelity Audio • Kits • Radio
Control • Short-Wave Listening •
What's New • How it Works • How to
Make It • How to Use It • Carl & Jerry

IN THIS MONTH'S
RADIO & TELEVISION NEWS
(November)

Choosing Your Hi-Fi Loudspeaker
Junk Box "Sending Iron"
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Make this TRANSISTORIZED "Electric Organ"

You don’t need to be a skilled musician to pick out tunes on this unusual "Electric Organ". It's easy and inexpensive to make using the Raytheon CK722 Transistor (now only $3.50) and complete information on how to build it is free. Just write to Dept. P2
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(Also see page 6)
New EMC Model 208*  
"For many tests all tube types quickly, easily...accurately...in the field or shop.  
The sensational new EMC Model 208* gives you for the first time a complete precision tube tester for less than $25.00.  
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MODEL 208 TUBE TESTER (COMPLETELY WIRED AND TESTED) Only $24.90  
MODEL CMA (PICTURE TUBE ADAPTOR OF MODEL 208) $4.50.
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If you are unable to find these listed products locally,
write direct to the manufacturers at the addresses given.
Also see the monthly review of new items of interest to
the electronic hobbyist in "Tools & Gadgets" appearing
on pages 93 and 94 of this issue of POPULAR ELECTRONICS.

COMING NEXT MONTH

POPULAR ELECTRONICS

An Automatic Light Switch for the Home
A Frequency Meter Monitor for Ham Stations
Power Supply
What We Hear
How to Add Extension Speaker
Plus More On
High-Fidelity Audio • Kits • Radio Control • Short-Wave Listening •
What’s New • How It Works • How to Make It • How to Use It • Carl & Jerry

IN THIS MONTH’S

RADIO & TELEVISION NEWS

(February)

A Preselector for the SWL
“Mobile Meter” of Many Uses
A 60-watt “Ultra-Linear” Amplifier
Radio Licensing and the FCC
A “Universal” Counter
Intermodulation Distortion Tester

PLUS FREE... with this special offer
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Total retail cost if purchased $6.46

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Model 500 (in kit form) .............................. $19.75

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Electronic Music With The Theremin
Compact AM Tuner
Transistor Push-Pull Oscillator
20 Watt Novice Transmitter
Simple Power Supply for the Experimenter
Project Cyclone
Plus More On
High-Fidelity Audio Kits Radio Control
Short-Wave Listening What's New
How It Works How to Make It How to Use It Carl & Jerry

IN THIS MONTH'S

RADIO & TELEVISION NEWS

(Audio Noise Check List
TV Stations on the Air
Loudspeakers—The Weakest Audio Link
New British Power Amplifier
Narrow-Band Speech Unit
The Audio Squelcher
Light Amplifier

PLUS FREE... with this special offer
Model CRA (Picture tube adapter for model 208) $4.50
2 Model 15 (Instrument stands) 1.98
Total retail cost if purchased $6.46

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You get ALL three of these precision instruments...in this sensational offer!

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Model 106 (wired and tested) $35.90
Model 106 (in kit form) $23.90
Accessory probes available

EMC model 500 R.F. Signal Generator
Price of this individual unit
Model 500 (wired and tested) $29.75
Model 500 (in kit form) $19.75

EMC model 208 Tube Tester
Price of this individual unit
Model 208 (wired and tested) $24.90
Picture tube adapter available

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ELECTRONIC MEASUREMENTS CORP.

200 LAFAYETTE STREET, NEW YORK 12, N. Y.
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Stereophonic Sound
The Boom in Radio-Controlled Boats
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An Electronic Combination Lock
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www.americanradiohistory.com
Line Voltage Booster
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connection isn't easy to determine while you're doing the wiring, so the best way to proceed is to do all the wiring but make the transformer primary connections temporary. Then set switch $S_3$ to the 12.6-volt position, $S_1$ to line, and plug the booster into an a.c. outlet. Note the meter reading.

Now switch $S_1$ to boost. The meter reading should increase, indicating that the transformer secondary voltage is being added to the line. If the meter reading decreases when $S_1$ is set to boost, unplug the booster and reverse the two transformer primary (black) leads.

An "economy" booster will be sufficient in a large number of applications, since 6.3 volts of boost is all that is required. The circuit is shown in wiring diagram (B). In this particular model, the transformer has a 3-amp, 6.3-volt secondary and can be used to boost the line voltage to any device requiring up to 300 watts of power.

The transformer may be phased in exactly the same manner described for the de luxe model using a TV set plugged into the receptacle and phasing the transformer for maximum picture size when the booster switch is set in the boost position.

Other uses for line boosters are almost as great as the number of appliances designed to be plugged into an a.c. outlet. A booster is especially effective when used with voltage-sensitive appliances, such as electric food mixers, sewing machine motors, electric fans, hand power drills, etc. Photographic darkroom enthusiasts will find a booster just what the doctor ordered for keeping the enlarger or contact printer lamp up to full brilliance.—B. W. Blackford.

METAL LOCATOR QUIZ
(Questions on page 88)
1. Beat-frequency locators indicate the presence of metal by a change in pitch: the field-distortion type reacts by changing the loudness of the tone and also, at a rule, by a visual meter indication. 2. If a non-ferrous metal causes a rise in pitch, a ferrous metal will produce a falling pitch, and vice versa. 3. The field-distortion type. See cost chart. 4. Although rain water alone is a poor electrical conductor, it dissolves minerals in the soil to form electrolytes, or current-carrying liquids. These react on both forms of metal locators by producing spurious indications. 5. This orientation minimizes the direct pickup from transmitter to receiver so that the initial balancing adjustment may be made sensitive to small distortions of the field by metals or ores.

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Audible IR Indicator—checks the operation of your IR transmitter
Digital Logic Probe—the kit that you can build in only one evening and use for a lifetime

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Rebuild Your Weller Soldering Station—it's geared for reconstruction
One-Shot PC Boards—a down and dirty way to make one-time-only printed-circuit boards
High Seas Radio Pirate Challenges FCC—some Erroll Flynn's of the electronic age are swashbuckling with big brother himself
How To Replace Rechargeable Batteries—you can locate and replace wired-in NiCd cells and repair the gadgetry they power
Learn By Doing—get a firm foundation on data transmission by grounding yourself in amplitude and frequency modulation

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Will Writer Program—use your computer to prepare and update your will
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Friedman On Computers—computerized newsletter/paper or magazine on disk—going desktop!
Ellis on Antique Radio—the readers speak out
Saxon On Scanners—a scanner with 100-channel memory capacity
Circuit Circus—a handful of components and a little electronic know how lets you convert dot bar indicators to numerical displays
Carr on Ham Radio—radio-wave skip makes world-wide communications possible even with relatively low-power equipment
Wels' Think Tank—singing the unsung heroes

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Night-Light Controller—automate your porch, driveway, or outdoor lights, without RF interference
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Experimenter's Powered Solderless Bread/Clip Board—put schematic diagram, notes, power supply, breadboard, and parts on one board.
Tachometer Tester—lets you gauge the accuracy of your tachometer
Universal Power Supply—the power-supply board whose output can be tailored to fit the need
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19 Popular Electronics' Guide to Big-Dish Satellite TV
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31 Build the Bio-Stimulator
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54 Build a Versatile DTMF Tone Pad
It's an easy way to add a touch-tone-type keypad to your current transceiver; it costs just a fraction of what similar commercial units run—Brian Pilifer

57 Build a Refrigerator-Door Alarm
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35 Design your own Subwoofers
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42 Choosing a Super Scanner
Listening to scanning radios is one of the most popular parts of the electronics hobby, but how does a beginner know which radio will be the best to get him or her started? It's easy! Just follow the hints and guidelines presented in this article—Karl T. Thurber
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**37 3-D Video**
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**42 Add Daytime Running Lights to your Car**
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29 Build an Anti-Carjack Module  
Fight the forces of evil with this easy-to-build, easy-to-install circuit that protects your property from carjackers without placing yourself, or your loved ones, in any further danger. It can even be used to deter normal car theft—Anthony J. Caristi

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34 Build an Undercover Scanner Antenna  
This simple and unusual accessory allows you to be unobtrusive when using a handheld scanner, yet works better than a “rubber ducky”—John R. Somers

45 Build a Caller-ID Computer Interface  
It lets you send the caller-ID information that accompanies nearly every telephone call to your personal computer. Use it for computer-BBS security, or just to keep track of who’s been calling you—Terry J. Weeder

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38 Sky Cops  
Ever wonder who keeps the airwaves clear and usable for all of us? Here’s a look at those responsible for working out the differences between governments worldwide, and governments and their citizens. Also, learn how you can lend a hand—Karl T. Thurber, Jr.

50 Electronic Search and Rescue  
When either man-made or natural disaster strikes, these electronic aids can help searchers find victims faster, dramatically improving their chances for survival—Bill Siuru
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This fully programmable robot will have you believing in artificial intelligence in no time. It can move around your house without ever getting stuck in a corner, and could be modified to imitate many other types of thought—Mike O'Connor

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39 Build the Unlock-Too
If your vehicle has doors that automatically lock when you turn on the ignition, this circuit will save you the trouble of having to manually unlock them when you turn the ignition off—Josh Friedman

51 Build a Solid-State Stroboscope
With this precision handheld unit you can make remote RPM measurements, view rotating devices in stop-action, and take some impressive photos of moving objects. Best of all, it costs much less than commercial units—Skip Campisi

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41 All About Reflector Antennas
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45 Toy Trains
Modern electronics have made this hobby more enjoyable than ever. Here's a look at toy trains of the past and present, and at what you can do to get started with your own setup—Dennis Eichenberg

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31 Build the Goblin Greeter
This Halloween, why not greet trick-or-treaters with a special treat of your own? With the Goblin Greeter installed, every time someone rings your doorbell, he or she will be welcomed to your abode by a spooky, hologram-like phantom and haunting noises. The circuit can also be used indoors to provide your next Halloween party with a frightfully fun host—D. Derek Verner

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56 Build a Delayed Sweep Adapter
This simple, plug-in circuit will increase the capabilities and performance of your scope. For less than $30, the Adapter lets you add a delayed sweep to just about any oscilloscope you choose. That saves you the added cost of buying an oscilloscope with the feature built-in—Skip Campisi

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39 Using Digital Panel Meters
Here are some great applications for digital panel meters that you can use as stand-alone units or as springboards for your own circuit designs. Once you know how to work with DPMs, you’ll be able to increase the accuracy of the next project of yours that requires a display, and give it a more attractive, professional look—Bill Stiles

45 Radio Amateurs
Just who are hams and what do they do? There seem to be more than a few misconceptions about the amateur-radio hobby and its practitioners. Learn the truth in this panoramic look at radio amateurs, and see just how easy it is to become a ham yourself—Karl T. Thurber, Jr.
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33 Build the Easyscope
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41 Build an Active High-Impedance Probe
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50 Build an Inductance Meter Adapter
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23 A Holiday Gift Guide
Let us help you find the right electronic gifts for everyone on your shopping list. There’s something in this guide that’s sure to match just about every budget and interest—Teri Scaduto and Christopher Scott

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32 Build the Light Animator
If you want to add some motion and excitement to your Holiday lighting this year, this is the project for you. This circuit will control up to eight strings of lights, letting you create unique animated displays that will make your house the talk of the neighborhood—Rodrick Seely

43 Build the Color-Blind Illusion
Here’s a neat little “magic” trick that will fool just about anyone. It’s an electronic version of the old three-card Monte con game that will keep your friends puzzled for hours. Like those who witness any good illusion, those in your “audience” won’t be able to believe their eyes—Rick Duker

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39 High-Tech Electronic Building Security
What can technology do to prevent terrorism and crime? You’ll find some answers to that and other questions here as we explore how electronics help provide public safety by detecting guns, explosives, and bad guys before they get a chance to enter a building—Bill Siuru
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41 Build a Multi-Color Projector
Sit and watch this unit’s changing color patterns for just a few minutes and it will provide you with some biofeedback-type stress relief. Or just use it any time you need a light source of various colors. Either way you apply it, it’s hard to look away from this device once it’s on—Skip Campisi

48 Build a Temperature Adapter
Just how cold is it around your workbench this winter? How hot is that IC really getting? Now you can find the answers to all of your temperature questions by connecting this simple circuit to your DMM—Marc Spiwak

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45 Monitoring Military Aircraft
Every day there are several real-life dramas unfolding over the skies of the United States. If you’d like to listen in on the exciting transmissions of our nation’s military pilots, you’re in luck. With an ordinary scanner and the listening tips given in this article, you’ll feel as if you’re part of the action in no time—Laura Quarantiello
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Is the performance of your car stereo lacking in some areas? Are your road trips just not as entertaining as they could be? Put some real power into your vehicular audio system with this amplifier that looks small but actually sounds big. Best of all, it costs less than $20 to build—Gary Clifton

**Construction**

**32 Build an Automatic Headlamp Control**
In many states, if your car’s windshield wipers are on, the law requires you to turn on the vehicle’s headlamps too. With this circuit you’ll never have to remember to do that again. Just switch on your vehicle’s wipers and let the Control module do the rest for you—Anthony J. Caristi

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Use it to operate your computer from across the room with any TV or VCR remote control—Stuart Ball

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**39 Cruising the Lowest Ham Bands**
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39 Build an Alphanumeric Pager Decoder
This innovative device lets you view digital pager messages right off the airwaves. Just connect the circuit to a scanner radio and your computer, load up some special software, and you can be certain your beeper is grabbing all the messages that it should—Alan D. Jones

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45 Build an Electronic Parrot
Having a parrot repeat what you say can be a lot of fun, but teaching one to talk can also take a lot of time. With this easy-to-build circuit you can have all the fun of an accurate mimic, in about an evening. Best of all, there's no cage to clean!—David Williams

52 Build an AC Line-Voltage Monitor
Just how safe are your expensive electronic devices? Find out if the AC outlets in your home or workshop are producing "clean" electricity with this inexpensive circuit—Marc Spiwak

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48 Cars That Can Call for Help
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58 Intelligent Micromachines
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31 Build a Lie Detector
Find out who's telling the truth with this Galvanic Skin Resistance monitor. Just press two fingers on the Detector's "electrodes" and you're all set. It's great for parties or even classrooms. The Lie Detector can also be used as a biofeedback device by providing you with a visual and audible indication of how your skin's resistance is changing—Skip Campisi

Construction

42 Build a High-Efficiency Lighting System
Tired of high lighting bills? Quit wasting electricity on lights that don't work as efficiently as they could; here's a better option. With this system you'll save 90 percent on your monthly lighting bill—these are substantial savings you'll notice right away. Build these units for both home and office lights and save at both locations—Stephen R. Rosenberg

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39 Recharging Electric-Vehicle Batteries
Electric vehicles have finally hit the streets, but just how far can you travel in them before they run out of battery power? Join us for a look at the methods and systems being put in place to ensure EVs get you to and from your destinations—Bill Siuru

45 All About Amateur Communications Modes
The technology used by radio amateurs has certainly improved over the years; we've really come a long way. Here's a historical exploration of the many communications methods used by hams, past and present. From Morse code to computers, it's all right here—Karl T. Thurber, Jr.
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With just a couple of chips and a handful of support components, you can assemble one of the most useful test instruments in digital electronics—Carl J. Bergquist

45 Build a Duty-Cycle Monitor
Using a few simple, easy-to-get components, you can assemble this useful little monitor, and save your oscilloscope or frequency counter for some other task—Skip Campisi

56 Build a DC Motor Speed Controller
This easy-to-build circuit allows you to control the rotational speed of a DC motor without wasting any of the input power—Marc Spiwak

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33 Build The Time-Off
Armed with this simple count-down timer, you can cut your electric bills, keeping a greater share of your hard-earned money, even if you fall asleep with the lights on or rush off to work each morning, leaving all sorts of appliances on until the evening—D. Derek Verner

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45 The PC Parallel-Port Relay
Home automation can help free you from some of those repetitive tasks around your home. All you need is an old PC and the PC Parallel-Port Relay board, which we'll show you how to build, and your home will practically take care of itself—Marc Spiwak

50 The Electronic Garage Door Opener
A simple four-digit code along with the easy-to-build circuit presented here can take the place of your "emergency key." Now you won't lock yourself out of the house, and you can allow friends and relatives to enter when you can't be there—James E Tarchinski, N8PTG

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Build a simple controller circuit that allows you to remotely operate servo-motors to control surveillance cameras, aim your outdoor antenna, actuate robotic arms, and more—D. Derek Verner

44 Ham Radio Code Filter
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46 All the Time in the World
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55 Safety For Electronic Hobbyists
Electrical safety is not just a personal matter. All members of your household should at least be acquainted with some aspects of electrical safety. Your life or that of a family member could depend on it!—Joseph J. Carr

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Use this circuit-breaker-like electronic fuse substitute when testing electronic equipment that have operating currents ranging from 0.5 to 5 amps. It will spare you some of the frustration of finding replacement fuses, while safeguarding the equipment's overworked internal fuses—Larry Ball

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50 Experimenting with the 4093 NAND Schmitt Trigger
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33 Build a Digital Capacitance Meter
Whether you are an electronics circuit designer, technician, or a hobbyist, our Digital Capacitance Meter can go a long way to taking the guesswork out of your construction or repair projects—Patrick Bunker

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Rid yourself of unwanted telephone solicitations and sales pitches with an easy-to-build circuit that quickly terminates the conversation, disconnects the line, and gets you off the hook—Anthony J. Caristi

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45 Before Their Time
While some electronic pioneers received acclaim for their work, others were largely forgotten. Here is your chance to get acquainted with some of the unsung heroes of the electronics age—Larry Lisle, K9KZT

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—Fred Eady

41 APPLIANCES ON THE INTERNET
Utilities can now "talk" to appliances through the information superhighway, allowing your utility company to measure demand, forecast load growth, and more. Learn how they do it.
—Bill Siuru

45 NON-LINEAR CONFIGURATIONS
Linear integrated circuits do not have to be limited to linear applications; there are a variety of non-linear services that these useful devices can perform.—Joseph J. Carr

51 HIGH-VOLTAGE GENERATION
How to turn low-voltage AC into very high DC voltages. All it takes are a few readily available components and some technical know-how.
—Bill Cody

PRODUCT REVIEWS

4 GIZMO
Portable LCD Photo Album; Wireless Inter-entainment System; CD Recorder; e-Mail Traveler; Mobile Scanner; In-Dash MiniDisc Receiver; DVD Player; Human/Solar-Powered Radio; New Desktop Computers.

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9 COMPUTER BITS
Graphics on the cheap: How to get the graphics you need and how to process them to get the results you want.

13 PROTOTYPE
Spinning Gold into Electronics; Holographic Optical Data Storage; Clues to Astronomical Mysteries; Liquid-Crystal Display Panels.

20 AMAZING SCIENCE
Making exposures with our Kirlian photography equipment using sheet film and cameras.

23 SERVICE CLINIC
Solving the most common VCR play and record mechanical problems with some practical technical help from Sam Goldwasser.

57 Q&A
You've got questions? Michael Covington has the answers.

61 ROBOTICS WORKSHOP
More on the BasicX-24 microcontroller and using it with radio-control servos.

66 TECH MUSINGS
Using transfer functions; lithium polymer batteries; understanding non-linearity; algae hydrogen source; and more.

72 BASIC CIRCUITRY
Experiments with infrared LEDs, transistors, and phototransistors.

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29  A HIGH-POWERED TESLA COIL

Everyone loves high-voltage equipment! The sheer excitement of man-made lightning and the smell of ozone instill awe and wonder in anyone who has witnessed this equipment in operation. Our Tesla coil is large enough to throw 30-inch sparks.
—Robert Iannini and Chester H. Lawrence

43 CALL ALERT

Unsolicited telephone calls can be very frustrating. One solution is to turn off your phone's ringer when you don't want to be disturbed. Give your friends a secret code, and they can let you know when they are calling.
—Raymond C. Buck III

48 PC KEYBOARD

Learn how the IBM AT keyboard works. With that knowledge, you can recycle old keyboards into a new project, add one to an existing device, or even build an input device that can take the place of a keyboard.
—Craig Peacock

PRODUCT REVIEWS

3  Gizmo®

Digital-audio player, wireless modem, voice-controlled car stereo, two-way family radio with weather reports, laptop carry case/desk, all-in-one boombox, digital-video camcorder, Internet streaming-audio broadcaster, high-definition receiver/computer monitor, signature digitizer.

PR1  ProService Review—follows page 103.

The 2000 National Professional Service Convention, building great Web sites, and more.

DEPARTMENTS

6  COMPUTER BITS

Film at 11. Ted Needleman scans and digitizes film slides to store them on a disk.

9  NET WATCH

Joe Black takes a look at various services for making free or low-cost telephone calls over the Internet.

15  PROTOTYPE

Neural-network avionics, quantum computers, high-performance search-engine chips, microgravity-generated optical fibers, computer-security protocols, and thunderstorm detectors.

20  AMAZING SCIENCE

Learn the basics of superconductors from John Iovine in preparation for some super-cold experiments.

24  Q&A

You've got questions? Michael Covington has the answers.

59  SERVICE CLINIC

Sam Goldwasser discusses VCR sensors.

62  ROBOTICS WORKSHOP

Gordon McComb shows you how to use DC motors.

65  BASIC CIRCUITRY

LEDs for fun and "prophet" with Charles Rakes
FEATURES

29 TRAIN YOUR PETS WITH THE SCATCAT
Although you might love the four-footed, fur-covered members of your household, they sometimes decide that they're allowed to go wherever they want—even if it's a "no-no" area like the kitchen counter, the dining-room table, the living-room sofa, or if Kitty likes to play "Godzilla" on the toy-train layout! Animals aren't dumb; they're clever enough to realize that they can "get away with it" if you're not around—especially at night. This month's cover story describes a training device that will sound a high-pitched alarm and flash a light whenever an animal enters a "forbidden zone." After a few startling episodes, even the most stubborn pet will "get the hint!"—Russ Shumaker

39 SOLAR-CELL INVERTER
Solar cells are a wonderful, non-polluting source of electricity, but the voltage that they put out is too low for most transistor-based circuits. With this device, you can boost the voltage level of any solar cell to usable levels.—Fred Nachbaur

42 ALL ABOUT ELECTRONICALLY-TUNABLE ACTIVE FILTERS
Active filters, being one of the fundamental circuits in electronics, are even more valuable if you can change their response with a control voltage. Learn how they are designed and work with this "hands-on" approach using tested designs.—Ron Tipton

PRODUCT REVIEWS

3 GIZMO®
Network Walkman, direct-view HDTV, wireless e-mail, clock radio, still/motion digital camera, THX-certified speakers, music software, portable tablet computer.

AND MORE

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36 VIDEO-SIGNAL GENERATOR FOR NTSC OR PAL
Working with video equipment can mean the occasional readjustment to your equipment to be sure that everything is in top-notch condition. With this simple circuit, aligning a television for proper color reproduction is a snap. What’s more, the same circuit can output NTSC- or PAL-format signals by changing a handful of simple parts.
—Thomas Gould

43 LOOKING FORWARD TO DTV
In just a few short years, your television set is going to explode! While that description is more figurative that literal, the day is fast approaching where today’s TVs will stop working, never to display a soap opera or newscast again. What we’re referring to is the coming of digital television, or DTV. With all of the controversy surrounding the rollout of the new broadcast standard, we take a look behind the scenes at the technology that gives DTV its edge. After all, aren’t you curious how they plan to squeeze a high-definition picture and 6-channel surround sound into the same bandwidth of today’s television signals? In this first of two parts, we discuss video and audio encryption and compression.
—Geophrey McComis

51 A COLORBURST-BASED FREQUENCY REFERENCE
How many times have you tried to set up a frequency counter or an oscilloscope only to be frustrated by a lack of a stable, accurate frequency standard? With this circuit, such a reference standard is no farther away than the closest television-broadcast signal.—Thomas Gould

PRODUCT REVIEWS

3 GIZMO®
Indoor/outdoor speakers, electronic spelling dictionary, home-theater transmitter, USB-to-printer adapter, PCMCIA adapter for desktop PCs, Minidisc player, radar-detector/compass/safety-alert system, interactive television, inkjet printer, home-theater bundle.

DEPARTMENTS

6 PEAK COMPUTING
Ted Needelman digs deep into an old Celeron-based system in an attempt to breathe new life into an aging warhorse.

9 COMPUTER BITS
On the home front, Ted Needelman gets around to squeezing tons of papers onto CD-Rs.

12 SURVEYING THE DIGITAL DOMAIN
Reid Goldsborough strikes it rich with free Web-design services and free on-line encyclopedias.

17 PROTOTYPE
Detecting smashed atoms, detecting land mines, detecting nuclear weapons, detecting cholera outbreaks from space, cockpit retrofit, kiddie phones, and network-service standards.

21 Q&A
Michael Covington offers answers to the latest batch of perplexing questions.

55 AMAZING SCIENCE
Experience chills and thrills as John Iovine performs some cool superconductor experiments.

58 ROBOTICS WORKSHOP
In this “lost episode,” Gordon McComb reveals the hidden secrets of the BasicX microcontroller.

62 SERVICE CLINIC
Sam Goldwasser takes control of VCR control-system problems.

65 BASIC CIRCUITY
All aboard with Charles Rakes as he builds simple circuits to test components. Download the circuits from www.electronicsworkbench.com/poptronics and play with a “virtual workbench” on your computer.
FEATURES

29 AN FM/TV AUDIO RECEIVER
How many times have you missed a favorite television program because you just couldn't get to a screen? Perhaps you were in the kitchen or garage or working outside. You couldn't (or didn't want to) stop what you were doing, but the task was mindless enough to make television a welcome distraction. Now you no longer need to worry that you set the VCR properly. This small, battery-powered receiver can fit in a shirt pocket with the right case. By changing a few select components, you can tune in different TV or FM-radio bands. What better way to pass the afternoon than listening to soap operas while weeding the garden?—Anthony J. Caristi

37 LOOKING AHEAD TO DTV: PART 2
The first part of this technological look behind the scenes of the digital-television standard took the video and audio signals, digitized them, compressed them, and squeezed them down to a fraction of their original size. This month, we chop them up, pack them together, and send them out over the airwaves to appear soon on a digital television near you.—Geophery McComis

45 GETTING INSIDE AN NCO
Numerically-controlled oscillators are usually "unsung heroes" when it comes to generating an accurate waveform over a wide frequency range. Not only do we tell you all about how NCOs are designed, you get your hands dirty by building an actual NCO from discrete parts—a learning experience much more valuable than buying a single-chip device off the shelf.—Tom Napier

PRODUCT REVIEWS

3 GIZMO®
"Top-end" CD player, mood lights, handheld GPS system, flat-screen monitor, digital-audio jukebox, wireless GyroMouse, emergency batteries, multi-channel speaker system, TV/VCR combination, Internet privacy software.

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6 NET WATCH
Kick tires, peek under hoods, and "test" shocks as Joe Black shops for a new car on line.

8 SURVEYING THE DIGITAL DOMAIN
Before Reid Goldborough tries out Web-based applications, he tells you how your PC is out to get you—physically.

11 COMPUTER BITS
Ted Needlemann ties every computer in the house together with a "network in a box" kit.

13 PEAK COMPUTING
When Ted Needlemann gets tired of crawling around the back of his computer to access the ports, he brings them "up close and personal" with some handy port-replication hardware.

17 PROTOTYPE
Telescope mirrors, compressing medical images, rewritable DVDs, right- and left-handed nanoclusters, software for "designer genes," a history of "green" chemistry.

21 Q&A
Problems and their solutions from Michael Covington, the Poptronics "Answer Man."

51 ROBOTICS WORKSHOP
Gordon McCombs' position on servomotors in robotics...depends on the size and accuracy of the unit! After he shows you how to work with them, you can choose a position of your own—or make them free-wheeling.

55 AMAZING SCIENCE
John Lovine "wrecks a nice beach" with a circuit to "recognize speech."

60 SERVICE CLINIC
Sam Goldberg takes control of your VCR's play and record problems.

63 BASIC CIRCUITRY
Turn off those sirens! Charles Rakes is alerting us about alarm circuits!
FEATURES

25 ELECTROSURGERY
When we think of "electronics in the operating room," the usual impressions are of sophisticated monitoring devices that keep track of the patient's vital signs, alerting the doctors if any reading deviates from the "norm." Surprisingly, one of the most advanced electronic inventions to assist the surgeon is an electric scalpel that cuts flesh by means of a high-voltage, high-frequency signal. What's more, this device has been used in hospitals for longer than you might think! Learn the "hows and whys" behind electrosurgical units in this fascinating peek behind the sterile curtain.—Albert Lozano-Nieto, Ph.D.

29 AF/RF SIGNAL CHASER
When the "weak link" breaks in a chain of audio or RF circuits, it can be difficult and frustrating to find the spot where traffic stops. Instead of chasing your tail, you can use this device to sniff out any audio or radio-frequency signal, giving you a great advantage in the "fox and hound" game that has plagued repair technicians through the years.—Netwon C. Braga.

38 TUBE AMPLIFIER BIAS CHECKER
The vacuum-tube-based amplifier has been a staple of musical instruments since the development of amplified instruments. The venerable tube has also enjoyed a resurgence in the home-stored market over the past few years owing to its "warm-sounding" distortion characteristics when driven to its limits. One problem with tube rigs is setting the bias and balance of the output circuit. If that isn't set correctly, the amp will sound horrible and the output tubes will burn out faster. Here is a fast and—more importantly—safe way to read the bias current of any standard amplifier. Not only is it easy to get an accurate reading of the bias setting, the procedure doesn't expose you to dangerous high voltages.—Gary McClellan

PRODUCT REVIEWS

7 GIZMO®
Digital camera, VHF/UHF antenna, CD recording deck, home-theater projector, multimedia monitor/receiver, DVD development system, portable media player, camcorder tote bag, Hi8 camcorder, surge protector.

AND MORE

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11 PROTOTYPE
Airborne laser mapping, virtual medical system, molten-glass measurement system, high-speed fiber-optic laser, judgmental videoconferencing system, and tracking the Los Alamos fire aftermath.

15 COMPUTER BITS
A starry-eyed Ted Needleman examines some heavenly bodies with computer-controlled telescopes.

20 SURVEYING THE DIGITAL DOMAIN
The Web helps those who help themselves. Reid Goldsborough shows you how to help yourself to knowledge about the Internet in order to build a better Web site.

33 NET WATCH
Joe Black buys toys ... and then tries to get them fixed.

43 Q&A
Go on, ask away: Michael Covington has the answer to your most puzzling dilemmas.

49 AMAZING SCIENCE
John loveine muscles his way into the world of air muscles.

53 ROBOTICS WORKSHOP
Exploring the basics of robot "brains" with our resident electro-mechanical reanimator, Gordon McComb.

57 SERVICE CLINIC
Sam Goldwasser maps last month's battle by tackling video recording and playback problems in VCRs.

61 BASIC CIRCUITRY
Spoil a would-be burglar's "party" with more of Charles Rakes' alarm circuits. Download the circuits from www.electronicsworkbench.com/poptronics and play with a "virtual workbench."
25 A TALKING TOY-TRAIN STATION
Sound and animation have been a part of toy trains since the technology advanced far enough to make such enhancements possible. Unfortunately, the early attempts, while very effective, were not always practical. Here's a way to update an American Flyer concept from its pre-WWII record format (“Daddy, what's a 'record'?”) to modern solid-state voice-recording-and-playback chips. —Dennis Eichenberg

27 INSIDE A FURBY
Who would have thought that a simple electronic toy that does little more than act "cute" (or annoy as the case may be) would take the world by storm? That's just what the Furby has done. You can get them in a range of colors and special editions. Come with us as we peel back the fur and expose their secret inner workings.—Julian Edgar

32 THE GAMEENHANCER
Don't you hate finding out that board games are frequently dull and boring compared to the television game shows that spawned them? If you're the "MC" in a game, how can you make a fair judgement call as to who raised their hand/shouted out/squeezed their "clicker" first? The GameEnhancer takes the guesswork out when determining who goes first—and includes programmable background songs you can code yourself. What's more, it makes a great PIC programmer as well.—Steve Henry

DEPARTMENTS

5 PEAK COMPUTING
Ted Needleman sheds some light on optical-drive upgrades.

10 NET WATCH
Chris Lamorte gets root privileges as he shows you how to get a top-level domain of your own.

13 SURVEYING THE DIGITAL DOMAIN
Scrap your PC for a Net Appliance or replace it with the "latest and greatest?" Reid Goldsborough gazes into the next millennium of computing and reports his opinions on the matter.

21 PROTOTYPE
Off-the-shelf supercomputer clusters, next-generation planetary rovers, back-up warning devices, self-synchronizing pendulums, and piracy-resistant digital-video systems.

46 Q&A
Michael Covington serves up a cornucopia of solutions to some of our readers' "real stumpers."

49 AMAZING SCIENCE
John Lovine plays with "the world's smartest metal."

53 ROBOTICS WORKSHOP
Instead of stumbling around in the dark, let Gordon McComb show you how to add collision-avoidance and detection circuits to your robot.

57 BASIC CIRCUITRY
Charles Rakes combines last month's alarm circuits into a full-fledged security system. Download the circuits from www.electronicsworkbench.com/poptronics and test them on a "virtual workbench."

PRODUCT REVIEWS

7 GIZMO®
PlayStation 2, MP3 player, MP3 carrying case, underwater camera system, flat-panel monitor/TV, handheld personal two-way communicator, Microsoft games, satellite dish for RVs, and a color eBook.
FEATURES

25 ULTRASONIC MOTORS
Everyone knows that electric motors turn electricity into magnetism that turns the rotor, right? Well...not really. If your motor turned electricity into a pulsing surface at ultrasonic frequencies, you'd have an ultrasonic motor, of course! Learn about these fascinating devices and how they just might play an important part in your future. There's even enough general advice provided to build your own USM.—Jim Van Laarhooven

31 VIRTUAL RETINAL DISPLAYS
Small portable displays have gone from helmet-based units made famous in the video arcades to small cubes suspended in front of one eye. The next generation now being tested is built into a pair of glasses—the ultimate "stealth" display (short of the yet-to-be-invented biological implants popular in science fiction and movies) that doesn't block your vision.—William Siuru

33 AN RF FIELD-STRENGTH METER
Electromagnetic fields are all around us. Study after study is starting to suggest that there is some danger in the higher frequencies that are increasingly found in our latest gadgets. Find out how strong a radiated field can be with this simple hand-held unit.—Rudolf F. Graf and William Sheets

PRODUCT REVIEWS

9 GIZMO®
High-resolution digital camera, dual-tray CD recorder, digital vehicle compass, hands-free adapter for cell phones, thunderstorm detector, in-wall home-theater speakers, ultra-tiny MP3 player, DVD-RAM drive, reusable CD labels, plasma flat-panel display, and a computer-free Internet audio player.

14 HANDS-ON REPORT
Aqcess Technologies Qbe Cirrus tablet computer.

DEPARTMENTS

5 NET WATCH
Get ready for some "death and destruction" fun as Chris LaMorte looks into the world of BattleBots.

12 PEAK COMPUTING
Ted Needleman offers guidance on whether to keep riding the upgrade merry-go-round.

21 PROTOTYPE
Self-driving vehicles, full-scale airport simulator, environmentally-friendly batteries, new micromachining methods, and finding a new type of greenhouse pollution.

41 Q&A
Michael Covington's final curtain call of Qs and As.

44 COMPUTER BITS
Join Ted Needleman as he uses software and hardware to gaze at the night sky.

47 AMAZING SCIENCE
John lovines designs and builds some neat Nitinol-based toys.

51 ROBOTICS WORKSHOP
If friends describe your robot as a "bull in a china shop," Gordon McComb can help fit some collision-avoidance sensors to your pride and joy.

55 BASIC CIRCUITRY
If you're in the area, Charles Rakes' proximity sensors will find you.

58 SURVEYING THE DIGITAL DOMAIN
Looking to spend your money on-line? Reid Goldsborough has some good advice on both e-tailing and auctions.

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29 THE ALTA PRO 2000
One secret to adding more features to projects while keeping parts count and size small is to use programmable microcontrollers and microprocessors. But there's another way to keep things small: programmable-logic devices. How do you program them? Our PLD programmer can handle the task, now or in the future. It's versatile, expandable, and obsolescence-proof.—Robert G. Brown

25 FILTERING AGAINST EMI/RFI
There are times when simple shielding is not enough to protect sensitive circuitry. How do you protect your project when you must have wires connected to it? We take a look at the different paths electromagnetic interference uses to sneak into the "inner sanctum" and spoil the party and how to protect against those intrusions.—Joseph J. Carr

37 ANALOG MEMORY MODULE
If you've tried troubleshooting ultra-fine circuit traces or twisted yourself into a knot to reach that test point deep in the heart of your TV, you know the frustration of watching where your test probes are while trying to read your meter's display. This simple add-on device grabs and holds the voltage for reading at the test site or back at the bench.—Stanley J. York

PRODUCT REVIEWS

13 GIZMO®
FSR radios, DVD/MP3 player, Game Boy holster, outdoor plant pot/speaker system, ultimate electronics carry bag, translucent "boombox," wireless modem phone jack, easy Internet-access mouse, report-writing software, magnesium-chassis notebook computer, and an all-in-one office machine.

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8 PROTOTYPE
Cars with 42-volt automotive electrical systems, fuel cells, and other energy innovations. Also, a look at the latest research from university and private industry research labs.

17 NET WATCH
If you surf the Web, you never have enough bandwidth. Chris La Morte looks at some wideband alternatives to the "antique" analog modem.

19 SURVEYING THE DIGITAL DOMAIN
Plug into the "world community" with Reid Goldsborough's advice, including how not to spam!

21 COMPUTER BITS
When Ted Needlemen's house lights go out, he can bask in the glow of his CRTs with the aid of UPSs.

23 PEAK COMPUTING
Get the "big picture" as Ted Needlemen checks out the scanner scene...flattened image scanners, that is.

45 Q&A
Introducing the "new kid on the block," Dean Huster.

49 AMAZING SCIENCE
John Irvine's juices up some fuel cells.

54 SERVICE CLINIC
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Adding vision to Parallax's BOEBot might seem a simple task, but the obvious way is not always the best way.

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In this piece of short fiction, two cousins need a project for the high school Science Fair.

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LEGO MINDSTORMS robots are given the gift of sight with the Vision Command add-on package.

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YOU'VE GOT MAIL ..................................................... Bob Ziller 25
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TELEMARKETERS' NIGHTMARE ................................... John Carter 37
An easy way to get your telephone number off the contact lists.

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TV/DVD/VCR combo, digital "records," PS2 steering wheel, mobile maps, tiny PDA, and more.

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PROTOTYPE ................................................................. 10
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NET WATCH ................................................................ 17
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