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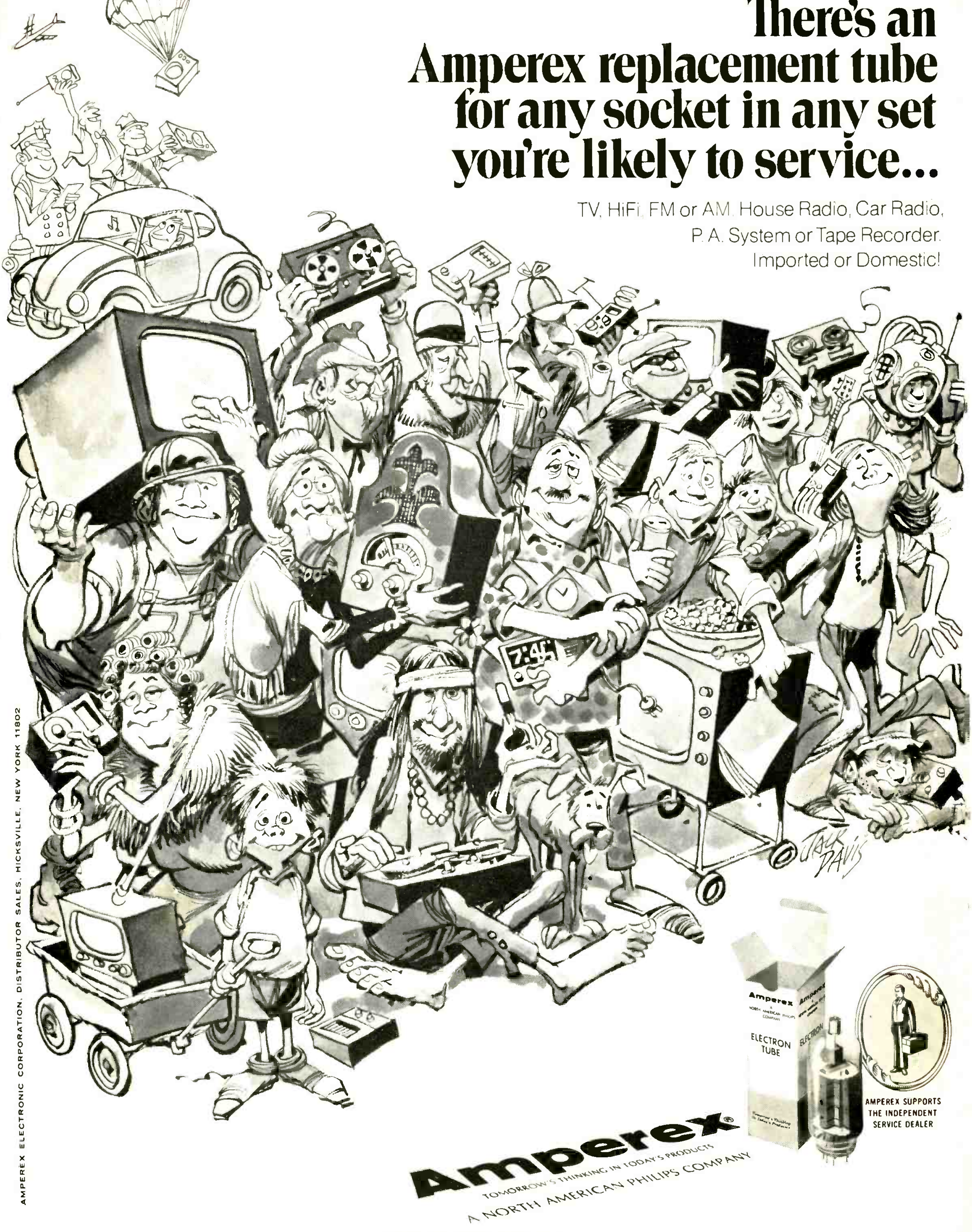
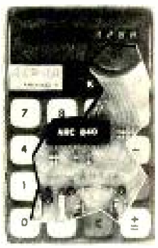


Circle 3 on reader service card

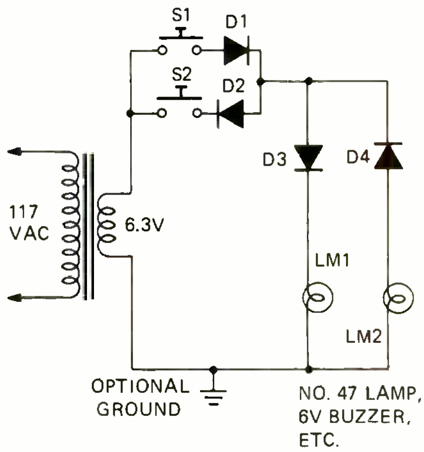
Radio-Electronics®

FOR MEN WITH IDEAS IN ELECTRONICS

May 1972



A MIGHTY HANDFUL is the only way to describe this pocket-size four-function IC calculator. **. . . see page 40**



SWITCHING DIODES can do all kinds of tricks. Try some of them yourself. **. . . see page 54**

Cover photograph by Walter Herstatt
Cover design by Marius Trinque

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looking ahead

Green light for CATV

Ending seven years of a virtual freeze on construction of new cable TV systems in populous areas, the FCC finally has issued its long-awaited CATV decision, a long complex series of rules designed to permit expansion of cable TV without injuring the broadcasting industry. As to pickups from television stations, cable systems in all parts of the country are permitted to carry the signals of stations carrying programs of the three commercial networks. In the top 50 markets, signals of three independent stations may be added (if there aren't three in the local market, signals may be imported from other markets). In the next 50 markets, two independent channels can be included, and in other markets one independent is allowed. CATV systems 35 miles from any station may carry any and all station signals they wish.

In the top 100 markets, systems must have at least 20 channels, of which three must be "public access" channels for expression of local opinions. Additional non-broadcast programming will be required on most systems. New systems won't start building immediately. The FCC order is expected to be challenged and could be delayed for some time. But for all practical purposes, the freeze is over, and there are widespread forecasts that a new era in home communications is on the way.

'Live' instant replay

Soon you'll be able to see a football game at the stadium as well as you do at home—instant replays and all. At least you will if you see the game at the new 80,000-seat Louisiana Superdome now under construction in New Orleans. Suspended from the ceiling at the new domed stadium will be six huge color television screens, each as much as 40 feet wide, visible to every spectator. The screens will be used at sporting events to present replays of key action, closeups, etc. The projectors will be the newest version of Eidophor, that deliver 7,000 lumens of brightness, designed to give a clear image in stadium lighting. Eidophor, manufactured by Gretag, Ltd. of Switzerland, uses a "control layer" principle rather than a cathode ray tube. An electron gun modulates a layer of thick oil, through which a high-intensity light source is passed, making possible extreme brightness. Eidophor is sold in the United States by TNT Communications, Inc. It hasn't yet been announced whether the Louisiana Superdome will make its spectators feel completely at home by also presenting giant-screen commercials, but the new development will certainly be an exciting one for sports enthusiasts.

Projection TV again?

If you're an old-timer, you'll remember television's early battle between the direct-view screen advocates and those who favored projection à la the movies. The dispute raged from television's postwar introduction in 1946 for a couple of years and then died when it was proved by Allen B. DuMont and others that large-screen cathode-ray tubes were economically practical. From 1946 through 1949, Americans purchased about 40,000 projection television sets. High costs, service problems and dim pictures helped end the fad.

Comes the age of color TV and some people are taking a new look at projection television sets for the home. The first to announce such a product is Sony of Japan. Sony has held public demonstrations of a projection system which it says will be available this fall. Trouble is, the projector alone will cost $1,300, the special screen $160, and a tuner $140—a total price of $1,600 in Japan, or about $2,500 in the United States. The projection device uses a souped-up high-brightness 12-inch three-color Trinitron picture tube with a special lens. Sony says the brightness on a 2½ x 3⅓-foot screen is about 3 foot-lamberts, which it claims is at least as bright as the average super-8 home movie projector. This means, of course, viewing in almost total darkness.

An American company, Advent Corporation, also claims to have a home projection color TV system in about the same price range, but it says it could be produced in a less deluxe version and in large quantities to sell for about $1,000. Advent's system uses three specially designed cathode-ray tubes (one for each color) incorporating their own special lenses, and the brightness claimed for this system is more than 10 foot-lamberts—or about the same as the picture in a commercial movie theater—on a screen measuring 4 by 6 feet.

A $300 home VTR?

While those promised "home" videoplaying devices gradually turn out to be $1,000-$2,000 gadgets for the homes of Texas oilmen but not for the rest of us, one of the pioneers in magnetic recording is quietly working on a home VTR that he thinks can be realistically priced to retail at $200 to $300.

Supervising the development is Marvin Camras, of Illinois Institute of Technology Research Institute, which holds many of the basic magnetic tape patents. While others concentrate their energies on helical-scan recorders, Camras is working on a far simpler approach—the approach first taken and then discarded in VTR. This is the fixed-head, longitudinal scanning system used in audio recorders.

Higher-density tape and new heads make this approach interesting again, and Camras may have other new developments he's not talking about yet. His recorder is claimed to use no more parts than a conventional audio recorder. It uses quarter-inch tape in a cassette with an undisclosed number of longitudinal recording tracks. Past longitudinal recorders have had the disadvantage of momentary "blackouts" when the tape reached the end of the reel and reversed, switching to the next track.

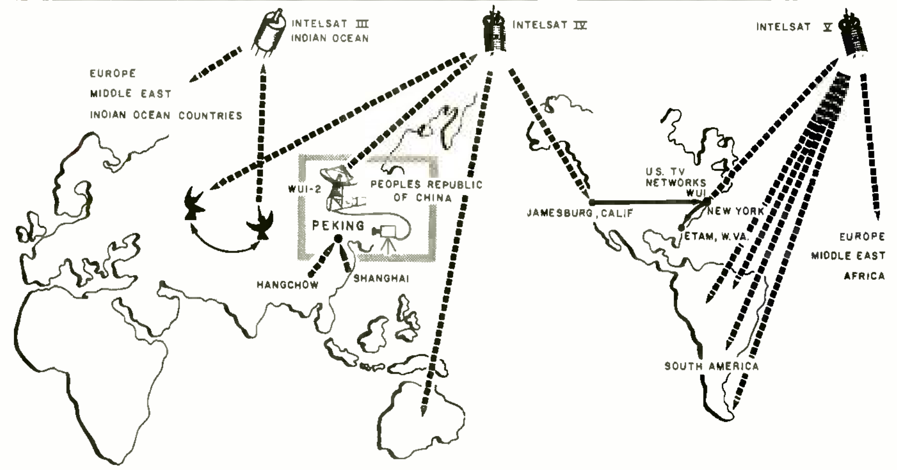
Camras says his system has no such blackout problem. If development work proceeds on schedule, it will be shown to prospective manufacturers some time this year.

In brief . . .

Some 52.6% of American households, or 32,800,000 homes, had color TV sets as of Jan. 1, 1972, according to NBC. That's an increase of 5,200,000 during 1971 . . . Motorola has discontinued portable and table radios, portable phonographs and portable tape recorders to concentrate on television, stereo consoles and automobile radios and auto tape players . . . A stereo-FM decoder on a single IC chip is being offered to set manufacturers by Motorola Semiconductors. It uses phase-locked loop technology which eliminates the need for inductors, making possible complete integration, and is claimed to combine higher reliability with lower cost. . .

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

new & timely



THIS IS THE TRANSMISSION ROUTE of live color television, telephone, press and telegraph coverage for President Nixon's trip to China this past February.

Satellite covers Peking trip

The Peoples Republic of China provided live color TV, telephone, press and telegraph coverage of President Nixon's historic visit to Peking using Western Union International's transportable satellite earth station, *WUI-2*. Hughes Aircraft Company built the station, and China will pay for its use of the equipment which was operated jointly by Western Union, Hughes, and Chinese engineers.

The antenna on the *WUI-2* is a 24-foot diameter fiberglass parabola with limited motion in azimuth/elevation; motor drive two axes approximately, and is manually positioned to any-look angles. It can receive 3.7 to 4.2 gHz and transmits 5.925 to 6.425 gHz frequencies. The *WUI-2* is fully operational under diverse environmental conditions, including up to 60 mph winds, at an altitude from zero to 10,000 feet, and in temperature of minus 40° to plus 130°.

Electrostatic system patented

A self-energized electrostatic system that makes electrostatic stereophone listening practical for the home has been assigned a patent by the U. S. Patent Office. Koss Corporation first introduced the system in 1968 and subsequently has used it in several models of stereophones.

The system eliminates the need for an external ac power supply. The electrostatic stereophone principle produces sound by using an electrostatic field to operate a diaphragm and delivers a frequency response of 10 audible octaves, four beyond conventional stereophones. Until the Koss technological breakthrough, only dynamic-type stereophones were practical.

Radiation levels

Figures are now available from the Environmental Protection Agency showing the state-by-state radiation levels from natural radiation. Colorado residents are found to be exposed to the highest average levels of natural radiation. An inter-agency Special Studies Group which is reviewing radiation doses in the U.S. from all sources has released these figures, but the study is not expected to be completed until June 1972.

Natural radiation exists everywhere. Part comes from radioactive materials in rocks, and from the earth's crust. Part is due to cosmic rays from outer space. Each person's body has some radioactive material received through food and water.

Because natural levels rise with higher altitudes, such as are found in the mountainous Western states, natural radiation varies from place to place. This is due mainly to increased cosmic radiation at these high altitudes. Radiation levels also rise with an increase in geomagnetic latitude, up to 50°.

Radiation doses are measured in millirems, and it was found that, on the average, each person in the U.S. receives a dose from natural radiation of 130 millirems per year. The next highest amount

(continued on page 12)

STATE-BY-STATE BREAKDOWN OF AVERAGE ANNUAL EXPOSURE TO INDIVIDUALS FROM NATURAL RADIATION
(expressed in millirems)

Alabama—135
Alaska—130
Arizona—145
Arkansas—140
California—115
Colorado—250
Connecticut—125
Delaware—125
District of Columbia—120
Florida—120
Georgia—125
Hawaii—115
Idaho—170
Illinois—135
Indiana—125
Iowa—135
Kansas—135
Kentucky—130
Lousiana—100
Maine—150
Maryland—120
Massachusetts—140
Michigan—135
Minnesota—150
Mississippi—130
Missouri—130
Montana—175
Nebraska—155
Nevada—150
New Hampshire—135
New Jersey—125
New Mexico—200
New York—135
North Carolina—145
North Dakota—145
Ohio—140
Oklahoma—135
Oregon—135
Pennsylvania—125
Rhode Island—130
South Carolina—135
South Dakota—210
Tennessee—140
Texas—100
Utah—180
Vermont—120
Virginia—125
Washington—135
West Virginia—135
Wisconsin—130
Wyoming—245
American Samoa—115
Guam—120
Puerto Rico—115
Canal Zone—115
Virgin Islands—115

National Average—130 millirems per person per year.

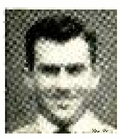
You get more for your money from NRI

—more value, more solid experience so essential to careers in Electronics. NRI's pioneering "discovery" method is the result of more than half a century of simplifying, organizing, dramatizing subject matter. In each of NRI's major courses you learn by doing. You demonstrate theory you read in "bite-size" texts programmed with NRI designed-for-learning professional lab equipment. Electronics comes alive in a unique, fascinating way. You'll take pleasure in evidence you can feel and touch of increasing skills in Electronics, as you introduce defects into circuits you build, perform experiments, discover the "why" of circuitry and equipment operation.

Almost without realizing it, the NRI discovery method gives you the professional's most valuable tool—practical experience. You learn maintenance, installation, construction and trouble-shooting of Electronic circuits of any description. Whether your chosen field is Industrial Electronics, Communications or TV-Radio Servicing, NRI prepares you quickly to be employable in this booming field or to earn extra money in your spare time or have your own full-time business. And you start out with training equivalent to months—even years—of on-the-job training.

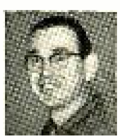
NRI Has Trained More Men for Electronics Than Any Other School

—By actual count, the number of individuals who have enrolled for Electronics with NRI could easily populate a city the size of New Orleans or Indianapolis. Over three-quarters of a million have enrolled with NRI since 1914. How well NRI training has proved its value is evident from the thousands of letters we receive from graduates. Letters like those excerpted below. Take the first step to a rewarding new career today. Mail the postage-free card. No obligation. No salesman will call. NATIONAL RADIO INSTITUTE, Electronics Division, Washington, D.C. 20016.



L. V. Lynch, Louisville, Ky., was a factory worker with American Tobacco Co., now he's an Electronics Technician with the same firm. "I don't see how the NRI way of teaching could be improved."

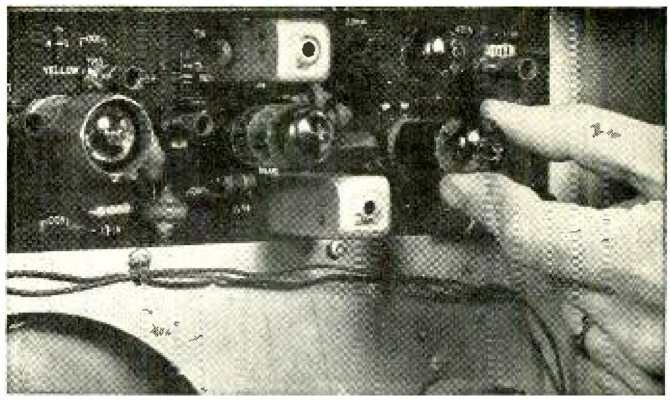
G. L. Roberts, Champaign, Ill., is Senior Technician at the U. of Illinois Coordinated Science Laboratory. In two years he received five pay raises. Says Roberts, "I attribute my present position to NRI training."



Don House, Lubbock, Tex., went into his own Servicing business six months after completing NRI training. This former clothes salesman just bought a new house and reports, "I look forward to making twice as much money as I would have in my former work."

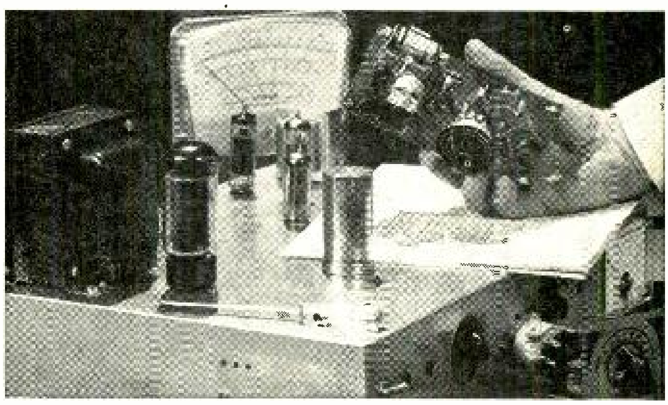
Ronald L. Ritter of Eatontown, N.J., received a promotion before finishing the NRI Communication course, scoring one of the highest grades in Army proficiency tests. He works with the U.S. Army Electronics Lab, Ft. Monmouth, N.J. "Through NRI, I know I can handle a job of responsibility."

APPROVED UNDER NEW GI BILL. If you served since January 31, 1955, or are in service, check GI line on postage-free card.



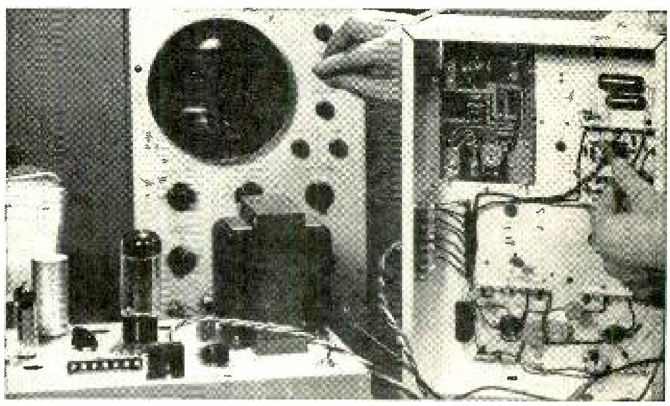
COLOR TV CIRCUITRY COMES ALIVE

as you build, stage-by-stage, the only custom Color-TV engineered for training. You grasp a professional understanding of all color circuits through logical demonstrations never before presented. The TV-Radio Servicing course includes your choice of black and white or color training equipment.



COMMUNICATIONS EXPERIENCE

comparable to many months on the job is yours as you build and use a VTVM with solid-state power supply, perform experiments on transmission line and antenna systems and build and work with an operating, phone-cw, 30-watt transmitter suitable for use on the 80-meter amateur band. Again, no other home-study school offers this equipment. You pass your FCC exams—or get your money back.



COMPETENT TECHNICAL ABILITY

can be instantly demonstrated by you on completing the NRI course in Industrial Electronics. As you learn, you actually build and use your own motor control circuits, telemetering devices and even digital computer circuits which you program to solve simple problems. All major NRI courses include use of transistors, solid-state devices, printed circuits.

new & timely

(continued from page 6)

comes from medical diagnosis and treatment, estimated dose in 1970 of about 90 millirems per person per year. Fallout from past atmospheric tests of nuclear weapons and exposure from nuclear power reactors and allied facilities came to an average annual exposure of five millirems per person per year.

Hugo Gernsback scholarship winner

Gary A. Messick, whose family resides in Carmichael, California, is a 1972 winner of the Hugo Gernsback Scholarship Award, selected by the Cleveland Institute of Electronics from among its students. **Radio-Electronics** magazine each year gives a $125.00 scholarship to each of eight students learning electronics at home-study schools.

Gary is now in Okinawa, in the Navy with the rank of Communications Technician Maintenance Second Class. He has completed four years of a six year enlistment. After the Electronics Technology course Gary will be studying Broadcast Engineering with C.I.E. He is no stranger to studies, since he was graduated from Sacramento State College with a B.S. in Business Administration in 1967. He also successfully completed the Navy's ETA School, HFDF "C" School in advanced electronics, and has the FCC's Second Class Radiotelephone License.

Communication system

A small communication system, designed to provide tourist information to

(continued on page 14)

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SONY® achieves true integration

In all too many transistor integrated amplifiers, the preamp stage does not quite live up to the performance of the amplifier section.

Not in Sony's new TA-1130. Thanks to an FET front end, this integrated package has a preamp stage that really does full justice to its output section.

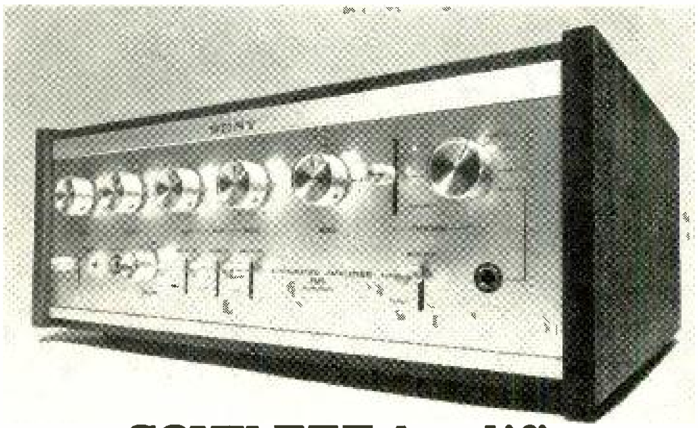
Why FET's

For the same reason that we use them in our tuners and receivers, and in our studio professional condenser microphones; because FET's have a far wider dynamic range than ordinary transistor types.

And the preamplifier needs that range. Because it has to be sensitive enough to handle the lowest-output, moving-coil cartridges, yet still accept the highest output cartridges without overloading. (The power amp has it easier: you keep its input level fairly constant with your volume control.)

Power to Spare

But if the power amplifier doesn't need that range, it does need power. The output section of TA-1130 has it: 230 IHF watts (into 4 ohms), with continuous power rated at 65+65 watts into 8 ohms. (With all that power, we made sure that both transistor and speaker protection circuits were included.)



SONY® F.E.T. Amplifier

Nothing Stands Between You and the Sound

Both sections are powered by balanced positive *and* negative supply voltages (not just positive and ground), so there need be no coupling capacitors or interstage transformers between you and the sound.

Without them, the TA-1130 can extend its power band width down to 7 Hertz, and actually *exceed* its rated damping factor of 100 all the way down to 5 Hz.

An Abundance of Audiophile Conveniences

Of course, the TA-1130 has all the control facilities that you could ask for: low and high filters, tape monitor, a speaker selector, and even an Auxiliary input jack on the front panel. The selector switch is Sony's instant-access knob-and-lever system.

There's even provision to use the TA-1130's power amp and preamp sections separately, to add equalizers, electronic cross-overs, or 4-channel adapters to your system.

In fact, you can even get the power output section separately, as the model TA-3130 basic amp. It makes a great match for our TA-2000F preamp, too. Your Sony dealer has both models available, and at down-to-earth prices for the performance they offer. Sony Corporation of America, 47-47 Van Dam Street, Long Island City, New York 11101.

Circle 6 on reader service card

new & timely *(continued from page 12)*

people traveling through the West, was put into operation in Montana for the first time last year. Known as Info Systems, Inc., its use is expanding into many fields and production is rapidly increasing.

Based on an invention by Darrell S. Smith, the device is actually a low-power, limited range, automatic radio station. The AM band radio operates below FCC limitation and does not interfere with commercial radio. The individual transmitters can be set to operate at any frequency between 550 and 1600, depending on the vacant spot on a local dial.

Info Systems operates from daylight to dark through a timer system. It works on either ac or dc current and tests in Yellowstone Park show it has a range of four-tenths of a mile and up, depending on the situation. Messages, half of them giving tour information and half giving commercial information, run from 7-1/2 to ten minutes in length. Motorists stopping in safety rest areas may dial their radios to the frequency indicated on signs posted nearby to receive the tourist information.

One of the expanded uses for Info Systems is in dispensing traffic reports. California authorities undertook a motorist survey when Info Systems was used after a spring earthquake to aid motorists away from damaged areas where delays were expected. The authorities found that the

system could disseminate motorist information and at the same time eliminate the visual taxation of a motorist's senses.

Radio beam creates heat bubbles in ionosphere

Last month in this column you read the report of the National Oceanic and Atmospheric Administration telling of radio frequency energy increasing electron temperatures in the ionosphere. Now we have the Department of Commerce report with unexpected results of Utlaut and Cohen's experiments.

The scientists are creating immense, invisible, short-lived bubbles in the upper atmosphere. The heated bubbles are formed in seconds at altitudes up to 200 miles by the action of a 100-million-watt radio beam. They grow to their full 50 to 100 mile size in about 20 minutes under the influence of geomagnetic forces. Composed of the electrified gas of the ionosphere, the bubbles elongate upward and downward under constriction of "tubes of force" that are generated and shaped by the earth's magnetic field. Within minutes or hours, depending on time of day and conditions in the high-level environment, the modified region of the ionosphere rebounds to its natural state.

Another major surprise was the artificial creation of a natural phenomenon known as Spread F—"F" referring to the upper layer of the radio-reflecting region of the ionosphere and "Spread" describing the patchy pattern of reflected signals.

Still another surprise to the airglow observers was the enhancement of infrared emissions from excited oxygen molecules (as opposed to atoms) by an unexplained mechanism.

Under certain natural and as yet theoretically unexplained conditions, F-region echoes become diffuse, suggesting instabilities in the ionospheric plasma. If they do appear, it is almost always at night, generally after midnight. No one had predicted that the transmitter was capable of generating this Spread F. But this is what the ionograms repeatedly revealed, in daytime as well as night.

The unexpected also was observed in a large *attenuation* in radio-wave reflectivity from the regions of heated electrons. They had expected their diagnostic signals to undergo *enhanced* reflection from the modified portions of the ionosphere.

All these observations of effects of radio beams on the upper atmosphere should lead to better understanding of the ionosphere, to improvements in long-distance radio communications, and to the advancement of plasma physics, a science with potential applications in power production by nuclear fusion and magneto-hydrodynamics. **R-E**

letters

DOLBY PROTECTS QUALITY

In the letter titled "Is Dolby Necessary?" (**Radio-Electronics,** February 1972), Mr. Clyde Wade, describing the broadcast practices by which fidelity is suppressed, seems really to be asking whether or not FM itself serves any useful purpose.

If, as he suggests, FM is preponderantly a medium for the transmission of highly compressed, limited and distorted program material, and the dynamic range of such broadcasts is rapidly decreasing, what, indeed, is the purpose of *any* attempt to improve reception quality and audience coverage?

On the other hand, there are FM stations which are committed to quality FM service, and which maintain high standards in programming as well as signal characteristics. Many of these stations have expressed interest in the Dolby System because it serves these ends; others have already started Dolby broadcasting for limited periods, and several are considering full-time Dolby broadcasting.

Like other broadcasting developments, such as the availability of color TV transmissions, the Dolby System requires listener equipment changes only if the listener wishes to obtain the noise reduction benefit the system provides. Since Dolby and non-Dolby broadcasts are compatible, as in the color TV example, there need be no forced obsolescence. In fact, the Dolby-encoded FM signal is clearly and entirely within the FCC's fidelity standards.

Mr. Wade's final point is that the Dolby System's use "bypasses the reasons" for FCC transmitter power limits. This implies that there are reasons for those limits other than prevention of interference between services and stations. The power limits exist to protect quality, and so does the Dolby System. Fortunately for listeners, one does not exclude the other.

ROBERT BERKOVITZ
Dolby Laboratories
London, England

LIQUID CRYSTAL DISPLAYS

Regarding Don Lancaster's story in the February 1972 issue of **Radio-Electronics,** "Liquid Crystal Displays", chemicals may also be obtained from

(continued on page 22)

One of our most successful students wrote this ad!

Harry Remmert decided he needed more electronics training to get ahead. He carefully "shopped around" for the best training he could find. His detailed report on why he chose CIE and how it worked out makes a better "ad" than anything we could tell you. Here's his story, as he wrote it to us in his own words.

By Harry Remmert

Harry Remmert gives his CIE Electronics course much of the credit for starting him on a rewarding career. He tells his own story on these pages.

"AFTER SEVEN YEARS in my present position, I was made painfully aware of the fact that I had gotten just about all the on-the-job training available. When I asked my supervisor for an increase in pay, he said, "In what way are you a more valuable employee now than when you received your last raise?" Fortunately, I did receive the raise that time, but I realized that my pay was approaching the maximum for a person with my limited training.

"Education was the obvious answer, but I had enrolled in three different night school courses over the years and had not completed any of them. I'd be tired, or want to do something else on class night, and would miss so many classes that I'd fall behind, lose interest, and drop out.

The Advantages of Home Study

"Therefore, it was easy to decide that home study was the answer for someone like me, who doesn't want to be tied down. With home study there is no schedule. I am the boss and I set the pace. There is no cramming for exams because I decide when I am ready, and only then do I take the exam. I never miss a point in the lecture because it is right there in print for as many re-readings as I find neccessary. If I feel tired, stay late at work, or just feel lazy, I can skip school for a night or two and never fall behind. The total absence of all pressure helps me to learn more than I'd be able to grasp if I were just cramming it in to meet an exam deadline schedule. For me, these points give home study courses an overwhelming advantage over scheduled classroom instruction.

"Having decided on home study, why did I choose CIE? I had catalogs from six different schools offering home study courses. The CIE catalog arrived in less than one week (four days before I received any of the other catalogs). This indicated (correctly) that from CIE I could expect fast service on grades, questions, etc. I eliminated those schools which were slow in sending catalogs.

FCC License Warranty Important

"The First Class FCC Warranty* was also an attractive point. I had seen "Q" and "A" manuals for the FCC exams, and the material had always seemed just a little beyond my grasp. Score another point for CIE.

*CIE backs its FCC License-preparation courses with this famous Warranty: graduates will be able to pass the applicable FCC License exam or their tuition payments will be refunded in full. This warranty is valid during the entire completion time established for their course.

"Another thing is that CIE offered a complete package: FCC License and technical school diploma. Completion time was reasonably short, and I could attain something definite without dragging it out over an interminable number of years. Here I eliminated those schools which gave college credits instead of graduation diplomas. I work in the R and D department of a large company and it's been my observation that technical school graduates generally hold better positions than men with a few college credits. A college degree is one thing, but I'm 32 years old, and 10 or 15 years of part-time college just isn't for me. No, I wanted to *graduate* in a year or two, not just *start*.

"When a school offers both resident and correspondence training, it's my feeling that the correspondence men are sort of on the outside of things. I wanted to be a full-fledged student instead of just a tag-a-long, so CIE's exclusive home-study program naturally attracted me.

"Then, too, it's the men who know their theory who are moving ahead where I work. They can read schematics and understand circuit operation. I want to be a good theory man.

"From the foregoing, you can see I did not select CIE in any haphazard fashion. I knew what I was looking for, and only CIE had all the things I wanted.

Two Pay Raises in Less Than a Year

"Only eleven months after I enrolled with CIE, I passed the FCC exams for First Class Radiotelephone License with Radar Endorsement. I had a pay increase even before I got my license and *another* only ten months later.

"These are the tangible results. But just as important are the things I've learned. I am smarter now than I had ever thought I would be. It feels good to know that I know what I know now. Schematics that used to confuse me completely are now easy for me to read and interpret. Yes, it is nice to be smarter, and that's probably the most satisfying result of my CIE experience.

Praise for Student Service

"In closing, I'd like to get in a compliment for my Correspondent Counselor who has faithfully seen to it that my supervisor knows I'm studying. I think the monthly reports to my supervisor and generally flattering commentary have been in large part responsible for my pay increases. My Counselor has given me much more student service than "the contract calls for," and I certainly owe him a sincere debt of gratitude.

"And finally, there is Mr. Tom Duffy, my instructor. I don't believe I've ever had the individual attention in any classroom that I've received from Mr. Duffy. He is clear, authoritative, and spared no time or effort to answer my every question. In Mr. Duffy, I've received everything I could have expected from a full-time private tutor.

"I'm very, very satisfied with the whole CIE experience. Every penny I spent for my course was returned many times over, both in increased wages and in personal satisfaction."

Perhaps you too, like Harry Remmert, have realized that to get ahead in Electronics today, you need to know much more than the "screwdriver mechanics." They're limited to "thinking with their hands"... learning by taking things apart and putting them back together... soldering connections, testing circuits, and replacing components. Understandably, their pay is limited—and their future, too.

But for men like Harry Remmert, who have gotten the training they need in the fundamentals of Electronics, there are no such limitations. He was recently promoted, with a good increase in income, to the salaried position of Senior Engineering Assistant working in the design of systems to silence submarines. For trained technicians, the future is bright. Thousands of men will be needed in virtually every field of Electronics from two-way mobile radio to computer testing and troubleshooting.

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RE-03

Circle 10 on reader service card

LETTERS
(continued from page 16)

the distributors of Eastman Kodak Organic Chemicals. Catalog No. 46, pages 447 and 448, lists liquid crystals. Technical literature is available as well, under the code *JJ-14.* Write to the home office in Rochester, New York.
LESTER S. KAPALA
Lowell, Mass.

SUBBER CORRECTION

Cedric Western has informed us of an error in the schematic and parts list for his "TV Tuner-Subber" in the April 1972 issue of **Radio-Electronics.** Resistor R3 should be 220 ohms, 5%, instead of 270 ohms as indicated.

COLOR CONVERGENCE GENERATOR

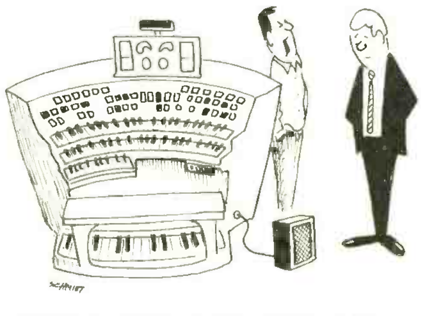
I'd like to thank your Technical Editor, Robert F. Scott, for help he gave me with a problem concerning the "Color Convergence Generator" story by B. R. Rogen in the January 1972 issue. I telephoned my difficulty, that I was not able to pick up the signal on the low band, but only on uhf.

Mr. Scott's suggesting the possibility of it heterodyning with a local uhf signal was the answer. I took the generator into work that night, and when I signed off channel 28, the generator's signal also left the uhf band. However, it was still nowhere to be found on the vhf low band. I then located a bad solder joint at the tap of L1. Resoldering put the signal on the low band.
BARRY ERICK
Kingston, Pa.

OUT-OF-PRINT REQUEST

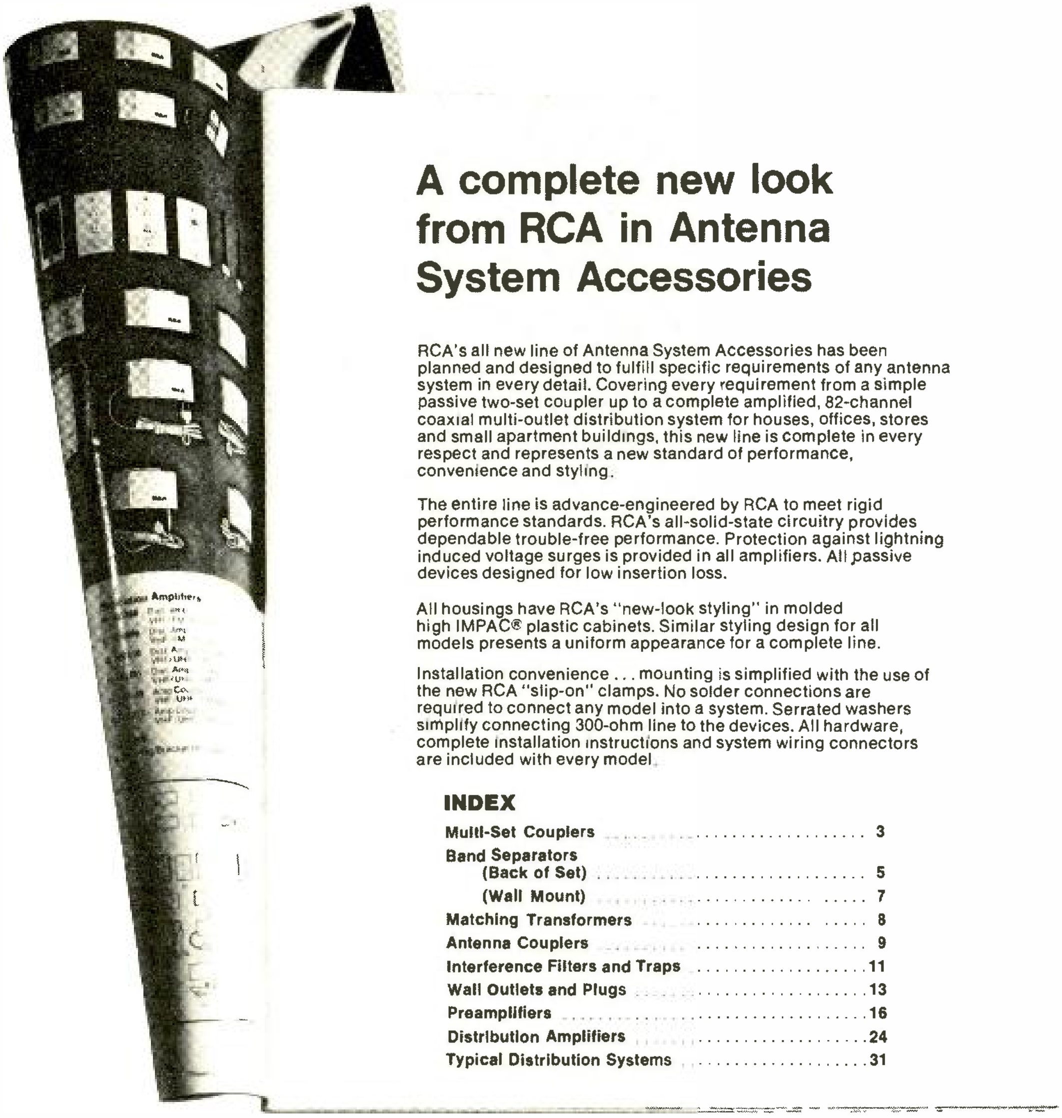
I'm hoping some readers of **Radio-Electronics** have out-of-print Gernsback Library books or older magazines, such as *Radio-Craft* or *Short-Wave Craft.*

Will anyone who can help please write directly to me.
LESTER ZEBRO
R.R. #2
Boyceville, Wisc. 54725 **R-E**



Right about here I ran out of money . . .

This is what this catalog is all about.



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Circle 13 on reader service card

appliance clinic

DC MOTORS, BLOBS AND PROBLEMS

by JACK DARR
SERVICE EDITOR

NOT TOO LONG AGO I RAN ACROSS AN interesting application of electronic equipment in home appliances (by special request. The request was "Daddy! My styling comb won't work!") For those unfamiliar with this latest fruit of our technology, it's a little hand-held gizmo like a hair-drier. It has a heating element and a fan. These are built into a small handle. A special comb or brush can be plugged into the warm air outlet. Long hair can be blown dry as it is combed out.

Dissecting this little monster with some difficulty, I found a miniature motor with a plastic fan, a heating element, and a blob. Three wires came out of the blob, which was tightly wrapped with glass fiber tape. These wires went to the heating element and the motor. Since the thing is powered by ac, I expected an ac motor.

However, the heating element heated, but the motor declined to operate. Out of the case it came, after more difficulty in locating a subminiature Phillips screwdriver. I expected the motor to be open. So some circuit-tracing was in order.

The heating element was tapped. Hmm. What for? Spreading it out on the bench, I drew out a circuit diagram (Fig. 1). Unwrapping the blob it turned out to have markings on it. Well, well. Maybe it's not going to be such a bad day after all.

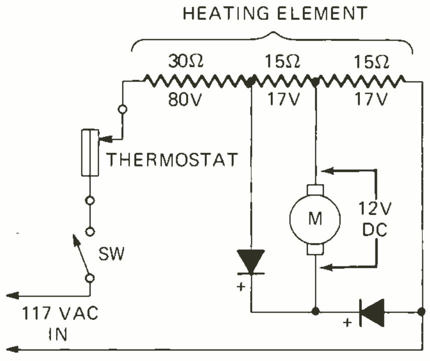


Fig. 1

Rearranging the crude first draft of the schematic, I could see what was going on. Evidently they were taking a low ac voltage off the taps on the heating element, applying them to the blob, which had to be a rectifier, and running the motor on dc! Now that I took a closer look at it, this looked exactly like some of the mini-motors used to run toys, etc. Unhooking the leads to the motor, I connected them to the bench variable dc power supply. The motor would run at only 3 volts, and at 10 volts it really turned up revs.

Checking out the blob, I could see the markings more plainly (Fig. 2).

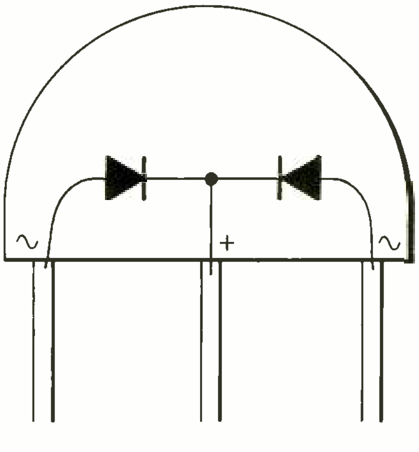
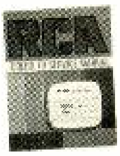


Fig. 2

Looked as if my idea about a rectifier was correct. There were two symbols which indicated ac on the outer leads, so the center lead had to be a common. A little fast work with the ohmmeter confirmed this. On one side, at least. The other one was slightly dead shorted. From the polarity of the surviving diode, the thing was a common-cathode full-wave rectifier. Now I needed a replacement.

Turning the heating element on again, I read about 15 volts ac on either side of the "center-tap". So peak voltage wouldn't be any problem. Current wouldn't be either. This little motor probably took about 1 ampere maximum. Picking up a pair of standard sili-

(continued on page 104)



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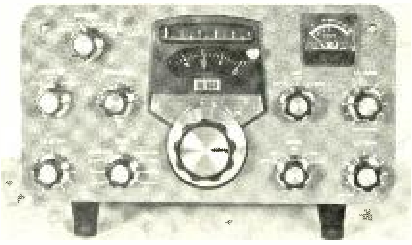
RE-52

Circle 15 on reader service card

equipment report

Heathkit SB-303 Ham-band receiver



Circle 26 on reader service card

HEATHKIT'S NEW SB-303 HAM-BAND solid-state receiver (10 through 80 meters, plus 15 mHz WWV) is a major departure from its immediate ancestor, the SB-301. While the block diagrams are quite similar, and both receivers use the same well-tried conversion scheme, the SB-303 has 27 transistors and one IC instead of vacuum tubes. The vacuum tube LMO, Heath has featured so successfully since 1964 in the SB line, has been updated to solid state in the '303. Although it may be equivalent to gilding the lily, the new vfo is even more stable and tracks better than its older brother. Accuracy of resetability and frequency readout are outstanding.

The construction of the SB-303 took 29 hours, of which about a third was spent on the eight printed circuit boards which contain nearly all the receiver's components. Mechanical assembly and mounting of hardware, etc., took an even larger part of the time. Final wiring is done rapidly with the help of a prefabricated harness.

The alignment procedure is speedy and simple, a big improvement on previous kits of comparable complexity. No record was kept, but it couldn't have taken more than 30 minutes from initial resistance tests to final operation. The manual offers a choice of alignment procedures with and without instruments. This kit was aligned without instruments—not entirely true, since even this way, you must use a vtvm for a few adjustments, the remainder being performed with the help of the S-meter. Just as a sample of how specific the instructions are, the alignment of the heterodyne oscillators proceeds by peaking up coils for each band, then backing off the slugs in a stated direction by a given amount. A typical step to illustrate, is ". . . back off slug counter-clockwise until voltage reading drops by .5 from its peak." Not even an rf probe is needed here because Heath has provided a test point where the rf voltage has been rectified and applied as dc.

Six of the eight pcb's are plug-ins. The other two, the mixer and rtty boards, are connected more conventionally to the wiring harness.

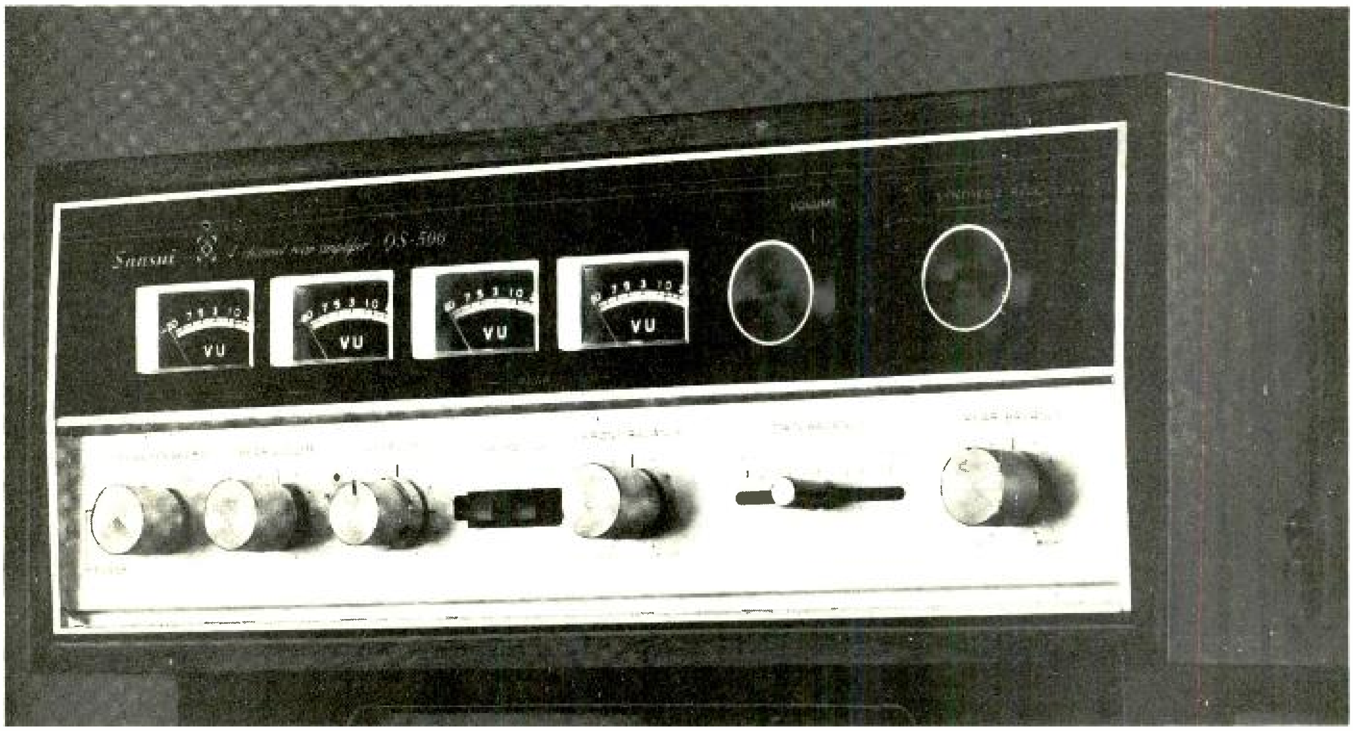
Both rtty and mixer boards are positioned in the set when mounted in such a way as to be completely accessible for in-circuit testing of voltages and resistances. The six plug-in boards, however, which are mounted vertically, cannot be reached in their normal positions. To overcome this, the kit includes two different kinds of what Heath calls extender boards. When service is necessary, the suspect board is unplugged and replaced by an extender, into which the circuit board then plugs.

Rtty enthusiasts will be interested in the FSK facilities incorporated in this receiver. Narrow shift (170 Hz), wide shift (850 Hz) and CW shift (50 Hz) for identification, signals are generated internally and brought out to an accessory socket on the rear panel. Also available at the accessory socket are two 15-volt lines for converters and agc.

The '303 seems to be able to handle tremendous signal loads effectively, no doubt due to the use of four dual-gate, diode-protected mosfets. With judicious manipulation of the built-in continuously variable 40 db attenuator and the rf gain control, one is able to copy weak signals adjacent to very strong ones without difficulty.

It's relatively easy to build a good receiver for 20, 40 and 80 meters and there's no doubt the '303 performs superbly on these bands. It is on 10 and 15, however, that the '303 comes into its own. I made numerous comparisons with a well-known high priced receiver. Many signals that were marginal or unreadable on the expensive job came through as solid copy on the '303, a real tribute to its sensitivity and signal-to-noise ratio. **R-E**

if you go for four channel...



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You can plug in a four-channel reel-to-reel or cartridge deck or any other discrete source. In the future — if you should have to — you can add any adaptor, decoder or what-have-you for any four-channel system for disc or broadcast that anyone's even hinted at. And a full complement of streamlined controls lets you select any function or make any adjustment quickly and positively.

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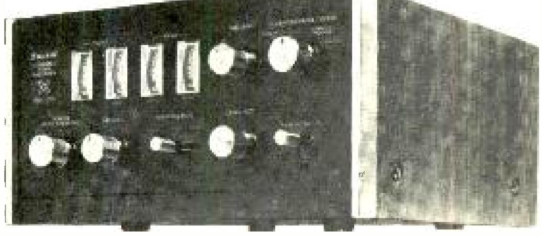
An alternate four-channel miracle-maker is the modest but well-endowed QS100, with total IHF music power of 50 watts (continuous power per channel of 18 watts at 4 ohms and 15 watts at 8 ohms). In a walnut cabinet, it sells for $214.95



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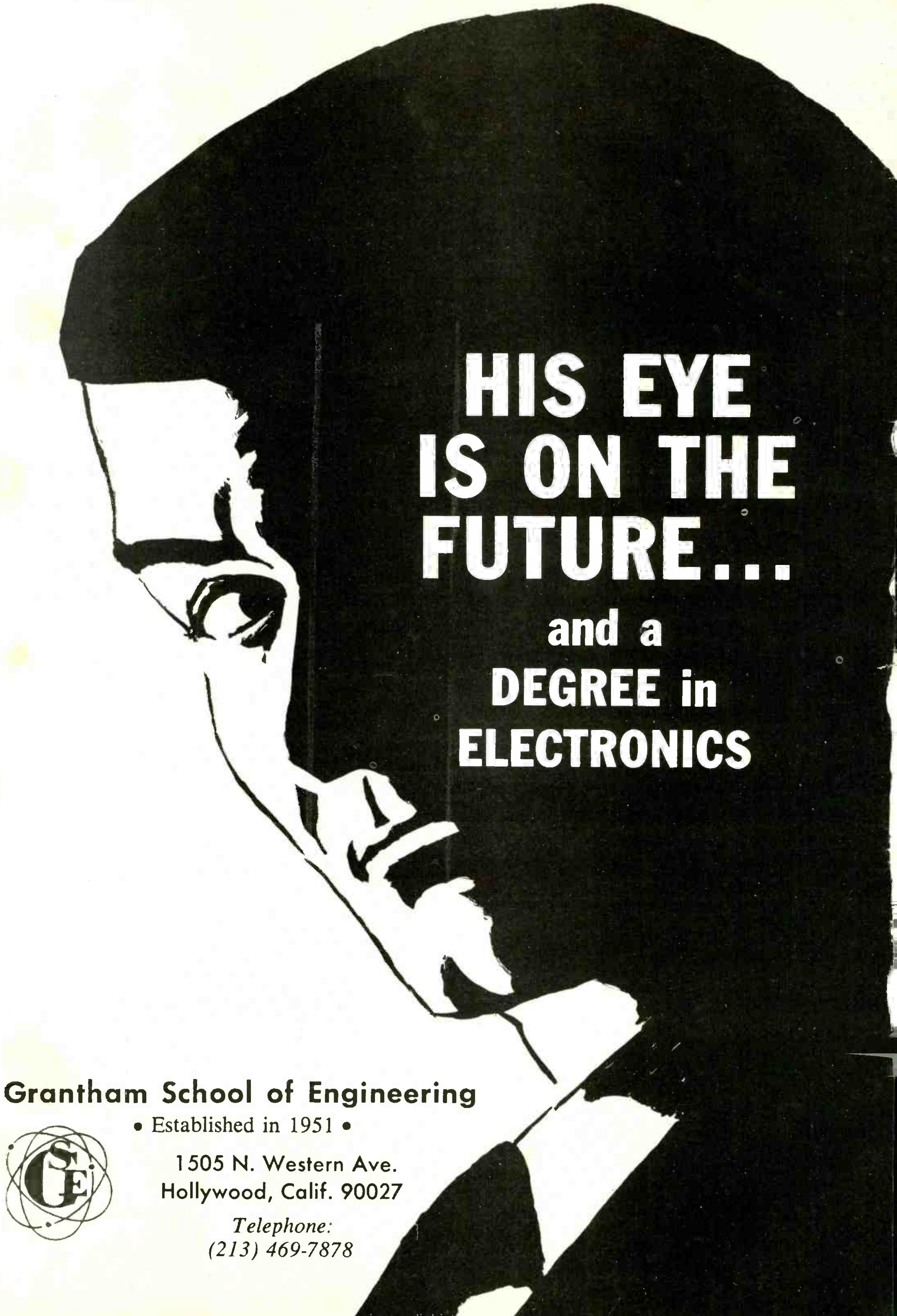
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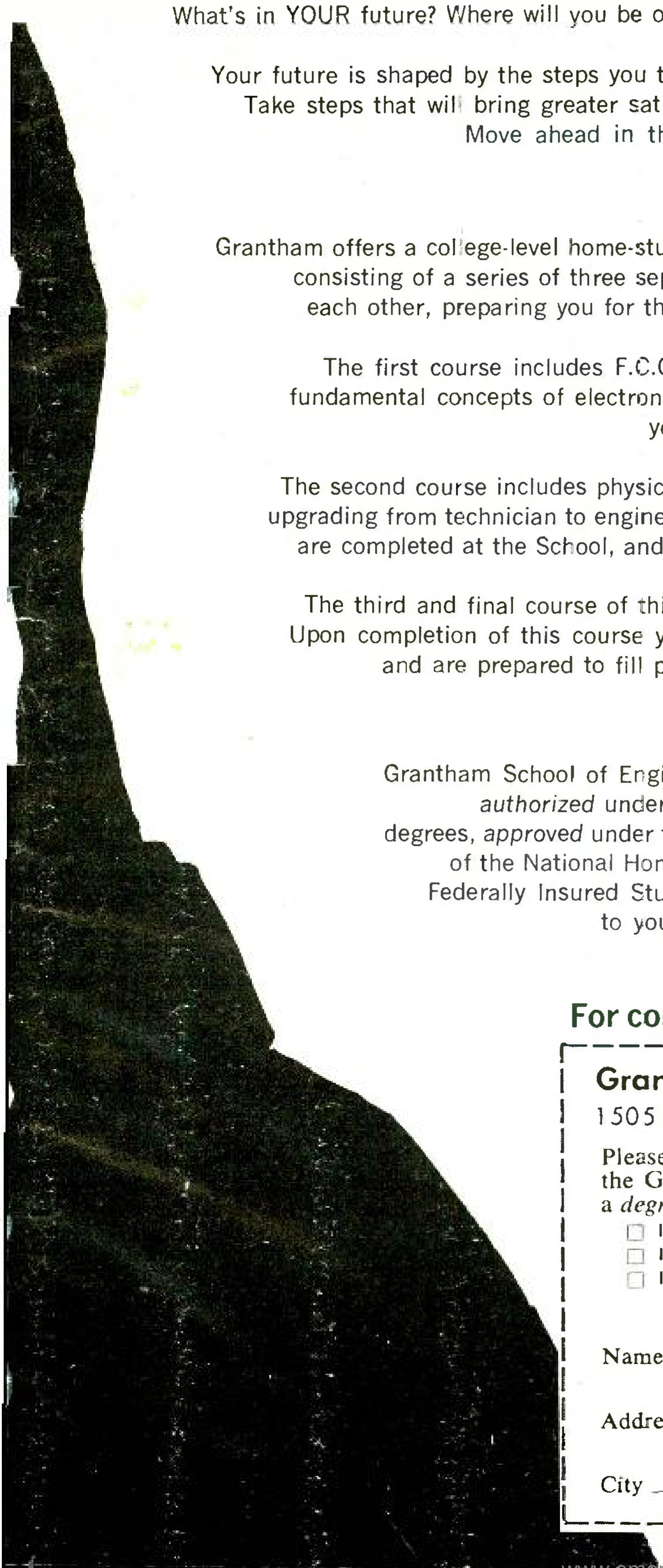

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Here's that piece of dream test equipment that can tell you if a digital logic IC is good or bad—section by section

Build R-E's Digital IC Tester

by JACK CAZES

HAVE YOU EVER WISHED YOU HAD A fast, easy way to test the surplus digital IC's in your spare parts collection? Have you wanted to check an IC *in-circuit*, under actual operating conditions? Wouldn't it be great to be able to monitor the logic states at several points on a digital circuit board . . . even supply power to the board from an external source?

The DIGI-DYNA-CHECK is a truly dynamic digital integrated circuit checker that can be used to test digital IC's under actual operating conditions; it can be made to perform just as though it were functioning in an actual circuit. Tests can be performed both in- and out-of-circuit. A 5-volt regulated supply, capable of delivering up to 1 amp, is available within the DIGI-DYNA-CHECK to "fire up" fifteen or more IC's on a circuit board via an adapter cable with its miniature IC connecting clip.

An internal "bounceless" pushbutton, mounted on the front panel, can be used to advance counters, dividers, shift registers, etc., one step at a time. If desired, such IC's can be put through their paces automatically at a rate suitable for observing with an oscilloscope. This automatic mode of operation is available via an internal 50-kHz conditioned clock with complementary outputs.

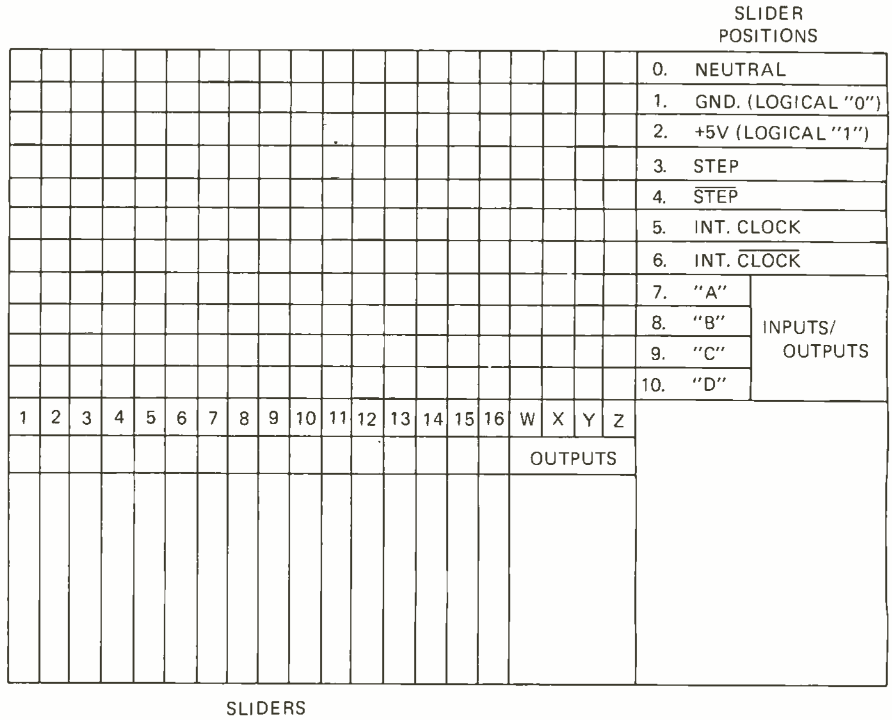
Connections to "the outside world", ie., to equipment external to the DIGI-DYNA-CHECK, such as a scope, other voltage sources, oscillators, etc., are easily made via eight 5-way binding posts mounted on the front panel. Any internal or externally available function can be patched to any pin or combination of pins on the integrated circuit under test by means of the matrix programmer in the DIGI-DYNA-CHECK."

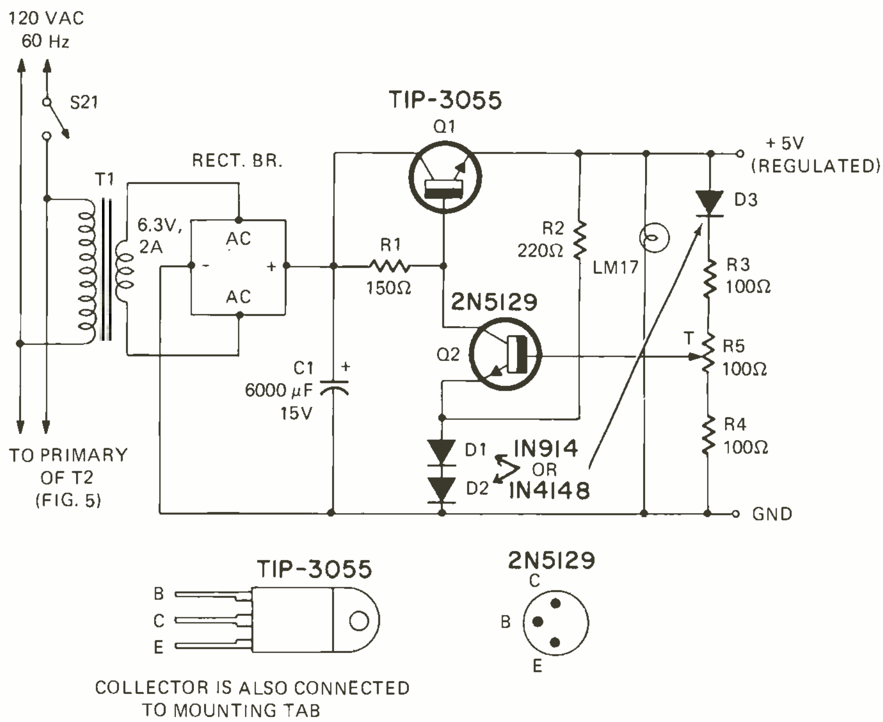
The heart of the checker is a 20-slider by 10-position matrix switch that is used to program the internal and/or external functions and logic levels for the IC under test. Another article will describe, in great detail, the programming and test procedures employed for a variety of digital integrated circuit types.

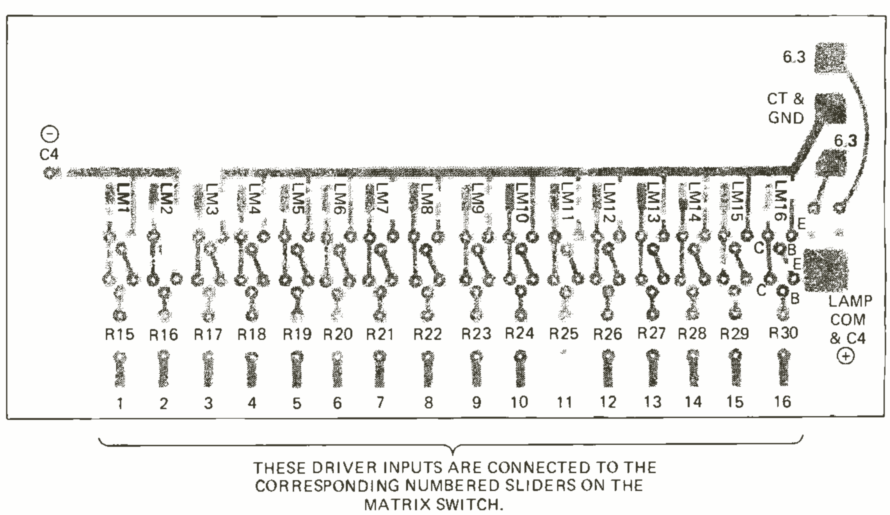
A schematic of the matrix switch used in the DIGI-DYNA-CHECK is in Fig. 1. It shows the connections between the various functions and the pins of the IC being tested. Basically, it consists of twenty 10-position slide switches mounted together in a single frame, with corresponding positions on all switches wired together. Thus, when two or more *sliders* are in the same *position*, they are connected internally. Additionally, each *slider* has a "home" or neutral *position* (no connection to any other slider).

The first sixteen *sliders* are connected to the correspondingly numbered pins of a 16-pin DIP (see Fig. 2) IC test socket and to sixteen lamp-driver assemblies used to monitor logic levels present at all sixteen IC pins *simultaneously.* The remaining four *sliders,* marked **W, X, Y,** and **Z** in Fig. 1, are wired to four similarly marked 5-way binding posts. Six of the matrix *positions* are connected internally to ground (logical **0**), +5 volts (logical **1**), the two complementary "step" functions, and the two complementary "clock" functions. The remaining four matrix *positions* are brought out to 5-way binding posts marked **A, B, C,** and **D.** This provides a 4 X 4 matrix (**ABCD** by **WXYZ**) that can be used for making a variety of special test connections, both internal and external to the DIGI-DYNA-CHECK.

Two power supplies are built into the checker. A regulated, highly filtered 5-volt supply capable of delivering up to 1 amp, continuously, is used to power the internal step and clock circuits (Fig. 4), and to supply V_{cc} and logic **1** level voltage to the integrated circuit under test. The regulated supply can also be used to provide power to a board containing many IC's for in-circuit tests. A filtered, but unregulated 5-volt supply provides power to the lamps and their



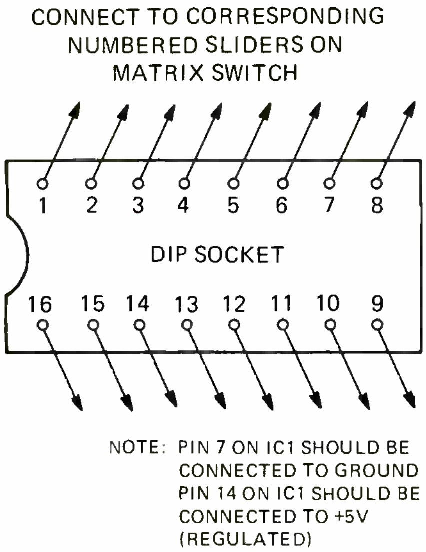


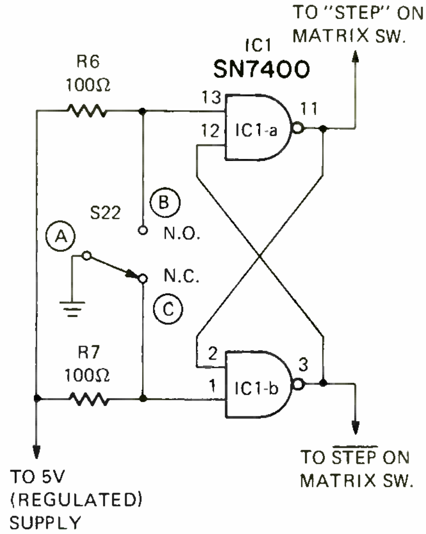


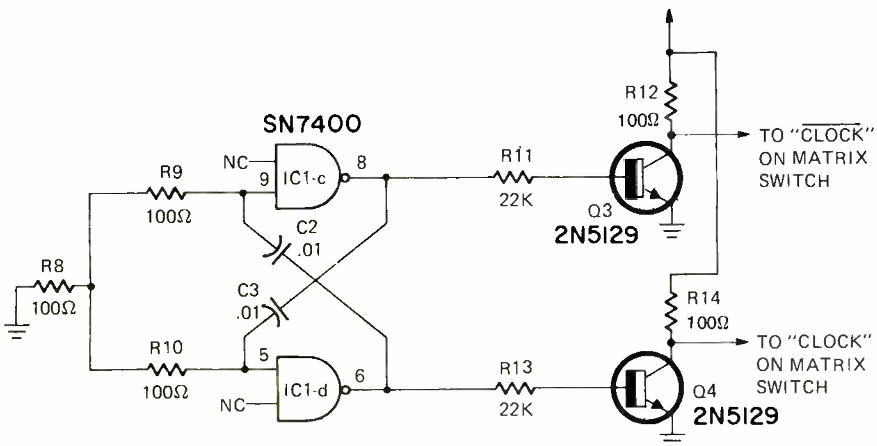
PARTS LIST

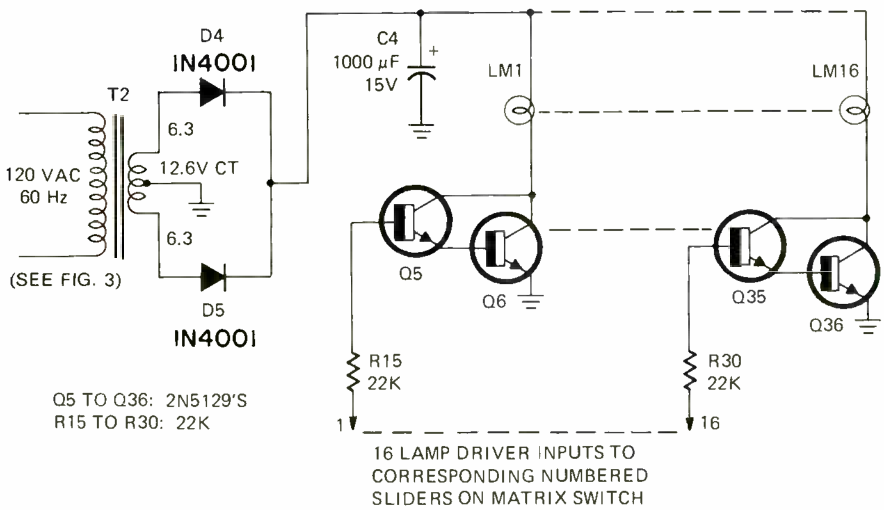
All resistors ½-watt 10% unless noted
R1—150 ohms
R2—220 ohms
R3, R4—100 ohms
R5—100 ohms, Trimpot
R6, R7, R8, R9, R10, R12, R14—100 ohms, ¼ watt
R11, R13, R15 thru R30—22,000 ohms, ¼ watt
C1—6000 µF, 15V, electrolytic
C2, C3—0.01 µF, 100V
C4—1000 µF, 15V, electrolytic
D1, D2, D3—1N914 or 1N4148
D4, D5—1N4001 or similar (1A, 50V)
Rectifier Bridge—full wave, 1A, 100V PIV
IC1—SN-7400 (quad 2-input NAND gates)
BP1 thru BP16—5-way binding posts, insulated
LM1 thru LM7—4V, 50mA miniature lamp assembly
Q1—TIP-3055
Q2 thru Q36—2N5129
Matrix Switch (S1 thru S20)—20-pole 10-position (Part C10-42A, Cherry Electric Co., 1650 Old Deerfield Road, Highland Park, Ill. 60035)
S21—spst miniature toggle
S22—spdt miniature toggle
Miscellaneous parts:
16-pin DIP test sockets (2)
16-pin DIP test plug
16-pin DIP test clip
16-lead ribbon cable (2½ feet)
PC board
Perf board with 0.1-inch hole spacing
Heat sink for TIP-3055 transistor
Case

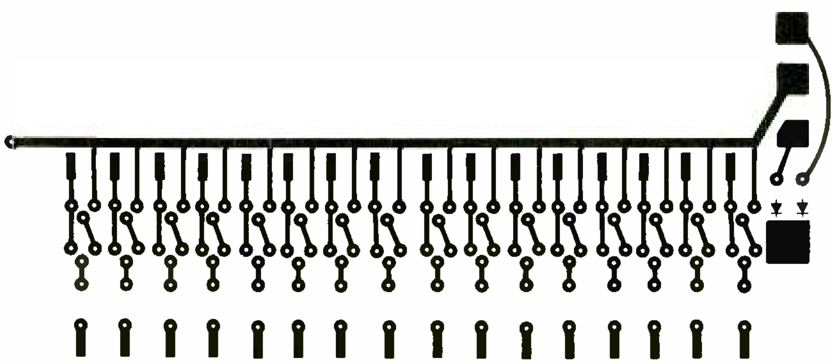
FIG. 1 (top)—MATRIX SWITCH layout. See cover photo for 14- and 16-pin DIP settings. FIG. 3—POWER SUPPLY for 5 volts regulated to step and clock circuits and the IC under test. FIG. 7-b (right)—PARTS LAYOUT for lamp-driver board. The C-B-E terminals at right are for Q35 and Q36. Transistor pairs Q5—Q6 through Q33—Q34 are positioned from left to right.











associated driver circuits. This is shown in Fig. 5.

The stepping circuit is merely an electronic contact bounce eliminator. Solid metal switch contacts are inherently noisy and must be conditioned when used with high-speed solid-state circuits. An s.p.d.t. momentary pushbutton switch (S22 in Fig. 6) is connected to a basic NAND gate memory circuit. In the position shown, the output of ICl-a is at logical **0** level, while that of IC1-b is a logical **1**. Noisy, multiple contacts with **C**, as the switch moves toward **B**, has no effect on the outputs; the gates cannot change state until gate 1-a input is at **0** level. This occurs only at the time when the switch first contacts B. The output of IC1-a then swithces over to **1** and output of IC1-b switches over to **0.** Once these levels have been established in the manner described, they are not affected by further "make" and "break" movements of the switch (contact bounce) at **B.** Complementary outputs are available from this circuit. The STEP output is initially at logical **0** and produces a fast rise transition to logical **1** and then rapidly back to **0** when the pushbutton is depressed and released. The converse is true for the STEP (called NOT STEP) output. Both of these complementary functions are useful for testing digital IC's.

The clock circuit shown in Fig. 4 is an astable multivibrator made up of the two remaining NAND gates of IC1 (an SN-7400). The values of the gate input-sinking resistors (R8, R9, and R10) were chosen to maintain the gate input levels near the logic threshold. In this way, as C2 and C3 charge and discharge, the gate input levels oscillate above and below the threshold level. This results in the gate outputs oscillating in a complementary manner. The frequency of oscillation is determined primarily by the values of C2 and C3 according to the equation

$$\text{Frequency} = \frac{1}{2(R8 + R9) \cdot C}$$

where C = C2 = C3 and R9 = R10. The component values shown in Fig. 4 result in a frequency of approximately 50 kHz. Some fine adjustment can be made by varying R8. A pair of transistor amplifiers (Q3 and Q4) is used at the complementary outputs to provide more than adequate power to drive sev-

FIG. 2 (top left)—IC SOCKET TERMINALS are wired to matrix switches on instrument panel. FIG. 4 (second from top)—INTERNAL CLOCK is a free-running multivibrator. FIG. 5 (third from top)—LAMP DRIVERS are Darlington pairs to reduce loading on IC under test. FIG. 6 (top right)—STEP SWITCH with electronics added to eliminate effects of contact bounce. FIG. 7-a (left)—FOIL PATTERN for lamp driver. Enlarge so foil is 7½ inches across at widest point.

eral IC loads simultaneously. This is especially important where in-circuit testing is to be performed on a board that contains a multiplicity of IC's.

Sixteen lamp readouts continuously monitor the logic condition simultaneously at all pins of an IC under test. A voltage level above approximately 1.4 volts will cause a lamp to turn on, indicating a logical **1** level. Darlington-pair transistor amplifiers are employed as lamp drivers so that the IC under test cannot be overloaded by the lamp monitors. The selection of 1.4 volts as the threshold level permits the lamps to indicate properly logic levels for most RTL, DTL, TTL, and MOS digital integrated circuits. However, see the second article in this series for special precautions involving RTL IC tests. The lamp-driver circuits are shown in Fig. 5.

Mechanical construction

The author's prototype of the DIGI-DYNA-CHECK was assembled in the home-made sloping-front aluminum case shown in Fig. 8. Although case design and front-panel layout are not essential to the proper functioning of the tester, the arrangement shown offers convenience in use. Alternatively, a commercially available box of any design can be used, provided it is large enough to house all of the components.

Drill and punch the front panel to accept those components that will be mounted directly to it. These include the DIP test socket, the matrix switch, the readout lamps, pilot lamp and power switch, step button, and the 5-way binding posts. Rectangular openings can be cut out either with a nibbling tool or with a Bernz cutter. Several holes will also have to be drilled in the rear apron of the case to accommodate the line cord with its strain relief bushing, the two power transformers, and two pairs of L-brackets for the two circuit boards containing the lamp drivers, the 5-volt supplies, and the STEP and CLOCK circuits. The case can now be painted and lettering applied. Dry-transfer letters are particularly well suited for this job. It makes the checker more convenient to use if two different colors are used to number the test socket, lamp readouts, and matrix sliders to differentiate between the leads of 14-pin and 16-pin DIP integrated circuits as shown in the cover photo.

All components except the two circuit boards can now be mounted in the case.

Wiring the tester

The two circuit boards should be prepared and wired first. Then put them aside until all other wiring has been completed. Either copper-clad PC boards or perforated board construction can be used, as wiring layout is not criticial. The foil pattern in Fig. 7-a corresponds to the schematic for the lamp drivers. Since there are sixteen identical driver circuits involved, the handwiring approach would be tedious here. This foil pattern also includes the unregulated 5-volt supply of Fig. 5. The ac input to this board is from the secondary of T2, mounted at one end of the rear apron next to T1. Do not connect the power to this board until it is ready to be mounted to the case. Connect one end of a 16-lead cable to the sixteen inputs of the driver circuits on this board. Number the leads at the other end of this cable. They will be connected later to the matrix switch.

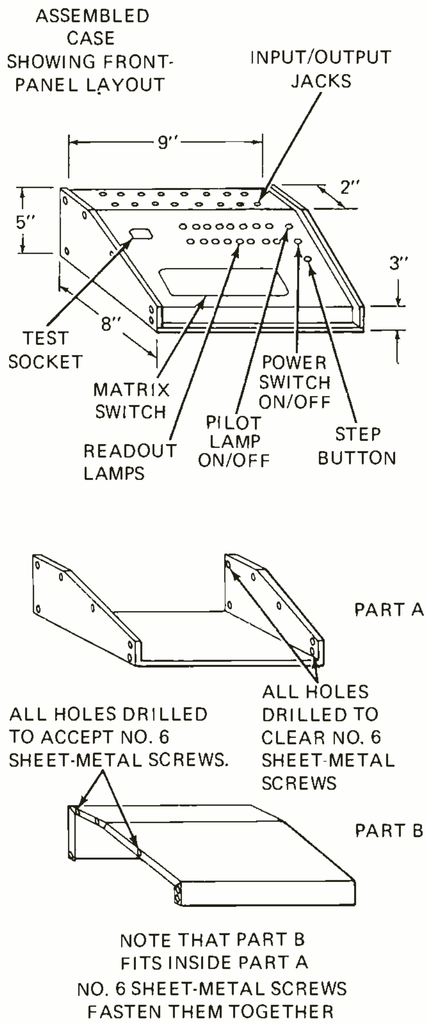


FIG. 8—SLOPING-FRONT INSTRUMENT CASE, its dimensions, construction and how the two parts are fitted and joined together.

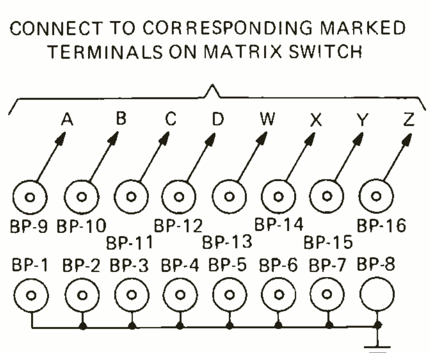


FIG. 9—BINDING POSTS are mounted across the top of the case and connected to the matrix circuitry as indicated.

Next, prepare the board containing the regulated 5-volt supply and the STEP and CLOCK circuits. A perforated board with 0.1 inch hole spacings was used in the author's model. This hole spacing readily accommodates the pins on the socket into which IC-1 will be inserted. Follow the schematics in Figs. 2, 3, and 4, making certain that all +5-volt points are tied together, and all grounds are tied together. Wire the line cord, pilot lamp, power switch, and transformer primaries as shown. Now plug IC-1 into its socket.

The 5-way binding posts (BP1 to BP16) should now be wired according to Fig. 9. The ground bus joining BP1 thru BP8 should be connected to matrix switch *position* 1. The remaining eight binding posts can then be connected to their respective *sliders* (**W** thru **Z**) and *positions* (**A** thru **D**) on the matrix switch.

Connect one end of a 16-lead cable to the sixteen contacts of the DIP test socket. Number the leads at the other end of the cable to correspond with the socket contacts. This end will be wired later to the matrix switch together with the correspondingly numbered leads on the cable that was previously connected to the lamp driver board.

Wire the miniature lamps (mounted on the front panel) to the sixteen output pads on the driver board. One lead from each lamp should be connected to a common +5-volt tie point on the board. This board can now be mounted to the rear apron of the case with two L-brackets. Connect the secondary leads from T2 to the proper locations on the board.

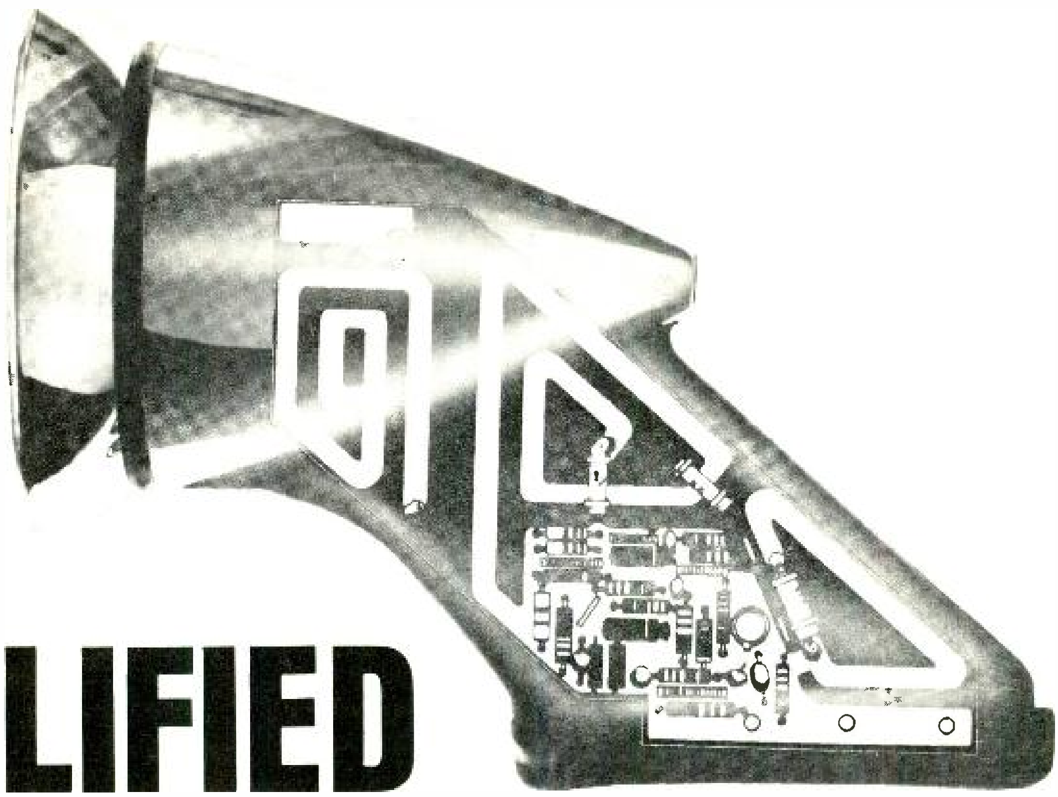
Connect the two 16-conductor cables (from the DIP test socket and from the lamp driver board) to the matrix switch. Be sure that all leads go to correspondingly numbered *sliders* on the matrix switch. Thus, the lead from pin No. 1 on the test socket and the lead from input No. 1 on the lamp driver board should both be connected to *slider* No. 1 on the matrix switch, etc.

The perf-board can now be mounted on the rear apron of the case, just above and parallel to the driver board. Solder the secondary leads from T1 to the perf-board. Now, connect the +5-volt (regulated), ground, clock, clock, step, and step outputs from the perf-board to their respective *position* terminals on the matrix board.

Finally, connect the ground terminal from the lamp driver board to the ground terminal on the matrix switch (*position* 1).

Construct an adapter cable as shown in Fig. 10. This will be used for in-circuit testing of integrated circuits.

(continued on page 85)



AMPLIFIED car radio antennas

by GARY K. JOHNSON*

A description of the theory and design of active antennas with technical details of the first commercial development of an active antenna.

AT THE HIGH FREQUENCY ENGINEERING Institute of the Technical University of Munich, West Germany, experiments to integrate antennas with transistors have led to the development of a new type of transistorized receiving antenna. The director of this Institute, Prof. Dr. H. H. Meinke, prefers to describe the invention as an *"Active Antenna"*. Active antennas have smaller dimensions and a better signal-to-noise ratio than (conventional) passive antennas of the same bandwidth. This article should give you a better understanding of how active antennas work.

The basic concept of active-antenna design is to combine an active device (transistor) with an electrically short antenna. This concept gives a completely new dimension to the design of radiating structures and makes it possible to create extremely small antennas. The sensitivity limit of a receiving system depends on the noise produced in the first amplifying stage as well as how the antenna system, including lead-in and transformation circuits, is matched to the first amplifier stage. With an active antenna the first transistor in the receiving system is integrated with the antenna's elements. In this way a natural match between the first amplifying stage and the antenna can be obtained without disturbing the passive transmission parts.

Noise matching

The sensitivity of a receiving system is ultimately limited by its noise temperature (signal-to-noise ratio). Antenna gain, a figure of merit, is not a decisive factor in a receiving system because, with low noise level, amplification can easily be done in the receiver without any natural limitations. The most crucial point in a receiving system is the input stage (first amplifier stage) where the desired signal is at its lowest level. The antenna system must be able to deliver a signal level that is greater than the noise level of the receiver's input stage as well as its own internal noise. Therefore, signal-to-noise ratio is the main factor limiting the reception of weak signals and consequently the most important factor to be considered with an antenna system.

The signal-to-noise ratio of a receiving system is primarily determined by three main noise sources:

1. Antenna noise: The passive antenna receives noise out of the surrounding space. This external atmospheric noise can be expressed as a noise temperature T_A.

2. Inter-network noise: This is the network between the passive antenna and the input terminals of the first amplifying stage. This network has two effects:

a. The signal is decreased by attenuation since resistance in transmission lines and matching networks is unavoidable.

b. This resistance in transmission lines and the matching circuits is an additional source of noise.

3. Amplifier or transistor noise: The first amplifier stage creates an internally generated noise. Transistor noise can be expressed as a noise temperature T_T.

The total system noise temperature would be simple to define if the only noise sources were in the receiver. Since there are three main sources of noise in a receiving system, the total noise is described by a total system noise temperature (T_S) in relation to the exit terminal of the passive antenna.

To reduce noise and increase the

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*Corning Glass Works. Electronic Research Laboratory.

This article was written with the cooperation of Prof. Dr. H. Meinke and Dr. H. Lindenmeier. Prof. Meinke is the Director of the High Frequency Engineering Institute of the Technical University of Munich, West Germany. Dr. Lindenmeier is a Scientific Assistant in the same Institute.

signal-to-noise ratio the passive network between the antenna elements and the first amplifying stage has to be reduced to a minimum. This can only be accomplished by integrating the passive antenna with the first amplifying stage. As an example, Fig. 1-a illustrates the main parts of a common receiving system that consists of a passive antenna, matching network, coaxial cable and the receiver. A passive network is formed between the antenna and the first active stage (amplifier) in the receiver. The attenuation losses in this passive network decrease the available signal power as well as the signal-to-noise ratio. A second effect of this passive network is its influence on the maximum possible bandwidth of the total system. The passive network consists of frequency dependent, reactive elements, that cause the bandwidth to be limited not only by the passive antenna, but also by the antenna's feeding network. The overall noise temperature of the system in Fig. 1-a can be expressed as:

$$T_S = T_A + T_N + T_E/G \quad [1]$$

The system noise temperature T_S consists of antenna noise temperature T_A (the noise received from the surrounding space); noise temperature T_N (of the transmission line and its matching networks); and part of the receiver's noise temperature T_E/G. In the part T_E/G, T_E is equivalent noise temperature of the receiver and G is the "available gain" of the inter-network T_N. Also, if line losses are not too large, the passive inter-network T_N can be completely neglected in Fig. 1-a. Antenna noise temperature T_A is considered the theoretical lower limit of the system noise temperature T_S that can be obtained in equation [1] when the inter-network and the receiver do not contribute any noise. In practice, the receiving system is close to the theoretical limit and is considered ideal as far as noise is concerned as long as $T_S < 2 \times T_A$.

Fig. 1-b illustrates the same receiver with an added non-integrated line amplifier. An important value in the total noise temperature is the available gain of inter-network T_N in equation [1]. If a passive feeding network is used as shown in Fig. 1-a, then $G < 1$ and the part T_E/G will be larger than the equivalent noise temperature of the receiver T_E. Therefore, the longer the transmission line, the smaller G will be and the larger is the part of the receiver noise T_E/G in the total noise temperature of the system. Due to the normally high losses at higher frequencies, this factor can have an unbearable effect on the total system noise temperature. If an amplifier is placed between the antenna and the transmission line, the noise part of the receiver T_E/G will decrease. Obviously, an amplifier stage at the antenna's input will improve the total system noise temperature if the losses in the transmission line and matching networks are large. However, this input amplifier adds its own noise to the system so T_N in equation [1] is increased to a mentionable value. With the added active element in the passive inter-network the total system noise is:

$$T_S = T_A + T_N + T_E/G_{passive} \times G_{active} \quad [2]$$

In Fig. 1-c the same basic receiver is shown with an active antenna consisting of a transistor amplifier that is integrated with the passive antenna and the passive feeding network. Transistor noise depends considerably on the impedance of the external circuitry that is connected to the input terminals of the transistor. There will always be a certain value of source impedance (Z_A) that will provide the lowest transistor noise temperature. This desired impedance is termed Z_{opt}. There is a wide region of low noise around Z_{opt}, but the transistor noise temperature T_T rises very rapidly outside of this low-noise impedance region. If we assume that in equation [2] T_A and T_E are prescribed quantities, then we can get very low overall noise temperature T_S by minimizing T_N and maximizing G. However, this situation cannot exist in the same active antenna. An active antenna can be designed for minimum T_N (this is called noise-match) or for maximum G (this is called power-match) or for a compromise between noise-match and power-match. In most cases the difference between power-match and noise-match is small enough to not cause an appreciable loss in signal power. In any case, an active antenna will have more than enough amplifier gain to compensate for any matching losses.

Optimum coupling

Another advantage of integrating the amplifier is that the antenna's impedance can then be adjusted to a desired value (Z_{opt}), so that T_N in equation [2] will be considerably smaller when compared with the usual non-integrated antenna amplifier. The impedance of a monopole over a ground plane (as shown in Fig. 2) depends on "distance d" if the impedance is measured between the terminals 1 and 1'. With electrically short monopoles, the resistive part of this impedance increases with increasing "distance d" and easily matches either the transistor's input im-

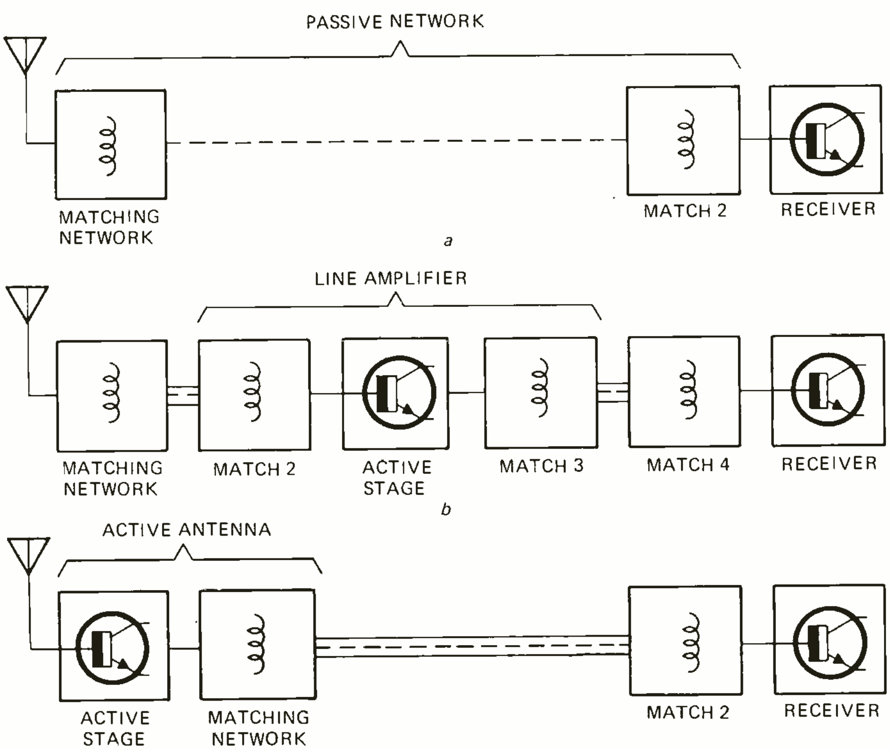


FIG. 1—THREE BASIC ANTENNAS. The simplest (a) is not amplified. Often a line amplifier (b) is between the antenna and the set. Active antenna (c) has a built-in integrated amplifier.

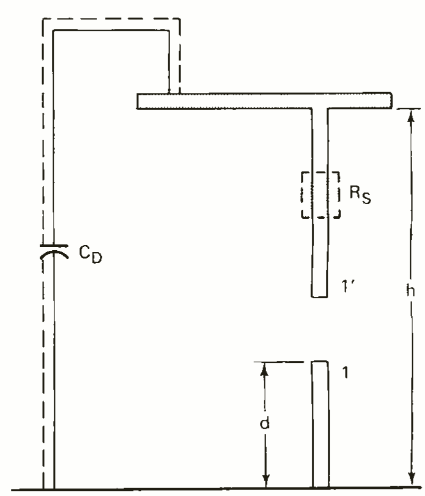


FIG. 2—IMPEDANCE OF MONOPOLE ANTENNA is measured between points 1 and 1'.

pedance or the impedance needed as a load in the transmitting case. By choosing optimum values of "h" and "d" the antenna's impedance (Z_A) can be adjusted to the desired value (Z_{opt}) and completely eliminate the need for a matching network. As a result, the noise T_N which the transistor adds to the total system noise T_S [2], is mostly determined by the impedance Z_{opt}. It is also never difficult to match the output of an active antenna circuit to a lead-in cable. Thus with the proper antenna structure a natural impedance match, with a minimum of losses, can be made between the antenna and the receiver. This procedure is known as noise-matching and provides an optimum noise figure for a given receiver that could not be obtained with a conventional line amplifier.

Transistor noise

At frequencies below 30 to 100 MHz atmospheric noise is so great that the signal-to-noise ratio is generally independent of the receiver-antenna system. Thus, in the hf range, a considerable noise mismatch is permissible, and relatively short antennas can be used without appreciably degrading sensitivity. As long as the antenna's length is small in comparison with the wavelength of the frequency it is designed to receive ($h_{eff} < \lambda/8$), it will not have a resonant characteristic and its impedance will not be frequency dependent. This provides more freedom in the choice of antenna impedance Z_A. As far as noise is concerned, ideal hroadband systems with short antennas exist only in those frequency ranges where the atmospheric noise is high.

The transistor noise temperature should always be less than the ambient or atmospheric noise temperature T_A—particularly if frequencies above 50 MHz are involved. This is because at frequencies above 50 MHz T_A becomes so small that considerable improvements in system noise can be obtained with noise-matching. At these frequencies the passive antenna elements should be dimensioned so that the transistor operates under optimum noise-match conditions over the full operational frequency band of the antenna. Active antennas are usually designed with resonant characteristics at these higher frequencies. Active antennas of this form use the principle of the double-resonance bandfilter. If plotted on a Smith Chart, the impedance curve forms a double loop in the operational frequency range that loops twice through the optimal impedance value Z_{opt} and obtains minimum T_N at two frequencies. An antenna with an impedance loop in this form can be called a "filter antenna" for its selectivity against signals outside the desired bandwidth. A double-resonance antenna generally has better selectivity outside the bandwidth than a single-resonance antenna.

Intermodulation and cross-modulation

Since an antenna receives many frequencies at the same time, the nonlinearity of the transistor causes the development of harmonic frequencies, sum frequencies, difference frequencies and cross-modulation. As all of these effects depend on amplitudes and increase very fast with increasing amplitudes an active antenna has to operate with the lowest possible amplitudes. Therefore, for all active antennas the effective length of the passive antenna should be as small as possible, to bring down the received amplitudes. As previously mentioned, only the signal-to-noise ratio is important for good reception and not a large received signal. Due to amplification the output power of active antennas (even with short antenna lengths) is usually higher than with conventional passive antennas. Also, through the use of bandpass filter design the unwanted signals outside the wanted frequency band can be reduced considerably and eliminate a high percentage of those nonlinear effects which come from signals outside the operational band. This bandpass filter is formed by combining the passive antenna with the proper input circuitry of the transistor.

Because this bandpass filter does not affect the output impedance match in an active antenna there is more freedom in the design of a bandpass filter in an active antenna than with passive antennas that have external amplifiers and filters. For suppression of nonlinear effects the emphasis is placed on the selectivity outside of the frequency band of the antenna and not on a special form of power curve within the bandpass. Therefore, the power bandwidth has no direct relationship to this selectivity against signals outside the band. The half-power bandwidth of an active antenna is mostly determined by the bandwidth of the passive part of the active antenna and by the transistor's input circuitry while the bandwidth of output impedance match is determined by the transistor's output circuitry. This change in bandwidth thinking explains one of the main advantages of active antennas.

With active antennas, Prof. Dr. H. Meinke and his colleagues have shown that the integrated active antenna can give a very remarkable improvement in antenna technology. Using the antenna as a part of the input circuit of an integrated amplifier eliminates the usual matching and tuning elements between antenna and receiver. As a result, rf losses are reduced and the noise temperature of the system is greatly improved.

Active car antenna

Basically the ALPHA-3 is an AM-FM car antenna that is built into an outside rear-view sports mirror. It is designed to be mounted on the fender of a car.

An AM-FM whip antenna is the most commonly used mobile antenna. To get satisfactory reception in all frequency ranges this antenna should be at least 39 inches long. However, this type of antenna is frequently damaged when driving through low garage doors, automatic car washes, etc. and has to be replaced. Because of this problem whip antennas are rarely extended to their proper length for maximum reception. It is also commmon for whip antennas to be installed in the most convenient mounting position, which in most cases is not the best electrical location for optimum performance. For these reasons, a car antenna was the first active antenna developed for commercial use.

The mechanical details of the active car antenna, ALPHA-3, are in Fig. 3. The frame and shell of the mirror consist of stainless steel and functions electrically as a top capacitance. The base of the mirror is made of Luran, a high-impact plastic which can be painted if desired. The active antenna is on a printed-circuit board and is secured inside the plastic base of the mirror. The most important geometrical dimension is the distance between the axis of the mirror and the vehicle body-ground. This distance was reduced step-by-step until the receiving quality in the AM-range was equivalent to that of the average receiving system with a whip antenna.

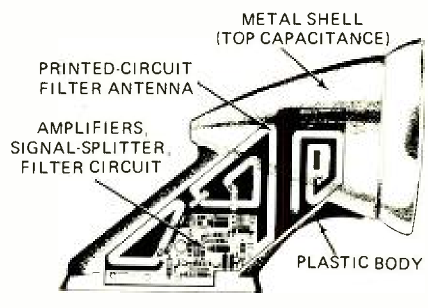


FIG. 3—PHANTOM VIEW of the Alpha-3 active AM/FM automobile receiving antenna.

The ALPHA-3 active antenna is designed for separate AM and FM operation (see Fig. 4). The antenna uses a printed circuit pattern for its passive elements in combination with its electronic circuitry. It consists of a common passive section from which the total received signal is fed through filter networks and then into special low-noise amplifiers. The outputs of the AM and FM amplifiers are then fed through a hand-splitting network that combines

(continued on page 78)

IC Pocket

One giant IC wired between a
readout; is the heart of this
calculator that adds, subtracts,

ADDITION: 13 + 12 = 25

1 3 $\overset{+}{=}$ 1 2 $\overset{+}{=}$

SUBTRACTION: 45 – 23 = 22

4 5 $\overset{+}{=}$ 2 3 −

ALMOST DAILY WE READ ABOUT A NEW Mini or Midi electronic calculator, selling for \$169, \$179 or \$199, and for about 6 months now many news releases about the elusive under \$100 pocketsize full-function calculator. If you've been waiting for the right mini or have a desk-size calculator and need the handy battery operated convenience of a mini, this is the story you've been waiting for.

The under \$100 calculator is here! It adds, subtracts, multiplies and divides, either straight or mixed; holds a constant for multiplication and division; has a full floating decimal point; bright 8-digit display; is battery operated (measures a mere 3¼ x 5 x 1½ inches).

If you or your wife buy groceries at the supermarket, have a checking account, try to balance a budget, are a businessman, salesman, pilot, engineer, technician, accountant or deal with figures simple or complex, the Americal-8 is for you. The calculator takes less than 2 hours to build, and is simple enough for a beginner to assemble.

How it works

The heart of the unit is a single MOS-LSI (Metal Oxide Silicon-Large Scale Integration) integrated circuit. It contains the equivalent of more than 6000 transistors and other parts which encode the keyboard, store and manipulate the entered data and decode the results for display. The only external parts required are a keyboard, clock

MIXED: $$\frac{\frac{12 \times 36}{16} - 84}{-16.33} = 3.4905082$$

1 2 X 3 6 ÷ 1 6 $\overset{+}{=}$ 8 4 − ÷ 1 6 . 3 3 −

K OPERATION: (CONSTANT) K SWITCH ON IN ALL STEPS

$3^3 = 27$

3 X $\overset{+}{=}$ $\overset{+}{=}$

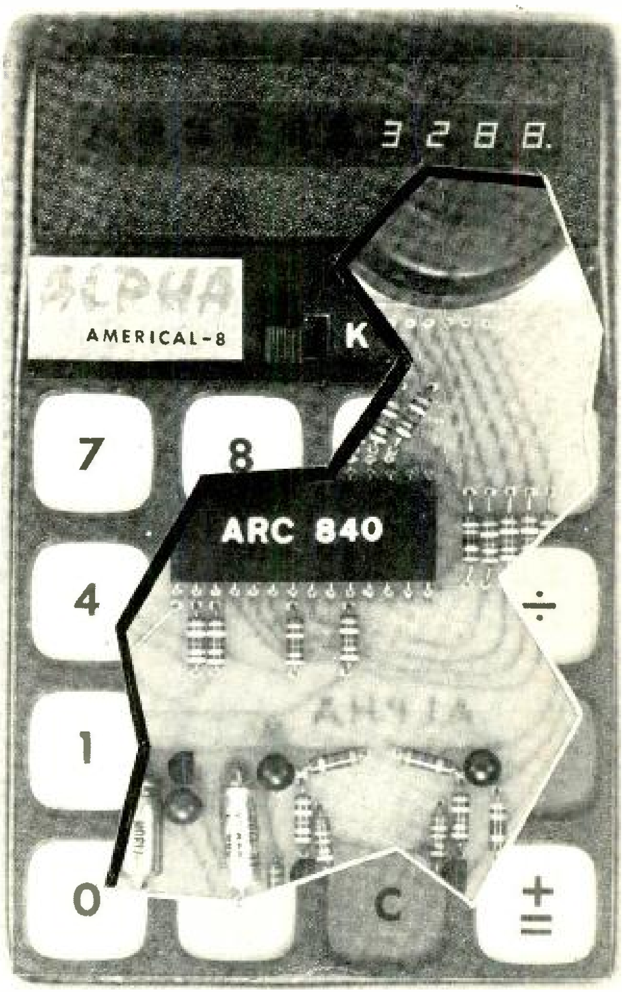
$\frac{16}{2^4} = 1$

1 6 ÷ 2 $\overset{+}{=}$ $\overset{+}{=}$ $\overset{+}{=}$

Calculator

keyboard and an LED 8-digit
battery-powered pocket-sized
multiplies and divides

by W. L. GREEN
President, Alpha Research Corp.



Actual size photo of calculator

MULTIPLICATION: 12 X 10 = 120

[1] [2] [X] [1] [0] [±]

DIVISION: 144 ÷ 12 = 12

[1] [4] [4] [÷] [1] [2] [±]

generator, power source and display.

Construction is fast and easy

Using a PC board is mandatory, as the LSI chip has 28 pins and though it has input protecting diodes it should be handled as little as possible to prevent static discharge damage. *DO NOT USE A SOLDERING GUN* and *DO NOT WEAR WOOL* or nylon clothing during assembly.

Assemble the complete PC board, except for the LSI chip first. Full-size patterns for the board and the parts layout are shown. Observe polarities of the diodes and capacitors and make sure the transistors are properly positioned. Then solder all connections before installing the LSI chip.

Solder carefully, and avoid forming any solder bridges on the board. Next, mount the keyboard and display in the case and wire them to the PC board. Double check all components and solder joints before applying power.

After double checking the wiring, install the batteries being especially careful to check polarity. Now turn on the power switch and depress the red C key. A zero and decimal point will appear in the right corner of the display.

Using the calculator

The white number keys (see keyboard top left) when depressed enter the corresponding number into the machine's memories. At the same time this number appears on the display entering

8 X 13 = 104

8 X 85 = 680

8 X 13.52 = 108.16

[8] [X] [1] [3] [±]

[8] [5] [±]

[1] [3] [·] [5] [2] [±]

$\frac{64.5}{12} = 5.375$

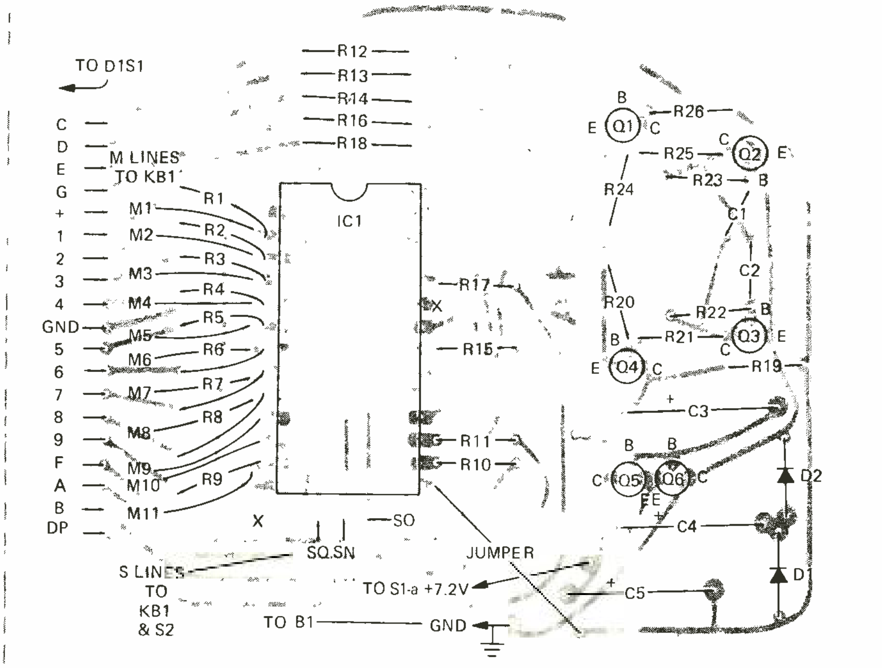
$\frac{144}{-12} = -12$

$\frac{1062}{12} = 88.5$

[6] [4] [·] [5] [÷] [1] [2] [±]

[1] [4] [4] [ ]

[1] [0] [6] [2] [±]



WHERE PARTS ARE MOUNTED on the PC board and how leads connect them to the display and the keyboard. Circuitry has been integrated to the point where assembly takes less than 2 hours.

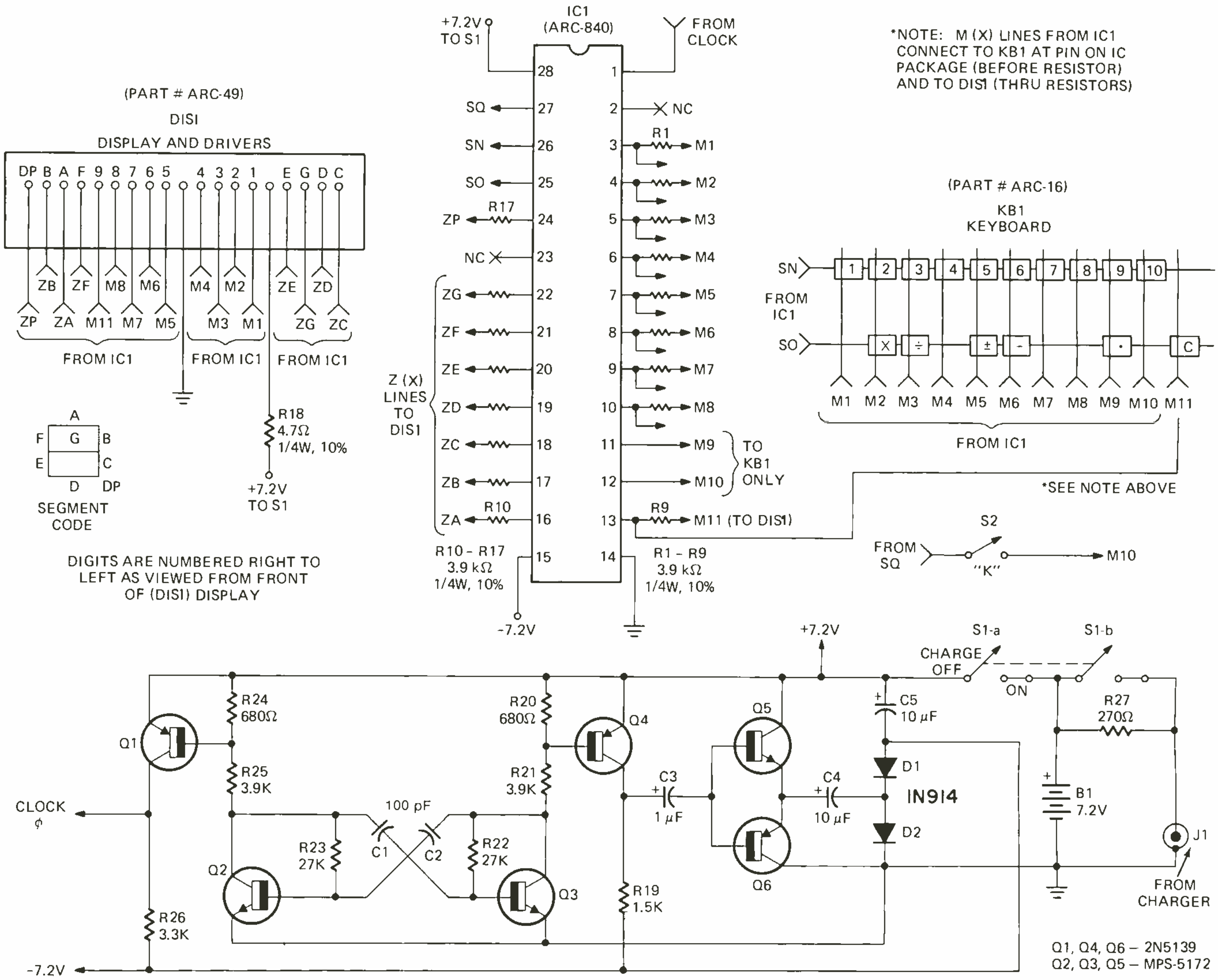
PARTS LIST

All resistors ¼ watt 10%
R1 thru R17—3900 ohms
R18—4.7 ohms
R19—1500 ohms
R20, R24—680 ohms
R21, R25—3900 ohms
R22, R23—27,000 ohms
R26—3300 ohms
R27—270 ohms (used with Ni-Cad battery only)
C1, C2—100 pF
C3—1 µF, 12 V, electrolytic
C4, C5—10 µF, 12, electrolytic
*D1, D2—1N914
*IC1—ARC-840
*Q1, Q4, Q6—2N5139
*Q2, Q3, Q5—MPS5172
*DISPLAY—ARC-49
*KEYBOARD—ARC-16
S1—dpdt slide switch
S2—spst slide switch
BATT—7.2V Ni-Cad or 8.4V mercury

***Starred items are available from:**
ALPHA Research Corp
PO Box 1005
Merritt Island, Fla. 32952

ARC-840—Kit of transistors, diodes, and IC ....$45.53 postpaid
ARC-49—Display module ....$48.14 postpaid
ARC-16—Keyboard ....$6.93 postpaid
7.2V Ni-Cad battery (ARC-72) ....$10.75 postpaid
PC board (MC-3) ....$4.00 postpaid
Complete kit less battery (DC-8) ...$102.40 postpaid
Complete kit w/Ni-Cad battery & charger ...$112.90 postpaid
Prices are for US and Canada only.

ESSENTIAL CIRCUITRY OF THE CALCULATOR. Heart of the instrument is the large-scale integrated circuit that encodes, stores, manipulates and decodes the results for display on readout.



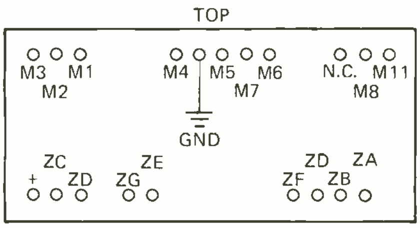
from right to left.

The blue • key is used to enter a decimal point at any desired place during number entry. The blue multiply and divide keys perform their assigned functions and during mixed calculations provide a subtotal.

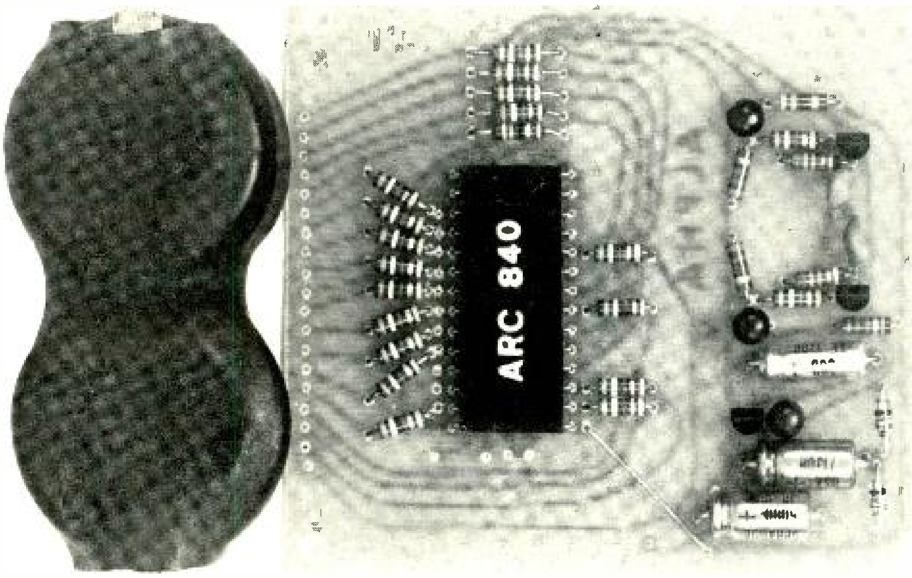
The red – key and white ±keys will perform their assigned functions and will also supply a total or sum. They may be thought of as equals keys.

The **K** switch holds the first digits in multiply and the last digits in divide as a constant.

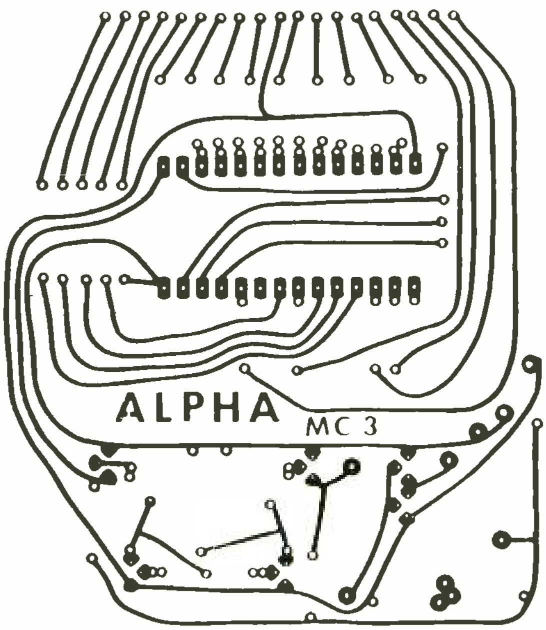
If an error in entry is made, merely reverse the operation by re-entering the numbers entered in error and depress the complementing key to correct the error. If more than eight digits are entered into the machine, or if the result of calculations exceeds eight whole numbers, the far left overflow and sign digit will light. If an overflow condition causes the indicator to light the machine will automatically latch up, preventing further operations, and the answer will be displayed with the decimal point positioning itself so that the answer may be read by mentally moving the decimal point eight places to the right. A negative answer is noted by the – bar lighting in the left digit. **R-E**



PIN CONNECTIONS FOR THE LED DISPLAY used in the Americal-8 calculator.



CALCULATOR'S PC BOARD and its associated parts are seen when keyboard and display are removed. Round objects at left are the re-chargeable batteries wrapped in heat-shrink plastic tubing.



FULL-SIZE PATTERN OF PC board. You can make your own or order it along with the other parts you'll need to build this electronic calculator.

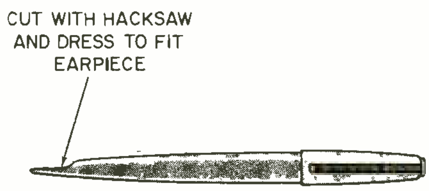
TAPE-HEAD TEST STICK

This small tape-head tester is built around the coil assembly of a miniature earphone. Select a magnetic earphone with an internal resistance of thirty ohms or more. The more resistance, the greater sensitivity of the tape recorder checker. Do not use a 6- or 10-ohm impedance earphone.

To remove the small coil assembly, from the miniature earphone, cut three slots around the metal case with a metal hacksaw. Now pull off the metal front piece with a pair of pliers. Remove the small brass ring and metal diaphragm. Next, remove the small round magnet. If the magnet is glued to the coil assembly, use a pocket knife and pry it off.

Leave the coil assembly and hookup cable intact. If the coil assembly is loose within the plastic case, cement with rubber sealer. Now grind or cut off the plastic case so the center metal polepiece sticks out 1/16 inch.

Pick up a discarded ball point or



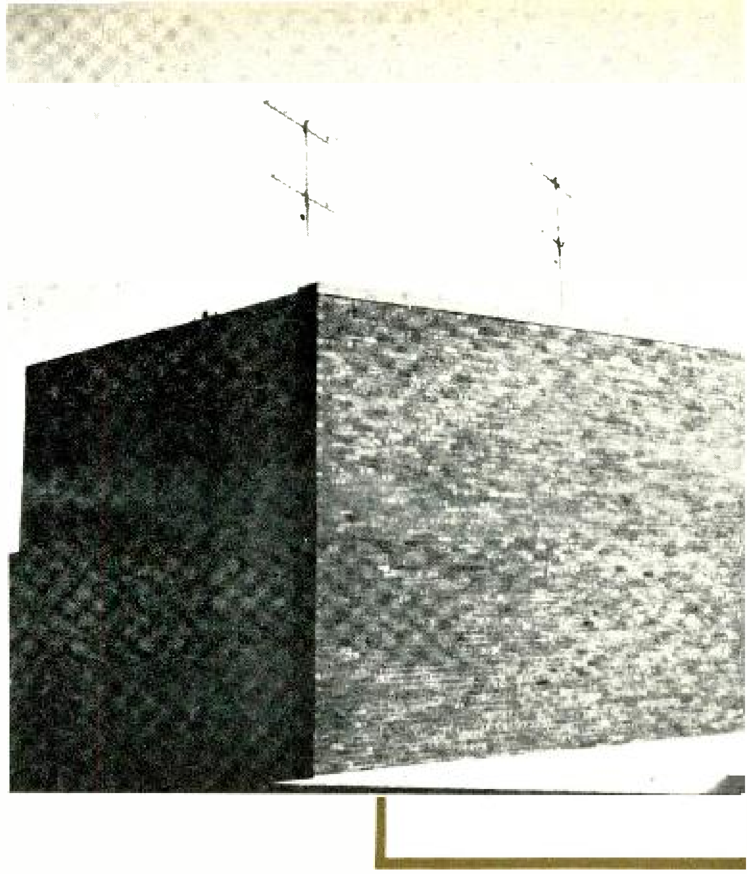
ink pen and cut as in the drawing. Push the earphone cable through the pen barrel and cement together with rubber silicone seal. Leave to setup over night.

Now solder the earphone cable to a small earphone jack and cement into the plastic pen. Be sure the pen cap will screw into place. A permanent connection can be made by running the earphone cable through the pen with two alligator clips soldered to the flexable earphone cable.

An audio signal from a pencil-type signal generator or audio signal generator can be connected to these alligator clips. Place the tape-head test stick upon the record/playback head. In the PLAY mode a 1-kHz note can be heard in the tape recorder's output. With this method the record/playhead can be checked for actual reproduction.

To check the tape head of an automatic stereo tape player in the car, mount the earphone piece on the end of the ball-point pen. These tape sticks are cheap to make, so why not construct one for the stereo tape player and another for the tape recorder.—*Homer L. Davidson*

MATV SYSTEMS ALL START with the antenna on the roof of the building to be wired for television.



MATV how it works

A close look into the system, what it does and how it affects the independent service technician

by BERT WOLF*

MASTER ANTENNA TV (MATV) IS ONE OF THE MOST PROFITable and rapidly growing fields in the electronic industry. The present demand for systems is exceeding the supply of technicians capable of designing and installing them.

For example, about 2000 new motels are being built each year and more than 90% have TV in every room. You can see this in perspective when you realize that only half the motel rooms have telephones. Apartment house construction, too, is breaking records.

Although Educational TV funds are tight right now, virtually all new schools are being wired for TV at the time of construction, to avoid the extra cost of wiring at a later date; also to simplify the job. It's much easier to wire a system before the walls are up than after.

Every hotel, motel, apartment house, condominium, mobile home park and school needs an MATV system. What's more, many home owners are beginning to see the advantages of having a TV antenna outlet in every room, just as they have electrical outlets in every room. The MATV field is wide open for qualified sales–installation–service oriented businessmen.

Principles of MATV

MATV systems are generally divided into two basic parts: the *head end* and the *distribution* system. The head end consists of antennas that pick up the TV signals, plus preamplifiers and amplifiers to make the signals strong enough to be sent through the system. The head end also includes any filters, mixers, traps, converters, etc., necessary to process, "clean up" and balance levels.

The distribution system is made up of splitters, coaxial "feeder" lines, and tapoffs (outlets for individual TV sets). Most MATV system designers start with the distribution system and work back to the head end. The distribution system design must conform to the physical layout of the building. The head-end design must deliver enough signal to overcome the total losses of the distribution system.

Distribution system design

Distribution system design has recently been simplified by improved tapoffs. Fig. 1 represents the two types of loss caused by a tapoff. R1 represents thru loss, while R2 represents isolation. You need isolation to prevent interaction be-

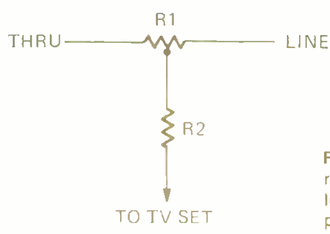


FIG. 1—EQUIVALENT CIRCUIT of a resistive tap-off. R1 represents the loss between feeder input and output. R2 represents isolation.

tween TV sets and to tap only the required amount of signal from the feeder. Generally, isolation values are chosen between 12 dB and 23 dB.

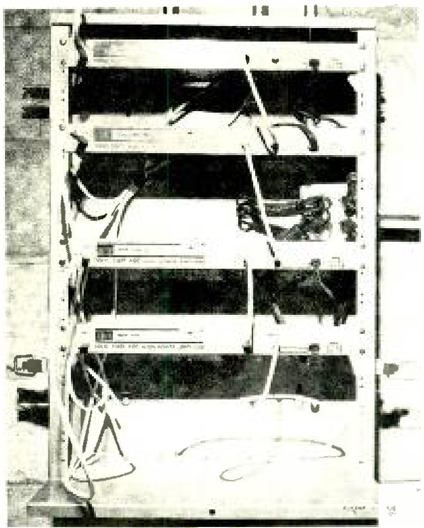
Close to the head end, you need maximum isolation, because this is where signals are strongest, while at the end of a feeder, minimum isolation may be used, keeping in mind that as isolation decreases, thru loss increases. Thus, the system designer has to know which tap isolation value to use where and how to calculate losses to each tapoff.

Some manufacturers tried to solve this by recommending that a single isolation value be used throughout the system—usually 17 dB. Except for small systems, however, this is an inefficient solution. TV sets near the head end are likely to overload. Sets connected to tapoffs at the end of the line are likely to be snowy.

Now, a number of manufacturers are supplying a new type of tapoff that features variable isolation. Thus, a single type of tapoff can be installed throughout the system. This not only minimizes stocking problems, it also simplifies system design.

Using the new types of variable tapoffs (see Fig. 2), let's take a look at some typical distribution systems to see how they are laid out. Figs. 3, 4 and 5 are the most common configurations you will encounter. Fig. 3 is a distribution system for long, low buildings (often "L" shaped), typical of new motels, schools and some nursing homes. Fig. 4 is a six-story building, typical of small apartment houses and urban buildings in general. Fig. 5 represents a high-rise building,

*Manager, DSD/ECSD Division Jerrold Electronics Corp., Philadelphia, Pa.



DISTRIBUTION AMPLIFIERS take the signal from the antenna, amplify it, and feed it to the individual viewers sets.

TV SET IN WIRED BUILDING connects to antenna jack on the wall. A typical hookup using a standard wall plate is shown.

typical of new apartment buildings and hotels. In low buildings, feeder lines are run through conduit horizontally, as in Fig. 3. In taller buildings, feeder lines are run vertically. Splitters are used to provide the desired number of feeder lines.

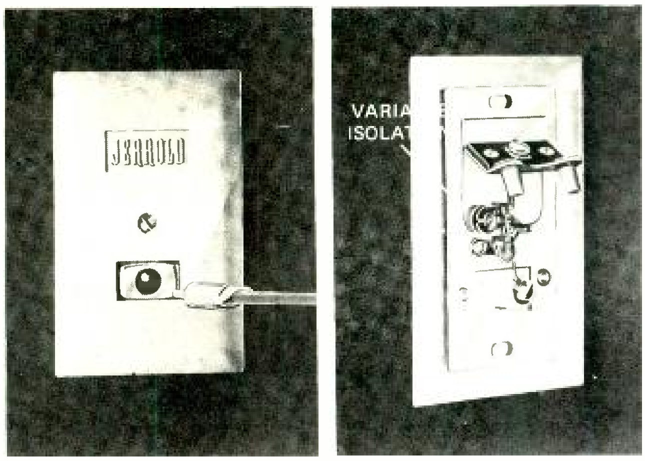


FIG. 2—FRONT AND REAR VIEWS of the type V-75F Omni-Tap, a wall-mounted tap-off that provides adjustable isolation.

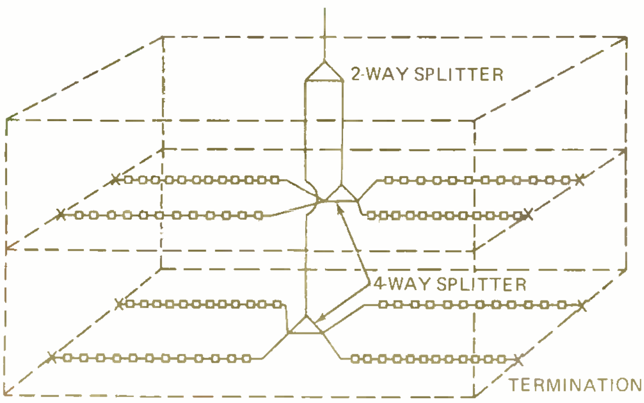


FIG. 3—TYPICAL LAYOUT OF MATV CABLE and tap-offs in long, low rambling buildings such as schools and motels.

Calculating losses

Once the distribution system is laid out, you have to calculate the losses caused by the splitters, tapoffs and cable. With variable tapoffs, this is relatively easy.

Suppose, for example, that you plan to distribute uhf and vhf TV signals through a system such as the one in Fig. 4. All you have to do is make sure that you get enough signal to the last set at the end of the longest line. If we can do this, we assume that (provided isolation values are adjusted properly)

(continued on page 50)

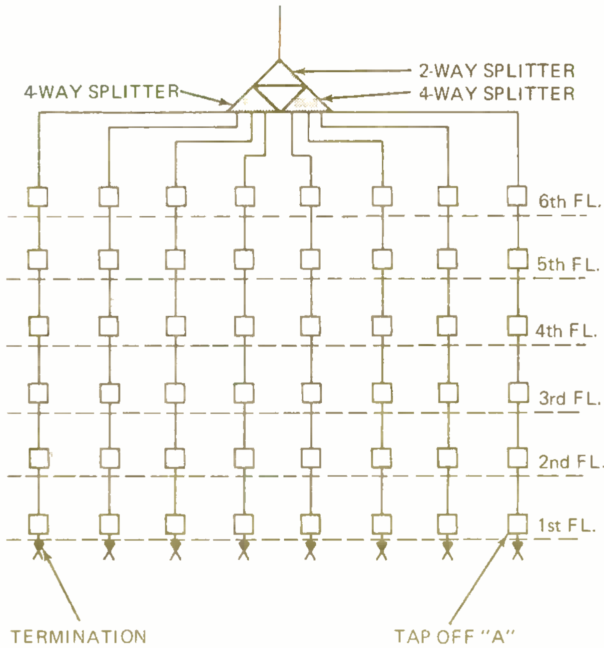
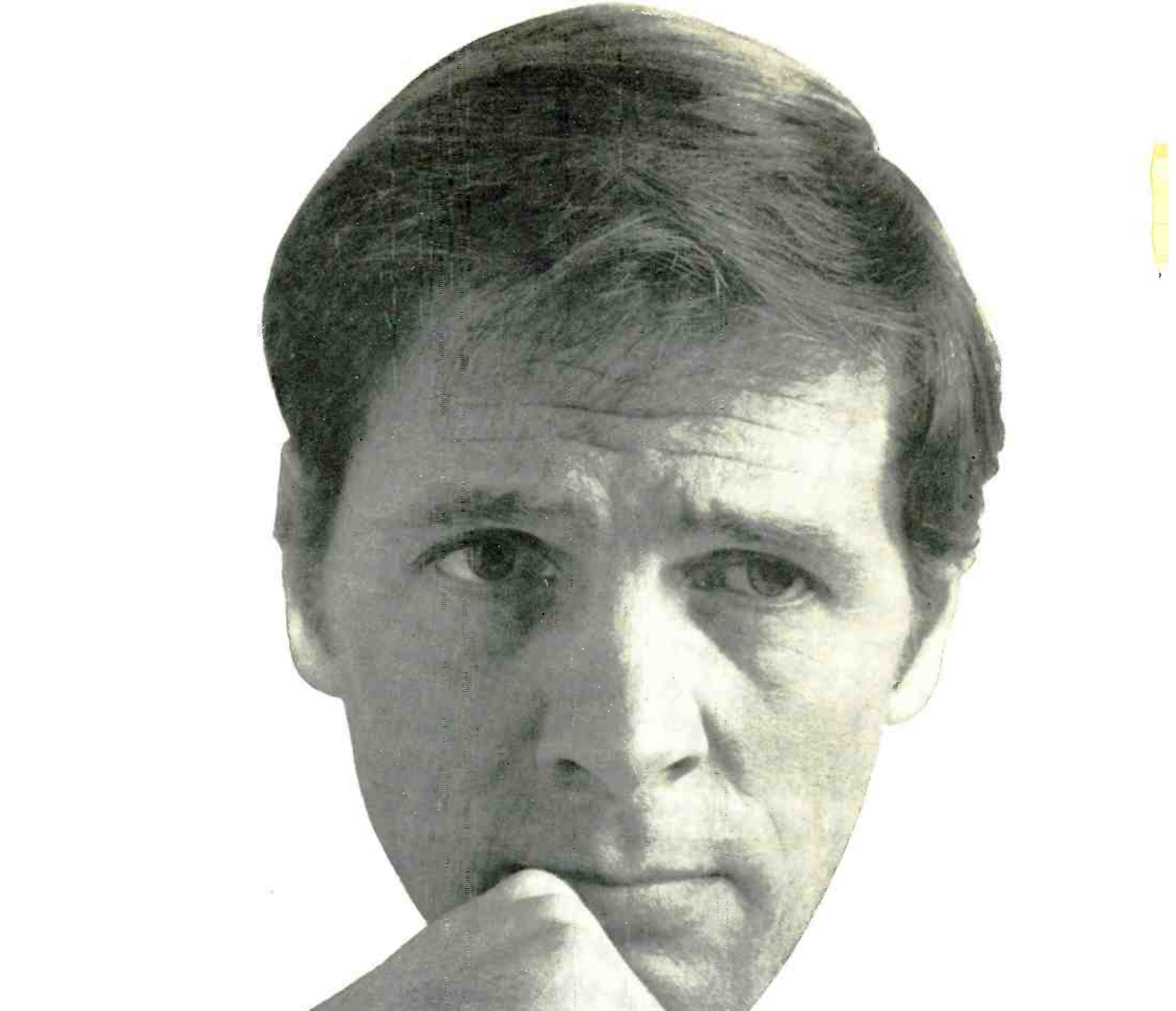


FIG. 4—HOW CABLES ARE LAID OUT in a typical building of moderate height. Three splitters drive the eight feeder lines.



Your paycheck says a lot about you

It tells you more than how much you make. It tells you how far you've come. And if your paycheck looks very much the same as it did last year, or the year before, it simply means that *you* look very much the same as *you* did last year and the year before.

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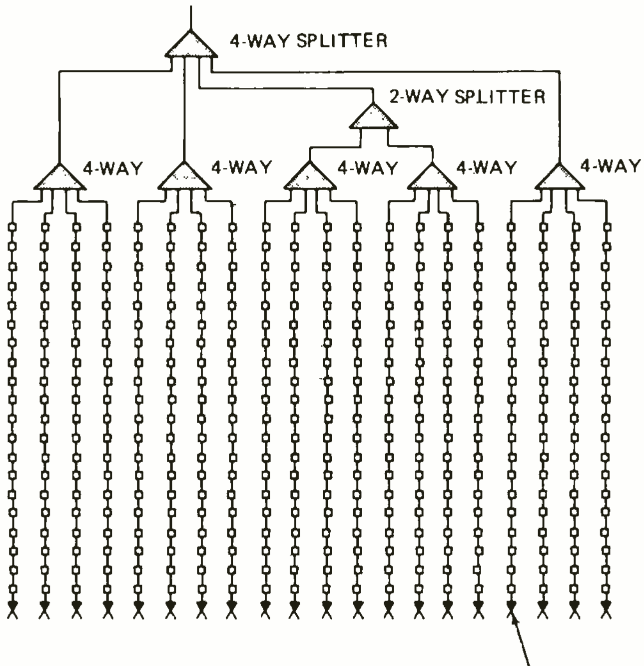


FIG. 5—CABLE AND TAP-OFF LAYOUT in a typical high-rise apartment building. Feeders run vertically from top to bottom.

we can get the right signal levels at the outputs of all the other taps.

To calculate losses, start at the last tapoff in the line, in this case tapoff **A**.

Going through tapoff **A**, we immediately encounter 12 dB of isolation. Then, we hit the thru line loss of each of six tapoffs. While thru line loss varies with isolation, we can use an average figure of 1 dB per tapoff, for a total of 6 dB. Next, we encounter the loss of a four-way splitter (8 dB) and the loss of a two-way splitter (4 dB). Finally, we have to add in the loss of the length of cable between the last set in the line and the output of the head end. As indicated in Fig. 4, this cable is about 150 feet.

Cable loss, of course, varies with frequency, as well as the type of cable used. The most commonly used MATV coaxial cables have copper or copper-plated steel center conductors, foam polyethylene dielectric, and aluminum tape shield, covered either by drain wires or aluminum braid. The jackets are generally black polyvinylchloride (PVC).

Three sizes of cable are commonly used, and they have attenuation characteristics approximately as follows:

	ATTENUATION IN dB/100'	
CABLE	**CH. 13**	**CH. 57**
RG-59	4.3	7.8
RG-6	3.2	5.6
RG-11	2.5	4.3

RG-59 is used for economy. For most applications, RG-6 is preferred, while RG-11 is used for very long runs. Let's assume that we use RG-6 throughout the remainder of this article.

If it's a vhf-only system, cable loss is always calculated for Channel 13. Even if Channel 9 is the highest channel in the area, it's usually a good idea to design for 13. However, cable loss is a bigger factor at uhf, so we generally design uhf systems for Channel 57, rather than Channel 83, since 90% of all uhf channels in use today are below Channel 57.

The cable attenuation in our example, then, would be 150 feet @ 5.6 dB/100' or 8.4 dB. Let's put all the losses together:

Tapoff Isolation	12 dB
Tapoff Thru Loss (6 x 1.0 dB)	6 dB
4-way Splitter Loss	8 dB
2-way Splitter Loss	4 dB
150' Cable Loss (1.5 x 5.6 dB/100')	8.4 dB
TOTAL DISTRIBUTION LOSS	38.4 dB

We call this sum the *total distribution loss* because it is the amount of loss the head end must be able to overcome. This calculation will help us to choose our head-end amplifier. Using similar calculations, we would determine that the total distribution loss of Fig. 3 is:

Tapoff Isolation	12 dB
Tapoff Thru Loss (12 x 1.0 dB)	12 dB
4-way Splitter Loss	8 dB
2-way Splitter Loss	4 dB
150' Cable Loss (1.5 x 5.6 dB/100')	8.4 dB
TOTAL DISTRIBUTION LOSS	44.4 dB

In a system as large as Fig. 5, it is not cost effective to distribute uhf *on Channel*. UHF channels are converted at the head end to unused vhf channels. Therefore, this system would be calculated at Channel 13 as follows.

Tapoff Isolation	15 dB
Insertion Loss (20 x .6 dB)	12 dB
4-way Splitter Loss	7.0 dB
2-way Splitter Loss	3.5 dB
4-way Splitter Loss	7.0 dB
250' Cable (2.5 x 3.2 dB/100')	8.0 dB
TOTAL DISTRIBUTION LOSS	52.5 dB

Head ends

The job of the head end is to pick up TV signals, remove interference and provide enough signal output to overcome the total distribution loss. This brings us to the question, "How much signal does a TV receiver need?" The answer, of course, varies with the TV receiver. A set with a "hot" front end can get along with less signal than an old set with weak tuner tubes. More signal is required for color than for black and white. The MATV industry has pretty much decided on 1000 millivolts across 75 ohms as the standard *minimum* signal. This minimum can also be expressed as 0 decibel millivolts, abbreviated to 0 dBmV. 0 dBmV is equal to 1000 microvolts.

The head end must supply enough signal voltage to deliver *at least* 0 dBmV of signal on every channel to every set connected to the system. Fig. 6 shows the simplest type of head end, consisting of a broadband antenna and a broadband amplifier. This type of head end will fit many installations. If all channels are broadcast from the same direction, at about the same power, this type of installation is convenient and economical.

All you have to do is to decide what antenna and what amplifier to use. Some installers use ordinary home TV antennas for small MATV systems, but this is not recommended. Use heavy-duty, professional-quality antennas. Much more rugged than home antennas, they deliver better picture quality over a longer period of time.

In choosing a head-end amplifier, two specifications are vitally important: output capability and gain.

The desired output capability of the amplifier is determined by the total distribution loss. For example, if you have a system like Fig. 4 with total distribution loss of 38.4 dB, you need an amplifier that can put out at least 38.4 dBmV without distortion. (38 dBmV means 38 dB above 1 millivolt, or approximately 80 millivolts *per channel*).

Amplifier gain required is determined by the difference

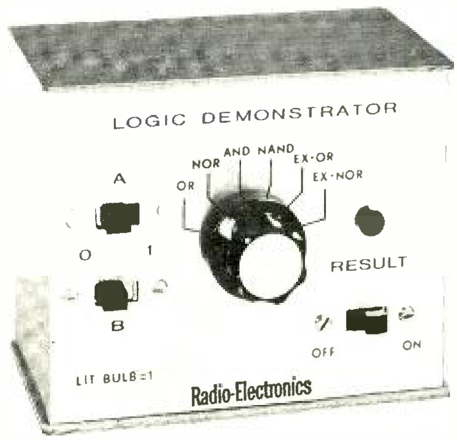
(continued on page 97)

BUILD R-E'S LOGIC DEMONSTRATOR

Simple demonstrator shows how the six most common logic functions operate

by DON LANCASTER

HERE'S A SIMPLE PROJECT THAT SHOWS you the basics of OR, NOR, AND, NAND, EXCLUSIVE OR and EXCLUSIVE NOR logic functions. You can use this as a personal study aide, as a teaching demonstrator, as a science fair project, or as a school lab project. It's also a dandy first TTL (Transistor-Transistor Logic) project, showing you the basics of mounting, supplying, decoupling, and visually indicating states with TTL. Kits for this project are commercially available.



About logic

Logic is the fundamental language of the digital world of computers, calculators, digital instruments, and digital electronics in general. It is one way machines have of talking with each other or with humans, and it is the way they are taught to provide the correct responses for a given set of input situations.

The most common logic in use today has two possible conditions or *states*. These states are ON or OFF, YES or NO, or, in digital language, a **1** or a **0**. Logic is simply a set of rules of what a circuit, called a *logic block*, will do. A logic block will provide either a **1** or a **0** in predetermined response to a specified collection of **1**'s and **0**'s at its inputs. Enough logic blocks taken together provide the memory for a computer, the answer for a calculator, or the counting for a digital voltmeter.

The *Logic Demonstrator* uses a TTL integrated circuit. When using TTL, it is common to call a **0** a voltage very near ground or 0 volts and a **1** any voltage between +2.4 and +5 volts. This is called a *positive logic convention* and is often, but not always, used with TTL.

A TTL logic block *accepts* **1**'s and **0**'s at its inputs and then *provides* new **1**'s and **0**'s at its outputs in response to a predetermined set of logic rules it has been trained to respond to.

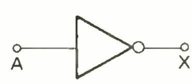
One-input logic blocks

The simplest useful logic block would have one input and one output. The output could be taught to do any of *four* possible things: It could *ignore* the input and always put a **1** out; it could *ignore* the input and always put a **0** out; it could *follow* the input and put a **1** out when the input is **1** and a **0** out when the input is **0**; or it could *complement* the input, and put a **1** out when the input is **0** and a **0** out when the input is a **1**.

The first two possibilities are patently worthless, while the third would be useful only if we were increasing the drive capability or something else rather special. Thus only the fourth possibility is genuinely useful. We call a one input, one output logic block that complements its input an *inverter*.

Logic people have a way of building up a little chart that lists what a logic block will do. This chart is called a *Truth Table*, and it lists the output response you will get for every possible combination of every possible input. With an inverter, there is only one input, and it can only be a **1** or a **0**. The truth table looks like this:

INVERTER	
A	X
0	1
1	0



Inverters are used whenever we want to generate the complement of a logic signal. They are sometimes also used to increase the drive capability of a logic system.

Two-input logic blocks

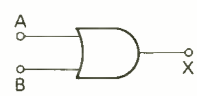
Logic blocks with two inputs and one output are far more versatile than single inverters, for they may be used in combination to build up *any* logic function, however complex, from the simplest NAND gate to the biggest computer memory. With the two-input logic block, there are four possible input conditions—**00**, **01**, **10**, and **11**. The output can be anything we teach the block to do, with a **1** or a **0** cropping up in any of the four output slots.

Some thought will tell you there are *sixteen* different ways we can teach or program the logic block. Of these, six ignore at least one input and thus are essentially worthless. Four others are rather specialized and thus see little use. The remaining six logic block programs, called the OR, NOR, AND, NAND, EXCLUSIVE OR, and EXCLUSIVE NOR blocks are the workhorses of digital logic, and, together with the inverter, give you a stock of seven basic logic blocks with which any digital machine can be built up.

OR function

The OR function gives you a **1** out for a **1** in on *either or both* inputs:

OR		
A	B	X
0	0	0
0	1	1
1	0	1
1	1	1



It is used any time we want to verify the presence of a **1** on any input.

NOR function

The NOR gives you a **0** out for a **1** in on either or both inputs. One way to build it is to follow an OR gate with an inverter. Its truth table looks like this:

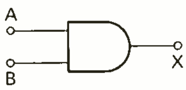
NOR		
A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

It's usually used anytime we want to stop something from happening if a **1** shows up on any input.

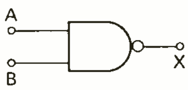
AND and NAND

The AND function needs a **1** on *both* inputs to get you a **1** out, while a NAND is a AND plus inverter that gives you a zero out for 1's coincident on the input. The truth tables look like this:

AND		
A	B	X
0	0	0
0	1	0
1	0	0
1	1	1



NAND		
A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

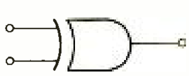


The AND is used to detect a *coincidence* of 1's at its inputs; NAND is used to stop something from happening at the coincidence of input ones. Two NAND gates back-to-back form a set–reset flip-flop, or the most basic digital storage element.

EXCLUSIVE OR and NOR

The EXCLUSIVE OR gives you a **1** out if *one but not both* inputs have a **1** on them, while the EXCLUSIVE NOR gives you a **0** for one but not both inputs being a **1**. Looking at it another way, the EXCLUSIVE NOR gives you a **1** out if the inputs are *identical* and a **0** if they are *different*:

EXCLUSIVE OR		
A	B	X
0	0	0
0	1	1
1	0	1
1	1	0



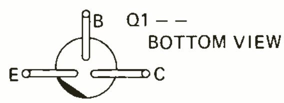
EXCLUSIVE NOR		
A	B	X
0	0	1
0	1	0
1	0	0
1	1	1

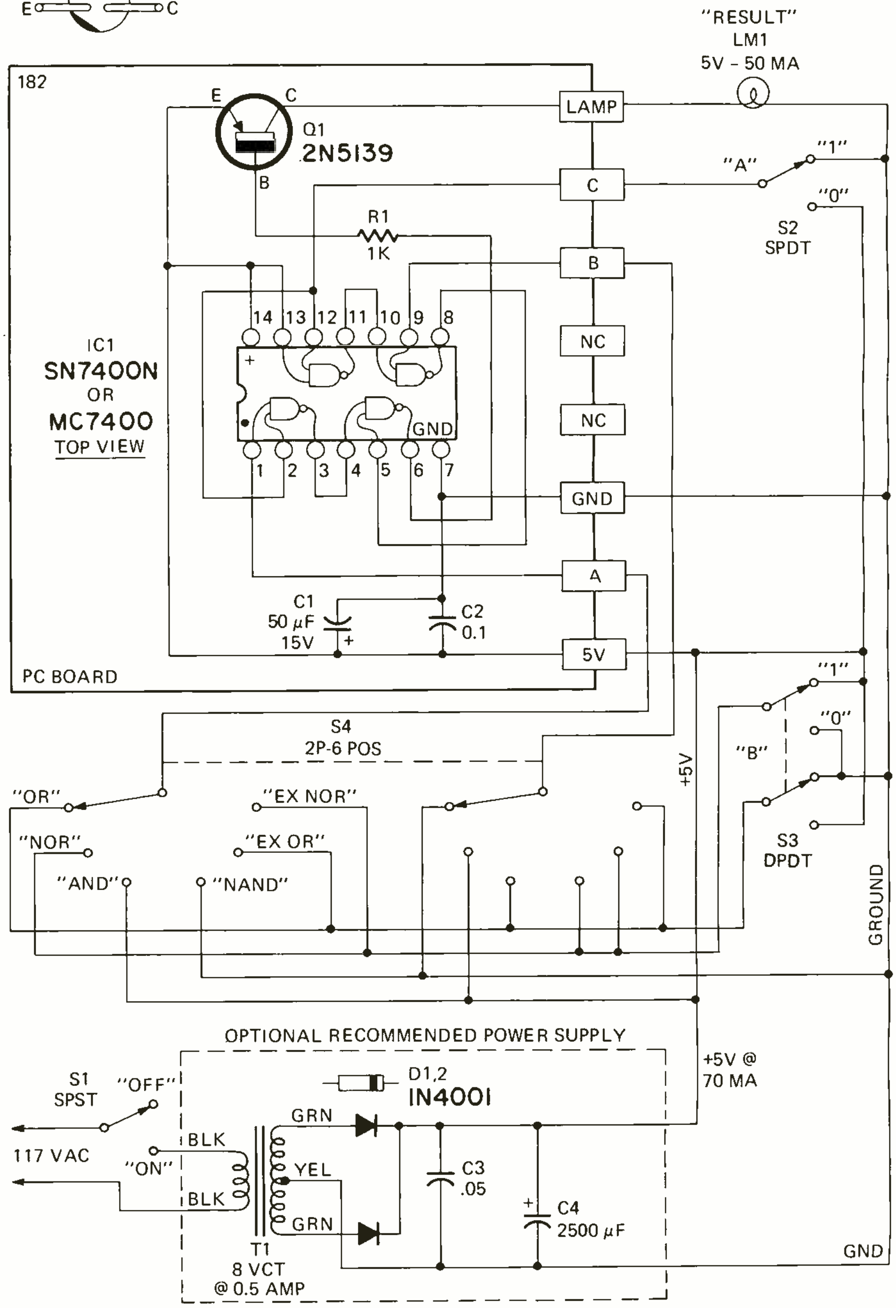
The EXCLUSIVE OR circuit is used to perform binary arithmetic. When doing this, it goes by the name of a HALF ADDER. Two half adders and an inverter can perform binary addition, and thus EXCLUSIVE OR circuits are the cornerstone to digital computation. The EXCLUSIVE NOR is also called a COM-

PARTS LIST

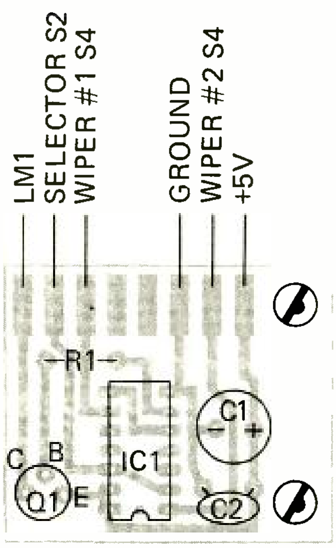
C1—50 μF, 15V, electrolytic
C2—0.1 μF, 10V, disc ceramic
*C3—.05 μF, mylar or disc ceramic
*C4—2500 μF, 10V, electrolytic
*D1,D2—1 amp, 50 PIV, power diode: 1N4001 or equal
IC1—SN7400 or MC7400 TTL Quad Two-Input Gate
LM1—5V, 50 mA, pilot lamp assembly
Q1—2N5139
R1—1000 ohms, ¼ watt
S1—spst slide
S2—spdt slide
S3—dpdt slide
S4—2-pole 6-position non-shorting selector switch (Mallory 3226J or equal)
*T1—primary, 117Vac; secondary, 8Vct, 0.5A transformer
MISC—1⅜" x 1⅝" PC Board (see text); PC Mounting brackets; switch hardware; ¾" knob; walnut and gold colored case, bottomplate and endplate assembly, prepunched and prefinished; mounting feet (4); wire; solder; line cord and strain relief*; terminal strip*; power supply hardware*; wire nut*; etc. . . .

NOTE: The following parts are available from Southwest Technical Products, 219 W. Rapsody, San Antonio, Texas, 78216: Etched and drilled PC Board No. 182, $3.00 Complete kit of all parts less power supply No. 182K, $8.25 Power supply components (* above) No. 182PS $4.25 postpaid in US.

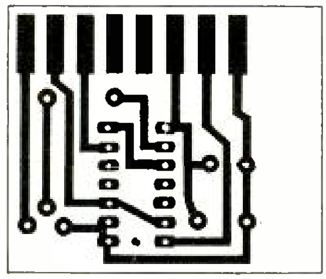


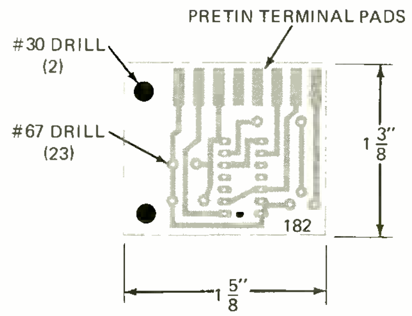


COMPLETE SCHEMATIC OF THE LOGIC DEMONSTRATOR. You will note that the unit is built around a single IC and its functions are switch selected.



COMPONENT SIDE





ONE REQ'D -- MAKE FROM $\frac{1}{16}$" G-10 PC MAT'L

FOIL SIDE

FIG. 2—FULL-SIZE FOIL PATTERN above is the circuit board you need for your own logic demonstrator. Use this pattern as is.

FIG. 3—DRILLING GUIDE (top right) shows drill bit sizes to make proper size holes in the circuit board.

FIG. 4—PARTS LAYOUT (left) on the circuit board. All connections are shown actual size.

PARATOR, for it lets you *test* to see if inputs are identical or different. It is used in coincidence and counter circuits.

Build a demonstrator

The schematic is shown in Fig. 1. A small printed circuit board is recommended to support the TTL logic gate and lamp driver transistor. You can buy this item commercially, or you can build one following the layout of Fig. 2 and the drilling guide of Fig. 3. Components are located per Fig. 4. Watch the polarity on C1 and the IC, and be sure to use a small soldering iron and fine solder for assembly.

The photos and Fig. 1 should serve as an assembly guide. The PC board mounts on two brackets above S2, and interconnections are soldered directly to the terminal pads on the PC board.

It is best to check the circuit out function by function as you progressively wire S4 to prevent any possible switch wiring errors. Use the truth tables to verify operation.

The circuit may be powered by a 4½ volt battery, a 5 volt, 100 mA bench supply, or the recommended power supply shown in Fig. 1. The recommended supply may be assembled inside the bottom of the case for trouble free line operation. **R-E**

makeshift ac wattmeter

Just the thing for ac power measurements when accuracy and convenience do not warrant a lab wattmeter.

by George Lennie

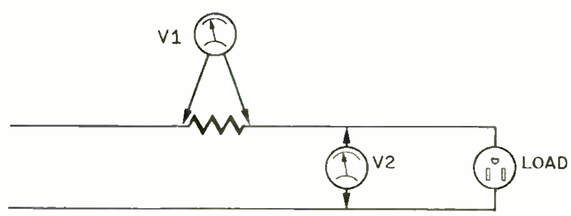


FIG. 1

In the March 1971 issue, Jack Darr presented valuable information on using a wattmeter when servicing home appliances. I have a makeshift wattmeter that was originally made up to check the current consumption of an automobile block heater. Its basic operation is illustrated in Fig. 1.

A low-resistance power resistor (R) is inserted in series with the line and the load. By measuring the voltage drop across R, we calculate the load current from I = V1/R and load wattage from W = I x V2. The wattage calculation is approximate—neither impedance nor power factor have been considered—but is sufficient to indicate whether power consumption is much out of line.

A 1-ohm, 25-watt resistor was mounted in a surface-type outlet box along with a parallel-ground duplex receptacle. Leads from the ends of the resistor are brought out to a terminal strip as in Fig. 2. (Both meter terminals are "hot" to ground and present a shock hazard. Insulated binding posts or jacks in the side of the outlet box will be safer.—*Editor*) A 3-wire cable and plug complete the wattmeter adapter. A Heathkit audio voltmeter is used since it can indicate very low ac voltages. The line voltage drop due to the resistor is small and can be ignored in most instances. **R-E**

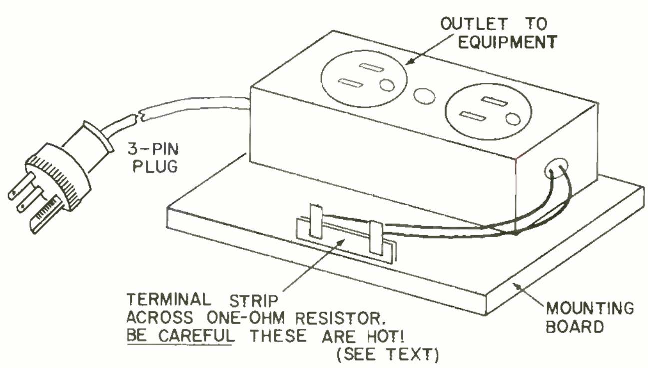


FIG. 2

Switching Tricks

The silicon-diode switch is a infinite applications. Some ones are shown

by MATTHEW MANDL
CONTRIBUTING EDITOR

SILICON DIODES HAVE LONG BEEN popular rectifiers for radio and TV sets. Compared to tubes and the older selenium diodes, the silicon units are much more compact for the same current and voltage ratings, and have an excellent front-to-back resistance ratio. It is this last feature that also contributes to the silicon rectifier's usefulness, because it makes an ideal switching device. Thus, digital computers use numerous silicon diodes to form logic switching circuits to gate in or out certain signals as required.

By using combinations of silicon diodes we can form a number of tricky but useful switching circuits for signalling purposes, between two or more locations, or for providing a combination-type system that can be made to work only by identifying the correct contacts. Also, diodes can be used to build *electronic keys* for opening garage doors electrically, opening locks, or turning on electric equipment such as power tools or hi-fi systems to prevent use by others.

Diode selection and testing

Remember that current and voltage ratings of silicon diodes are maximum values, and operation at lower values is not only all right, but desirable. Thus, if you have some 0.25A diodes (100V types) on hand and intend to use No. 47 pilot lights for signalling devices, you have a wide margin of safety, since the lamp is rated for 6.3 volts at 0.15 ampere. With a silicon diode rectifier in series with such a lamp, the current drawn is even lower (less than 75 mA).

If you intend to use diodes already on hand, you can use the simple tester shown in Fig. 1. While this unit will not indicate current or voltage limits, it will indicate correct wiring polarities and will also show whether the unit is open or shorted.

While the ohmmeter section of your tester could be used, you would have to make sure of the ohmmeter testing polarities. With the unit shown in Fig. 1, the diode diagram should be drawn at the test points and the battery wired into the circuit as shown. The voltage can range anywhere from 1.5 to 9; whatever is convenient.

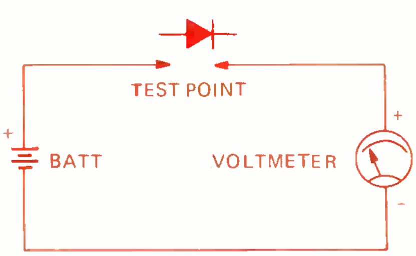


FIG. 1—SIMPLE DIODE TESTER detects opens and shorts and indicates device polarity.

To use the tester, reverse the diode at the test points until you get a reading, at which time the diode polarity is as shown. If you get a reading for both the initial position and the reversed position (for silicon diodes) the diode is shorted (or has a high leakage in the reverse direction) and should not be used. If neither the initial or reverse position at the test points gives a reading, the diode is open.

Selective calling unit

A circuit using two silicon diodes to form a selective signalling system is shown in Fig. 2. Here, one remote unit can be signalled without the other, with only two wires interconnecting the entire circuit. For 6- or 12-volt systems, bell wire, lamp cord, or twin lead can be used.

Buzzers or door bells can be used for short-signal calls. Light bulbs are useful for maintaining the signal for some time in silence. If, for instance, the person being called is not in the room, the light can be left on until he returns, at which time he can return the call with an intercom or by phone. If you use buzzers or relays, check the current consumed during operation to make sure the diode's ratings are not being exceeded. Also check the operating voltage at the buzzer to make sure the buzzer will operate reliably.

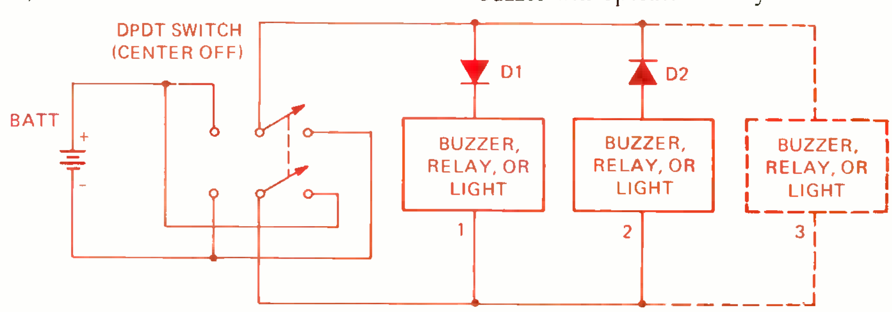


FIG. 2—SELECTIVE CALLING SYSTEM uses the polarity of the control diodes and the polarity of the applied voltage to select the signalling device at the desired remote location.

As shown, a double-pole double-throw switch is used to reverse polarity to select either one or the other of the remote call units. A toggle switch with a center-off position can be used, or knife switches can be substituted. If desired, you can add a third remote unit as shown by the broken lines. This unit, without the series diode, gets all calls received by either No. 1 or No. 2 For remote units with the series diodes, how-

with Silicon Diodes

tiny solid state device that has
of the more interesting
in this article

ever, current flows only when the correct battery polarity is present, so the selective feature still operates just as it did before.

If pushbutton convenience is desired, the unit shown in Fig. 3-a can be used. With this system, both remote units can be called at the same time, or either one selected individually, as before. Two voltage sources are needed, as shown. The pushbuttons should be momentary contact types, such as those used for door bells. Miniature ones can be used (Allied Radio Shack catalog No. 275-1547, or GC Electronics No. 34-000).

You can eliminate the batteries by using a 6.3-volt transformer as shown in Fig. 3-b. Two additional diodes are used to create a circuit that is fairly simple but forms a sophisticated switching system. It uses only two interconnecting wires, yet permits an ac source to select either one or the other, or both remote units as desired. If, for instance S1 is closed, diodes D1 and D3 will have identical series polarities and the resulting current flow through LM1 lights the lamp (or activates a buzzer). With S1 closed, however, diode D4 is opposite in polarity to D1 and does not permit current flow through LM2. Similarly, depressing S2 puts diode D2 in polarity-coincident series with D4 and current flows through LM2. Incidentally, a lamp could be used at one location and a buzzer or bell at the other, as required.

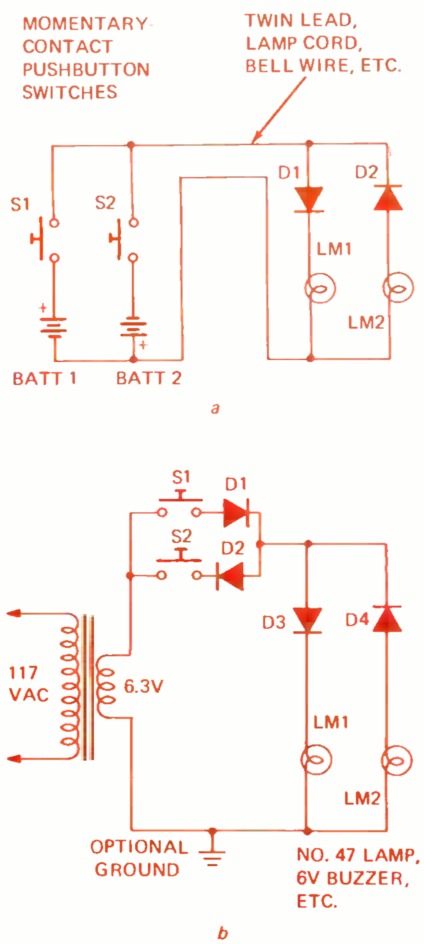


FIG. 3—PUSHBUTTON SWITCHES control the battery-operated (a) and line-powered (b) selective signalling systems.

Secret combination system

Diode switching principles can be used to create "secret combination" systems. A typical one using push buttons is in Fig. 4. In this kind of system we must prevent the system from working when all buttons are pushed down simultaneously. For Fig. 4 this is done by using a normally-closed relay in series with diode D4 as shown. The normally-open relay is the one that applies the power to the power tools, the garage-door opening mechanism, or other device when the correct combination is used.

Any combination can be formed, though for Fig. 4 push buttons Nos. 1, 3, and 7 must be depressed simultaneously for the normally-open contact relay to close. With these contacts closed, diode D2 is in series with D3 of the same polarity. Since diode D4 is of opposite polarity, the normally-closed relay does not trip.

If all buttons are depressed at one time, or button No. 7 is depressed in combination with No. 2, or No. 4, etc., diode D1 is placed in series with D4, and since their polarities are identical, the normally-closed relay opens, thus preventing the other relay from operating.

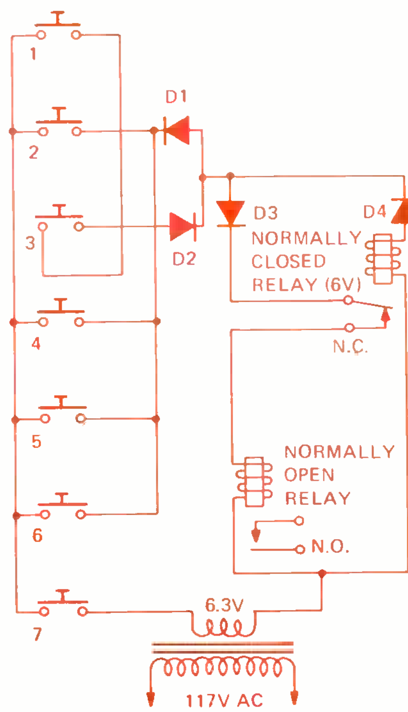


FIG. 4—COMBINATION LOCK requires closing three correct switches simultaneously.

If desired, an alarm buzzer or bell can be connected so it will ring if an incorrect combination is tried. Instead of spst contacts on the normally-closed relay, a spdt arrangement can be used so that current flow through this relay not only opens the line to the other relay, but also closes contacts to a bell or buzzer circuit.

If the relays in Fig. 4 are ac types, they will function satisfactorily, even though pulsating dc is obtained from the series diodes. If dc relays are used, shunt them with 100-μF capacitors for smoother operation. The shunting capacitors filter the ripple component and provide a smoother operating voltage. Be sure to observe the correct polarity for the electrolytic shunting capacitors.

Electronic keys

As shown in Fig. 5 a phone plug can be used as an electronic key, with the jack acting as the keyhole. Wire a single diode across the two contacts of the phone plug to form the electronic key element. Use a normally-open relay to apply power to the desired device when the proper key is inserted. I recommend a dc relay with two 100-μF electrolytic capacitors (35wV or higher) wired back-to-back as shown. If a solid metal rod is inserted into the phono jack in an effort to trip the mechanism, only ac is applied across the relay. Since it is a dc type, it will not operate.

The shunting capacitors also act as a low reactance and have a bypass effect on some of the ac signal energy. When the phono plug (with its internal diode) is inserted, the ac is rectified by the diode and filtered by the capacitors, thus applying the required dc to the relay for proper operation. A higher-voltage transformer can, of course, be used if higher-voltage relays are employed.

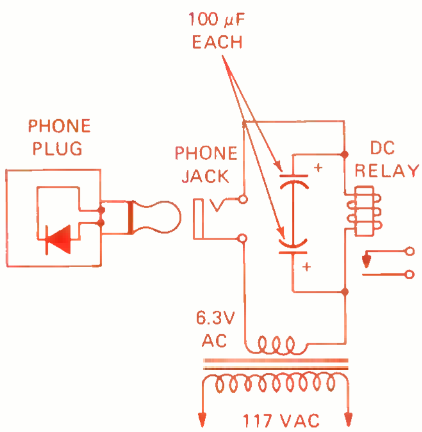


FIG. 5 (above)—SIMPLE KEY FOR ELECTRIC LOCK is diode in phone plug to rectify applied ac and provide dc for the relay.

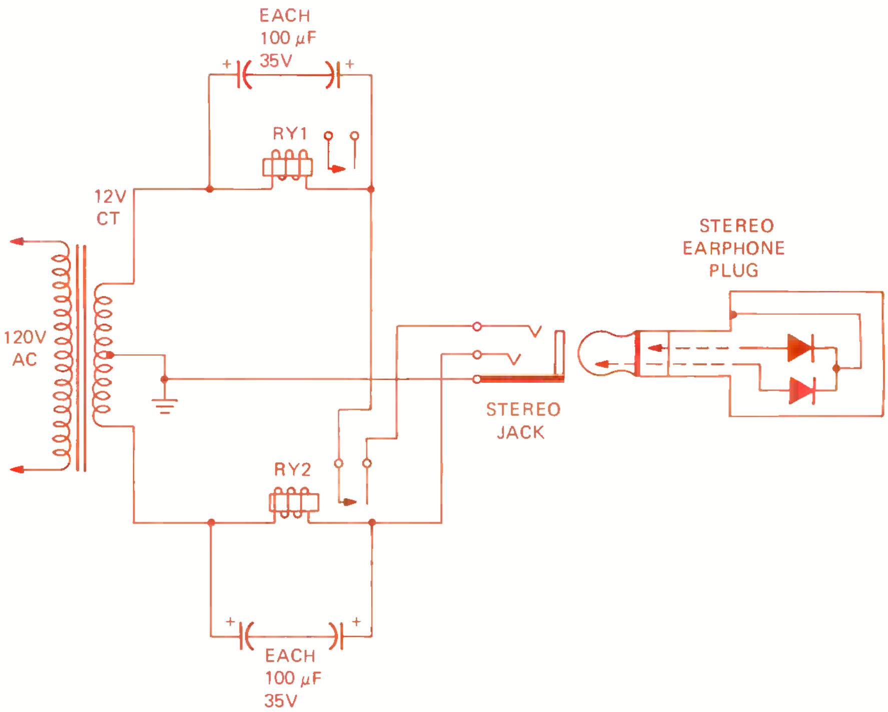


FIG. 6 (right)—ELABORATE LOCK has a simple key consisting of a pair of silicon diodes inside a stereo phone plug.

Again check the current flowing through the relay winding so the proper ampere rating is found for the diode. If 0.5 ampere flows, use a 1-amp diode (or higher). Also, remember polarized capacitors used back-to-back do not double the voltage rating. So use a capacitor voltage rating high enough to be on the safe side, particularly since some back emf is developed by the collapsing fields of the relay coil when current flow stops through it. If bulk is no factor, use 50-volt units (or higher).

A more elaborate electronic-key version is shown in Fig. 6. Here a stereo plug is used, with two internal diodes instead of the single one used for the key in Fig. 5. Another relay like the one that was used in Fig. 4 is included as an additional precaution against use of a false key or shorting wires.

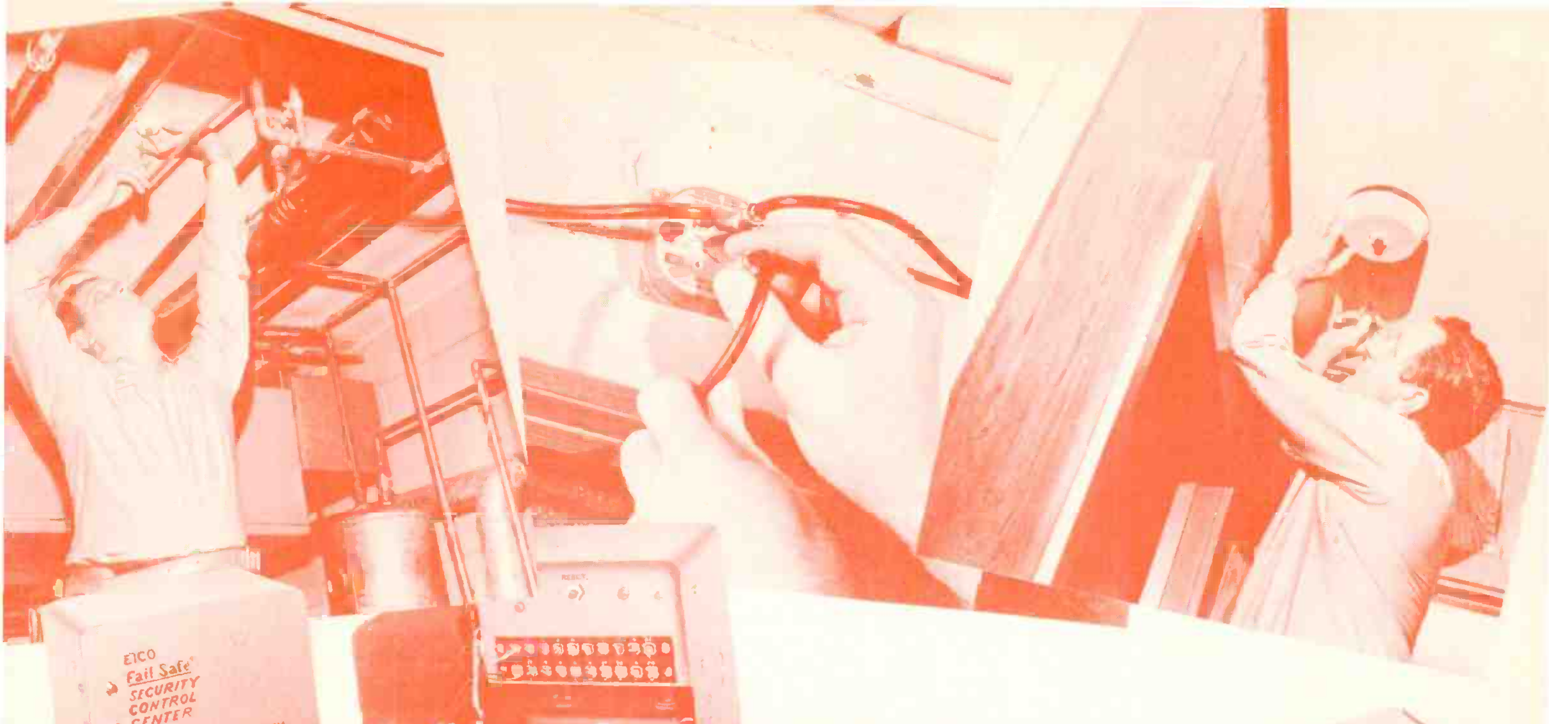
The two relays are also dc types with shunting back-to-back capacitors as in Fig. 5. A 12-volt transformer with center-tap is used to obtain two 6-volt sources. As opposed to the relay combination of Fig. 4, the two used in Fig. 6 are *both normally-open* types as shown.

The stereo-plug key places a diode in series with each 6.3-volt section of the circuit and thus converts the alternating current to dc which is also filtered by the capacitors shunting the relays. Thus, both relays are energized. There is a slight delay for RY1, since the normally-open contacts of RY2 must close to complete the circuit for RY1. When RY1 is energized, its contacts close and apply power to whatever system is turned on by this electronic key circuitry.

If the stereo jack contacts are shorted in an attempt to cheat the system, only ac is applied to RY2 and it doesn't close. Consequently, an open circuit is maintained for RY1. The back-to-back capacitors across the relay prevents ac damage to the polarized (dc) electrolytics. Even if a diode is placed in series with the RY2 circuitry, RY1 will not be energized if its contacts are shorted, since dc is necessary.

The two rectifiers within the stereo plug key can be polarized in either direction and the circuit still functions. These diodes rectify the ac and so long as current flows through the relays in a single direction they will be energized, regardless of the particular direction of such direct-current flow.

The transformer used should be a good one so it will not warm up appreciably when the primary is left connected to the 117-volt ac lines. As an added safety precaution, fuses can be placed in series with each of the relays. As an alternative, a single fuse can be used between the transformer center tap and ground. **R-E**



IT'S EASY TO INSTALL BURGLAR ALARMS – MATV – PA – INTERCOMS

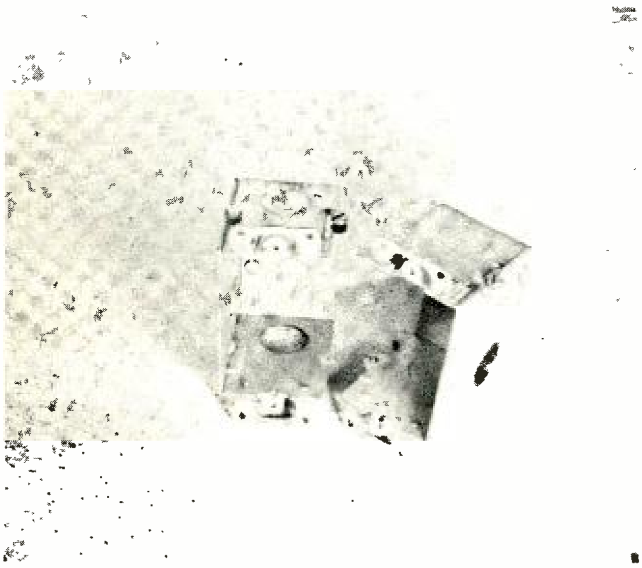
Installation is hard work at best. To keep the job from becoming impossible read this article now

by EUGENE WALTERS

If you've spent the better part of your spare hours over a hot soldering iron, chances are you have never had the opportunity to pick up some of the fundamentals of house wiring. Being familiar with the local electrical codes and electrician's techniques and tools may be necessary for putting in a new electrical outlet or wall-switch; not so when you decide to run extension speaker wire, burglar alarm system wiring, intercom cable or TV wire through the walls for built-in custom-wired receptacles. (turn page)

Yet there are a few tricks the electrician uses that are not only helpful but virtually a must if you're going to string cables between the plasterboard. One of the first tools that will need some introduction is called a *snake.* The snake is a length of ⅛-inch wide spring steel that comes in a coil and can be purchased at most electrical supply houses. It's not to be confused with a snake used by plumbers for freeing clogged pipes; they are totally different animals. The electrician's snake generally has one end bent into a hook, and can be cut to whatever lengths you happen to need. It's almost always too long when you buy it.

The snake has one purpose in life: to fish wires between walls, through holes and past obstructions. Generally the proper use of the snake requires two people for best operation. One is the feeder—pushing the snake through a hole toward another hole in the wall. For want of a better name, the other person could be called the grabber. He's the one who shouts when he spots the snake in his flashlight beam while peering through a rough hole in the plaster. He yells and reaches in with a short, hooked snake to grab the one that has



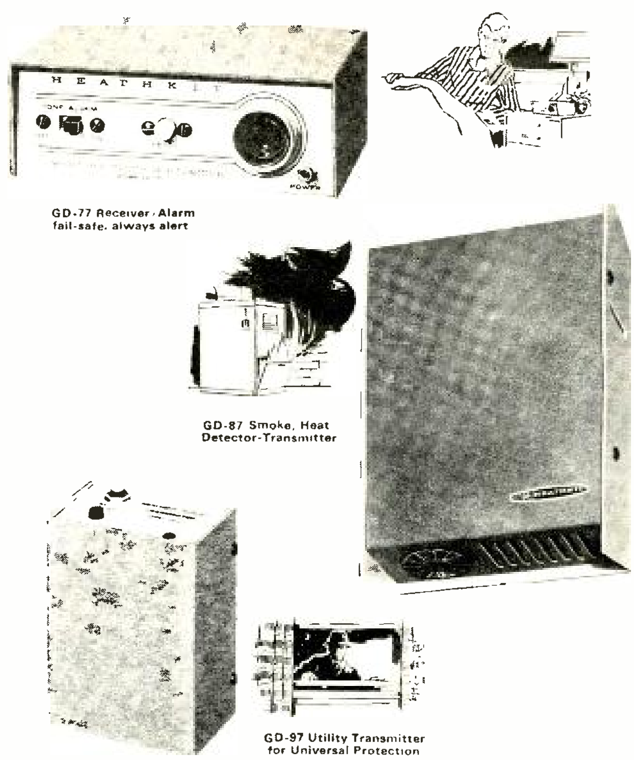
SIMPLE GEM BOXES are used as terminal boxes for all wiring. They can be obtained in most hardware stores and all electrical supply houses.

been fed through. From there on, you're home free (usually).

Next step is to tie the ends of the wires that you want to fish through the wall to the hook end of the snake and wrap with one or two layers of smooth plastic electrical tape. Then pull the snake in the other direction until the wires come through the hole. Sound simple? In a way it is, but there are a few other pointers that you should bear in mind before you attempt to tackle any wire fishing operation through your walls.

The first consideration is the type of wire that you are going to use. Since this wire will not be carrying anything near the 117-volt ac house current that is covered by electrical codes, you can pretty much toss the electrical code book out the window, unless your local electrical code does cover this type of wiring. There are some items of hardware used for ac wiring that will come in handy, though.

One of these is the standard ac wall box or Gem box. While these metal boxes are not necessary to an installation, they do help to make the work neater and provide a convenient anchoring point for the screws that hold trim and mounting plates in place on the wall surface. Generally, a Gem box of the type commonly available in virtually any chain store electrical department will do the job very nicely. If you want to go this route, be sure to use the kind of box that has an expansion type of bolt on each side. This screw-driven anchor expands and pulls up behind the plaster wall or a plasterboard much the same way that an expansion bolt

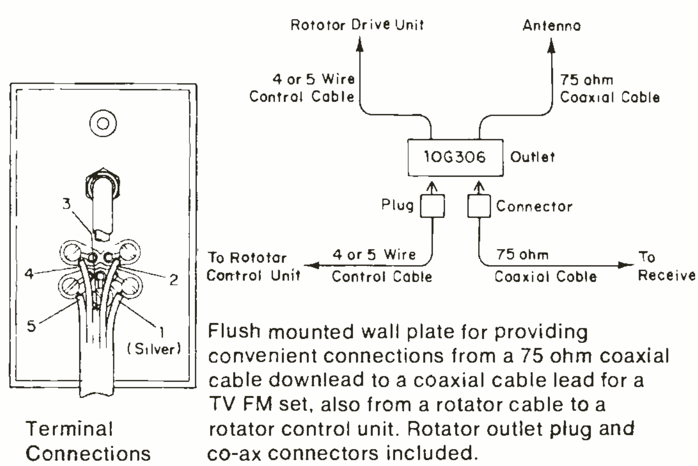


A COMPLETE HOME-PROTECTION SYSTEM that is easily installed is manufactured by Heathkit. It offers both fire and burglar protection.

does when used for anchoring in a wall. An alternate method is to use readily available metal insert tabs to hold the box in place—however, these do not provide as solid a mount as the expansion bolt mount.

When wiring into a standard ac box, you must cut the proper size hole for the box, but don't mount the box in the wall until after you have pulled the wires through. Leave about two feet of extra wire hanging out of the hole where you intend to mount the box. Pry loose one of the connector hole tabs with a screwdriver. Run the wires through this hole and tighten the inside screw connector. You may find that the wires are not thick enough for the screw clamp to grab tightly. If this happens, a convenient way of anchoring the wires is to use the old knot technique—simply tie a knot in the wire to keep it from slipping out of the box while providing adequate strain relief.

Consider for a moment the type of wire that you intend to run through the walls. If the wire is to be used for audio work only, possibly the most convenient to use is a multi-conductor intercom cable; the more conductors in this cable, the better off you will be for future expansion.



WALL OUTLET FOR AN ANTENNA ROTATOR connection. RCA unit also provides a TV antenna lead-in hookup on the same outlet plate.

There's just one fly in this particular ointment: if you intend to have a junction box in every room in the house, be prepared to do lots of twisting, splicing and soldering. If you go to something like a 26-conductor cable, the box will contain the cut ends of three cables for a total of 78 cut ends to be stripped, twisted and soldered—that's 78 in *each box!*

This number can be reduced by just tapping off the two or three or more wires you need for that location; this reduces the number of cut ends to 55—still a prodigious quantity! This method, by the way, is guaranteed to make you blanch at the sight of intercom cable in the future.

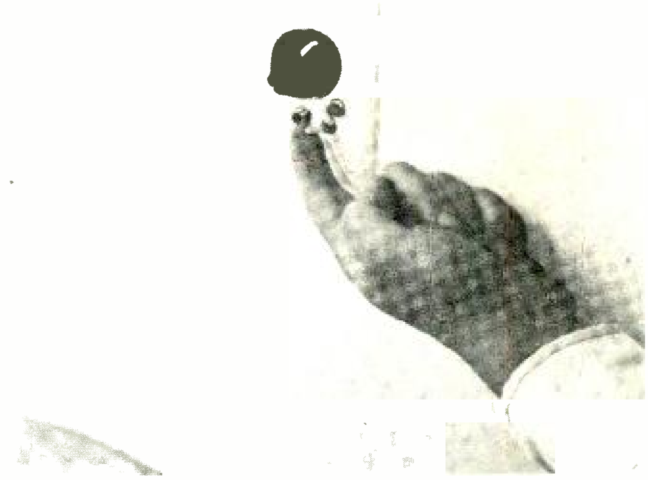
Wiring the house for a burglar and fire alarm system can be relatively easy once you have a multi-conductor intercom cable installed. Generally, such a dual-purpose system will require three conductors with a continuous run from the farthest tripping device or sensor to the central alarm box location. If you decide to go the antenna rotor cable route, use a

ONE COAX INPUT AND FOUR COAX OUTPUTS in this Finney G-204 82-channel line splitter make it useful in MATV distribution systems.

three- or four-conductor cable instead of the five-conductor type you are using for the stereo system. There are two reasons for this: so you can tell which cable is which; and because the alarm system simply doesn't require five conductors in most cases. Remember—a *continuous* cable run is needed; any breaks or unsoldered wires will trip the system every time you turn it on.

Another convenient cable for audio is antenna rotor wire. This flat ribbon cable is available in as many as five conductors which is just dandy for stereo extension speakers;

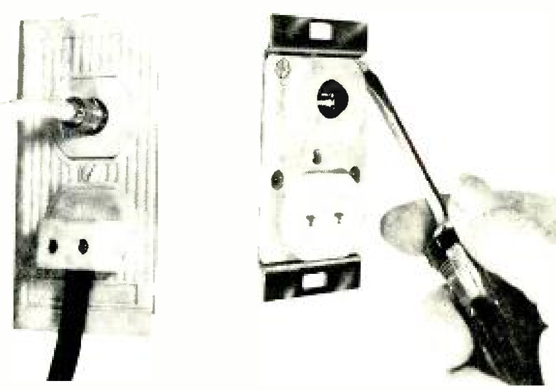
TO RUN WIRES THROUGH THE WALLS you're going to need an extension shaft for your electric drill (top) and a good high-speed wood bit.



SPEAKER SWITCHING CONTROL is a must if you are going to use several sets of remote speakers with your hi-fi system.

three wires are used for the speakers, and the remaining two for a low-voltage remote control system for the stereo rig. (Caution: some stereo amplifiers require that you use two separate ground connections.) Such a setup can be put together relatively easily using a single-pulse latching relay (P & B PC11A with 12-volt ac coil). This relay can be tough to find, but is available for $9.00 postpaid with construction plans from: David National Co., P.O. Box 381, East Brunswick, N.J. 08816.

A type of wire you'll probably be stringing most frequently of all is TV antenna wire. Whether you use 300-ohm twin-lead or 75-ohm coax is a matter of personal taste. Generally speaking, a shielded, foam-filled twinlead will possibly be easier to use and lighter on the pocketbook than coax. But if high electrical noise is a problem you will have to use coax. Common setups use twinlead from antenna to distribution amplifier; coax from the amplifier to the TV's. Whichever cable you choose, hardware is available for conve-



VARIABLE ISOLATION WALL TAPOFFS from Channel Master offer two different kinds of connections—plug-in 300-ohms and screw-on coax.

nient wall-mounting receptacles that let you plug in the TV in any room in the house.

TV cables are pulled and mounted much the same as the other types. But the hardware that goes into that wall box is something else again. This is especially true if you use coax and want to avoid the need for ugly transformers hanging on the wall or on rear of your TV—not to mention that highly visible round, black cable snaking across the wall to the set location. There are receptacle covers available that contain a built-in matching transformer, which will let you use clear 300-ohm twinlead from the receptacle to the TV.

If you do elect to wire the house for TV, bear in mind that you will probably be creating a sizable loss in your antenna signal with all those tapoffs. If you do insist on an outlet in every room, it's a good idea to install a preamplifier near the antenna, and certainly start with an antenna that is oversize to get that extra signal level you'll need so desperately.

Before you start chopping holes in the plaster and running all kinds of wires through the walls and making a mess in general and aggravating your wife in particular, draw up a blueprint of your present and projected requirements. If you have a stereo system in your den and want to install extension speakers in other rooms, decide which rooms you really want the speakers in, what kind of speakers you will use, where they will be mounted (flush in the ceiling, surface mounted on walls, etc.) and any special features you would like to build in such as color organs, etc. Once you have drawn up the blueprint, start taking some measurements and decide where you can best run the wires.

Inspect the footings of your walls in the basement and attic wherever possible, since this is probably where you will be doing the bulk of your wiring. It's a lot easier to fish a wire up between walls from the basement than it is to try to reach down between walls from an attic crawl space. The latter method, by the way, is almost impossible in some houses.

When fishing the wires, try to use inside walls only. There are two reasons for this: outside walls tend to have very little space between the exterior clapboard, cinder block or brick and the inside plasterboard or lath; also, outside walls are usually stuffed with insulation, and you will probably never get a wire fished through that insulation.

When you draw up your master plan, be sure to include such items as locations for TV line splitters and proximity of electrical outlets to proposed TV antenna outlets. After all, you have to plug the set's line cord in some place!

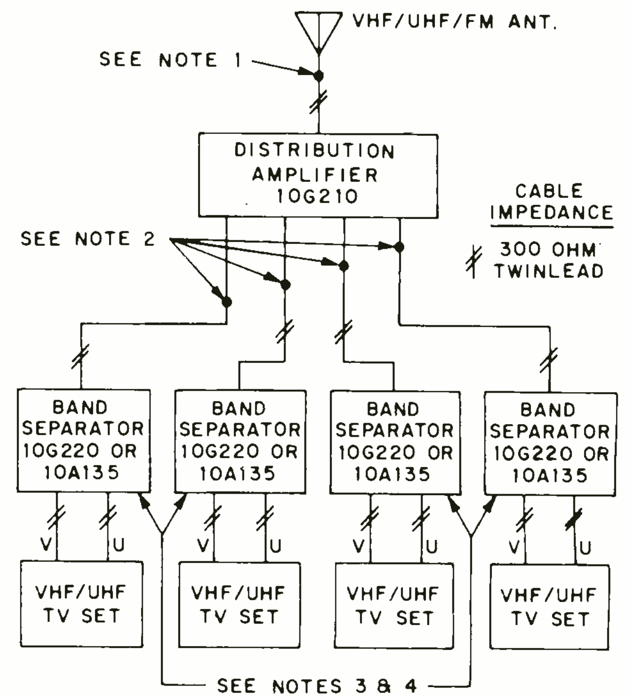
If you are wiring recreation rooms and other areas that are likely to have suspended ceilings, running wires can be as easy as pie. All you have to do is lay the wires across the ceiling support members and then slide the ceiling panels back into place. Of course, you still have to get them down behind the wall, but the problem of crossing room locations is solved nicely by the suspended ceiling.

When selecting the finishing hardware for each individual location, don't forget that there are many ready-made switch panels with the appropriate hardware already mounted on them. If you want two screw lugs on a wall switchplate, you can purchase plates already made up this way. If you require a switchplate with a special type of finish, then buy a plate with the smallest size hole available—usually cut out for a common ac toggle switch—and then enlarge the hole with a nibbling tool to meet your needs.

A two-screw lug terminal on a plate is readily available under the guise of a TV antenna outlet. This type of plate is most easily adaptable to use for stereo loudspeakers. For TV antenna installations, you will be better advised to use a female jack plate.

Since you are installing extension speakers, you may want to provide some sort of local volume control—really an absolute necessity, since no two listeners in different locations will want the same speaker volume. For that matter, different speakers operate at different efficiency levels and individual room volume controls are really a must. To do a first-rate custom job, select a blank metal wall plate and drill it to hold the various components. Typically, the components might be a stereo L-Pad for speaker volume, a dpdt miniature toggle switch, a 3-conductor headphone jack and a miniature pushbutton. The toggle switch turns the speakers off and switches on the headphone jack, through a couple of 47-ohm resistors that protect the phones against overload. The dual L-pad controls headphone volume when used this way. The pushbutton is for the stereo rig's remote control.

There is still another method which you might want to try in inaccessible locations or if you have some of those damnable outside walls to do. Try silver print, available from



Note 1: If separate VHF, UHF, or FM antennas are used, install proper RCA antenna coupler.

Note 2: To connect additional receivers use RCA 2-set and/or 4-set coupler(s).

Note 3: Band separators are not required for VHF TV or FM receivers.

Note 4: For combination VHF/UHF/FM receivers use an RCA 10G224 or 10G233 Band Separator.

BLOCK DIAGRAM OF A DISTRIBUTION SYSTEM set up for 4 TV receivers. Additional sets can be added by using multiset couplers.

printed circuit material suppliers. What you do here is simply "paint" wires (conductors) along the wall or baseboard to the speaker locations. Then paint over the conductors to match the rest of the wall. Although this method is unorthodox, it will certainly let you reach locations that would be forever lost to you with conventional wiring techniques. It also eliminates problems with landlords if you're just renting.

The tools that you will need for this work are not much different from those you use in your everyday electronics wiring and repairs. First of all you'll need the usual types of pliers: long-nose, diagonal cutters, electrician's pliers. You will also need the usual assortment of screwdrivers, and of course a soldering iron and plastic electrical tape. Also needed: an electrician's snake which might give you a merry chase before you find one. Try an electrical supply house.

You will need one or two wood-cutting bits for your high-speed drill—about ½ to ⅝ inch will give you a large enough hole to work with in most cases. Better buy two of these; it's not unusual to run into some unexpected plaster which dulls the bit very quickly. Another gadget you might want to get is a 12- to 16-inch extension shaft for your drill. It lets you reach into hard-to-get locations that just can't be done any other way.

Otherwise, the wiring job is pretty straightforward with a few wrinkles that you may not have realized were necessary. But there's no longer any reason to turn down wiring a customer's house for audio, video, burglar alarms and remote-control devices. All it takes is time and patience. **R-E**

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SCREEN SYMPTOMS AS GUIDES — WHERE TO CHECK FIRST

SYMPTOM PIC	DESCRIPTION	VOLTAGE	WAVEFORM	PART
	Sound weak or possibly dead	Q1 base	WF4	C1, C2, C6
	No sound at all	Q1 collector Q1 emitter	WF3 WF5	R2, R4, R5, R7, R8, C1, C2, C6, C7, T1, Q1, VDR1
	Sound very weak	Q1 base Q1 collector	WF3 WF5	R1, R4, R5, R6, R8, C3, C5, C7
	Sound too loud	not much help	WF4 WF5	R2, R7
	Sound weak and muffled	not much help	WF2 WF3	R3, R6
	Repeated failure of Q2	not much help	not much help	C7, VDR1, R7

NOTES:
Use this guide to help you find which key voltage or waveform to check first, or to guide you to the causes of symptoms that don't have voltage or waveform clues. (There are no visual symptoms for these stages.)
Listen to the sound, with station tuned in as best you can. Turn the volume control up and down as you listen.
The most helpful clues to the cause of whatever symptoms you hear are found at the key test points listed opposite them.
With a test signal applied (see Waveform Guide), make whatever voltage and/or waveform measurements are indicated.
Use the Voltage Guide or Waveform Guide to analyze the results of those measurements.
For a quick check, test or substitute the parts listed as most likely to cause the symptoms you hear.

DC VOLTAGES AS GUIDES

Voltage change	to zero	very low	low	slightly low	slightly high	high
Q1 base Normal 6V	R4 open R5 open R7 open R8 shorted C6 shorted	C1 shorted R6 open	R1 low R5 high R6 high R8 low C1 leaky C2 shorted C3 shorted C5 leaky		R8 open	R1 open R2 open R2 high R5 low
Q1 emitter Normal 5.4V	R4 open R5 open R7 open R8 shorted	R1 low R6 open C3 shorted	R5 high R6 high R8 low C1 leaky C2 shorted C5 leaky Q1 shorted		R8 open	R1 open R2 open R2 high R5 low
Q1 collector Q2 base Normal 7.2V	R4 open R5 open	R1 low C3 shorted	R5 high R8 low R8 shorted		R6 high R8 open	R1 open R2 open, high R5 low R6 open, high R7 open C1 leaky C2 shorted Q1 shorted
Q2 emitter Normal 6.7V	R4 open R5 open	R1 low C3 shorted	R5 high R8 low R8 shorted C5 leaky	R7 shorted	R6 high R8 open	R1 open R2 open, high R5 low R6 open, high R7 open C1 leaky C2 shorted Q1 shorted
Q2 collector Normal 92V			R1 open R2 open, high R5 low R6 open, high R8 low, shorted C1 shorted C2 shorted Q1 shorted	R6 high C1 leaky		R1 low R4 open R5 open R7 open R8 open C3 shorted

NOTES:
Use this guide and the Waveform Guide to help you pinpoint the faulty part.
With the volume control about one-third up, feed in a 400-Hz square-wave signal. Use enough signal to produce a waveform amplitude of about 0.1 volt p-p across the volume control.
Measure each of the five key voltages with your vtvm or fetvom.
For each, move across to the column that describes whatever incorrectness you find in that voltage.
Read which parts might cause that alteration.
Finally, notice which parts are also named as possible causes of other voltage changes you find.
Test those parts individually for the defect described.

The Stages

The sound, or audio, stages in monochrome and color sets are approximately alike. But some sound stages are more elaborate than others, and the sound section shown here is an example. Two feedback loops introduce some oddities in operation, noticeable mostly when you try troubleshooting.

The first stage is an ordinary npn common-emitter voltage amp. Signal voltage gain ranges from 5X to 10X, depending on the kind of signal. The square wave used to analyze this one gets multiplied about 5 times.

The output stage uses an npn power transistor. The connection is common-emitter, producing large voltage gain. Amplification is about 120 times for operating conditions shown in the schematic.

A feedback network ties the collector of the output stage to the emitter circuit of the input amplifier.

A small amount of feedback also occurs between the base and emitter elements of the first amplifier transistor. Both feedback setups are essentially negative, and their purpose is to achieve good frequency response as well as stability.

Signal Behavior

Because the complex audio waveform of TV sound is difficult to lock in with an ordinary scope, a square wave is used for analysis in these stages. The square wave beats a sine wave for this purpose because it shows more clearly what really is happening in the stages.

Capacitor C1 brings the signal to the base of Q1 from the volume control. Resistor R6 is the main input load for signal. Its signal ground is through C6, a high-value electrolytic.

Capacitor C2 couples some of the signal to the emitter, which introduces slight degeneration. A signal applied to the emitter, if it's in phase with the signal at the base, affects amplification in the transistor just the opposite. Capacitor C3 bypasses emitter resistor R1, so the true emitter load for the signal drives the emitter.

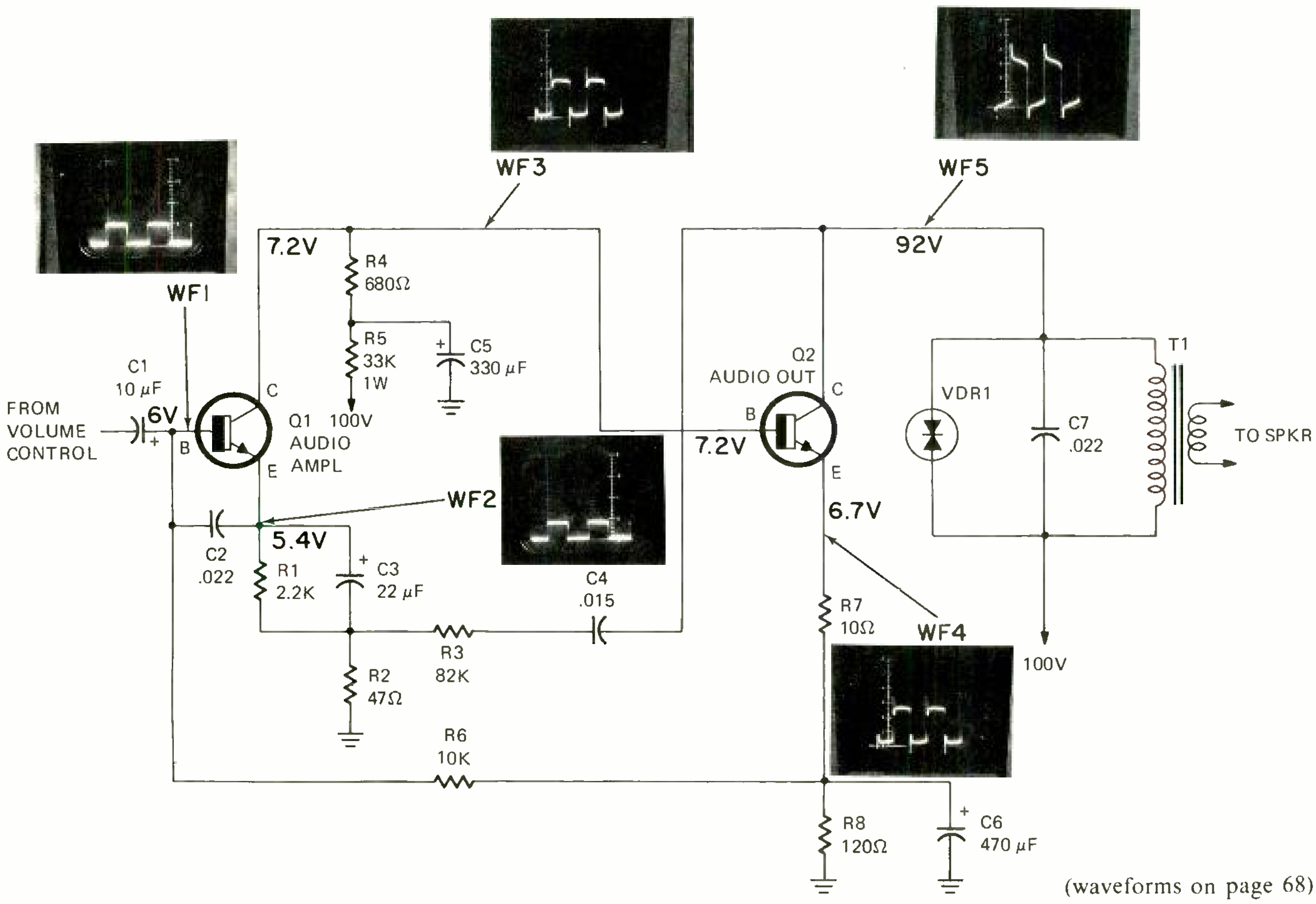
Q1 amplifies the signal 5 or 10 times. The collector of Q1 is direct-coupled to the base of Q2. Therefore, resistor R4 serves as the output load for Q1 and as the input load for Q2. Ground return for R4 is through C5. R5 and C5 decouple the stages from the dc power supply.

Power transistor Q2 imparts a voltage gain well over 40 dB. T1 matches the high output impedance of Q2 to the low Z of the loudspeaker. Capacitor C7 absorbs any transient spikes that might damage the output transistor, with additional protection supplied by VDR1. During ordinary operation, the resistance of VDR1 is fairly high. But if overvoltage occurs for any reason, the resistance drops and reduces momentarily the voltage across Q2. Otherwise, the voltage surge might break down the collector-base junction of Q2.

The emitter of Q2 goes to ground (for signal) through C6. Though unbypassed, R7 is so small, signal degeneration across it is inconsequential.

Important signal feedback travels from the collector of Q2 through C4 and R3 to the emitter of Q1. R2 is the feedback load resistor, and C3 couples the feedback directly to Q1. The signal is degenerative, improving frequency response and stability of this high-gain (more than 1000X overall) audio section.

(text continues on page 69)



(waveforms on page 68)

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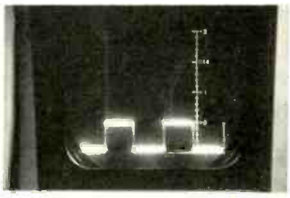
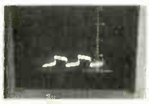
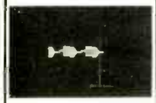
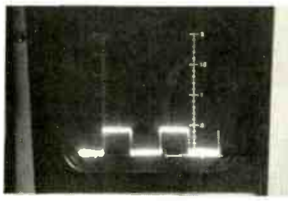
WAVEFORMS AS GUIDES



WF1 Normal .05 V p-p

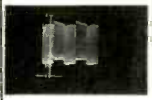
Taken at the base of Q1, this is the input square wave coupled by C1 from the volume control. Frequency for most television sound sections should be in the neighborhood of 400 Hz. Amplitude of WF1 depends on volume control setting unless signal is injected just preceding C1; then, level depends on generator output.

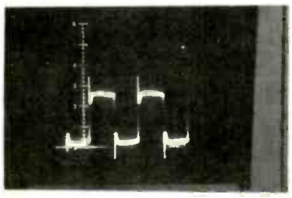
V p-p low	V p-p high	V p-p zero	Changed Shapes	
		C1 open	 .03 V p-p C2 shorted Q1 shorted	 0.5 V p-p R3 low



WF2 Normal .04 V p-p

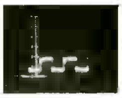
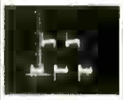
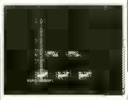
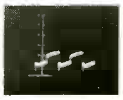
Taken at emitter of Q1, amplitude is slightly lower than at input of transistor; gain is less than unity (one). Capacitor C2 contributes to this waveform, coupling some of the input signal to the emitter, thus introducing overall degeneration. In effect, the load across which this waveform is taken is R2.

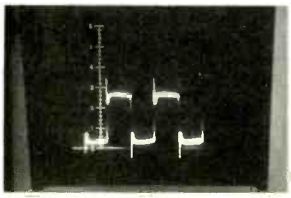
V p-p low	V p-p high	V p-p zero	Changed Shapes		
R1 open R6 open		C1 shorted C1 open C6 shorted R4 open R5 open R7 open R8 shorted	 .02 V p-p C2 shorted Q1 shorted	 4 V p-p R3 low	 .03 V p-p R6 low



WF3 Normal 0.25 V p-p

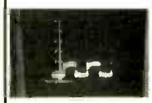
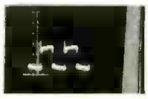
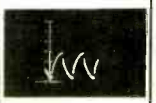
Taken at the collector of Q1 or at the base of Q2, this is the output waveform for the first amplifier stage. Note the overshoots, which are a result of peaking in the stages. Amplitude listed as normal is from flat to flat, and doesn't include the overshoot spikes. R3 and C4 both affect shape (response).

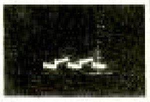
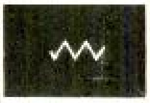
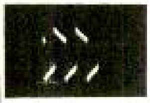
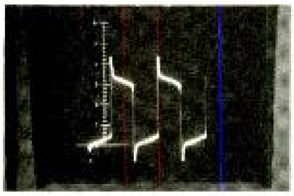
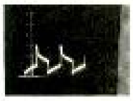
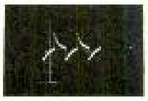
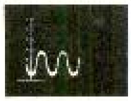
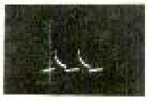
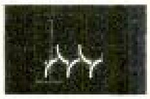
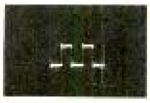
V p-p low	V p-p high	V p-p zero	Changed Shapes					
R1 open C2 leaky C3 open	R2 shorted	R2 open R4 open R5 open R7 open R8 shorted C1 shorted C1 open C2 shorted C5 shorted C6 shorted Q1 shorted	 0.1 V p-p C1 leaky	 .25 V p-p R1 low C3 shorted	 0.3 V p-p R3 low	 0.5 V p-p R3 open C4 open	 .25 V p-p C4 shorted	 .07 V p-p R4 low
			 0.2 V p-p R5 low	 1.8 V p-p C5 open	 .15 V p-p R6 low	 0.1 V p-p R7 shorted	 0.7 V p-p R8 open	



WF4 Normal 0.25 V p-p

Taken at emitter of Q2, this is what's coupled through from the base. Its amplitude is the same as or less than that impressed on the base. Shape is essentially the same as WF3, but some clues offered by the abnormal waveshapes are diagnosed better from this waveform than from the Q2 input waveform.

V p-p low	V p-p high	V p-p zero	Changed Shapes			
R1 open C2 leaky C3 open	R2 shorted	R2 open R4 open R5 open R7 open, high R8 open, shorted C1 open, shorted C2 shorted	 0.1 V p-p C1 leaky	 .25 V p-p R1 low C3 shorted	 0.3 V p-p R3 low	 .15 V p-p R6 low

		C5 shorted C6 shorted Q1 shorted	 04 V p-p R6 open	 07 V p-p R7 shorted	 0.7 V p-p C6 open		0.5 V p-p C7 shorted T1 shorted VDR1 shorted
	**WF5 Normal 30 V p-p** Taken at collector of Q2, this is the output waveform fed through transformer T1 to the speaker. The peaking characteristic shows, but some rolloff tilt is revealed—caused by the characteristics of T1-C7-VDR1. Note the large voltage amplification of this power transistor, along with current boost.						
R1 open R4 low C3 open C6 open	R2 shorted	R2 open R4 open R5 open R7 open, high R8 open, shorted C1 open, shorted C2 shorted C5 shorted C6 shorted C7 shorted T1 shorted VDR1 shorted Q1 shorted	 20 V p-p C1 leaky C2 leaky	 300 V p-p R2 shorted	 25 V p-p R3 low	 20 V p-p R5 low	
			 80 V p-p C5 open	 30 V p-p R6 low	 70 V p-p R7 shorted		

NOTES:
Use this guide to help you pin down the fault possibilities. Inject a 50-mV square-wave signal, at about 400 Hz, at the input of C1. Or, clip the square-wave generator test lead across the volume control and set the VOLUME *knob and generator output for a 50-mV signal at the base of the first amplifier.*
Use the direct probe of the scope. Set the scope sweep for about 130 Hz, to display three cycles of the square waveform. Check the waveforms at the five key test points.
Note the amplitude. If it's low or high, check the parts listed under those columns.
Note the waveshape. If there's a change that matches one of those shown, check the part or parts indicated for the change you find.

DC Distribution

Collector voltage for Q1 is applied through R5 and R4. The dc path to ground for the Q1 emitter is through R1 and R2; the drop across them sets dc voltage at the emitter. Base bias for Q1 is applied through R6, originating across R8 in the emitter circuit of Q2.

Base voltage for Q2 is the same as collector voltage for Q1—notice the dc coupling. R5 and R4 carry the dc operating voltage from a 100-volt source. The collector of Q2 is supplied through the primary winding of T1 from the same 100-volt dc line. Current through R7 and R8 develops bias voltage for the emitter of Q2. (The role of R8 in biasing Q1 was already explained.)

Station and Control Effects

Naturally, the signal levels in these stages depend on the setting of the volume control (not shown). Also, signal levels vary with sound modulation at the television station.

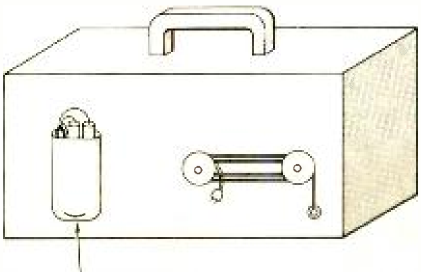
For testing, a fixed signal is the only practical means. You tune the channel selector away from any station, and set the volume control for some level that doesn't overload the first amplifier.

Levels of signal fed to the section have no significant bearing on dc voltages.

Quick Troubleshooting

The feedback loops produce some complication when you hunt trouble in these stages. You can disconnect R3 and proceed as if the loops didn't exist. You can trace signals with a scope, using station sound. Or, you can inject signals with one of the inexpensive pulse injectors or with any audio generator, listening at the speaker to analyze symptoms.

Neither method, however, tells you as much as feeding in a 400-Hz square wave and tracing it through the stages by scope, keeping the feedback loops intact. The charts show what you should find, and what's wrong when the shape or amplitude of the waveform changes drastically from its normal appearance. **R-E**



PROBES STAY WITH METER

You can make your vtvm a bit more compact and handy for work outside the shop by keeping its test probes with it and its line cord untangled. An eyeglass case screwed to the back of the meter case carries the probes. Two TV cord holders or two large washers and spacers are fastened to the case as a reel for the line cord when it is not in use.—*Peter Legon*

R-E's Service Clinic

agc circuit loops the loop

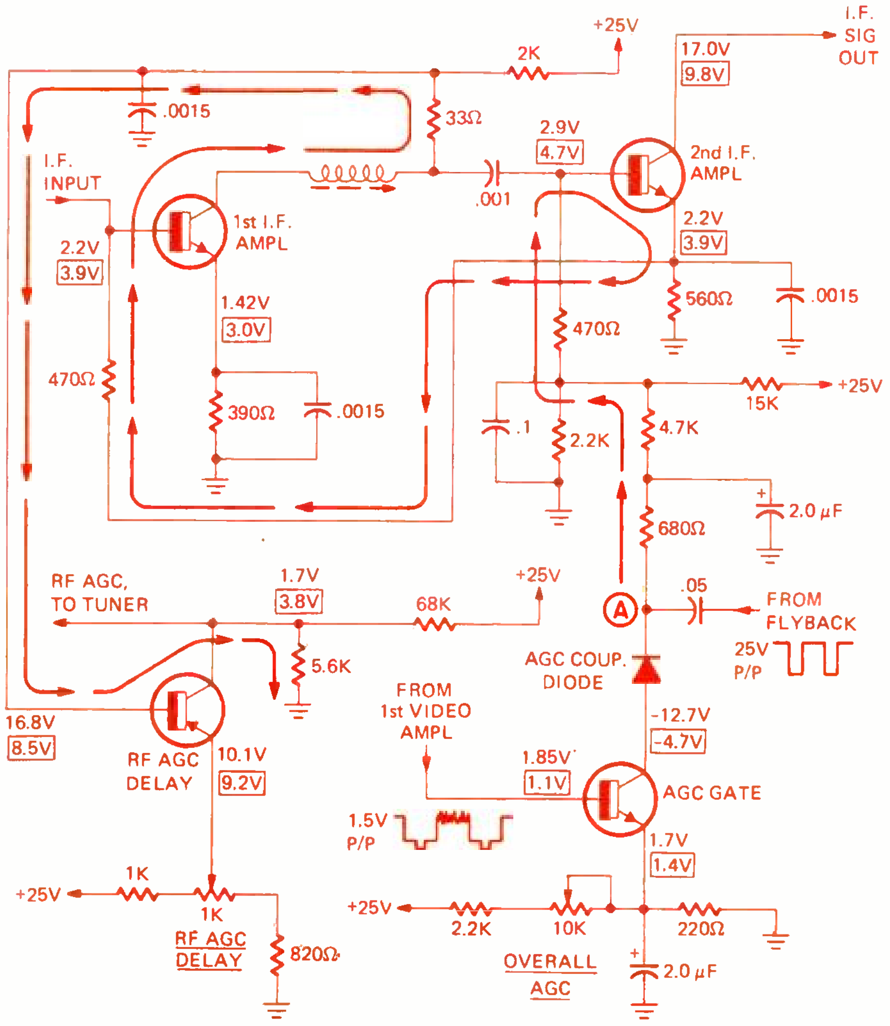
New arrangements in transistor TV's

JACK DARR
SERVICE EDITOR

YOU'RE ALL FAMILIAR WITH THE tube agc circuit. The stock version rectifies the tips of the horizontal sync pulses, develops a dc voltage proportional to their amplitude, then feeds this to the i.f. grids. From the feed-point, through some kind of delay circuit, the same voltage is fed to the rf stage, after the i.f. agc has gone as far as it can to control signal level.

Now you'll see some new things in transistor TV sets. Not actually new, of course, since this is basically just an agc circuit, but the thing turns back somersaults on the way from the agc keyer to the i.f./rf. This happens because we can have either positive-going or negative-going agc in transistor circuits! It can be forward agc where the transistor is biased so that forward bias *reduces* the gain, or reverse agc, which is the type used with tubes. The bias developed is in a direction which tends to cut off the tube or transistor.

The diagram shows a compound agc circuit, as used in Admiral 1H5 and 2H5 transistor TV's. Looks like quite a bag of worms! However, there's no need for alarm. Take it one piece at a time, and the circuit is just as easy to check out as any of them. There is nothing in here but a bunch of perfectly *normal* reactions! For example, if you increase the forward bias on a transistor base (if it's forward-agc) you have less gain, and so on. In any case, you'll be



This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, New York 10003.

able to see the "reaction"—there will be a distinct *change* in the agc voltage when the signal is applied or taken off. Follow these reactions through the circuit and you'll soon pin down any trouble. Find the point where you *do not see* normal reactions and there you are.

Let's go through this one a step at a time. You'll find this, and similar circuits, in a lot of chassis, of different makes. The diagram shows only the agc circuit and the working parts. Some have been left out for clarity.

We start with a stock agc keyer, the AGC GATE. About 1.5V peak-to-peak video is applied to its base. A keying pulse from the flyback, shaped to a sawtooth, is fed to the collector through a gate diode. The conduction of the keyer transistor is adjusted by varying its emitter voltage. This is done by the OVERALL AGC control; part of a voltage-divider from the +25 volt source to ground. The agc voltage is picked off at the diode cathode, filtered by a 2-μF capacitor, and starts out on its long journey **(A)**.

From here it goes through a voltage divider to the base of the second video i.f. transistor. It is an npn, forward-agc controlled. The agc voltage at this point goes *more positive* with an increase in signal. So the higher the signal-level, the greater the gain-reduction in this stage. From the emitter of this stage, we pick up another varying voltage. It is developed by the emitter-collector current flowing through the emitter resistor. When the agc makes the base more forward-biased, the current and the voltage rises. Here too, the agc voltage goes more positive with a rise in signal.

Off we go again. This time to the base of the first i.f. transistor. It is also an npn. Since the agc voltage is still positive-going, this stage is also forward-agc biased. We have now agc-ed the first and second i.f. stages, with only one connection to the agc itself. Next we need some agc voltage for the rf stages. It must be delayed, so it will have no effect (leave the rf stage at maximum gain) until the i.f. agc has done all it can to hold the signal level down. We do this with an extra rf-agc-delay transistor.

The i.f. voltage causes a change in the emitter-collector current of the first i.f. transistor, just as before. Now though, we take off at a different point. We break the collector load resistor into two parts—2000 ohms from the +25 volt supply, and 33 ohms. The rf-agc-delay transistor's base is connected to the junction of the two. When the first i.f. transistor's collector current rises with increasing agc voltage, there is a voltage drop across both resistors. Most of the drop appears across the larger resistor. Now if the i.f. voltage increases, the agc voltage goes *more negative.* The rf-agc-delay transistor is a pnp. So though we have changed polarity, we still have a *forward agc* voltage.

The +25 volt supply is fed to the rf-agc-delay transistor emitter, through still another voltage-divider. The collector goes to ground, through another one, also returned to the +25 volt supply. So the voltage developed across the 5600-ohm part of the collector divider goes more positive (greater current through the resistor) with an increase in signal. It is the rf agc control voltage. It is fed directly to the base of the rf amplifier transistor, an npn. Once again, this is a forward-agc reaction.

A separate control is provided, in the voltage-divider in the rf-agc-delay transistor's emitter circuit. This control can be set to get whatever delay we want. It holds off conduction of the rf-agc-delay transistor until the i.f. agc voltage reaches a certain level. From this point on, the rf agc takes hold, to prevent overloading the i.f. stages.

How do we service this circuit? It's a lot easier than it looks. The first thing we do is go directly to the source of the *initial reaction*, the agc keyer (Gate) itself. Read the dc voltage at point **A**. Then hook up the antenna and see if it *varies.* (Should go more positive, of course.) If it doesn't, check all the parts and signals in this circuit before going any farther. Look for the keying pulse. It is a negative-going 25-V peak-to-peak pulse. Check the dc voltages on the transistor and all resistors.

If the thing refuses to vary voltages when the agc control is turned, check the transistor for *leakage.* You'll have to take it out of the circuit to do this, of course. It doesn't take much leakage to upset things here. If you find any leakage, replace the transistor.

Once you get the correct reaction on the agc diode, follow it through the second i.f. transistor. Use the same basic methods and tests. You *must* get the normal *voltage-variation* on the emitter of this one. From here, onward and upward to the first i.f. where you do it all again. This time look for the voltage variation on the collector.

From here, we go to the base of the rf-agc-delay transistor. Look for voltage variation again. If you see it on the base, but nothing happens on the collector, check the transistor for leakage. There are also some parts in the tuner, such as another 2.0-μF capacitor, resistors, and the rf transistor, which can upset things. However, after what you've through to get this far, this should be easy!

Dc voltages shown are for a no-signal condition. The voltages in the little boxes are typical voltages you should see with a fairly strong signal applied to the input. By the way, one of the quick-disconnect "clothespin" antenna clips is awfully handy for making these tests. With the clip in one hand, and the vtvm probe in the other, away you go!

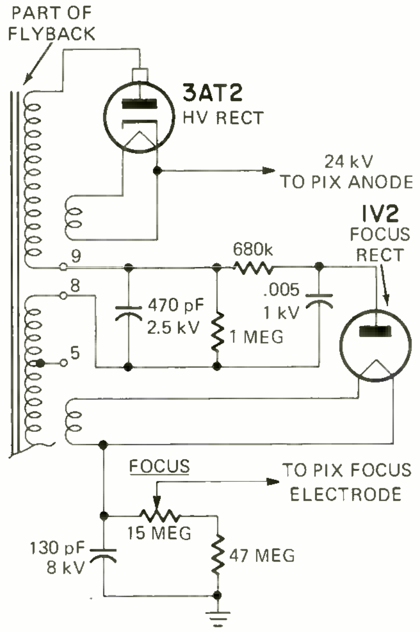
Finally, and a lot of fellows don't know this—you *can clamp a* transistor agc circuit with a bias-box for testing, just as you do with tube sets. Check the no-signal voltage at any given point and adjust the bias-box to that value. This is the "condition of maximum gain" for that particular point in the circuit. May help out in cases where you have doubts. Good luck! **R-E**

Reader Questions

FLASHOVER IN FOCUS RECTIFIER

The 1V2 socket in an Admiral 3G11 color chassis went bad. I have replaced it, but I still get flashover from plate to filament. Doping it doesn't help. Could I replace it with a 1X2, or a type with the plate on top?—V. V., Clifton, N.J.

Yes, but it might be a little tricky. How about using a solid-state focus rectifier? If you can find a good solid



mounting, it will work nicely. I've done it.

Also, you might check the R-C network between terminals 9 and 8 of the flyback that feed pulse to the focus rectifier plate. In this chassis, and some Philcos using a very similar circuit, arcovers have been known to damage these resistors and capacitors. If so, this will cause flashovers later on. Be sure that the resistors are well-insulated types, at least 3-watt rating.

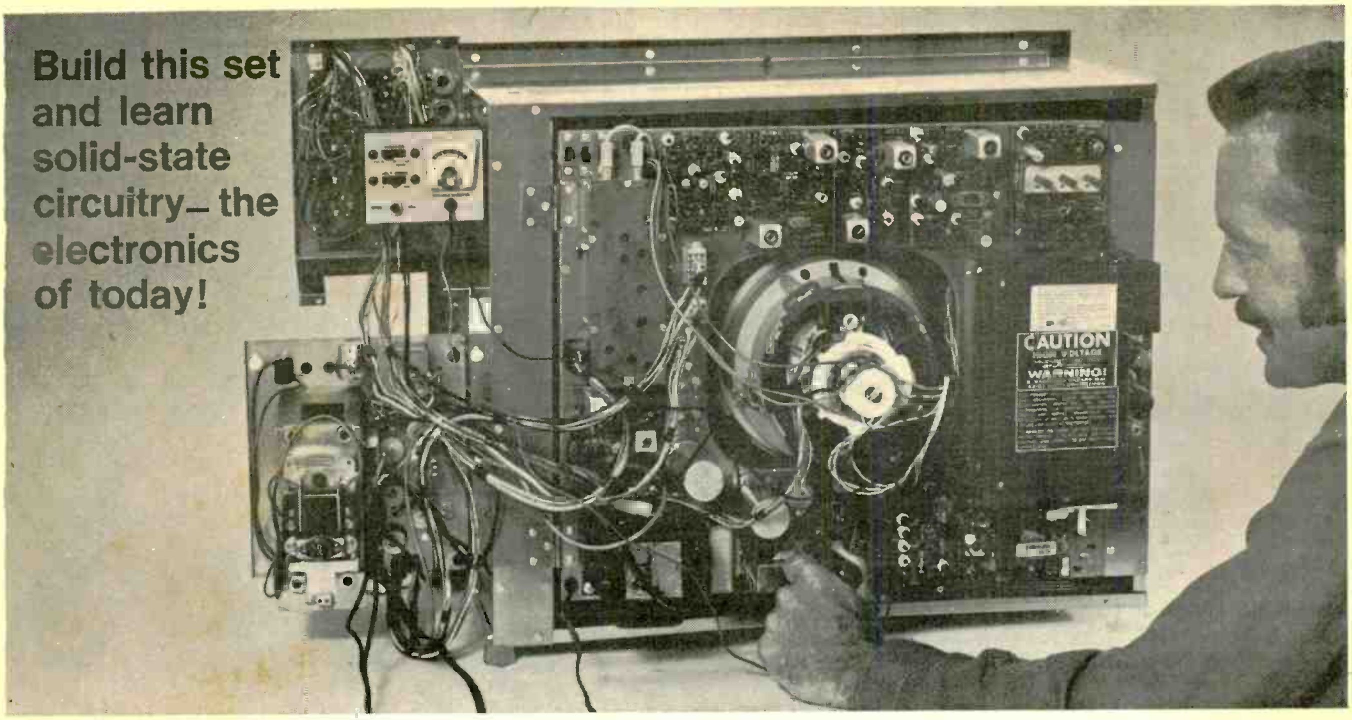
HORIZONTAL OUTPUT TRANSISTOR

I have a small GE transistor TV with the horizontal output transistor blown. Can't find a replacement that will fit; they're all too small! It's a TB chassis.—J.B., Indianapolis, Ind.

I think you'll find that an RCA SK-3035 will replace the GE 15X5 transistor in the output stage. A Motorola HEP-235 for the output or Motorola's latest horizontal deflection output transistor, the HEP-740. This thing has a peak voltage of 750 volts. So, it should hold up.

For the horizontal driver, RCA SK-3020, or HEP 736. This is a small transistor, and a lot of standard "general-purpose audio" transistors will work here.

Be sure to connect a dc milliammeter in series with the horizontal output before you turn it on. Then watch the current. Normal is about 800 mA. If you get a lot more than that, turn it off quick! **R-E**



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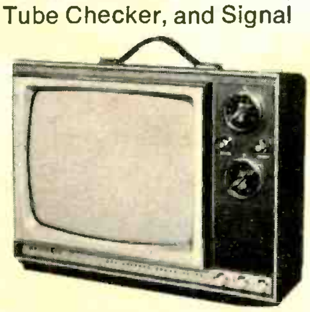

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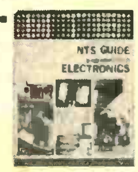

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ACTIVE ANTENNAS
(continued from page 39)

the signals and feeds them through a coaxial cable to the receiver. The output-capacitance of this band-splitter and the capacitance of the coaxial cable in the AM-range is included in the input circuit that is tuned when the antenna is installed.

The printed circuit with its components is shown in Fig. 5. An equivalent circuit diagram of this active antenna is in Fig. 7. In combination with the top capacitance C_D, which is about 10 pF, inductors L6, L7 and L8 form the passive antenna elements that pick up the high-frequency energy from the received wave. These inductors are formed with comparatively broad leads to obtain minimum losses. The conductors printed on the reverse side of the substrate are indicated by dotted lines in Fig. 7.

The optimum impedance for a noise-match in the FM-range is formed by inductors L6, L7 and L8 in combination with capacitors C2, C3 and C4 and the radiation resistance (R_s in Fig. 7). This optimum impedance exists between the terminals 1 and 1′, the connection point between the passive antenna elements and the active FM-amplifier. In the FM-range the active antenna represents a modified, bi-resonant bandfilter circuit with capacitive coupling. The first resonant circuit consists of the series arrangement: C_D, C1, L6, C2, and L7. The parallel circuit of C4 and L8 completes the second circuit with C3 representing the coupling capacitance. A bandfilter circuit is used in order to suppress any signals outside the FM-band which could cause nonlinear effects in the transistor Q3. The FM bandfilter circuit also operates as a bandsplitter to separate the AM signal from the FM signal.

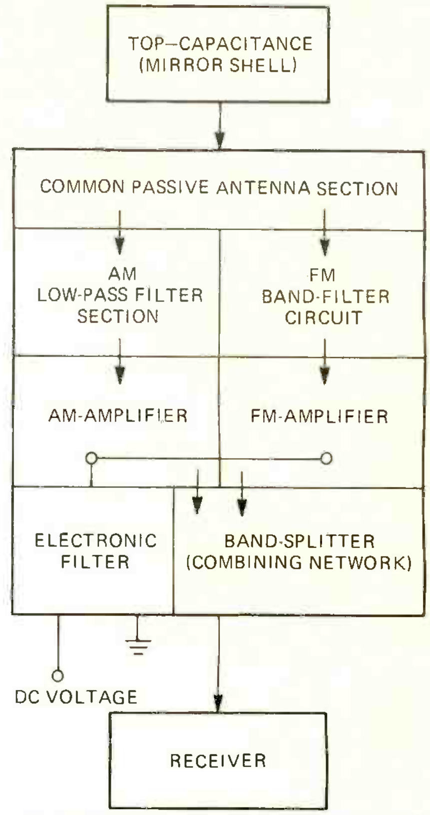


FIG. 4—BLOCK DIAGRAM of the Alpha-3. AM and FM signals are separated, amplified and recombined before going to the receiver.

The AM amplifier consists of transistors Q1 and Q2 in an emitter-follower circuit with negative feedback. The feedback is introduced by resistor R11 and increases the linearity and therefore the dynamic range of the circuit without decreasing the field-strength sensitivity of the amplifier. The input impedance of the AM amplifier (between terminals 2 and 2′ in Fig. 7) is much larger than the source impedance that is provided by C_D and C3 in parallel. This input impedance consists of a highly resistive, capacitive reactance in series with a

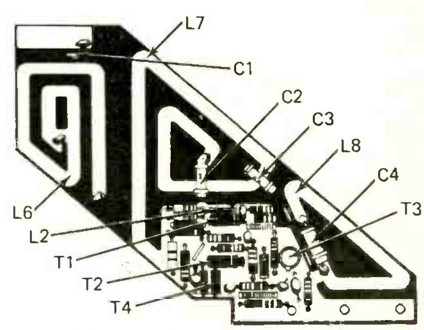


FIG. 5—PC BOARD showing location of all parts for the Alpha-3 auto radio antenna.

very small radiation resistance. C2 forms a load between the terminals 2 and 2′ that has little influence on broadband sensitivity. Because C1 is essentially larger than the top load C_D it acts as a static decoupler of the metal shell.

It is not possible to obtain a broadband noise-match in the AM-band because of the unfavorable impedance relationship over such a wide range of frequencies (150 kHz to 25 MHz). An optimum noise-match is not essential in the AM band, because at these low frequencies an ambient atmospheric noise temperature of many millions of degrees may be encountered. Thus, in the AM range, a considerable noise mismatch is permissible and relatively short antennas can be used without appreciably degrading the sensitivity of the system.

With constant received field strengths, a capacitive dipole, like the passive printed-foil antenna for the AM-band, provides a frequency independent open-circuit voltage. This means that all the signals in the AM band are at the input of the AM amplifier. The AM amplifier must, therefore, have a high field-strength sensitivity with a dynamic range large enough to avoid non-linear effects. This problem was solved by developing a wideband amplifier that is frequency independent with a satisfactory noise limited sensitivity.

The outputs of the AM and FM sections are combined in the band-splitter network and fed through a coaxial lead-in cable to the receiver. L5 and C11 form a high-pass filter, that matches the output of the FM-amplifier to the co-axial lead-in cable. In the Am range L5 acts as a short circuit and prevents the AM signals from entering the FM amplifier. In the same manner L4 keeps the FM signals away from the AM amplifier. The total output capacitance of the active antenna consists of the sum of C10, C11 plus lead-in cable capacitance.

The active antenna is powered by the vehicle's battery and any dc voltage from 4.8 to 14 volts can be used. A filter circuit removes noise from the vehicle's ignition system, electrical accessories, etc. The filtering of low-frequency interference is handled by R1 and the electronically enlarged capacitance of C5. This capacitance is multiplied by the current amplification factor of transistor Q4. This circuit also allows R1 to have a relatively small value, so that even with 6-volt operation the voltage loss is small. The filtering of the high-frequency interference is done by L1, C6, R4 and C7.

Performance of the Alpha-3

Antenna gain, a figure of merit, is very important in evaluating a passive antenna's performance. Available an-

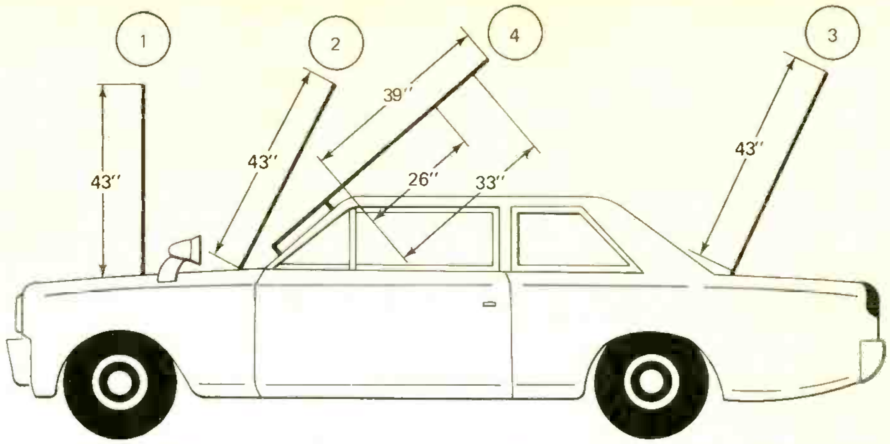


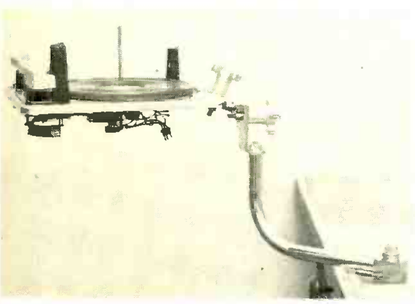
FIG. 6—WHIP ANTENNAS for automobile radios are usually mounted in one of four possible positions. The antenna on windshield post (4) is seldom fully extended to 39 inches and is usually pulled out to between 26 and 33 inches.

(continued on page 88)

new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card on page 111 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

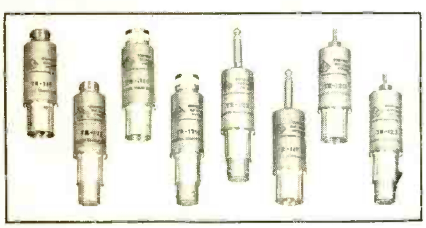
THIRD HAND, *Right Arm Uni-Swiv.* Useful for repairing record changers, portable TV's, and other chassis. Additional clamp included to hold other objects: round, etc. Swing action permits full compass rotation. Wide-angle sweep extends over



bench to permit underside adjustment. Tilts to allow easy access for repair. *Uni-Swiv* is approximately 14 inches by 12 inches. $24.95 each.—**INDUS, Div. Carlisle Corp.,** 1815 Madison Ave., Indianapolis, Ind. 46225.

Circle 31 on reader service card

MICROPHONE MATCHING TRANSFORMERS. Selection of eight in-line transformers available. Feature full frequency response 20 to 20,000 Hz, magnetically shielded, matching 25- to 50-ohm and



150- to 250-ohm microphones to high-Z inputs. Mating connectors and complete instructions are included.—**Scientific Electronic Systems (SESCOM),** 505-1/2 N. Centinela Ave., Inglewood, Calif. 90302.

Circle 32 on reader service card

DRILL SETS. Electronic, tap, master drill sets (or individual drills), for the hobbyist, experimenter, small industrial concerns, or laboratories. Made from industrial twist drills with hexagonal brass handles permanently bonded to the drill to give one-piece, trouble-free operation and longer drill life. All the drills, sizes 19 through 80, can be chucked in standard three jaw chucks for use with power drills, or hand held. Sets packaged in plastic case holding each drill securely in individual

pocket. Sets range from $10.00 to $20.00. Any individual drill $1.00 each (minimum $5.00).—**Kandu, Inc.,** 6115 Miller St., Arvada, Colo. 80002.

Circle 33 on reader service card

TV TUNER SUBBER. Substitutes for the vhf tuner in defective TV receiver to prove if original tuner is good or bad. Also simplifies analyzing i.f. and agc system de-

fects and tests the uhf tuner. Only two connections must be made, antenna and i.f. cable. Set of i.f. extension cables is furnished. Solid-state tester is battery powered. The portable unit uses a transistor vhf tuner with external gain control affording a gain reduction range of 40 dB independent of receiver agc. $22.95 for kit; $29.95 factory wired.—**Castle TV Tuner Service, Inc.,**5710 N. Western Ave., Chicago, Ill. 60645.

Circle 34 on reader service card

TV TUNER CLEANER/LUBRICANT, specially blended compound of methyl alkyl silicones and transport fluids in new type silicone chemistry for polishing and lubricating tuner contacts. Provides continuous cleaning for both color and black-and-white TV tuners. Developed for the professional service technician, this lubri-

cant is safe for all plastics, is driftless, non-flammable, will not evaporate or run, resists temperature extremes and is both paintable and solderable after normal cleanup. Available in 8-oz. aerosol can with extension spray nozzle.—**General Electric Co., Silicone Products Dept.,** Waterford, N.Y. 12188.

Circle 35 on reader service card

RADAR MOTION DETECTOR, *model 307,* operates at 915 MHz and is FCC approved. Requires 12 volts dc at 70mA for operation and this voltage can be supplied by any well regulated 12-volt source. Unit has omnidirectional radiation pattern. Its range can be varied with a sensitivity control, from a few feet to approximately 40 feet in diameter. Any person entering the doughnut-shaped field energizes the alarm circuit consisting of a C-form dry closure relay with 1-amp contacts. May be wired into any perimeter loop or used to directly trigger dialers or other alarm de-

vices. $90.00 complete with ground plane-antenna.—**Detectron Security Systems, Inc.,** Box 313A, Bay St., Sag Harbor, N.Y. 11963.

Circle 36 on reader service card

DIGITAL READOUT TRANSCEIVER, *model SB-36.* Amateur SSB transceiver has digital-readout counter providing six-digit direct frequency readout on all amateur bands. Features include single sideband power of 500 watts P.E.P., full-frequency coverage 80-, 40-, 20-, 15- and

10-meter, built-in VOX capability; semi-break-in operation on CW, and a deluxe sideband-generating system with separate crystal lattice filters for upper and lower sideband. Vacuum tubes are used where they are best suited.—**Linear Systems, Inc.,** 220 Airport Blvd., Watsonville, Calif. 95076.

Circle 37 on reader service card

4-CHANNEL STEREO RECEIVER, *model LR-440.* This compatible 4-channel

AM/FM stereo receiver has Columbia *SQ* decoding circuitry for playback of new *SQ Quadraphonic* records. Provides both discrete and derived 4-channel stereo, using the four separate amplifiers, built-in *SQ* decoding for 4-channel records, or "Composer" circuitry for deriving 4-channel dimensional sound from conventional 2-channel FM stereo broadcasts, records and tapes. Will also play 4-channel FM broadcast when approved by the FCC with an external plug-in adapter. 170 watts (±1dB); 140 watts rms at 4 ohms, 100 watts rms at 8 ohms. Frequency response: 20-20,000 Hz ±1.5dB. THD: 0.8% at rated output. Harmonic distortion 0.3% at 100%. $378.60.—**Lafayette Radio Electronics,** 111 Jericho Turnpike, Syosset, L.I., N.Y. 11791.

Circle 38 on reader service card

SPEAKER SYSTEM, *model 20.* "Linear Suspension" 3-way system has 12-inch woofer, 2-inch hemispheric dome midrange and 1-inch hemispheric dome tweeter. Handles 50 watts maximum power, 10 watts rms minimum power. May be used in bookshelf or free-standing. Woofer has ported cone cap that virtually eliminates non-linear distortion and helps

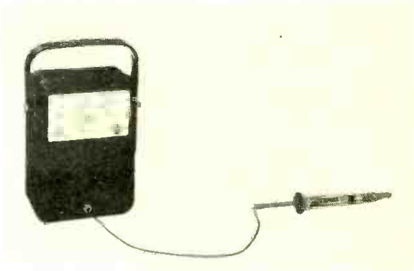
generate full-bodied bass response. Enclosure is ¾ inch thick, with oiled walnut finish. Frequency range, 35 to 20,000 Hz. Impedance, 8 ohms. Woofer free-air resonance, 28 Hz. Crossover frequencies 700 Hz, 7,000 Hz. $199.95.—**Onkyo Sales Section, Mitsubishi Int'l. Corp.,** 25-19 43rd Ave., L.I.C., N.Y. 11101.

Circle 39 on reader service card

TEMPERATURE METER, *Loner.* Portable thermocouple-type temperature meter for calibrating Edsyn's soldering instruments. Meter may also be used to measure other conventional and variable-range soldering

Circle 61 on reader service card

irons, solder pots, ovens, etc. Expanded mirror scale covers a range between 400°F. and 900°F. The Centigrade scale is divided into easy-to-read 5° increments and the Fahrenheit scale is spaced into



10° increments. The *Loner* meter has a thermoplastic protective cover and a general-purpose thermocouple probe with a 5-foot cable is included.—**Edsyn, Inc.,** 15954 Arminta St., Van Nuys, Calif. 91406.

Circle 40 on reader service card

ELECTRONIC CALCULATOR KITS, *models 816-A and 816-B.* The *816-A* has 8-digit input and 16-digit output while the *816-B* has both 16-digit input and output. Both feature leading zero suppression, digital output, adjustable fixed-decimal system, automatic error-detection circuit,

and operation with a constant. Can be put together by a beginner in less than 10 hours. The *816-A* kit for $159.88; $245.00 assembled. The *816-B* kit for $174.50; $269.80 assembled.—**Micro Instrumentation & Telemetry Systems (MITS),** 2016 San Mateo, N.E., Albuquerque, N.M. 87110.

Circle 41 on reader service card

SPEAKER SYSTEM KIT, *model AS-103,* uses the three *AR-3a* drivers in a sealed acoustic-suspension enclosure to deliver

IC TESTER
(continued from page 36)

Testing

Plug the Digi-Dyna-Check into a 120-volt, 60-Hz supply and turn on the power switch. Adjust R5 on the perfboard to obtain *exactly* 5 volts at the output of the regulated power supply. This should be measured with a VTVM, an FET input voltmeter, or other similar high input-impedance device. With all matrix *sliders* in the neutral *position,* only the pilot lamp should be on. Move *sliders* 1 thru 20 to *position* 1 (ground). None of the lamps should light. All IC test socket pins and binding posts **W** thru **Z** should be shorted together and at ground level. (Check with an ohmmeter). Move all *sliders* to *position* 2 (+5V). All sixteen readouts should be on. All DIP test socket pins and binding posts **W** thru **Z** should be at +5-volts. Move all *sliders* to *position* 3 (Step). All socket pins should be at logical **0** together with binding posts **W** thru **Z.** Depressing the STEP button should cause all lamps to turn on and bring all socket pins and binding posts **W** thru **Z** to logical **1.** Releasing the STEP button should return everything to their initial states. Move all *sliders* to *position* 4 (Step). Everything should behave as the inverse of that described for position 3. Move all *sliders* to *position* 5 (Clock). All lamps should glow at half brilliance due to the 50% duty cycle of the square wave clock output. A 50 kHz square wave should be present at all DIP test socket pins and at binding posts **W** thru **Z.** With all *sliders* at *position* 6 (Clock) you should see the inverse of that observed for position 5. Wave forms in positions 5 and 6 can be observed with a scope at binding posts W thru Z. Moving any of the *sliders* to any of the four *positions* 7 thru 10 should connect their corresponding circuits to binding posts A thru D, respectively.

If everything described here checks out A-OK, you're ready to use your Digi-Dyna-Check to check IC's. **R-E**

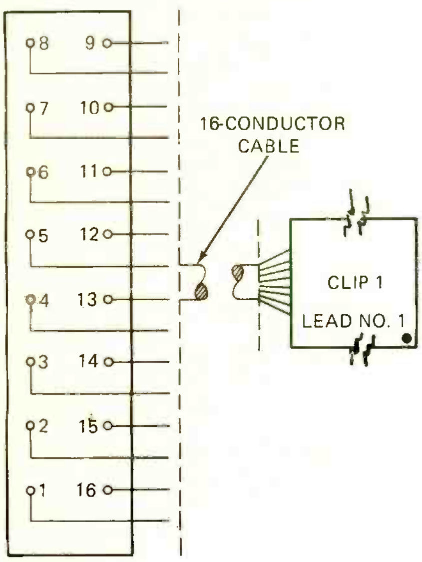


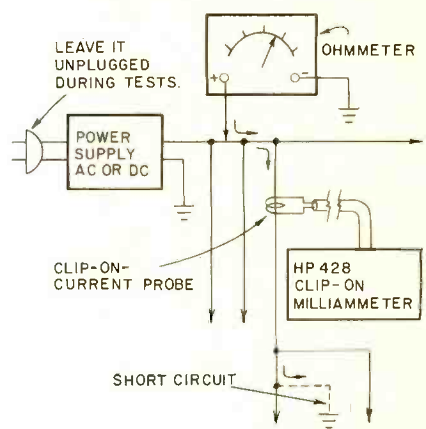
FIG. 10—ADAPTER CABLE consists of 16-pin plug and clamp and is used for in-circuit testing of DIP-type integrated circuits.

BUILD A SOLID-STATE LASER
Our June cover feature presents complete construction details of a solid-state laser. It's both easy and inexpensive to build. If you've been waiting for a low-cost low-power "safe" laser to experiment with you won't want to miss the June issue of **Radio-Electronics.**

LOCATE SHORTS WITHOUT A SMOKE TEST

When checking out a new piece of industrial electronics equipment the first item on the agenda is to look for shorts in the wiring. An ohmmeter will readily indicate a short in one of the various power leads. Which lead or leads from the various branches can be determined by the process of elimination by unsoldering one at a time. If two or more are shorted it gets rough.

A much simpler and less messy method is to leave the ohmmeter connected (as a current source), and use a HP 428 (or equivalent) clip-on dc milliammeter. The arrow on the clip-on-



probe even indicates in which direction the short is located. With more than one short, the current merely divides itself according to the conductances of the shorts. The method works equally well with shielded wires, since they don't have appreciable effectiveness at dc frequencies. The clip-on-milliammeter does depend upon an ac "carrier" for its operation, so currents in shielded wires may appear lower than expected. But, remember, it's shorts we're looking for, not current readings.—*Roy A. McCarthy, K6EAW*

REMOVING TV TUNER TUBES

The next time you have difficulty removing a TV tuner tube because of a fixed shield, try making a tube puller from a 2-inch piece of black plastic tape. Stick each end to an exposed area of the tube and move the tube from side to side while pulling upward.

If the tuner assembly is removed, the tube can be easily removed by inserting a small screwdriver through clean response and low distortion. Response is 30 to 20,000 Hz. The 12-in. woofer provides bass down to 30 Hz with very low distortion. Hemispherical dome midrange and tweeter, combined with crossover network. Separate output level controls on rear of cabinet for both midrange and tweeter allow the user to tailor the sound to suit acoustic environment. Oiled walnut cabinet. $189.95—**Heath Company,** Benton Harbor, Mich. 49022.

Circle 100 on reader service card

ELECTRONIC IGNITION SYSTEM, *Mark Ten B,* capacitive-discharge ignition. Patented circuitry extends the spark duration during starting and idle modes. Mounts on the firewall. Ten-minute installation. Operates from any 12-volt negative-ground electrical system. Reduces combustion contaminants, provides instant

starts in all weather, increases engine performance and eliminates three out of four tune-ups. Two-piece aluminum housing has neoprene seals for dust and moisture protection. Comes with switch for instant return to standard ignition—**Delta Products, Inc.,** P.O. Box 1147, Grand Junction, Colo. 81501.

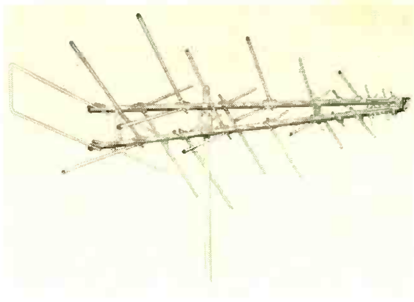
Circle 42 on reader service card

VEHICLE ALARM, *Ear Smasher.* Police and emergency type sound produces a repetitive, penetrating, yelping scream when

activated. Available now in car alarm kits 6 and 12 volts.—**Universal Security Instruments, Inc.,** 1315 E. Pratt St., Baltimore, Md. 21231.

Circle 43 on reader service card

ALL-CHANNEL ANTENNA, *model J-283X.* 82-channel TV-FM antenna for seashore, high wind, and industrial areas provides 6- to 7-dB gain on channels 2 through 6, 8- to 10-dB gain on channels 7 through 13, and



6- to 8-dB gain on most commonly used uhf channels. FM gain is 5 dB. The *J-283X* is made of seamless aluminum tubing. Ends are sealed to lock out moisture. All parts protected by anti-corrosion finish. Withstands hurricane force winds, heavy ice loading and corrosive salt air. Output is matched to 75-ohm coaxial cable. Front-to-back ratio is 18 dB at vhf and 20 dB at uhf. Beamwidth 70° in vhf low band, 45° in vhf high band and 55° for uhf channels. $150.00.—**Jerrold Electronics Corp.,** 401 Walnut St., Philadelphia, Pa. 19105.

Circle 44 on reader service card

Circle 64 on reader service card

new lit

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free for the asking. Turn to the Reader Service card on page 111 and circle the numbers of the items you want. Then mail the postage-paid card.

SCIENCE, OPTICS & ELECTRONICS CATALOG, *No. 722,* lists 4,000 unusual bargains for hobbyists, experimenters, science and crafts enthusiasts, students, gardeners and workshop buffs. Everything from air pollution testing equipment to zoom binoculars, illustrated with charts and diagrams, including tools, games, puzzles, rockets, microscopes, telescopes, photographic attachments, black-light equipment, lighting products, and kits for youngsters to use for science-fair projects.—**Edmund Scientific Co.,** 380 Edscrop Bldg., Barrington, N.J. 08007.

Circle 45 on reader service card

OSCILLOSCOPES CATALOG, *No. 5, 7/71,* a 14-page test equipment booklet presents the line of oscilloscopes and a curve tracer. These scopes, with built-in TV field and line triggering, find special application in TV service. Single-trace, dual-trace, and dual-beam scopes are shown. Fully illustrated. List of Field Engineering offices where technical assistance may be obtained.—**Tektronix, Inc.,** P.O. Box 500, Beaverton, Ore. 97005.

Circle 46 on reader service card

TECHNIQUES FOR REPAIRING ELECTRONIC ASSEMBLIES, *Bulletin No. 700-005.* Most recent booklet in the series concerns "Notations on Solder Joint Removal, Conformal Coating Removal, Component Lead Forming". Highlighted are applications and illustrated procedures for the removal of specific types of solder joints and conformal coatings. This 24-page booklet is fully illustrated with photos and diagrams. Request on company letterhead.—**Pace Inc.,** 9329 Fraser St., Silver Spring, Md. 20910.

Circle 47 on reader service card

REPLACEMENT COMPONENTS CATALOG, *No. 100, 1972.* This fully illustrated 68-page catalog of replacement components for radio and TV includes resistors, fusing devices, circuit breakers, sockets, convergence controls, service accessories, electronic chemicals, audio cables, adapters for hi-fi and cassette tape recorders, battery holders and prototype kit components. Available free to qualified distributors, service technicians and experimenters.—**Workman Electronic Products, Inc.,** Box 3828, Sarasota, Fla. 33578.

Circle 48 on reader service card

Write direct to the manufacturers for information on item listed below:

REPLACEMENT PARTS CATALOG, four pages on solid-state replacement and renewal parts for color TV receivers including SOLID-TUBES, cartridges and multipliers. Lists solid state SOLID-TUBE high voltage rectifiers, focus rectifiers and damper diodes, silicon and selenium focus cartridges, diagrams showing dimensional drawings and socket connections for SOLID-TUBE solid state replacements of vacuum tubes with maximum ratings for pulse rectifier service.—**Electronic Devices, Inc. (EDI),** 21 Gray Oaks Ave., Yonkers, N.Y. 10710.

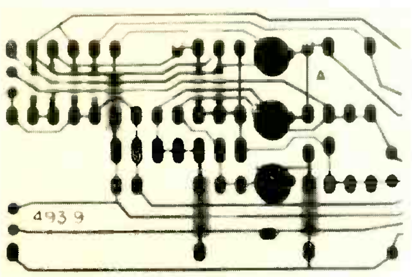
ELECTRONICS CATALOG, *1971.* 10,000 items described in this 64-page general catalog. Included are batteries, capacitors, controls, resistors, semiconductors, switches and timers plus new security systems, cassette recorders and cassette recording tapes. Available from authorized distributors.—**Mallory Distributor Products Co., Div. P. R. Mallory & Co.,** 101 South Parker, Indianapolis, Ind. 46201. **R-E**

try this one

holes in the base of the shield and gently prying upward.—*Admiral Service News Letter*

X-RAYS TRACE PC BOARDS

An article ("Surplus Printed Circuit Boards Give That Professional Touch," Clement S. Pepper, October, 1966) shows how to trace the circuits on surplus PC boards so you can adapt them to your needs. There is a much simpler scheme open to doctors, X-ray technicians and others with access to X-ray equipment.



About fifteen of the small boards can be lined up on a single 14 x 17 inch sheet of X-ray film. One X-ray picture shows both sides of the board. The large negative can be cut apart so shots of the individual boards can be enlarged and printed. The wiring and components become clear as shown.—*Arthur B. Cecil, Jr.*

RENOVATING EQUIPMENT CABINETS IN ONE EASY LESSON

Metal cabinets for electronic equipment are expensive and for this reason many projects are forced to go nude. How does one go about applying the finishing touch to the gear without finishing the wallet at the same time?

At one hamfest this past summer I managed to pick up three very nice cabinets, worth over twenty five dollars, for $1.75. They didn't look like much when I got them. The previous owners had added several holes which the manufacturer had not intended and then proceeded to remove about half of the paint by various methods and over a period of years. Had you seen them you would have understood why I had no competition in buying them.

The first step in renovation was to strip each down to the bare metal. Paint remover followed by sandpaper and elbow grease in the time honored manner is the best route here.

Next was a trip to a local auto supply store for a can of epoxy/fiberglass body filler. Several layers of masking tape were applied behind each unwanted hole as backing and filler was spread across each hole as evenly as possible. Using a putty knife or straight edge, the filler was leveled off slightly above the surrounding area and allowed to cure per directions on the can. When cured the filler was filed and sanded level (a belt sander works wonders). The tape may now be removed, it having now served its purpose.

The cabinet may now be sprayed with whatever finish you might desire. I prefer a wrinkle finish because it hides my mistakes. Hammertone or plain enamel would do as well if you apply slightly more effort to the sanding process.

The total cost of all three cabinets, in new condition, amounted to less than $4.25, or about one half the price of one new one.—*William P. Turner* **R-E**

ACTIVE ANTENNAS

(continued from page 79)

tenna gain is the criterion of the obtainable field-strength sensitivity of a receiving system. With an active antenna the amplification is an additional source of gain. Therefore, the gain of an active antenna has to be defined as an overall gain that is the product of antenna gain and internal amplification gain. The Alpha-3 is designed for a good signal-to-noise ratio and not for a high gain, which can easily be obtained by amplification in the receiver. In fact, the amplification of the active antenna must not be too high or it will cause nonlinear effects in modern (sensitive) car receivers. On the other hand amplification has to be high enough to show a considerable improvement in the signal-to-noise ratio for an older (insensitive) receiver. Therefore, the amplification was adjusted to provide an antenna voltage 10 to 15 dB higher than that of a conventional whip antenna in both the AM and FM bands. This value was measured with both antennas in the same location mounted on a car.

For a comparison of antenna height and location the Alpha-3 and four common models of vertical whip antennas are shown in Fig. 6. Extensive driving tests were made in comparing these various whip antennas with the active antenna. The results of these measurements for the signal-to-noise ratio of the various whip antennas in comparison to the active antenna are shown in Fig. 8 and Fig. 9.

Taking all the measurements that are plotted in Fig. 8 into account, we can say that in spite of the small antenna height of the Alpha-3 the signal-to-noise ratio of the active antenna is equivalent to that of the average conventional receiving system (a whip antenna and a modern receiver) for the AM-band.

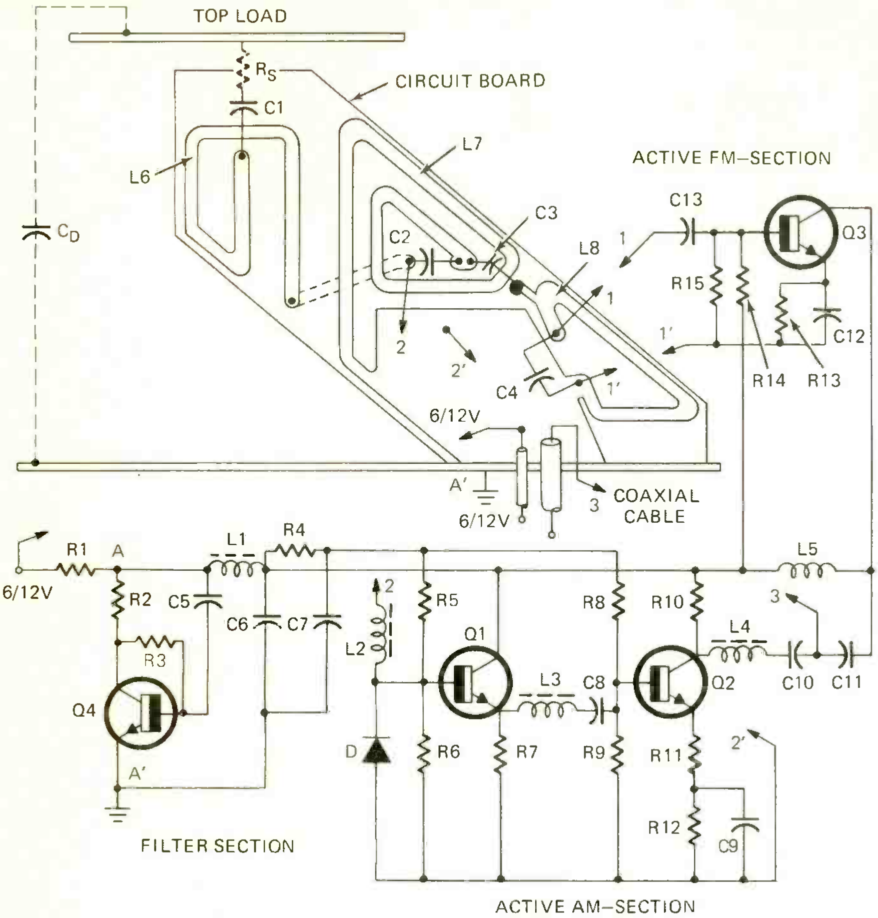
Similar measurements comparing the signal-to-noise ratio in the FM-band are shown in Fig. 9. The curve in Fig. 9 illustrates that the S/N of the active antenna is considerably higher than the S/N of a whip antenna mounted in its optimum position (antenna No. 1 in Fig. 6).

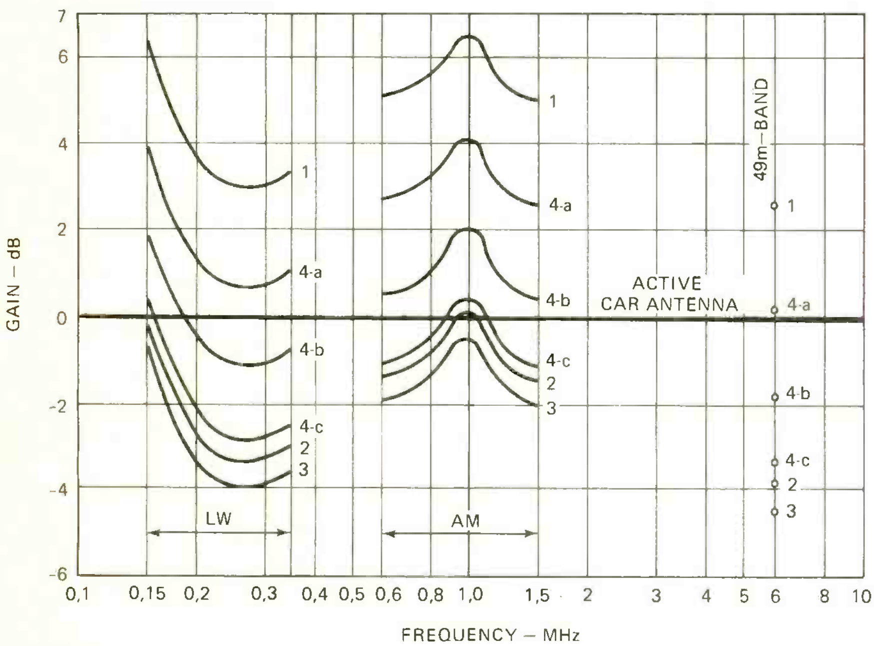
There are two main reasons for this improvement in signal-to-noise ratio:

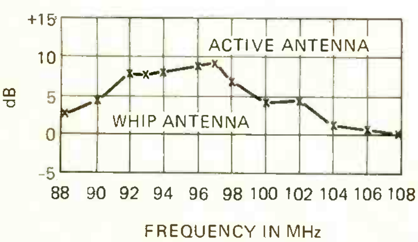
FIG. 7—EQUIVALENT CIRCUIT of the active antenna. Low-pass and band-pass filters separate AM and FM signals before amplification.

FIG. 8—SIGNAL-TO-NOISE CURVES (right middle) compare whip antennas mounted in four positions (Fig. 7) to the active antenna on the LW, AM broadcast and 49-meter SW broadcast bands. Curves 4-a, 4-b, and 4-c are for antenna in position 4 extended to 39, 33, and 26 inches, respectively.

FIG. 9—ACTIVE ANTENNA (right) signal-to-noise ratio approaches 10 dB in center of FM band when compared to a 43-inch whip in position No. 1.







1. Noise optimization due to the band filter design in the FM-range.

2. Optimum positioning of the antenna in relation to the signal wave-field in the vicinity of the conductive vehicle body.

To get an optimum signal-to-noise ratio and the maximum amount of de-

(continued on page 91)

new books

WIRING THE WORLD—The Explosion in Communications, edited by Joseph Newman. U.S. News & World Report, Book Div., 2300 "N" Street N.W., Washington, D.C. 20037. 5¼ x 8 in. 207 pp. Softcover, $2.95.

Easily understood by the general reader, and complete enough to be useful to specialists, this book on the challenges and opportunities of cable television explains the nature and implications of the radical change that is coming in the communications life of the nation. Presents history of growth of CATV; description of how it works; analysis of its programming; advantages and disadvantages compared to broadcast TV; and describes government regulation of CATV. Illustrated with maps, charts, tables and photographs, plus an index.

ELECTRONIC CIRCUITS MANUAL, by John Markus. McGraw-Hill Book Co., 330 W. 42nd St., New York, N.Y. 10036. 8¾ x 11¼ in. 988 pp. Hardcover, $19.75.

Engineers, experimenters, hobbyists and students will appreciate this compendium of over 3,000 advanced circuit designs, each complete with values of all components, illustrated and labeled. Similar circuits grouped together for easy comparison and browsing. Each entry contains complete abstract and citation to the original article, book, report, or other source from which more information can be obtained, including foreign publications and manufacturers' literature. Circuits such as automotive ignition, high-voltage, laser, magnetic tape, metal detector, tachometer, etc., are discussed.

MUSIC MACHINES—AMERICAN STYLE, by Cynthia A. Hoover. Published for Nat'l. Museum of History and Technology by the Smithsonian Institution Press; available from Supt. of Documents, U.S. Gov't. Printing Office, Washington, D.C. 20402. Stock No. 4700-0182. 8½ x 10½ in. 140 pp. Softcover, $2.75.

This illustrated program of the Smithsonian exhibition surveys the development of music machines in America. It emphasizes the ways in which science and invention have affected the performer and his audience. The nostalgia produced by seeing old "crank" phonographs, reproductions for advertisements from long ago, the Victor stained-glass window showing "his master's voice," Bing Crosby during a 1935 broadcast, right up to the present rock bands with all their electronic equipment, is an exciting experience to the musician, the technician, and the listener.

R-E

NEXT MONTH

If you build the IC tester described in this issue you'll want to know how to use it. Next month Jack Cazes shows some of the tests you can perform using this instrument.

ACTIVE ANTENNAS
(continued from page 89)

FIG. 10—ACTIVE WHIP ANTENNA—the Beta-3—is just slightly more than 15 inches long.

sired signal with a given antenna, the polarization of the antenna must be the same as the electric field strength of the incoming signal. With the high frequencies in the FM-range the incoming wave-field is greatly disturbed by the irregular shape of a vehicle's metal body (ground plane). This causes the electromagnetic wave-field to become inhomogenous with an undefined polarization. A vertical whip antenna obtains its effective ground plane from a vehicle's metal body and extends with its upper part into the inhomogeneous range of the electromagnetic field. This means that the electric field lines will not be parallel to the whip antenna and, therefore, the upper part of the antenna provides only a small contribution to the total received signal power. In spite of this fact, a vertical whip antenna cannot be shortened for impedance reasons. A vertical whip antenna is a single element radiator, that is resonant at only one frequency and with decreasing antenna height the mismatch between the antenna and the receiver increases considerably.

However, a very short antenna mounted vertically to the vehicle's body will always be parallel to the electric fieldlines. This means that the antenna will be optimum polarized with a polarization that is effectively independent of the polarization that is being transmitted by a radio station. It is a well known fact that electric field lines are forced into a vertical position on the surface of a ground plane regardless of the original polarization of the wave-field.

Cross-modulation

Many tests were also conducted for cross-modulaion and interference-modulation from combination frequencies. As with previous field testing, the active antenna was compared with the whip antennas in Fig. 6. The field tests were conducted near Munich, Germany, where the transmitting antennas from the AM stations Radio Munich and the US Armed Forces Network are very close to each other. Both of these stations have a radiated power of 100 kW. When the test car was 0.62 mile (1 kilometer) from both of these transmitting antennas it was possible to pick up distant stations without noticing any interference from cross-modulation. In these field tests, cross-modulation was first noticed at 320 yards (300 meters) from one of the 100-kW transmitting antennas. Since similar results were obtained with the vertical whip antennas, the antennas were equal in this respect.

In July of this year Fuba released a new electronic car antenna called Beta-3 (see Fig. 10). This new model is designed for mounting practically anywhere on the body of an automobile and is suited for any style of automobile or vehicle. I understand, that the electronic performance of Beta-3 complies with the principals already used with the Alpha-3. **R-E**

JUNE 1972—OP-AMPS AND YOU
A new feature that shows a spectrum of op-amp applications that are so practical that you won't want to wait to try them.

A super 25V Color TV—new electronic calculator

NEW Heathkit "Computer Tuner" — we've brought new digital technology to FM stereo for the man who knows his music

NEW TO CONSUMER ELECTRONICS — pure digital design philosophy brings you one of the most fascinating and satisfying kits you'll ever build. Plus, a piece of precision audio gear that's already the talk of the stereo world. With the Heathkit AJ-1510 "Computer Tuner" you "keyboard" your FM station frequency and, if the broadcast is receivable, you hear it instantly. Numerical display tubes show your location on the FM spectrum. And the "Computer Tuner" automatically center-tunes for optimum reception! Gone are the knob, slide-rule frequency scale and tuning meter. A digital frequency synthesizer, employing phase-lock-loop techniques, does the tuning — with channel frequency accuracy better than 0.005%. The preassembled varactor FM RF tuning unit (front end) uses field-effect transistors to provide high sensitivity (less than 1.8 uV) and low cross modulation with no overload on strong signal local stations. The familiar mechanically-ganged variable capacitor has been replaced by varicaps (voltage variable capacitance diodes) to provide complete electronic tunability. An inductorless digital frequency discriminator of the pulse counting (averaging) type follows two fixed-tuned five-pole LC IF filters thus eliminating all IF and discriminator adjustments while achieving distortion levels of 0.1%.

THREE TOTALLY DISTINCT PROGRAMMING MODES. Besides the exclusive keyboard tuning, you can select your FM with a sweep/scan mode. Push a button and the synthesizer counts down through the band, stopping at each station of listenable quality, or just stereo stations if you prefer. Or, you can pre-program your favorite frequencies on the computer-type punch cards included with the kit. Up to three cards can be inserted simultaneously behind the hinged front panel with instant access to these stations via A, B, C pushbuttons.

AUDIBLY SUPERIOR PERFORMANCE SPECS. Selectivity and IF rejection are better than 95 dB. Image and spurious rejection are better than 90 dB. Signal-to-noise ratio better than 65 dB, separation better than 40 dB. The 55 ICs, 50 transistors and 50 signal diodes mount on 10 modules with seven plugging into a master board for maximum computer modularity. And that makes assembly even easier. Order your "Computer Tuner" and start enjoying the FM sound that only true digital technology can bring.

Kit AJ-1510, "Computer Tuner" less cabinet, 23 lbs. **539.95***
AJA-1510-1, optional pecan cabinet, 6 lbs. **24.95***

The Heathkit AA-2004 Integrated Amplifier — 200 versatile watts for discrete or matrixed 4-Channel sound, and stereo or mono

AA-2004 puts you right in the middle of the 4-channel excitement — without obsoleting all the stereo gear you already own. It serves up a block-busting 200 watts through four channels, with control versatility that lets you put the power into any format — mono, stereo, matrixed 4-channel, discrete 4-channel.

IMPROVES WHAT YOU ALREADY OWN. Thanks to built-in matrix circuitry that decodes matrixed 4-channel recordings and 4-channel broadcasts, the AA-2004 lets you use your present turntable, tape equipment or tuner. Also, the decoder enhances your present stereo record & tape library, and conventional 2-channel FM broadcasts by feeding the "hidden presence" to rear speaker for an extremely satisfying 4-channel effect.

PUTS YOU AHEAD OF TOMORROW'S DEVELOPMENTS. As discrete 4-channel media becomes more prevalent, the AA-2004 is ready. Four conservatively rated and fully protected amplifiers produce 260 watts into 4 ohms (4x65), 200 watts into 8 ohms (4x50), 120 watts into 16 ohms (4x30). Controls are provided for every source, mode and installation. Amplifier sections are controlled in pairs with one complete stereo system for left & right front speakers and another for left & right rear — so your AA-2004 can be used to power two separate stereo systems if desired. With outputs for both main and remote speaker systems, it can be used to power two 4-channel systems (up to 8 speakers).

PERFORMANCE SPECS YOU'D EXPECT FROM HEATH. Make your own comparison of the AR-2004's impressive specifications: Full power bandwidth on all channels from less than 5 Hz to more than 45 kHz for 0.25% total harmonic distortion. IM distortion less than 0.2%. Damping factor greater than 100. Hum and noise −65 dB for phono, −75 dB for tape and aux.

GOES TOGETHER WITH TRADITIONAL HEATHKIT SIMPLICITY. Plug-in circuit boards and preassembled wiring harnesses reduce point-to-point wiring — make the AA-2004 as much fun to build as it is to use. Get with the 4-channel revolution now. Order your Heathkit AA-2004.

Kit AA-2004, 39 lbs., less cabinet **349.95***
AAA-2004-1, pecan cabinet, 7 lbs. **24.95***

—"Computer Tuner"—4-channel amp

And 350 other exciting projects in the FREE Heathkit Catalog

If you're not already into a Heathkit hobby, what's holding you back? Ask around and you'll find a Heathkit builder who can show you the rewards. You'll pay yourself back for your kitbuilding time with better products. Better in terms of price, value, performance specifications, and self-service features. And the Heathkit line-up is bigger and better than ever. Including color TV, stereo/hi-fi, electronic organs, home appliances, engine tune-up tools, radio control, shortwave, marine gear, instruments, hundreds more. They are all in the free '72 Heathkit Catalog. Send for yours now.

NEW Heathkit Electronic Desk-Top Calculator — full-function, 8-digit readout for a low, low kit price

Approximately eight enjoyable hours of your time can give you that calculator you've been wanting for home or office — at a price substantially below any assembled unit with comparable features. The new Heathkit 2008 Electronic Calculator handles addition, subtraction, multiplication and division with up to eight-figure totals displayed on extra-bright ½" seven-segment readout tubes. The 2008 accepts both positive and negative numbers. Solves problems in either constant or chain operations. Simply push the K (constant) key and multiply or divide by one preselected number, release the key and you can work a series of multiple-operation problems with the Calculator automatically displaying running sub-totals with each step.

FOOLPROOF CREDIT BALANCER. The IC-2008 automatically displays a minus result to make credit balancing as easy as keying in the credit and debit columns in any sequence. Touch the total key and you have the result with no need to manually sub-total. You can balance the family checkbook in minutes! A thumbwheel sets the decimal in any one of seven fixed positions, or you can select the floating mode for decimal totals carried out to completion. A ninth readout tube at the left of the display indicates plus or minus overflow, as well as a minus sign for negative results. A partial clearing key allows you to remove the last entry from the circuitry while preserving the rest of the problem.

DEPENDABLE AMERICAN-MADE LARGE SCALE INTEGRATED CIRCUIT is the "brain" of the Heathkit IC-2008 Calculator. Components mount on two roomy circuit boards for quick, neat construction. And you can wire your IC-2008 for either 120 or 240 VAC operation. Figure it out for yourself — the Heathkit IC-2008 is a great kit-form value. Take advantage of it today.

Kit IC-2008, 11 lbs. **129.95***

NEW Heathkit GR-900 25 V Color TV — the most technically advanced set we've ever offered

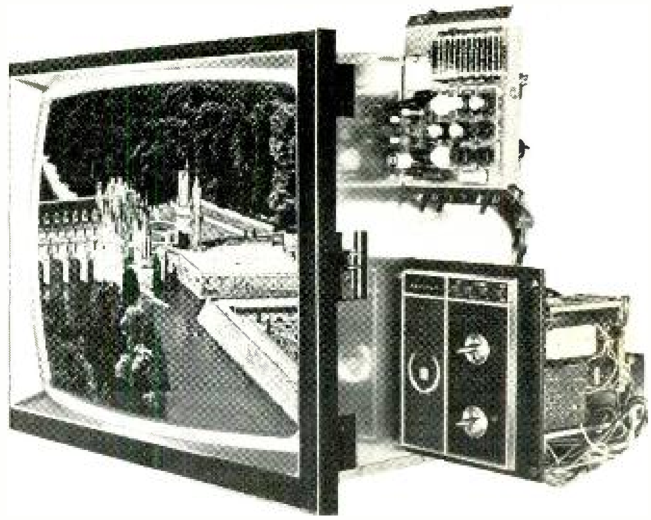
13 SUB-KITS SIMPLIFY ASSEMBLY — and take you from the first circuit board through final alignment. The result is the largest color picture you can buy anywhere, with a complement of convenience controls found only on the world's most expensive receivers. A soldering iron and a few conventional hand tools are all you need to get your GR-900 together. We supply everything else.

UHF/VHF DETENT POWER TUNING — heads up the impressive list of GR-900 features. Push a button and you scan either UHF or VHF channels, in either direction, with detent action locking in on the 12 VHF and any 12 preselected UHF channels.

NEW VOLTAGE-CONTROLLED VARACTOR UHF TUNER and a newly designed VHF tuner with MOS field effect transistor contribute to better fringe-area reception and increased sensitivity. A new angular tint control for "normal" or "wide angle" color demodulation minimizes tint and flesh tone change when you switch channels or when programs change. And check this list of deluxe features: "Instant on" with override; automatic fine tuning; adjustable tone control; stereo/hi-fi audio output; automatic chroma control; adjustable video peaking; adjustable noise limiting; gated AGC; illuminated channel identification. For total armchair control, there's even an optional wireless remote control.

EXCLUSIVE HEATH MTX-5 ULTRA-RECTANGULAR BRIGHT TUBE measures a full 25 inch diagonal, 315 sq. in. viewing area — has a specially etched face plate to cut glare, with each color dot projected against solid black background for extra crispness.

STATE-OF-THE-ART RELIABILITY. The modular solid-state design utilizes 46 plug-in transistors, 57 diodes, and four ICs, with the majority of the circuitry on plug-in boards. The built-in dot generator and tilt-out convergence panel are periodic adjustment aids you'll find only on Heathkit sets. And further, a built-in volt-ohm meter and simplified troubleshooting section in the manual permit self-servicing should the need ever arise. The '72



Catalog lists four beautiful cabinets for the GR-900, plus the exciting new Custom Wall Mount that allows you to build the set into a wall. Brighten your life with Heathkit solid-state color entertainment. Order your GR-900 now and know the pride of building and owning the best.

Kit GR-900, TV less cabinet, 125 lbs. **599.95***

Kit GRA-900-6, wireless remote control, 6 lbs. **79.95***

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TELEVISION SERVICE ASSOCIATION CODE OF ETHICS

THE TELEVISION ELECTRONICS SERVICE Association of St. Louis, Missouri, has prepared a Code of Ethics which they offer to the industry for consideration and adoption.

"Through this Code of Ethics we accept our responsibility to uphold integrity in advertising and business conduct. We pledge that we will. . .

"1. Employ qualified personnel and use approved methods and equipment in rendering service. Personnel shall be adequately trained for their assigned responsibilities, and carry proper credentials. Technicians shall not be paid on a basis that is contingent on the size of the customer's bill for service. The equipment and methods used shall be consistent with those recognized by the industry as standard.

"2. Advertise in a manner fair to both customers and competitors. All advertisements shall abide by the Standards as adopted by the television service industry and the Better Business Bureau of Greater St. Louis.

"3. Properly describe the service charges.

a. *Service Call*—A stated minimum charge for a Service Call should be presented with adequate explanation as to what it means. For example, a Service Call includes travel time, inspection, checking, adjusting and minor clean-up and repairs; none of which require removal of the chassis, the use of soldering iron or more than thirty minutes in the home.

b. *Trip Charge*—A Service Call should not be misconstrued with a Trip Charge. A Trip Charge includes only travel time to the home.

c. *Additional Labor* may be charged if repairs require removal of chassis, the use of a soldering iron, cleaning and lubricating tuner, technical adjustments or more than 30 minutes in the home.

d. *Shop Repairs*—All charges for shop repairs, estimates and "no repairs" shall be discussed with the customer prior to removal of the set from the home.

e. *In Warranty Handling Charges* are accepted by the television service industry as an additional charge to the customer to process warranty parts back to the manufacturer.

f. *Additional Sets*—Additional charges will be made to repair additional sets on the same call.

"4. Render service promptly and proficiently. Service shall be rendered as expeditiously as possible. The customer shall be promptly informed if parts are not readily available. Service and complaints shall be handled in a courteous, professional manner designed to create customer confidence.

"5. Give estimate in advance and perform only authorized repairs. Any estimate or cost quoted in advance as definite shall be fulfilled in that manner. Estimates and prices shall be fully explained and all agreements or understandings with the customer shall be respected and fulfilled. All repairs or service must be authorized. Giving a low estimate in advance with the intent and purpose of providing further service and parts at an additional charge is an unfair practice. The customer shall be informed in advance if there is an estimate fee in addition to a service charge.

"6. Install parts of the same or of better quality and performance rating. All parts and tubes shall be returned to the customer on request, except those under warranty or on an exchange basis.

"7. Issue an itemized bill. A written itemized bill for all parts, labor and any other charges shall be given to the customer upon completion of the work.

"8. Issue valid guarantees and warranties specific as to their terms. Guarantees and warranties shall be in writing and be specific in their coverage as to materials, parts, labor and length of time. The issuing company shall make the necessary provisions for fulfilling its obligations.

"9. Provide adequate protection of customer property in the process of service. Adequate insurance and/or financial responsibility shall be maintained against loss or damage." **R-E**

(continued from page 50)

between the signal output of the antenna and the total distribution loss. Suppose, for example, that the antenna picks up 10 dBmV of signal at Channel 57. The amplifier would have to make up the difference between the 10 dBmV input and the 40.0 dBmV total distribution loss. In other words, the amplifier would have to provide at least 30.4 dB gain.

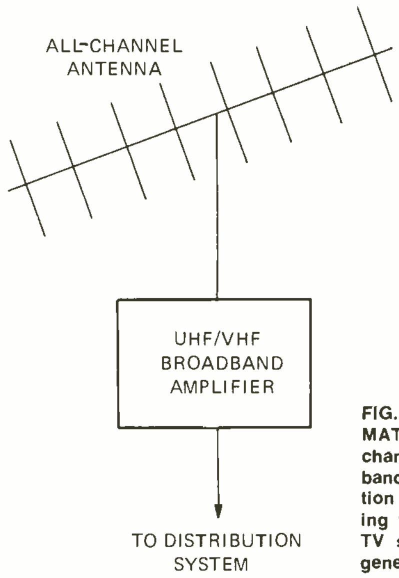


FIG. 6—BASIC HEAD-END for MATV system consists of all-channel antenna and a broadband uhf/vhf booster. Distribution system depends on building type, size and layout. All TV stations are in the same general direction.

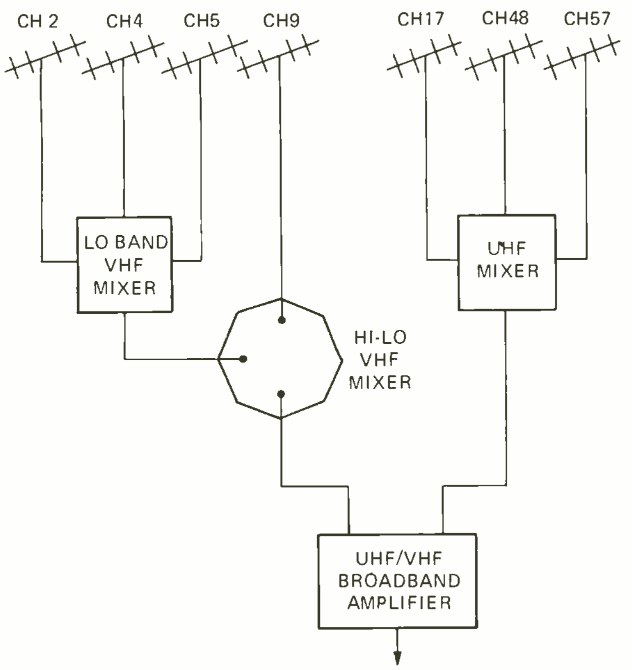


FIG. 7—SINGLE-CHANNEL ANTENNAS are needed when TV transmitting antennas are all in different directions from receiving site.

To choose a specific amplifier to serve a particular system, consult the manufacturer's specifications. But here are a few points to bear in mind:

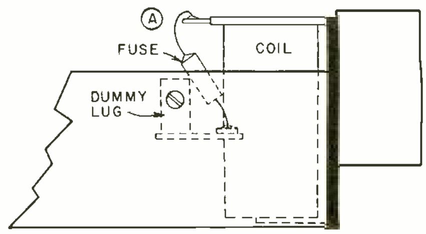
1. Choose equipment from a reliable manufacturer. It is all too easy to create paper tigers by fudging on specifications. Leading manufacturers don't do this.
2. Make sure your head-end amplifier is a solid state unit. Vacuum-tube equipment sometimes delivers more output power, but will require considerably

(continued on page 101)

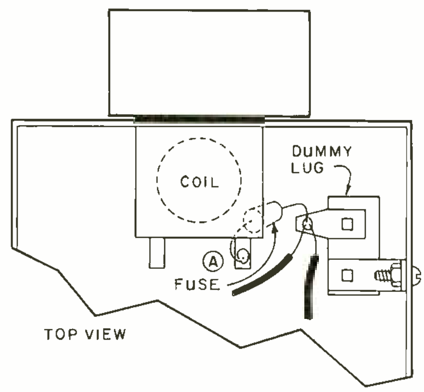
technotes

EMERSON MODEL 19P86

This model uses remote control chassis 471917 which, in late production, includes a thermal fuse (Emerson part No. 808028). The purpose of this fuse is to protect the stepping relay. It is wired in series with the relay coil and is dressed snugly against the coil body so as to react to any extreme temperature rise of the coil.



SIDE VIEW



TOP VIEW

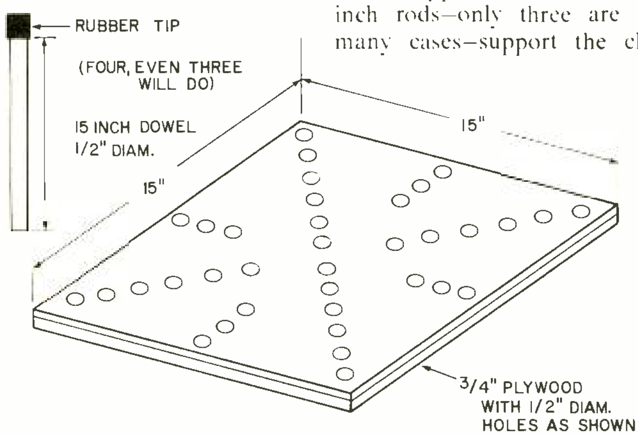
Whenever you service an early-run model 19P86 receiver, this modification should be added to the remote receiver. Fix-kit No. 966529, consisting of the fuse, a 1-point dummy lug, nut and screw, is available from the factory.

The drawings show top and side views of the relay end of the remote chassis. Install the dummy lug as shown. Remove the two wires from terminal A of the relay coil and connect them to the dummy lug. Then connect the fuse from the dummy lug to terminal A. Dress the fuse against the body of the relay coil to provide maximum sensitivity to coil temperature.—*Emerson Service Bulletin*

CHANGER SERVICE RACK

It is difficult servicing a record changer without an adequate support that does not obstruct any of its moving parts. Commercial changer racks are expensive and take up a lot of space.

The drawing shows a simple support that I have developed for servicing changers. It is inexpensive and easy to store. It consists of a 15-inch square of ¾-inch plywood with ½-inch holes drilled along the diagonals and vertical and horizontal center lines and four rubber-tipped ½-inch dowels. The 15-inch rods—only three are needed in many cases—support the changer. A round magnifying (shaving) mirror provides a view of the underside.—*Charles W. Nelson* R-E



next month

JUNE 1972

- **Build A Solid-State Laser**
  Low-power, "safe", and inexpensive add up to a laser every experimenter will want to build and use. Complete construction and operating instructions.

- **Electronic Combination Lock**
  A digital logic IC is the "active key" used to unlock any door protected by this different device.

- **More Developments In 4-Channel Stereo**
  A brief look at the Sansui matrix system plus several suggested speaker location setups to experiment with and experience.

- **Transistor Curve Generator**
  Use it with your scope to check transistors in and out of circuit. Also a handy instrument to have when you want to select matched transistors.

- **Op-Amps And You**
  Introduction to op-amps with several practical circuits to build while you learn.

PLUS:
Kwik-Fix Troubleshooting Charts
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Jack Darr's Service Clinic

HOW MATV WORKS
(continued from page 97)

more maintenance over the life of the system.

3. Don't cut too close. If the total distribution loss is 40.8 dB and you have a choice between a 41 dB unit and a 44 dB unit, pay the extra money and choose the bigger amplifier. This will allow some tolerance for design errors, longer cable runs than anticipated, system expansion, etc.

Fig. 7 shows a slightly more complex head end. Here, separate, single-channel antennas are used because channels are telecast from different directions. Signals from the antennas are mixed and fed into a broadband amplifier. Broadband amplifiers have their limitations, however. Fig. 8 shows the type of head end that would be used for a large system where many channels were available.

UHF amplifiers, at the present state of the art, have less output capability than comparable vhf amplifiers. Therefore, in very large systems, you are better off to convert uhf channels to vhf, as shown in Fig. 9.

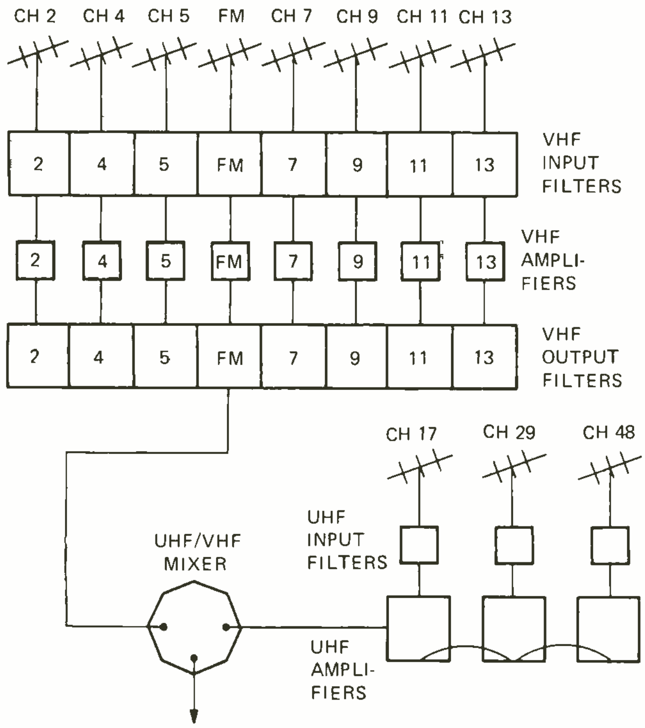


FIG. 8—HEAD-END ARRANGEMENT for uhf/vhf and FM reception. Uhf and vhf channels are received and amplified separately and then combined in a mixer that feeds the distribution system.

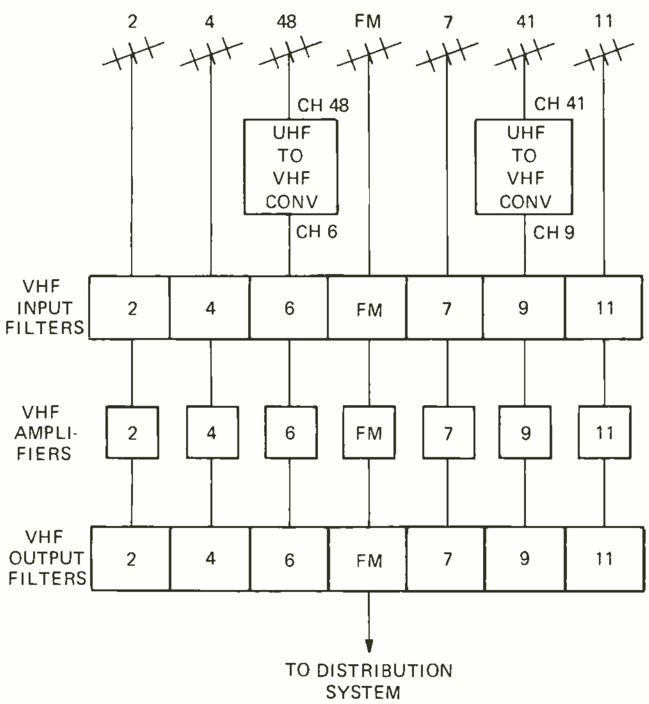


FIG. 9—FOR BEST UHF RECEPTION use a single down-converter with output on unused vhf channel for each desired uhf station.

Signal surveys

Every MATV system installer needs a good field-strength meter. You must know what kind of signals you are starting with, and a FSM is the only way to find out. Before you finalize your head-end designs, visit the building site, climb upon the roof and run a signal survey. (If the building isn't built yet, try to find a nearby building of about the same height.) Connect a small all-channel antenna to the FSM and record the signal strength on each sound and picture carrier. Then, connect the antenna to a small, battery operated portable TV and look and listen to each channel. The portable TV will show you interference that you can't detect with the FSM.

Suppose your Signal Survey provides results like this:

CHANNEL	PICTURE CARRIER
2	+35 dBmV
4	+14 dBmV
5	+17 dBmV
7	− 5 dBmV
9	+20 dBmV
11	− 2 dBmV
13	− 6 dBmV

If we fed these signals as is into a broadband amplifier,
(turn page)

we'd wind up with overload on Channel 2 and snow on Channel 13. Therefore, we would need an attenuator to reduce the strength of Channel 2 and mast mounted single-channel preamplifiers to boost the strength of Channels 7, 11 and 13. Channels 4, 5 and 9 we could leave alone. This is called system balancing.

Ghosts

Ghosts are actually multiple images caused by reflected signals. To erase ghosts, you have to eliminate signal pickup from undesired directions. This can usually be done by using highly directional antennas. In extreme cases, horizontal stacking of antennas is required to improve directivity.

Smears

Smears are a lot like ghosts. They are very closely spaced multiple images. Usually, smears are caused by standing waves within the MATV system. Standing waves can result from an unterminated trunk line, a mismatch, a poor connection or crushed cable.

Adjacent-channel interference

The FCC has allocated TV station frequencies in such a way as to minimize adjacent-channel problems. Adjacent channels (such as Channel 8 and Channel 9) are never broadcast in the same city. But one of the selling points of MATV systems is that they can pick up distant TV channels.

Fig. 10 shows an antenna system designed to pick up local channels 3, 6, 8 and 10, plus distant Channel 9. The local channels are picked up by a broadband antenna. A single-channel Yagi is used to pick up Channel 9, which is then amplified by a single-channel preamplifier. Channel 9 should come out of the preamplifier at almost the same level as the broadband antenna picks up Channels 8 and 10. Use your field strength meter to check this out. If the local channels are too strong, use an attenuator (not shown) to cut them down.

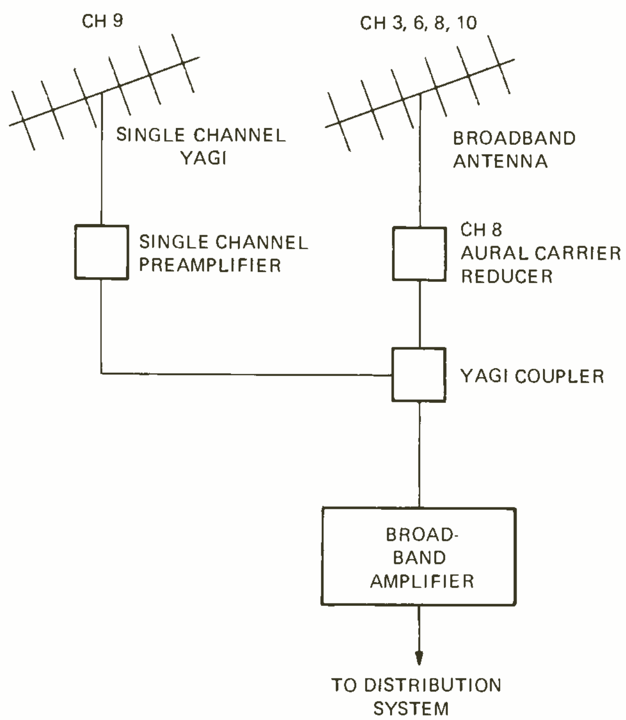


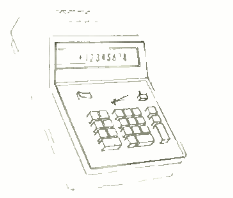
FIG. 10—AN ADJACENT-CHANNEL STATION in distant city needs single-channel Yagi and booster feeding all-channel feeder system.

Basic MATV system design is not really difficult. What's more, if you run into difficulty, it's not hard to get help. Most equipment manufacturers have engineering staffs who are glad to help technicians with specific design problems. **R-E**

IMPOSSIBLE? BARGAINS IN SURPLUS ELECTRONICS AND OPTICS

THIS MONTH'S SUPER SPECIAL!

CALCULATOR KIT



First announced in our January advertisements, the response to B & F's calculator kit can only be described as fantastic! We supply complete kit of everything (except a case) to build a professional calculator, for under $100.00. Includes extra large scale integration MOS Chips for calculator functions, complete professional keyboard, all parts for clock and drivers, all printed circuit boards, eight, seven segment readouts, power supply and complete step-by-step instructions.

Keyboard Functions: The input is organized to accept the following inputs: Numerals 0-9 plus decimal point – Constant Multiplier/Divisor Set – Decimal point Set – Clear – Clear Entry – Multiply – Divide – Sum and Execute – Subtract and Execute – Alternate Display – Equals.

Display Functions: The output is designed to produce the following output functions: Eight digit numerical display, in BCD code – Negative Sign Indication – Overflow Indication – Zero Suppression - all nonsignificant zeroes are suppressed.

Operational Description: The following descriptions apply for the designated calculator operations:

Figure Entry: Up to 16 digits – Up to seven decimal fraction digits – Entry of positive quantities only – Entry may be cleared without destroying intermediate results in accumulator – Decimal point.

Addition: Addition results accurate up to 16 digits – Overflow of 16th digit detected – Signed results possible during chained operations.

Subtraction: Subtraction results accurate up to 16 digits – Overflow of 16th digit detected – Signed results possible.

Multiplication: Product up to 16 digits with the eight most significant digits available for display. The least significant eight digits can be displayed on command of the Alternate Display key – Signed results possible in chained operations – Round off is not implemented (results truncated if necessary) – Solution time is 80 ms maximum at 200 KHz.

Division: Quotient up to 16 digits with eight most significant digits available for display. The least significant eight digits can be displayed on command of the Alternate Display key – Signed results possible in chained operations – Solution time is 120 ms maximum at 200 KHz.

General: Continued (chained) operation - capability is provided for continued multiplication, division, addition, and subtraction – Clear - all storage registers and display are cleared by command of the Clear Key. Decimal point position is not modified – Storage - the machine storage registers are cynamic shift registers – Overflow - overflow is indicated but overflow information is not saved. Further operation of keys (except "clear" or "clear entry") is inhibited – Electronic interlocking - electronic interlocking is provided which prevents erroneous operation due to simultaneous depression of two or more keys – Clear Entry - enables correction of a figure input error (and clears figure entry overflow condition).

☐ EALSI16DCK, Sh. wt. 10 lbs. $98.50
☐ Case (additional) 10.00
☐ Large scale integration MOS chips only 29.00

CALCULATOR KEYBOARD

We are offering the keyboard for our calculator separately. The keyboard provides a single closure for each key, brought out to an edge connector. May easily be matrixed or encoded in any fashion by external jumpers or used as is, depending on the input circuitry required. Brand New!

☐ Calculator keyboard $14.50

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Discounts on technical books are rare, since the publisher discounts are low, but B and F is happy to give you a 10% discount and postpaid delivery in the U.S. on what we feel are some of the best books in the electrical engineering field. They are:

☐ Alley and Atwood, *Semiconductor Devices and Circuits*. Wiley, 1971. Without relying on calculus, this book describes basic semiconductor devices and explains their use in electronic circuits. The operations and uses of linear and digital integrated circuits are given considerable coverage. List Price $11.95, B & F Price $10.75.

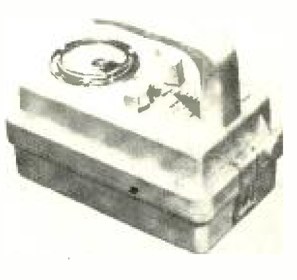
☐ Paul Siegal, *Understanding Digital Computers*, 2nd Edition, Wiley, 1971. A great introductory text for logic and computer design. We supply it as part of our logic experimenters kit. List $12.95, B & F Price $11.75 . . . . $11.75

☐ Eimbinders, *Semiconductor Memories*, Wiley, 1971. List $11.95 . . . . $10.75

☐ Eimbinder, *Designing with Linear Integrated Circuits*, Wiley, 1969. List $10.95 . . . . $9.85

☐ Barna, *Operational Amplifiers*, Wiley, 1971. List $9.95 $8.95

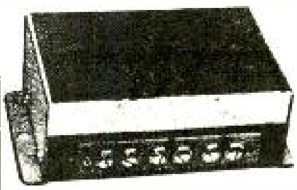
RADIATION METER ("Geiger Counter")



You can buy a complete radiation meter, complete with original instruction books, at less than the price of the meter movement alone. Range is 0.02 to 50 Roentgens/hour. This is not sensitive enough for prospecting, but useful for other radiation measuring and monitoring purposes. If not used for its original function, then the case, meter and battery holder alone are worth our asking price as a basis for building a metal locator, etc. Uses standard D cell and 22.5 volt Battery.

☐ Radiation Meter . . . . $9.50 + $1.00 postage & handling

ALL PURPOSE 12 VOLT SUPPLY



This supply delivers 12-14 volts D.C. at 1.2 amperes. Useful for hundreds of applications, use it to power projects, as a battery charger, for toy trains, you name it. At our low price you should order several to have around. No filtering is supplied, use an external capacitor.

☐ 12 Volt Supply . . . . $2.75 & 1.00 Postage.

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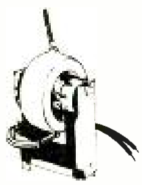

We have thousands of flyback transformers for TV sets, and have worked out an interesting modification of them so that using a pair of power transistors and a few resistors you can build a 12 volt D.C. powered oscillator converter providing an output of 18,000 volts. With this high voltage output you can perform many interesting experiments and demonstrations, such as a jacobs ladder . . . or lighting a florescent tube by just holding it near the supply. We supply the flyback transformer, two power transistors, resistors, instructions and an experiment manual. Use our 12 volt supply advertised on this page as a supply for this if you don't already have one.

☐ Flyback "Tesla Coil" Kit $4.75
Add $1.00 Postage & Handling
☐ Flyback Transformer only, with Instructions $2.75
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We have made a fortunate purchase of Sanken Audio Amplfier Hybrid Modules. With these you can build your own audio amplifiers at less than the price of discrete components. Just add a power supply, and a chassis to act as a heat sink. Brand new units, in original boxes, guaranteed by B and F. Sanken and the Sanken U.S. distributor. Available in three sizes: 10 watts RMS (20 watts music power), 25 watts RMS (50 watts M.P.) and 50 watts RMS (100 watts M.P.) per channel. 20 page manufacturers instruction book included. Sanken amplifiers have proved so simple and reliable, that they are being used for industrial applications, such as servo amplifiers and wide band laboratory amplifiers.

☐ 10 Watt RMS Amplifier . . . . $ 4.75
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☐ 50 Watt RMS Amplifier $22.50

☐ Complete kit for 100 watt rms stereo amplifier (200 watt music) including two 50 watt Sanken hybrids, all parts, instructions, and nice 1/16" thick black anodized and punched chassis $88.00
☐ Same for 50 watt rms stereo amplifier includes two 25 watt Sankens, etc. $58.00
☐ Same for 20 watt rms stereo, includes two 10 watt Sankens, etc. $30.00

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Molex soldercon connections for I.C.'s. With these you can build low cost I.C. sockets by just cutting off the number of connections required, i.e., two strips of seven for 14 pin socket.

☐ 500 Molex soldercon . . . . . $ 4.75

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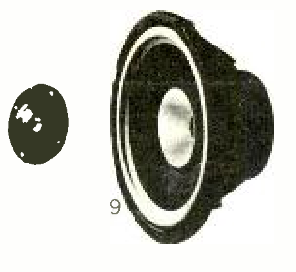
±15 volts @ 100 milliamps. Brand new, 115 VAC input, manufactured by Analog Devices, similiar to their model 902. List price $49.00, our price $32.50.

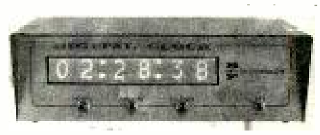
JENSEN HIGH COMPLIANCE SPEAKER SYSTEMS



A local manufacturer went out of the speaker enclosure business, and we were lucky enough to buy his inventory of Jensen high-compliance (acoustic suspension) speaker systems. These systems consist of a 12" extended range woofer, a hemispheric dome tweeter, plus crossover. The dome tweeter response extends into the supersonic. The dome shape provides an ideal polar pattern response. The system is ideal for use with our Sanken Amplifier Systems, or any system capable of putting out at least 20 watts rms per channel. Full instructions for cabinet construction are included.

Single System (One Woofer, Tweeter and Crossover) . . $29.00
Shipping weight 10 lbs.
Stereo System (Two of Above) $55.00
Hi Compliance Woofer Only (8 lbs.) $22.00
Dome Tweeter only (3 lbs.) $5.75

DIGITAL CLOCK KIT WITH NIXIE DISPLAY



We have well over 20,000 surplus nixies in stock, and because of this bargain purchase we can sell a complete digital clock kit for less than the usual cost of the display tubes only. We provide a complete etched and thru-plated circuit board, all integrated circuits, complete power supply, display tubes, I.C. sockets and a nice front panel with polaroid visor. We have never seen anyone offer this kit for less than $100.00 before. Includes BCD outputs for use as with timer option. May be wired for 12 or 24 hour display. Indicates hours, minutes, seconds.

☐ Clock Kit, complete less outside cover $57.50
☐ Aluminum blue or black anodized cover (specify) . . $ 4.50

SEALED NICKEL CADMIUM RECHARGEABLE BATTERIES

These cells have almost infinite uses in small and portable electronic equipment. Use for flashlights, small appliances, remote and radio control, alarms, transistor radios, model toys, miniature motors, pocket calculators, etc. Each cell provides 1.25 volts at 0.5 ampere hours. Recharge 12 hours at 50 milliamperes. Accepts at least 300 charge and discharge cycles. Welded tabs for solder connections, can be provided in interconnected groups of 1, 2, 3, 4 or 5 cells.

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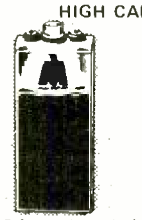
VENTED NICKEL CADMIUM HIGH CAPACITY BATTERIES



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Circle 89 on reader service card

APPLIANCE CLINIC

(continued from page 24)

con diodes from the TV replacement stock, I haywired them together, and hooked them up with clip-leads. Firing it up, the motor ran very nicely! I read 12 volts dc across the motor.

By clipping the leads of the diodes very short and making careful lap-joints, which I covered with short pieces of glass fiber spaghetti, I rewrapped the original tape and came out with a "package" that was actually a bit smaller than the original.

One unexpected problem cropped up. While testing I'd had the whole thing propped up on a plastic box to clear the fan. When I began to put it back together, I discovered that the delicate heating element was firmly stuck to the plastic! Answer? Simple. Turn the thing on again. When the element heated up, it came out of the plastic.

We will probably see quite a few similar applications of this, in the smaller hand-held appliances. The circuit is simple, but very ingenious. The tiny motors won't carry too much load, but in uses such as this, they don't have to. This one had only a small fan, which it turned with ease. Slightly larger motors and bigger rectifiers, and larger loads could be handled without trouble.

This could be done in several ways. One likely prospect would be small SCR's that varied the ac voltage applied to the rectifiers; or, variable resistors, or any one of several other ways. While checking this one, I noted that the motor speed seemed to be proportional to the applied dc voltage.

If you open up one of this type of appliance, with motor troubles, and find a little "three-legged blob", unwrap it and see if it isn't a rectfier. If so, it can be replaced with ease. The stock silicon diodes we use for TV power supply replacements have ample peak voltage ratings, and they can be bought with current ratings up to 2 amperes for a very nominal sum. Incidentally, encapsulated full-wave rectifiers just like the blob are available from any of several semiconductor makers. I just didn't happen to have one on hand. **R-E**

Circle 101 on reader service card

market center

PLANS AND KITS

TV RECEPTION TO 200 MILES, All American Sports Amplifier kit—$49.95. **TV AUDIO TUNER** kit—$39.00. Data Sheets, **CADCO SYSTEMS,** Box 18904, Oklahoma City, Ok. 73118

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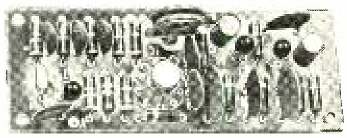

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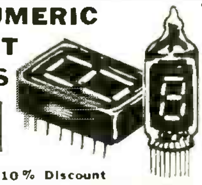

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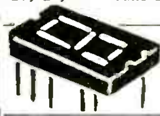

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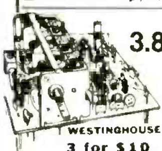

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epoxy TO-5 case
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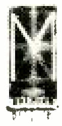

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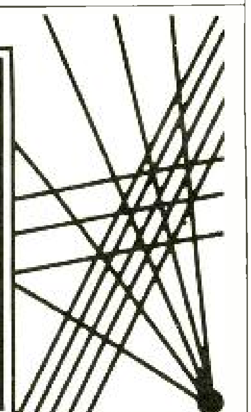

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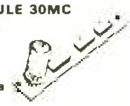

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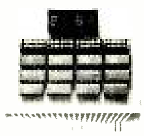
INVENTIONS & PATENTS

INVENTIONS WANTED, Patented; Unpatented. **GLOBAL MARKETING,** 2420-AE 77th Ave., Oakland, Ca. 94605

UNIVERSAL DECADE COUNTING UNITS

1. Easy to read single plane LED or Filament-type Readout with wide angle viewing.
2. BCD Outputs available
3. Readout Lamp Test
4. Selectable Ripple Blanking
5. Selectable Decimal Point
6. Counter Reset
7. Plug-in Module
8. Molex Sockets for all IC's & Readout
9. Tin-Plated G-10, 2-oz Copper, Glass Epoxy Board
10. Your choice of 1 to 6 decades on one P.C. board.
11. Grouping of 2 or more readouts on the same card, for custom designed appearance.
12. 5-Volt TTL compatable single supply.
13. First in a series of universal plug-in modules to be introduced soon; for frequency counting, time measurements, event counting, DVM, magnitude comparison, etc.
14. Well documented application note with step-by-step assembly and hook-up instructions.



Price (Per Decade):

Basic Unit consisting of 7490, 7447, Filament-type 7-segment Readout....$8.00

Options:
For LED Readouts instead of Filament-type add $2.00
For 7475 Latch add...$1.25
For 74176 instead of 7490 add............$0.50
For 74192 instead of 7490 add............$1.00
For 74196 instead of 7490 add............$0.75
For Fully assembled and tested unit add......$2.50

NEW IC TIMER (NE555)

FEATURES
- TIMING FROM MICROSECONDS THROUGH 1 Hr
- CAN EITHER FREE RUN OR LATCH
- OPERATES FROM 4 to 15 VOLTS FOR 1% CHANGE IN TIMING
- TIME DELAYS CAN BE RESET
- TEMPERATURE STABILITY 0.005% PER °C
- ADJUSTABLE DUTY CYCLE
- TIMING CAN BE CHANGED 10 1 WITH CONTROL
- OUTPUT CAN SOURCE OR SINK 100mA

$1.50 EACH

We have had many calls asking us if the components we sell are rejects? We would like to announce here that EVERY item sold by us is manufacturer's FIRST-RUN, fully tested and in perfect BRAND NEW condition. These parts are purchased through huge blanket orders mainly for our manufacturing requirements, and we are happy to pass on the savings to you. All parts are GURANTEED to be brand new, NOT EVEN SURPLUS NEW; but first-runs, manufactured within the last 9 months.

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0.01μF. Each.....11¢ 0.02μF. EACH......12¢

LOW VOLTAGE DISCS, Type UK.
1.0 μF, 3V.......25¢ 2.2 μF, 3V.......30¢
0.1 μF, 10V......12¢ 0.2 μF, 10V......20¢
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ELECTROLYTIC CAPACITORS:
All values are available in both, axial or upright (PC Board) mount. PLEASE INDICATE YOUR CHOICE.
10 μF, 15V.......15¢ 100 μF, 25V......25¢
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$4.95 Each

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Large ¼" 7-segment LED readout similair to the popular MAN-1 but with improved brightness. Has left-hand decimal point. Fits in a DIP socket. Expected life: Over 100 Yrs! Regularly $12.95 in single lots! These are BRAND NEW with full data sheet and 4-page MULTIPLEXING Application Note. Needs a 7447 for driver and ONE CURRENT-LIMITING RESISTOR PER SEGMENT. We can supply you with one or ten thousand FROM STOCK. Also available, ±1 OVERFLOW digit at the same prices. Mixing of Regular & Overflow digit allowed.

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Incandescent Type of 7-segment display. With right-hand decimal point. Rated 8mA per segment at TTL supply of 5V. Design life of 50,000 hours. Needs a 7447 as a driver. In DIP Package. Each $3.25

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7400	29¢	7450	29¢	74150	$2.00	NE501	$2.25
7401	29¢	7451	29¢	74151	$1.40	NE526	$2.75
7402	29¢	7453	29¢	74153	$1.95	NE531	$3.50
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7404	30¢	7460	29¢	74155	$1.75	NE536	$6.50
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7406	70¢	7472	60¢	74157	$1.95	SE540	$4.00
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7408	30¢	7474	50¢	74160	$1.95	NE560	$4.75
7409	30¢	7475	$1.00	74161	$1.95	NE561	$4.75
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7411	30¢	7480	90¢	74163	$1.95	NE565	$4.75
7413	75¢	7483	$1.55	74164	$1.85	NE566	$4.75
7416	60¢	7484	$2.25	74165	$1.85	NE567	$4.75
7417	60¢	7485	$3.25	74166	$1.85	N5111	$1.00
7420	29¢	7486	80¢	74167	$3.50	N5556	$2.00
7421	30¢	7489	$5.00	74176	$1.35	N5558	$1.00
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7426	45¢	7491	$1.35	74180	$1.50	N5596	$2.00
7430	29¢	7492	$1.20	74181	$6.00	709	50¢
7432	99¢	7493	$1.20	74182	$1.70	710	50¢
7437	70¢	7494	$1.45	74190	$3.40	711	50¢
7438	70¢	7495	$1.45	74192	$2.20	723	$1.20
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7441	$1.35	7497	$4.00	74196	$1.75	748	75¢
7442	$1.30	74100	$1.95	74197	$1.75	SN7511	$2.25
7443	$1.35	74107	70¢	74198	$2.75	SN75107	2.45
7444	$1.35	74121	70¢	74199	$2.75		
7445	$1.75	74122	90¢				
7446	$1.65	74123	$1.40	1N270	15¢	1N4002	15¢
7447	$1.65	74141	$1.50	1N751A	30¢	1N4154	15¢
7448	$1.55	74145	$1.50	1N914	10¢	2N3860	25¢

All IC's are supplied in 8-, 14-, 16-, or 24-pin DIP (Dual-in-Line) Plastic package, except for NE536, NE537, NE540, and SE540 which come in TO-5 package. We give FREE data sheets upon request, so ask for those data sheets that you NEED, even for those IC's that you are not buying! On orders over $10.00 we'll send you a new 270-page COMPLETE TTL IC data book FREE. Or, you may obtain a new 240-page LINEAR data book instead. On orders over $20.00 will receive both books. Orders over $50.00 will receive a complete LIBRARY of DIGITAL & LINEAR data & application books totaling 1000 pages FREE. PLEASE NOTE: Data books will be shipped separate from your order. Please allow two weeks for delivery.

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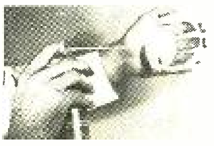

Fastest, easiest, safest way to remove dust and lint from optics, negatives, slides; any hard-to-reach area. Saves hours of brushing, cleaning, spotting to get rid of microscopic dust. Patented solid propellent Fluorogel 8-oz. areosol gives 2,500 jet sprays of moisture-free vapor. Dry air! Works in any position, even upside down! Handy 5" extension snorkle gets to it, wherever. It's like having a pinpoint portable 70-lb.-pressure compressor. Instrs.

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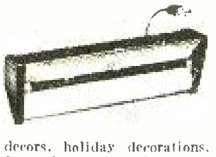
BLACK-LIGHT MIGHTY MITES

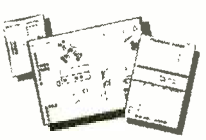


Relatively small (12") fixtures give surprisingly bright blacklight. Mirror-finished reflector makes instant starting 8-watt, high-intensity bulb look like 40-watter. Up to 5,000 hours of safe, long-wave (3660A) black-light to really turn-on parties, light & theatrical shows, psychedelic decors, holiday decorations. Shockproof end-caps remove for safe, easy replacement of bulb and starter. Stands upright or horizontal. Alum. case.

Stock No. 71,274EH ....$14.95 Ppd.

DELUXE OUTDOOR/INDOOR MODEL
Stock No. 71,299EH ....$19.95 Ppd.

PLAY "BEAT-THE-COMPUTER®"



New "today" computer programming game is absorbing fun . . . instructive too. Anyone (10–adult) can play—no science background needed! You'll learn to use a real program, solve EDP problems by moving your cards thru a simulated computer system; become knowledgeable about computer time sharing quesues, discs, tapes, input, output, sorting. Gameboard (18 x 24") accomodates 2 to 4 players. Instr. incl.

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50-150-300 POWER MICROSCOPE

Amazing Value—3 Achromatic Objective Lenses on Revolving Turret! Color-corrected, cemented achromatic lenses in objectives give far superior results to single lenses usually found in this microscope price range. Results are worth the difference! Fine rack and pinion focusing. Imported!

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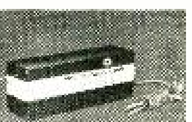
MOUNTED 500 POWER OBJECTIVE:
Threaded achromatic lenses, 3mm F.L.
Stock No. 30,197EH ....$5.88 Ppd.

NEW $99.50 HELIUM-NEON LASER!



Completely assembled, instant-starting w/3X power output of comparable models. Steady ripple-free light of moderate (safe) power. Excellent collimation. Simple and safe to use. 4½ lb. unit reaches 75% power in 2 secs.; 100%, typically 0.5 milliwatt (0.3 mW minimum) in 3 mins. Beam divergence 2 milliradians— 2 cms at 40 ft.

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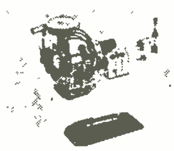
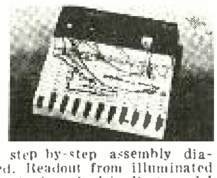
AMAZING NEW WANKEL ENGINE KIT!



Thrill to the fun of building your own see-through motorized model of revolutionary pistonless type engine . . . only engine experts think economically modifiable to meet new pollution standards. Replaces piston, cylinder, crank assemblies with rotating discs (sections removed for firing chambers). Smaller than conv.; fewer parts, greater rel., same speed w less h.p. Switch. Req. 2—1.5V batt. (not incl.).

No. 71,424EH ...... (4½" x 5" x 9") .... $6.75 Ppd.

NEW! ELECTRONIC DIGITAL COMPUTER KIT!



Solve problems, play games, predict weather with this actual working model of giant electronic brains. Amazing new fun way to learn all about computer programming . . . logic, decimal, binary systems. Laws of Sets—even do your own programming after completing simplified 116 page instructive booklet. Includes step-by-step assembly diagrams. Circuits easily changed. Readout from illuminated control panel. Req. 2 "D" batt. (not incl.). Best model we've seen for home, school, industry

No. 71,434EH ..... (11" x 12½" x 4") ..... $31.50 Ppd.

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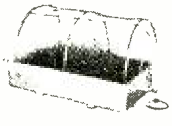
Be ecological and artistic . . . with this low-cost Bottle Cutter Kit. Easiest-to-use one we've found. Make saleable, attractive glasses, lamps, dishes, candleholders, vases . . . from ordinary no-return smooth-surface bottles, jars. Cut any bottle safely, easily in less than 5 minutes for fun, profit, home decorations with just an ice-cube and this superior kit. Includes cutter (3¾ X 7¼ X 2¼"), candle, 2-oz. grinding powder, smoothing cloth. Complete inst.

Stock No. 71,475EH ....$10.95 Ppd.

STARTS SEEDS IN 3 TO 5 DAYS!



New thermostatically controlled electric greenhouse provides constant 70° growing temperature, accelerates seed germination, helps produce healthy thriving plants ready for outdoor planting. Big 3 sq. ft. planting area —29" X 15" X 4" box holds ½ bushel of growing medium. Germinates tomato seeds in 3-5 days; asters, dahlias, petunias, wk. or less. Incl. 3 X 4 ft. clear plastic cover, supports 4 pkgs. of veg & flower seeds. Uses reg. home current.

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FLEXIBLE IMAGE TRANSMITTER

Hi-resolution image-transmitter lets you see into remote, inaccessible illuminated areas: through pipes, tubes or any ⅜"+ opening no matter how intricate. Provides clear, wide sighting. 7X magnifying eyepiece focuses from less than ½" from subject to infinity. Ideal for monitoring hazardous processes, surveillance instrument, demonstrate fiber optics. Over 4,000 coherent glass fibers (.002"). ⅜" dia. semi rigid gooseneck sheathing.

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See moon shots, orbits-stars, phases of Venus, planets close up. 60 to 180 power. New improved, aluminized and overcoated 3" diameter f/10 primary mirror, ventilated cell. Equatorial mount with locks on both axes. Equipped with 60x finder telescope, hardwood tripod. Included FREE: "STAR CHART"; 272 page "HANDBOOK OF HEAVENS"; "HOW TO USE TELESCOPE" book.

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Coordinate tape recordings with slide series. Hook up stereo recorder to remote control projector and TSS—then record what you wish for each slide. Playback and TSS AUTOMATICALLY changes slides in synch. w/tape. Your presentation "gives itself". Perfect for sales meetings, lectures, & "talking albums" of child's growth—a new dimension to vacations, parties . . . anywhere.

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6-FT CONNECTOR CORDS ....$4.75 Ppd. each
Kodak Proj. (#60,804EH) Airequipt (#60,805EH)

"SEE" SOUND! "WATCH" MUSIC!

New 2 channel Color Organ Lamp translates sounds into exciting visuals. Get flashing, pulsing colors from tapes, records, radio, TV, instruments—within 50 ft. Whisper as low as 65 decbls and see it react! Great party fun, conversation piece, hard-of-hearing aid—visually alert to doorbell, phone, footsteps. Plugs into any elec. outlet. 8" unbreakable wht translucent sphere, 4" dia. base. Incls 2 colored bulbs, instrs.

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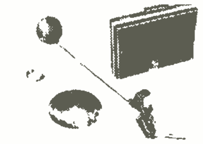
3-HEADED TREASURE FINDER!

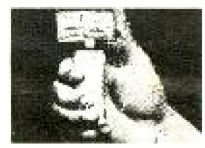


Best value solid-state metal detector we've seen. Extremely versatile—easily attached search heads: 10"—for quick, large area coverage; 5"—general search; 3"—extreme sensitivity. Telesconing aluminum rod (16" to 30"). Sep. volume, tuning control set for 1 hand operation. All fit snugly in handsome locking foamlined attache case. Incl: 9V trans. batt., earphones, instruct., 196 pp. book.

Stock No. 71,446EH ....$49.95 Ppd.

SAME BUT ONE 5" HEAD, NO CASE.
Stock No. 71,447EH ....$29.95 Ppd.

POWER HORN BLASTS A MILE



Frighten prowlers, muggers, vicious dogs with 118 decibels. Just press and this Freon powered pocket-sized horn can be heard a mile away to signal for help or fun. Great for boating (it floats), hiking, camping, hunting, seashore, rooting for your team. Can be heard over traffic and constr. noises to sound fire drill, lunch break or emergency. Weighs only 3 oz. but contains up to 100 mile-piercing blasts.

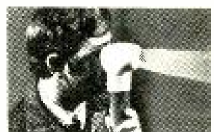
Stock No. 41,423EH ....$3.25 Ppd.
2 Refill Cartrs. (P-41,424EH) ....$2.75 Ppd.

3-CHANNEL COLOR ORGAN BARGAIN!

Create tremenuous variety of unusual & beautiful lighting effects with this low-cost top-quality 1500-Watt unit (500 W. per channel). Compare with others selling for twice the price. Has pilot light, plus individual sensitivity controls and channel indicator lights. Can operate ten 150 W. "spots" or 200 Christmas lights. Uses reg. house current—attaches to audio source w/RCA-type phone plug. 5¼" x 6¾" x 2½". 2½ lbs. Thermal setting plastic case. 6 ft. cord. Including complete instructions.

Stock No. 71,223EH ....$49.95 Ppd.

NEW "SEE-THRU" SIGHT LIGHT!



Ingenious see-thru flashlights lights up difficult-to-see-into areas. Puts a beam of light along your line of sight in spots you couldn't previously look into & illuminate simultaneously. Hundreds of uses at home, on the job. Use for pipes, sockets, engine parts, auto parts, gun barrels, recessed areas. Ideal for factory, workshop, mechanics, plumbers, electricians, sportsmen, hobbyists, doctors and dentists. Use it also as an all-purpose flashlight.

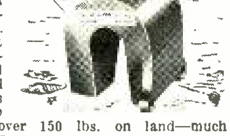
Stock No. 71,534EH ....$3.95 Ppd.

$8.95 ELECTRONIC STROBE!

Hand-sized solid state electronic strobe light at fantastically low price. Produces bright psychedelic effects like larger, far more expensive Xenon strobes, yet it's just 2-¾ x 4 x 1-⅜" thick. Adjustable flash rate, approximately 3-10 flashes per second. Make stop motion effects, posters come alive. Great to take with you to parties, dances, outing, etc. Requires 2 9v transistor batt. (not incl.). Instructions.

Stock No. 41,443EH ....$8.95 Ppd.
4 REPLACEMENT LAMPS P-41,444EH .. $1.00 Ppd.

"FISH" WITH A MAGNET



Go treasure hunting on the bottom! Fascinating fun & sometimes profitable! Tie a line to our 5-lb. Magnet—drop it overboard in bay, river, lake or ocean. Troll it along bottom—your "treasured" haul can be outboard motors, anchors, other metal valuables. 5-lb. Magnet is war surplus—Alnico V Type—Gov't. cost $50. Lifts over 150 lbs. on land—much greater weights under water.

Stock No. 70,571EH .... $14.00 Ppd.
Stock No. 70,570EH 3-½ LBS .... $8.75 Ppd.
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It's far more than love at first sight... it's a whole new way to use professional chemicals. In terms of convenience. And savings.

Because now, you can take it with you. "It" being the profit-making power of Chemtronics TUN-O-WASH, TUN-O-FOAM and TUN-O-BRITE.

The great "space war"

With all the tubes and parts a serviceman has to carry, he's often at a loss for space to fit in a large can of chemicals as well. Even knowing he can often make \$5.00 to \$10.00+ more per call.* And when he wants to do an extra-thorough job, degunking with a degreaser before using a cleaner/lubricant, the problem's even worse. Until now.

The world's finest chemicals are now the world's most portable

With a Chemtronics Transfer Kit, you can carry all you need in a shirt-pocket. With the refillable "Slim-Jim" cans in each Transfer Kit (each can, no bigger than the kind you fill a butane lighter from), you can carry a complete tuner service kit in your pocket. And still save money on the "economy-size" cans you re-fill from.

Proof? Ounce-for-ounce, transfer kits can save you up to 25% or more on the world's favorite electronic chemicals. And you get two "Slim-Jim" refillable cans that make them a breeze to take along.

It's the kind of idea only a serviceman would think of

It's simple—no special gadgets. Just half a minute, and the "Slim-Jim" is refilled with enough to service six to ten tuners (and the large cans are still in the shop for bench use!).

Why wait? It's at your local distributor's now

"Sex and the Single Can," more popularly known as the Chemtronics Transfer Kit, comes in three varieties, to meet the needs of knowledgeable technicians:

TCK-1 Double-Degreaser
Two 24 oz. TUN-O-WASH, Two "Slim-Jim" Transfer Cans

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One each of Bench Size TUN-O-WASH and TUN-O- BRITE, Two "Slim-Jim" Transfer Cans

TCK-3 Degreaser & Cleaner/Lubricant
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