Electronic Engine Analyzers

Expandable-Modular Concept and Easy-to-Service Features in...

...this new Hybrid Amplifier-Receiver
are you replacing top quality tubes with identical top quality tubes?

Now you can carry the identical tubes that you find designed into most of the quality TV sets you service. Chances are, you were not aware that these TV sets were designed around special Frame Grid tubes originated by Amperex and that even more tube types originated by Amperex are being designed into the sets you'll be handling in the future. Amperex frame grid tubes provide 35% higher gain-bandwidth, increase TV set reliability by simplifying circuits and speed up your servicing because their extraordinary uniformity virtually eliminates need for realignment when you replace tubes.

Tubes introduced by Amperex, currently used by major TV set makers include:

<table>
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<th>Others</th>
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<td>8AL3</td>
</tr>
<tr>
<td>4GK5</td>
<td>9A6</td>
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<tr>
<td>4E17</td>
<td>6E17</td>
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<td>6F117</td>
<td>27CB5</td>
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For optimum satisfaction for your customers and a better profit operation for yourself, make room in your caddy now for these matchless-quality tubes. Next time you visit your distributor, look for the green-and-yellow boxes and enjoy confidence in your work such as you never have before. Amperex Electronic Corporation, Hicksville, L. I., New York.
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the revolutionary new

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TV/FM ANTENNA

...Unparalleled performance because it has ALL 5:
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- SHARPEST DIRECTIVITY
- EXTREMELY LOW VSWR
- BEST FRONT-TO-BACK RATIO
- RUGGED CONSTRUCTION

HERE IT IS—the space-age TV/FM antenna from the only manufacturer with actual experience in making space-probing antennas!

All new, the PARALOG is the first home antenna that really comes through with log-periodic design plus a unique parasitic-element system for maximum all-channel gain and pinpoint directivity. Exclusive Cycolac insulating mounts assure constant impedance, eliminate troublesome cross-feed design. Extremely rugged construction.

There are fourteen PARALOG antenna models, listing from $19.95, including four electronic PARALOGs with Super Povermate preamplifier, and three special FM stereo models. See your Jerrold-TACO distributor now, or write Jerrold Electronics, Philadelphia 32, Pa.
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New Device Makes Speech From Written Characters

Reversing the old idea of a talking-into-typewriter, Melpar, Inc. has just demonstrated a working model of a system for generating speech from written patterns. The device is called EVA (electronic vocal analog) and is adapted from a somewhat similar device developed at the Royal Institute of Technology in Sweden.

One of the advantages of such a device is that it can be used on a much narrower band than an ordinary phone channel. The experimental model requires a bandwidth only about 1/30 that of a normal voice communications band. The chief use of the present model, however, is to study human speech. Learning how speech is put together could be very valuable in developing other instruments along the lines of EVA, phonetic typewriters and other speech-electronic devices.

Illegal CB Operator Faces Several Charges

Warren J. Currence of Elkins, W. Va., was arrested last August for alleged operation of an unlicensed citizens radio station. He was held under $1,000 bond for appearance before the grand jury, and three CB transmitters were seized.

Currence had earlier been charged with using obscenity on the air, and his citizens radio license was revoked. This was the result of complaints "by hundreds of Citizens Band licensees" in central West Virginia.

If found guilty of transmitting obscenity over the citizens band, Currence is subject to a maximum penalty of $10,000 fine or not more than two years imprisonment, or both. And, if convicted of transmitting after his license had been revoked, he faces a like fine or imprisonment not exceeding one year, or both.

Transistors in Ascendant At New York Hi-Fi Show

Transistors in almost very form and in nearly every kind of circuit were the hit of the 1963 High Fidelity Music Show, held September 11-15 in New York City.

Ampex's complete home-entertainment system has: an AM-FM stereo tuner; a record changer; a stereo control-center-and-preamp; a 4-track tape record-playback machine; a built-in stereo speaker system; color television: video tape recorder good for 90 minutes of TV recording; a vidicon camera that can be used with the recorder or with the TV set directly; two microphones for stereo recording; and a timer to preset the video recorder to take down a program without attention, or to record one while another is being watched. Total ac-line current drain is 12 amperes!

An Ampex engineer is part of the deal for as long as it takes to supervise installation.

The show, billed by the Institute of High Fidelity, its sponsors, as "the largest to be staged by the industry," was attended by more than 25,000 persons.

Emphasis was placed this year on decorative aspects of hi-fi. Several exhibitors' rooms were sumptuously furnished to show how well a stereo system could fade into the woodwork, and there was a gallery of photographs of installations from around the country.

But among the displays of 83 manufacturers all over the world, transistor equipment was probably the most prominent. For the first time, several major manufacturers (Sherwood, Scott, Fisher and Pilot among them) exhibited all-transistor equipment.

The prize for the most expensive single piece of home entertainment equipment must surely go to Ampex for its "Signature V", a $30,000 colossus in a 9-foot long walnut cabinet which, besides the usual AM-FM stereo tuner, changer and tape recorder, contains a color television set, a video tape recorder and a self-contained TV camera. (See photo above.)

Other highlights included comparisons of live and recorded music, some of it composed especially for the show.

New TV Sees The Invisible

A detection system for the invisible fire of liquid hydrogen has recently announced by General Dynamics/Avionics. Liquid hydrogen, which supplies nearly 40% more power than conventional propellants, used to be considered too dangerous...
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NOVEMBER, 1963
When you want the best transformer, insist on the proven standard of quality in the industry—Triad. The familiar red and white Triad box assures you of the highest quality materials and exacting design specifications. Whether you want utmost performance out of a T.V. or hi-fi set, greater reliability for an industrial application or better amateur radio operation, take a tip from leading military and aero-space components designers and specify Triad.

Your local distributor offers over 1,600 off-the-shelf models including: audio, chokes, filament, instrumentation, modulation, output and transistor transformers. For T.V. replacement, there are yokes, flybacks, vertical and power transformers to fit nearly every make and model. Check with your distributor for our latest T.V. replacement or Industrial Catalog, or write.

TV set at left is blank except for the small flame detected by the infrared camera. Middle picture is from standard T.V. camera which cannot see hydrogen flame. Two pictures are superimposed on monitor at right, which shows that a fire exists and pinpoints its location.

for rocket fuel, but it's now being used in the Centaur space vehicle, and other vehicles are being designed to use the high-energy fuel. The device that detects the invisible flame of burning hydrogen is another step toward increasing its usability.

The warning system uses a special lens which focuses infrared radiation on the vidicon tube of a TV camera. Beside the infrared camera is a standard camera, both covering the same field of view. The infrared picture, revealing the fire only, is superimposed over the scene viewed by the standard camera, displaying visually the location of the fire.

This system is expected to be used at hydrogen test facilities, around launching areas for hydrogen-fueled rockets and possibly as fire surveillance equipment aboard space vehicles.

Closed Circuit TV Adds Foreign Language Channel

TeleGuide, a closed-circuit TV system that operates in 41 hotels in New York City, has added a foreign language service. From 7:30 am to 1 am daily, half-hour films describing the attractions of New York City to tourists are presented in French, German, Italian, Japanese, Portuguese and Spanish. The program is on Channel 13, and is sponsored by Pan American Airways.

Magnet May Become Kitchen Tool

Green tomatoes, exposed to the south pole of a large magnet, ripen several days faster than nonmagnetized tomatoes, say Dr. A. A. Boe and Dr. K. Salunkhe of Utah State University.

Starting with green tomatoes, they exposed one group to the south pole of a magnet. These tomatoes were almost red in 11 days, while the nonmagnetized tomatoes were barely pink.

Magnetism's effect on organic substances is not a new idea. Louis Pasteur experimented with tartaric (Continued on page 14)

Lunar Vehicle To Precede Astronauts

The odd-shaped vehicle is an exploration vehicle, designed by the Westinghouse Defense Center to make the arrival of astronauts on the moon safer, and to make the work more useful. It would arrive before the astronauts and roam the surface of the moon to locate landing sites for manned vehicles. Stereo television cameras would scan the moon's surface and transmit images back to earth. The little wheel ahead of the vehicle detects crevices, and is also designed to collect samples of the surface for analysis.

(Continued on page 14)
What Job Do You Want In Electronics?

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NOVEMBER, 1963
NEW LOG PERIODICS WILL FURTHER DEMOLISH EXISTING ANTENNA CONCEPTS.

One year ago, JFD introduced the LPV antenna based on the patented new log periodic formula of the Antenna Research Laboratories of the University of Illinois.

Television (and FM) reception hasn't been the same since.

This revolution that changed the course of antenna history is gathering greater momentum. Our Research and Development Antenna Laboratories in Champaign, Illinois has just released several entirely new Log-Periodic television and FM antenna designs for production.

The first of this exciting new generation of JFD Log-Periodics will bring to UHF, even more so, the same superb frequency-independent reception qualities that are working such wonders in VHF. The new UHF Log-Periodics will consist of two antenna groups of three models each, and one UHF Indoor Log-Periodic. These dramatic new antennas will give you the flexibility you need in sensitivity and directivity to overcome the problems inherent in UHF signal behavior.

And if you're entering the rocketing FM stereo market, you can expect a solid boost from JFD in the form of new Log-Periodic antennas designed expressly for multiplex stereo.

Whether you are buying VHF, UHF, or FM antennas, we invite you to compare before you specify. Because after all is said and done about any antenna—at the moment of truth, the picture is the proof. Use, sell and install JFD Log-Periodics based on the formula discovered and patented by the Antenna Research Laboratories of the University of Illinois, and adapted for TV and FM by the JFD R & D Laboratories in Champaign, Illinois. See the difference it will make in your profits, performance and prestige.

JFD ELECTRONICS CORPORATION
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Can you do it without more education in electronics?

You don't want to accept second-best for yourself and those who depend on you. But you may have to unless you get more education. In electronics, you must learn more to earn more. And, because electronics keeps changing, you must keep learning. Stop—and you soon won't be worth what you're earning now.

Your job and family obligations may keep you from going to school. But you can continue your education in electronics beyond high school through a CREI Home Study Program in Electronic Engineering Technology.

CREI Programs cover all important areas of electronics including communications, servomechanisms, even nuclear engineering technology. They have just one purpose—to get you from where you are now to where you want to be in electronics. They do it by giving you the specialized knowledge of electronics that will make you worth more money to your employer.

You're eligible if you have a high school education and work in electronics. Our free book gives all the facts. Mail coupon or write: CREI, Dept. 1108-A, 3224 Sixteenth Street, N. W., Washington 10, D. C.

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E-3
Pardon us while we change you into Santa Claus

Do your Christmas shopping early at your G-E Distributor's. He has lots of wonderful gifts that you can get with the purchase of General Electric tubes... gifts for your family, friends and favorite customers. And there’re some you’ll want for yourself... such as a tube caddy that looks like fine luggage. You can also get Christmas cards designed only for service dealers... to mail to customers and friends.

See your General Electric Distributor and start packing your bag today. You’re going to be a sensational Santa!
Start packing your bag!

These Kodak Flashfuri camera outfits include everything that young photographers need: Hawkeye camera, film, clip-on neck strap, batteries, flash, bulbs, and instruction manual. They're yours when you buy G-E tubes.

Be good to yourself this Christmas. You can get these Armor Clad® tube caddies when you purchase G-E tubes. They look like fine pieces of luggage and the special vinyl coverings are longer lasting. They are reinforced with nickel plate at all stress points.

These Dick Tracy Power-Jet Squad Guns by Mattel® will be a hit with any boys you know. They're automatic cap-firing guns that shoot a stream of water 35 feet... farther than any water guns ever made. Give one to any boy and then stand clear.

Little girls will go wild over these Mattel® Sister Belle talking dolls. They're 17" tall and have a rag body and plastic head. Each one says eleven different things that little girls like to hear... like "Let's play house," "Give me a kiss." No batteries needed.

These G-E electric carving knives will make a great gift for the lady of the house. They even slice through hot bread or hot meat with smooth precision. Get several from your G-E Tube distributor.

Get these Christmas cards... prepared especially for you. They're in color on heavy, high-gloss stock and show a cartoon of you adjusting a TV set to say "Happy Holidays." 50 cards and 50 envelopes to a box. Get yours now for early mailing.

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CASTLE TV TUNER OVERHAULING

(Continued from page 8)

acid a century ago, concluding that the earth's magnetic field altered the arrangement of atoms in molecules.

Three years ago, magnetism was found to spur the growth of germinating seeds. This effect was named "magnetotropism." Its cause, Drs. Boe and Salunkhe suggest, is that a magnetic field quickens an enzyme system and thus respiration.

Dc Through GaAs Generates Microwaves

Microwaves can be generated by passing electric current through a block of gallium arsenide at room temperature, reports J. B. Gunn of IBM's Thomas J. Watson Research Center. The gallium arsenide has produced as much as 1/2 watt output at 1 gc, and oscillations have been produced from 0.5 to 6.5 gc.

Mr. Gunn discovered the effect while measuring the room-temperature resistivity of n-type gallium arsenide as a function of applied electric field. He found that resistivity increased abruptly at a field of about 2,000 volts/cm, and the current passing through the smaller samples began to oscillate coherently at high frequency.

The phenomenon depends to a great extent on the length of the specimen. Specimens longer than about .02 cm produce random oscillations, while the frequency of coherent oscillations in the shorter specimens is inversely proportional to their length.

Computer Makes Movies For Satellite Research

An ingenious way of visualizing the motions of an orbiting communications satellite has been worked out by Bell Labs scientists, to help in studies of such satellites. An IBM 7090 is programmed to generate a tape containing the data necessary for describing positions and attitudes of the orbiting satellite. This tape is then fed to a General Dynamics/Electronics SC 4020 recorder, which converts the digital data into line drawings on the face of a special cathode ray tube. Images on the face of the tube are photographed by a motion picture camera. The film, when projected, depicts the motion of the satellite yawing and turning over, and showed how undesired motion can be prevented by positioning the gyro stops properly.

CALENDAR OF EVENTS

1963 National Electronics Conference, Oct. 28-30; McCormick Place, Chicago.
1963 (Canadian) High Fidelity Music Show, Oct. 30-Nov. 2; Park Plaza Hotel, Montreal.
9th Annual Conference on the Use of Magnetism, at the Laboratory of Nuclear Sciences, UC, Los Angeles.
International Exhibition of Measurement, Control, Regulation and Automation (MESUCORA), Nov. 14-21, Paris, France.
14th National Conference on Vehicular Communications, Dec. 5-6; Adolphus Hotel, Dallas, Tex.
39th Annual Convention, National Association of Educational Broadcasters (NAEB), Nov. 16-20; Chalfonte-Haddon Hall, Atlantic City, N.J.
16th Annual Conference on Engineering in Medicine and Biology, Nov. 18-20; Lord Baltimore Hotel, Baltimore, Md.

Engineers Sometimes Slighted, Says NASA Spokesman

Scientists too often get credit for work done by engineers, said Dr. Hugh L. Dryden, NASA's Deputy Administrator, at the New Jersey Society of Professional Engineers.

"Engineers are only too rarely associated in the press with the great accomplishments of recent times," he said, referring to the atomic bomb, nuclear power plants and satellites, and other space-related developments.
The move into electronics is your decision. GRANTHAM SCHOOL OF ELECTRONICS makes your move easier...

...easier by teaching you electronics in a logical, step-by-step manner, preparing you for employment as an electronics technician or engineer.

Grantham School of Electronics offers training in the classroom, in the laboratory, and by correspondence, as explained below.

WHAT Training is Offered
The entire Grantham electronics training program is divided into a series of sections or levels, as follows:
Section IA “begins at the beginning,” with the assumption that the student has no previous knowledge of electronics. It prepares him to pass all F.C.C. examination required for a first class radiotelephone license.
Section IB is a laboratory training program which gives the student practical experience in the operation and maintenance of electronic equipment. Practical lab training is most valuable to the student who understands theoretical concepts upon which it is based. Therefore, Section IB is offered to Grantham students after they have completed Section IA.
Section II begins where Section IB ends, and trains the student in advanced electronics, usually while he is employed as an electronics technician. Section II prepares the student to advance in both status and income.

WHERE and HOW Training is Offered
Grantham School of Electronics was founded in August of 1951, in Los Angeles, California. Since that time, new divisions of the School have been opened in several other locations. In addition to the Headquarters Office (located in Los Angeles), there are now four teaching divisions. Three of these (in Los Angeles, Seattle, and Washington, D.C.) offer resident classroom training, and the fourth (in Kansas City, Mo.) offers home study training and resident laboratory training.

Grantham teaches more electronics in less time, because the Grantham Method is engineered with the student in mind.

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Your future depends on you. The move into electronics must be your decision. An important first-step in this direction may be to write for our 44-page brochure. It’s free for the asking — it’s your move.

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NOVEMBER, 1963
The U-Boost can’t clear up every UHF reception problem... but when it does—wow!

There has never been a booster made, UHF or VHF, that does everything for everybody—in every reception area. Take the Blonder-Tongue U-Boost, for example. If you are already using an amplified UHF converter, or a "hot" new all-channel TV set... forget it. The U-Boost is not for you. But if you're the one out of three who is suffering with poor pictures, and you're using an ordinary converter or all-channel set, the U-Boost can make a substantial difference. It can melt away "snow". It can make blacks blacker, whites brighter—give you sharper, more sparkling pictures than you've ever seen on your tired old set.

Vital statistics on the U-Boost: • triples antenna signal voltage (gain 10 db) • just a turn of dial pinpoints desired UHF channel from 14 to 83 • amplifies signal before conversion for best signal-to-noise ratio • easy to install (AC receptacle, patented 300 ohm stripless twinline terminals) • handsome styling to match the new Blonder-Tongue UHF converters. BLONDER-TONGUE U-BOOST, only $34.95. See your Blonder-Tongue distributor.

Telcan Coming to US

Despite the skeptical response of many to Telcan, the prospective British video recorder, it may be introduced into this country shortly. Cinerama, Inc. has signed a contract under which it will assist in further development of the Telcan recorder in exchange for certain manufacturing and marketing rights in this and other countries.

A spokesman for Cinerama suggested that a prototype may be shown in the United States within the next six weeks and stated that the finished instrument might "be sold in every type of store now selling tape recorders and TV sets." A price of "under $200" was suggested.

Brief Briefs

A silicon-carbide injection laser that emits continuously at room temperature is reported by Tyco Laboratories of Waltham, Mass.

Zenith Sales Corp. reports a new 19-inch hospital TV that supplies AM and FM radio and recorded music from the hospital communications system, as well as regular TV entertainment.

By special agreement with the Laguna Indians of Central New Mexico, Burnell Co. will construct a $1,000,000 research and development firm on the Laguna reservation near Albuquerque.

RCA has announced a new computer, the 3301, with a "scratch-pad" memory operating at 250 nanoseconds, about twice as fast as any previous computer.

G-E's new junction laser operates continuously at a power output of more than 1 watt—a tenfold improvement over the output of ruby and gas lasers.

Radars for pleasure boats are taking a high place in the marine electronics market. FCC licenses for radars installed on US yachts and commercial vessels in the first quarter of 1963 jumped 47% over the same period last year.
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NOVEMBER, 1963
Dear Editor:

Jack Darr’s “Start Service on a Shoestring” (R-E, July, p. 46) does little more than insult service shop owners.

The statement “Fact is, I don’t know of a better business for a young feller” is a direct contradiction of statistics. Service business failures are among the highest. Insufficient capital and poor record-keeping are two prime causes.

Your neophyte is starting out in a complex repair business with both those strikes against him. There was no mention of bookkeeping. Or won’t he need any?

“You can use a well stocked tube caddy in place of a tube tester . . .” With today’s multiplicity of tube types that caddy would need wheels!

Shop rent not being itemized implies that your man is setting up shop at home. He’d better check zoning ordinances first. He’ll have to pay business rates on phone and on power, unless he has a separately metered line installed to his shop. His fire insurance may become void. If he owns his home he should take out a contractor’s liability policy. Our courts keep quite busy with lawsuits.

One small item—hardly worth mentioning—“Fuse assortment in a plastic box.” That should cost no more than $25. Or will your man use the universal fuse—tinfoil? Perhaps 85% of TV troubles are caused by faulty tubes, but your man won’t service many of these. Someone told the druggist how much money he could make selling tubes at an unrealistic markup, so he got into TV service with no investment beyond floor space.

The other 15% will surely test the “young feller’s” mettle, with no spare parts and no schematics. He’ll get to know his distributor quite well. At 10 cents a mile for all that driving.

“Rent, utilities, transportation and other stuff” are brushed aside as presenting “too many variables to even get a halfway useful answer . . .” The ex-Timer had suggested that only a fool would go into—or stay in—the service business. Anyway, we gave Jack Darr a copy of Mr. Fischer’s letter, and below is his reply.—Editor

I fully realize the difficulties of which Mr. Fischer speaks, having had personal experience in large cities and small towns in just such projects, and having aided and abetted quite a number of young men like the XYH in similar enterprises. As for his “direct contradiction of statistics,” I can’t help quoting the old saw about the three kinds of lies—“Lies, dam’ lies and statistics!!” The “statistics” used in the article all came from personal experience.

On his contention about “insufficient capital and record-keeping,” I agree. I gave the XYH fits about that, if not in the article, at least in person! As to the omission, I can only say that there is room in a short article like this for only a few things; we hope to have another, going farther into this subject, in a forthcoming issue.

The “well-stocked tube caddy” is again personal experience, and, as stated very plainly, intended merely as a starter. By the way, if you test a tube, and don’t have one like it, isn’t it just as far back to the shop? The fuse assortment I carry, which has covered all sets for several years, cost me something like $7.50.

I would question Mr. Fischer’s “statistics” once again on his percentages of “only a tube” jobs that are taken away by drug-store tube-testers. Around here, and in quite a few other towns I know of, it is exactly reversed, if not more than that! Frankly, before the DIY tube testers were born, we had the same percentage of do-it-yourselfers. Then, they came in to your shop, with all the tubes from their TV set in a paper sack, and said, “You advertised free tube testing—check these!”

Some 27 tubes later, you found a dead 5U4. As you reached up for a new one, he said, “Did you say 5U4? Let me write that down. I don’t want to get the wrong one when I make out my order to Sears-Roebuck!” The drug-store has taken that business away from me, and I’m just about tickled to death! These are the people we’ll always have with us, but once again, thank goodness, they are a very small percentage. (They also are...)

(Continued on page 24)
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HAVES SERVICE BUSINESS OF HIS OWN. Don House, 3012 2nd Place, Lubbock, Texas, went into his own full-time business six months after finishing the NRI Radio-TV Servicing course. "It makes my family of six a good living," he states. "We repair any TV or Radio. I would not take anything for my training with NRI. I think it is the finest."

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continued from p. 18 the people who cause trouble by going to our distributors and buying parts wholesale!

So, frankly, Mr. Fischer, I think you take entirely too dim a view of the whole situation! As I told the XYH, personally and in print, the result you get out of any endeavor of this kind depends entirely on how much of yourself you're willing to put into it; in other words, how hard you want to WORK! Also, if you're a poor businessman, you're going to fail, whether you're a grocer, TV technician or anything else! We're presuming that the XYH is smart enough to handle all of the other details, until proven otherwise.

Therefore, I still maintain that there is and always will be a place in our electronics industry for the individualist, competent, hard-working independent technician! This sounds just a little Pollyanna-ish, I know, but I still believe you'll find enough spirit left in our young men to let them make a success out of that old American dream of owning their own place!

JACK DARR

Honor Inventors

Dear Editor:

It greatly irks me and others in electronics to view the usual trash programs on TV, while those scientists and inventors who have made TV possible remain unhonored, impoverished and even driven to suicide from sheer ingratitude.

It certainly would be highly fitting if these men could occasionally be honored on a few programs. I believe that such programs could be made interesting enough to hold the average viewer's interest, thereby attracting enough sponsors to cover costs, profits and even an overdue donation for some meritorious inventors and widows, who are practically destitute.

Dexter S. Bartlett
Portland, Ore.

Not So Unusual, Maybe?

Dear Editor:

On page 92 of the July issue (Note-worthy Circuits) you call the power supply circuit "unusual." I patented this circuit more than 15 years ago (Patent No. 2,426,599). It has appeared in QST and various handbooks.

I admire your magazine very much and I think I've bought every issue!

E. E. COMSTOCK
Choctawhatchee Beach, Fla.

[Sorry—we didn't realize it was patented, Mr. Comstock. But the circuit is still "unusual" in that it is unfamiliar to most readers. While it may have been used in a few transmitters, a reader wouldn't know of it unless he had either built the transmitter or made a detailed study of its circuitry.—Editor]
A complete tube tester that is smaller than a portable typewriter yet outperforms testers costing hundreds of dollars. A real money maker for the serviceman and a trusty companion for engineers, maintenance men and experimenters. Even though the Mighty Mite weighs less than 8 pounds, new circuitry by Sencore enables you to use a meter to check grid leakage as high as 100 megohms and gas conditions that cause as little as one half microamp of grid current to flow. Then too, it checks for emission at operating levels and checks shorts or leakage up to 120,000 ohms between all elements. This analytical "stethoscope" approach finds troublesome tubes even when large mutual conductance testers fail. And it does all this by merely setting four controls labeled A, B, C, & D.

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RADIO-ELECTRONICS
ELECTRONIC ROBOTS

...Are Human-like Robots Possible in the Foreseeable Future...

We often receive letters and calls in person from well-meaning, often highly-intelligent persons who wish to get "complete" technical information on the so-called Robots. How soon will we have robots, in human form, that can act like humans, think like humans, and perform various human tasks, and that can replace humans in industry and commerce?

Before we answer, let us give a short history of robotology, if we can call it such, because in our technological age many pseudo-science fiction themes sound not only reasonable but eminently possible.

It was Karel Čapek, science fiction writer of Czechoslovakia, who in 1920 coined the word Robot, from the Slav term robota, "work." He wrote a play, R.U.R. ("Rossum's Universal Robots") about artificial mechanical men put into mass production. These were sold as soldiers and workers. The play then goes on to its inevitable conclusion when the robots revolt and destroy man. The word, usually mispronounced, has the accent on the first syllable: ro-bot.

R.U.R. was first produced in New York in 1922, and soon caught the world's attention. The term robot is now known all over the globe in almost every language, yet the idea of artificial perambulating men is very old, going back thousands of years, and including the Hebrew Golem, the Frankenstein monster and many others in early science fiction.

To modern man the idea of an electromechanical, or electronic, robot will not down—it sounds too plausible! Even good science fiction writers—usually non-scientific, non-technical—are caught in the robot illusion. There is not a single year during the past 25 that has not had its quota of robot short stories or books. These are always in human form; often they masquerade as real humans from other worlds.

Few of these pseudo-science fiction authors ever think through, or technically work out, the (at present) almost impossible task of constructing a true, thinking replica of a human. What about the power to motivate such a machine independently, without a cumbersome engine? How to electrify it without a separate power plant? Batteries, fuel cells? These are wholly impractical if the robot is to be less than 10 feet high and weigh less than a ton. Atomic energy? Completely unrealistic in the foreseeable future! Remember that a robot, to perform like a human, must have a reasonably independent power supply so that it can do every kind of labor: walk, run, climb, lift weights, etc. This takes a good deal of energy. Where does a human-sized robot get it? Well, at present it is not even on the horizon.

But even if that problem could be solved in 300 years, where is the brain that will make the robot think and act?

Alas, the foremost computer scientists laugh at the idea of thinking computerized robots! Listen to just a few of them:

Says Dr. Philip M. Morse, Professor of Physics and Director of the Computation Center of the Massachusetts Institute of Technology: "The present state of computer design compares to the very early automobile design of 1913."

In the 1962 meeting of the Conference on Self-Organizing Systems in Chicago and New York, sponsored by the Office of Naval Research and the Armour Research Foundation, the talks centered on machines, devices and systems that could "learn" from experience and conduct themselves accordingly. The main obstacle, the speakers confessed, was lack of information on how the human nervous system operates during the thinking processes. This, in their opinion, points to the long paths that lie between us and true "thinking machines."

Says Dr. Marshall C. Yovits of the Office of Naval Research: "Some of the much-publicized systems, allegedly capable of learning or recognizing, must be taken with a grain of salt!" (Refer also to our editorial, "After the Computer, What?", in the June, 1963 issue of RADIO-ELECTRONICS.)

So much for the total impracticability of the robot in human form—at least for the foreseeable future.

Man is still the most complex, the best, the most efficient and the cheapest "robot" in existence!

Yet we do have excellent working robots all around us today, if we can forget that they are never in human form, but come in all shapes, sizes and weights, from a mere few ounces to hundreds of tons.

Every time you dial a number, you use a fairly intelligent robot. Every time you turn on a radio, a TV set, a washing machine, a dishwasher, start an automatic elevator, you use an intelligent, yet not thinking, robot.

Industry uses thousands of almost-thinking robots: Automatic typesetters, billing machines, typewriters that write automatically, auto-printing machines, automatic bowling pin resetters, near-automatic assembling machines that turn out radios and automobiles, and of course, the computers we have been discussing.

There are now hundreds of almost manless plants that work automatically, turning out and packing for shipment such articles as pins, screws or stampings of every kind. We have bottling plants, even automatic gasoline refining plants that take the raw product, crack the gasoline and deliver it ready for shipment, all without human hands.

It would take a large volume to list all the automated plants in use today. This is Čapek's R.U.R. in reverse. Today it isn't the robots that revolt and destroy man—it is man who is beginning to revolt against the robots and their automation.

What is desperately needed now is the renaissance of man in the automation age. It will take a great deal of ingenuity to devise means and ways to reintegrate man into the new electronic-robot age.

One solution would be free Government "conversion" classes in various parts of the country to retrain persons out of work because of automation. Such individuals would be taught various trades in which there is the best possibility of employment. Such an effort would certainly pay dividends to the country and reduce unemployment.

—H.G.
Early this year, International Telephone & Telegraph announced a remarkable new tube, made in Germany by Lorenz to be distributed here by ITT. Dubbed the ECLL800/6KH8, it contains two audio power pentodes and a low-mu phase inverter triode—all in a single nine-pin miniature envelope! A look at the specification sheet for the new tube soon had me convinced that I could build a dual stereo amplifier with two ECLL800's and a single 12AX7. I tried it, and Fig. 1 and the photos show what it looks like.

The circuit

The only unusual part of the amplifier is what surrounds the new tubes. Even there, the actual circuit is probably a good 30 years old. I would have preferred a different kind of phase inverter, but the fact that several elements are connected together inside the tube limits the ways it can be used. Despite my misgivings, though, the circuit performs very well.

The input stage of each channel is half a 12AX7 with plate and cathode resistor values selected for maximum gain. We'll need that gain for feedback later. To provide a point for applying negative feedback from the output transformer secondary, 120 ohms of cathode resistance (R5 and R6) is left unbypassed. This is such a small portion of the total cathode resistance that the gain of the stage (without overall feedback) is unaffected.

Since the grid of one of the power pentodes is common to the built-in phase inverter, the drive appears there, too, and then again on the phase inverter plate, delayed by 180°. Normally, this kind of phase inverter gives more gain on the inverted side than on the "straight-through" side, since there is one more stage in the inverted side. To compensate, most circuits of this kind split the grid resistor of the output tube into R1, R2, R7, R8, R9, R10, R11, R12-150,000 ohms R13, R14-1,000 ohms R15, R16-1,000 ohms R17-22,000 ohms R18-5,600 ohms, 1 watt R19-100 ohms, 10 watts R20-10,000 ohms, 20 watts R21-10 ohms R22, R23, R24, R25-220,000 ohms All resistors 1/2-watt unless noted C1, C2-100 µF, 6 v, electrolytic C3, C4, C5, C6-0.05 µF, 600 v, paper C7, C8-0.001 µF, 500 v, ceramic C9-40 µF, 450 volts electrolytic C10-40 µF, 450 volts electrolytic C11-500 µF, 50 volts electrolytic V1-12AX7 V2, V3-ECLL800/6KH8 (available from ITT distributors)

By replacing R1 and R2 with dual 1-megohm volume control, amplifier can be used as is with FM stereo tuner or high-output crystal or ceramic cartridge.

By Peter E. Sutheim

Associate Editor

Fig. 1—Circuit of the stereo amplifier. By replacing R1 and R2 with dual 1-megohm volume control, amplifier can be used as is with FM stereo tuner or high-output crystal or ceramic cartridge.
T1, T2, T3, C10 ON TOP OF CHASSIS - C9

Di - i4

R21 - R25

R, 8

V1

R7

R'7

PF (SEE TEXT)

C5

C4

R12

R4

V3

C3

R13

R II

UNDER

C1

R15

C7

C2

R2

R5

6

Ca

View underneath shows all components. Pads in corners protect finished surfaces.

(Fig. 2-a) feeding the inverter grid from the junction of the two resistors. The ratio of the resistors is chosen to attenuate the signal just enough to cancel the gain from the inverter stage. There lies this inverter’s worst drawback: the amplitude balance of the two outputs depends on the gain of the inverter tube, which is bound to change with time, while the resistors’ values stay pretty much the same.

In the ECLL800, the inverter triode has a transconductance of only 50 - count ‘em - 50 μmhos! Its voltage gain is nearly unity. (Note, by the way, that since the cathodes of all three sections of the tube share a common pin, the inverter grid will have to be biased the same as the output stage. Interesting.)

Now, there is something lovely about unity gain. It won’t go up or down very much during the life of the tube. And it has eliminated the nuisance voltage divider.

I wasn’t aware of all this until after I had breadboarded a circuit and played with it a few hours. I had (ingeniously, I thought!) made the phase inverter plate load a 150,000-ohm pot instead of a fixed resistor, so that I could compensate for what seemed to be inherent unbalance.

So convinced was I of the need to adjust that, when the experimental circuit showed there was no need for it, I attributed it to a fluke, and went ahead and built two pots into the final version. They’re still in, as you can see from the photos, but the center terminals are not used. They are now just expensive fixed resistors. I was too lazy to take them out.

About 24 db of negative feedback comes from the 16-ohm output taps back to the cathodes of the 12AX7 via R15 and R16. C7 and C8 counteract the transformers’ tendency to make the feedback positive at superaudible frequencies.

The output transformers deserve a special word. Unprepossessing as they look, they have golden hearts. Beneath all that unlovely “gunk” sleeps a very well-made transformer—especially considering the price: $5.35 from Allied Radio, Chicago. Though I made no measurements on the transformers themselves, the amplifier’s performance shows them up very well. There’s lots of iron, built up out of thin laminations—signs of a good transformer. They are designed for 18 watts, and are loafing here at a maximum of 10.

The power supply is done in modern conventional: four G-E 1N1696 silicon rectifiers connected in series pairs as a full-wave rectifier. The 220,000-ohm resistors (R22–R25) equalize backward voltage drop to prevent any one diode from carrying the full strain. R21 is a surge-limiting resistor; it protects the electrolytics and the rectifiers from the initial heavy charging current. Plenty
of filter capacitance (160 \mu F total) means low hum, better low-frequency stability and better short-term supply regulation.

**Blasing**

In this final version, straight cathode bias is used, with a 500-\mu F electrolytic bypass capacitor to improve regulation. I tried two other ways: a 12-volt 3.5-watt Zener diode (IN1594) between the output tube cathodes and ground, and a simple half-wave bias supply using as a source the 6-volt heater winding (one side grounded) and the unused 5-volt winding, connected in series. According to theory, the Zener bias system should offer pretty near the ultimate in bias regulation, since between its breakdown point and the point where it just gives up and melts, the voltage across it stays constant. Its dynamic impedance is about 1 ohm, so it needs no bypassing.

As it turned out, neither the Zener nor the fixed supply provided any improvement over good old cathode bias; so cathode bias—the cheapest way—was the method I used here. Feel free to experiment, but remember that Zener diodes are destroyed utterly and almost instantly once overloaded (at $3.85 a shot, by the way—I know), while a cathode resistor can usually take it for a while.

**Building it**

No unusual construction techniques were used here—just the usual “good wiring practices” every construction article mentions. I recommend this layout, because it’s logical, symmetrical and reasonably compact (everything fits neatly on a 9 x 7 x 2-inch chassis). If you use it, you should have no trouble with instability or hum. The only anti-hum precaution I took was to use balanced heater wiring (grounded center tap and twisted leads). The photo shows a central ground bus, but many things are grounded rather haphazardly at convenient points.

If you do have high-frequency oscillation, try first to get rid of it by moving the output transformer primary leads around, away from the grid resistors. If that doesn’t help, try a low-value ceramic or mica capacitor from one of the ECCL800 output grids to cathode or ground. I had oscillation troubles in one channel only, and licked them with an 18-\mu F ceramic across R13. This does not affect high-frequency response but now there is no trace of oscillation or peaking in either channel.

The amount of feedback used here is about the maximum. Any more will lead to instability and raise the output voltage required for full output to such a high value that many preamps will run into distortion trying to drive the amplifier.

So, on the whole, this makes a very respectable amplifier for a modest stereo system. Total cost of the parts, new, will be something around $40. Not bad, for an honest 10 watts per channel (more on a music power rating). Happy listening!
THE PATTERN DEPENDS ON THE PROBE

By ARTHUR CUNNINGHAM

Ever complain, "My scope patterns never look like the ones in the service data?"
The answer, almost always, is, "You're using the wrong probe with your scope!"
Here you'll see what happens (or doesn't happen) when you use the wrong probe, and how pretty everything looks when you use the right one. The table and diagrams will help you choose the proper probe.

These are traces of video information, made at video amplifier output. (a) What the scope shows with direct probe: a hopeless smear. (b) Through 50,000-ohm isolating probe, a little better—probe, cable, scope input capacitance have somewhat less effect. (c) Looks like what's in the book! Low-capacitance probe shunts higher frequencies very little. (d) Trace made through crystal probe.

Photos (e) through (g) waveform on last video i.f. grid as "seen" through direct, resistor and low-cap probes. Almost nothing to see! Crystal probe (h) can give you needed information; it demodulates video carrier and removes video. Notice how direct probe (e) shorts out video signal by its low impedance. Only blanking interval is discernible.

<table>
<thead>
<tr>
<th>PROBE</th>
<th>USED IN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>Low-impedance circuits, low-frequency signals. Response depends greatly upon input impedance and capacitance of scope’s vertical amplifier.</td>
</tr>
<tr>
<td>Resistive isolating</td>
<td>Low-frequency circuits which have “medium-high” impedance. Resistor used mostly to isolate input impedance of scope from circuit.</td>
</tr>
<tr>
<td>10:1 low-capacitance</td>
<td>High-impedance circuits, medium to low frequencies and, to some extent, on higher frequencies, such as horizontal oscillator and sound testing. Useful in video circuits after video detector.</td>
</tr>
<tr>
<td>Crystal</td>
<td>RF signals, before detection. Absolutely necessary for signal-tracing in video and sound i.f. stages or tuner output.</td>
</tr>
</tbody>
</table>

Inside four probe types: Direct probe (a) is a piece of coax, with shield running almost to probe tip, and grounded to instrument at other end. The isolating probe (b) is very similar, except for about 50,000 ohms resistance in series with hot lead. (c) 10:1 low-capacitance probe, compensated with trimmer for greater bandwidth. (d) Crystal detector probe: 2 diodes in voltage-doubler rectifier, dc blocking capacitor and filter capacitor.
One of the earliest electronic engine analyzers was developed approximately 10 years ago at the Socony-Vacuum Research Laboratory in Paulsboro, N. J. Several Socony engineers, seeking a better way to observe the ignition process of gasoline engines, worked out a hookup using an oscilloscope. Since that time, many improvements and additions have been made, and today the electronic analyzer is generally accepted as the way to observe engine operation. Among the automotive service problems to which it has been applied are irregular distributor cam lobes, wobbly breaker plate, incorrect breaker-spring tension, low compression, insulation leakage, coil-tower corrosion, fouled and cracked plugs, pre-ignition, and many others.

Let’s review the operation of a typical automotive ignition system. Referring to Fig. 1, when the breaker points are closed, current flows through the coil, setting up a magnetic field in the iron core. This field builds up relatively slowly, so the length of time the points remain closed (dwell time) is important.

As soon as the points open, current flow stops and the magnetic field collapses practically instantaneously, generating a voltage that tries to keep the current flowing. A voltage surge is induced into the secondary (which contains many more turns of wire). The net effect steps up the primary voltage to many thousands of volts, firing the spark-plug. (The actual voltage depends on compression, air/fuel ratio and spark-plug gap.) The distributor then moves to the next position, closing the breaker points by cam action and connecting the
next sparkplug to the secondary, and the process is repeated.

**Advantages of engine analyzers**

The electronic analyzer has given the mechanic a set of X-ray eyes so he can see what is occurring in the engine and thus end his blind guesswork groping.

All modern electronic engine analyzers are easy to use. About all that is necessary is to connect the power plug to an ac outlet, clip on two or three leads, make a few simple adjustments and begin observing engine performance.

The electronic analyzer saves so much time that many more jobs can be handled successfully in a work day than previously.

**Kit type analyzers**

One way to get an electronic analyzer at moderate cost is to purchase it in kit form and build it yourself.

The Heathkit electronic ignition analyzer kit model IO-20 is an example. Only four cables need to be attached, and there are only four controls to adjust. The instrument has six basic sections: the trigger circuit, sweep generator, horizontal deflection amplifier, vertical amplifier, power supply and CRT circuit.

**How they work**

The DuMont type 901 EnginScope is basically a cathode-ray scope with special circuitry built in to make engine tests. The instrument contains a CRT quite similar to the picture tube in a TV set, and the engine ignition voltage waveforms are displayed on its face. Special amplifiers deflect the electron beam horizontally and vertically. A "raster" presentation is featured in which each cylinder has its own ignition line, one above the other. Signals from the engine are picked up by cables running from the instrument and clamped onto various wires in the ignition system.

Battery current flows through the automobile coil while the points are closed. When the distributor cam forces the points open, the circuit is broken and the high-tension surge comes out of the coil tower and is delivered to the sparkplug where it jumps the gap.

In the oscillogram of Fig. 2, the plug firing is pictured as a straight line at the left edge of the waveform. After the plug fires, the unused energy in the coil diminishes. The scope pictures this diminishing power as a series of wiggles getting smaller and smaller.

When all the unused energy in the coil has dissipated, the wiggles stop and the ignition system is ready to start a new cycle. This is shown by a small group of wiggles which occur at the instant the points close. While the points are closed and the coil is building up the energy for the firing of the next sparkplug, the scope shows a straight line. The straight line ends when the points open. This is called the points-open signal. The period of dwell is measured by the distance between the points-close and points-open signals.

This represents a complete ignition cycle for one cylinder and is repeated...
tern, except that the high-frequency oscillations which follow "points close" appear below the line rather than above it. Other than this, the patterns are the same, and the explanation for the raster line also applies here.

The Sperry aircraft engine analyzer works in much the same way. Patterns are presented as a trace of light on the cathode-ray tube by a ray or beam of electrons that sweeps horizontally across the screen in step with engine rotation. As the beam is swept horizontally in sync with the engine, it is also deflected vertically by the changing voltage under observation, moving up and down as it crosses the screen, continuously plotting a dynamic graph of the voltage magnitude for every degree of crank angle over a selected portion of the engine cycle.

### Engine analyzer applications

Fig. 5 is a rundown of common ignition problems. The normal pattern for a single cylinder appears at the top for reference and comparison. Obviously, all ailments manifest themselves as noticeable changes in the pattern. A little study of Fig. 5 will enable the user to pinpoint trouble very quickly.

Much useful information can be obtained if the actual firing voltage of the plugs while operating in the car can be measured. Plug circuits in good condition will show similar patterns at approximately the same voltage. A normal

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**Fig. 4**—The parade display can be expanded to show only one cylinder.

**Fig. 5**—Patterns seen on an engine analyzer screen. The defects shown here cover 90% of all ignition-system faults.

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on the scope as a complete waveform for each cylinder as it fires. In the "raster" pattern, each cylinder is shown by its own spark line, as previously explained.

The Heyer Dyna-Vision analyzer includes a CRT, power supply and associated amplifiers. A "parade" pattern (Fig. 3) is obtained from this instrument. Here, signals from the various cylinders appear in a single line across the face of the tube. This pattern can be stretched out to permit close examination of the line from any individual cylinder.

Examining a single cylinder's section of the parade pattern (Fig. 4) shows that the pattern closely resembles that of one individual line in the raster pattern, except that the high-frequency oscillations which follow "points close" appear below the line rather than above it. Other than this, the patterns are the same, and the explanation for the raster line also applies here.

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The Heyer model 600 Dyna-Vision analyzer.

Fig. 8—This pattern reveals a bad distributor.

NORMAL OSCILLATION
NORMAL POINTS CLOSE PATTERN

(a)

PATTERN JUMPS UP AND DOWN AS SHOWN HERE

(b)

BROKEN OSCILLATION INDICATES OPEN AT COIL TOWER CONNECTION OR DISTRIBUTOR CAP

(c)

Fig. 9—Ignition problems. a—Normal secondary pattern. b—Open inside coil. c—Open in distributor coil lead.

Fig. 10—Open ignition condenser causes this pattern.

OPEN CONDENSER SHOWS OSCILLATION AND ARcing AT POINTS OPEN

Fig. 11—Non-electrical problems. a—Exhaust manifold pressure with hung-up valve at 60 mph. b—Engine noise, normal condition.

Distributor troubles are a common cause of irregular and erratic engine operation. A normal single-cylinder spark line is shown in Fig. 7, and the pattern of a car with a bad distributor in Fig. 8. This could be caused by worn distributor parts such as bearings or cam faces. About the only remedy is to rebuild or replace the distributor.

Coil and capacitor troubles can be easily diagnosed and pinpointed with an electronic analyzer too. In Fig. 9-a, a normal secondary pattern, note that the ‘oscillation’ and ‘points close’ parts of the picture are very clean and well-defined. Now examine Fig. 9-b, the pattern for an open inside the coil. Note that the pattern jumps about erratically and, in general, indicates a very bad situation in the ignition system. The pattern for an open in the distributor coil lead is shown in Fig. 9-c. Here, almost the entire secondary pattern has disappeared, indicating a serious fault in the ignition system. One pattern obtained with a faulty “condenser” in the system is depicted in Fig. 10. It is self-explanatory.

Nonelectrical troubles such as a hung-up valve, engine noise and pre-ignition can be diagnosed with the analyzer using the proper transducers to produce electrical signals to drive the scope. These patterns are shown in Fig. 11.

I wish to express my gratitude to the following companies who provided much useful information and all of the photographs used in this article: Heath Co., Div. of Daysstrom; A. B. Du Mont Laboratories, Div. of Fairchild Camera and Instrument; Sperry Gyroscope Co., and Heyer Industries.
EXPANDABILITY AND SERVICE CONVENIENCE FEATURED IN THE
BELL IMPERIAL 1000
FM STEREO RECEIVER

THE BELL IMPERIAL 1000 FM STEREO receiver is in the Cadillac class. Every detail shows thoughtful design and careful workmanship.

It is all-transistor except for the front end, which uses three nuvistors. The manufacturer claims that these provide greater freedom from cross-modulation than currently available transistor circuits, a point most engineers seem to agree on.

The receiver is designed with an "expandable hi-fi" modular concept. The amplifier-preamp can be purchased without the tuner, and the tuner added later by slipping its chassis into place, tightening four screws and making four plug-in connections (see photo).

The FM dial, tuning meter and all knobs are present even without the tuner, but the dial and meter are dark and inconspicuous until the tuner is plugged in. All that shows is the manufacturer's insignia, which glows red to show that the amplifier is on.

Sound is crisp and clean throughout. Stereo separation is excellent. Sensitivity is impressive, and approximately matches, in strictly numerical terms, the best of current FM tuners. I got fine stereo reception from three stations around New York City, even though all tests were conducted on the ground floor of a steel-frame apartment building, using only a 3-foot piece of wire connected to the 75-ohm (unbalanced) antenna input.

The 1000 has afc, but hardly seems to need it. Drift without afc, even from a cold start, was so small that I probably wouldn't have heard it in the sound if I hadn't seen it on the zero-center tuning meter.

With afc, tuning is a bit tricky. A little aggressive, in fact. A station on 96.3 mc and one on 97.1 could both be made to appear at about 96.7 because of the way afc compensated for mismatching. Takes some getting used to.

The meter becomes a mono-stereo indicator when you flip a switch on the panel. (Circuit switching between mono and stereo is completely automatic.) The meter is an adequate stereo indicator, but a unit intended to sell for around $500 could well incorporate some separate device to work full-time as a stereo indicator. While flipping a slide switch is no great strain, you have to remember to do it. If you want to look for a stereo station, you must switch to INDICATE and tune until you find a station that causes the meter pointer to swing well over to the right, into the region marked STEREO. Then you must return the switch to TUNE and tune in the station precisely, watching the meter now for a center-of-channel indication. There is no way of telling...
from a distance whether the receiver is in mono or stereo. Even if you leave the switch in its INDICATE position, you can't see the meter pointer from very far.

The heavy damping of the movement requires that you tune very slowly, allowing time for the pointer to swing unmistakably into STEREO. With rapid tuning, the meter merely fluctuates even on stereo stations.

The 1000 has variable muting to suppress interstation hiss—a fearsome noise on a receiver as sensitive as this. Like almost all muting circuits, this one suppresses weak stations along with the noise, and obliterates more and more stations as the control is turned clockwise until finally there is no sound at all. A kind of audio squelch.

The contour control is a kind of variable loudness compensation. According to instruction, this is how it's to be used: With the contour control fully off, turn the volume up until the room volume approximates the original sound level(!). Now reduce the level by turning the contour control to the level you want. This setting of a reference level by using the volume control helps avoid the difficulty of different levels from record to record that is such a nuisance—more so for dark glasses. All controls have that "solid feel" that betokens a well-built piece of machinery.

The entire chassis is constructed of very heavy, mirror-finish chrome-plated steel. Dial lighting is sharp and uniform, but not so bright as to start you looking for dark glasses. All controls have that "solid feel" that betokens a well-built piece of machinery.

A feature that will appeal to both user and servicer is the hinged front panel that drops away to expose most of the front-panel wiring. There is extensive use of cabled wiring harness.

Speaker outputs are individually fused to protect the output transistors in case the speaker terminals are shorted. The fuse will also blow if a speaker of impedance lower than the rated value is connected to the terminals (for example, a 4-ohm speaker to the "8-16-ohm" terminals). This is something that might be mentioned in the operating manual, to prevent needless agony on the part of the user!

Brief mention to one useful feature: a tape-monitor input and switch for simultaneous playback of tapes being recorded on a machine with separate record and play heads. Great for checking miking and quality as you record.

The Bell Imperial 1000 is well suited to serve as the heart of a top-quality home stereo system.

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**SPECIFICATIONS**

(All specifications are from the manufacturer)

**Amplifier**
- Frequency response (at full power): 9-50,000 cycles, ±1 db
- Power output (both channels): JHF music power—50 watts, Continuous rms—50 watts
- IM distortion (full output): less than 0.7%
- Harmonic distortion (full output): less than 0.7%
- Noise (hi-level inputs): 80 db below full output
- Sensitivity (for full output): 1.5 mv
- Magnetic input: 150 mv
- Aux input: 0.5 v
- Tape monitor input: 0.5 v
- Outputs: 8-16 ohm speaker (4 ohms at reduced power)
- Headphones: any impedance
- Tape recorder

**FM Tuner**
- Sensitivity (10-500 ohm input): 1.6 µv
- Harmonic distortion (100% modulation, full limiting): less than 0.5%
- Frequency response: 20-15,000 cycles, ±0.25 db
- Noise: 65 db below rated output
- S/N ratio: 2.5:1
- Stereo separation: 30 db from 20-15,000 cycles
- Image rejection: greater than 65 db
Above, multircuit array of thin-film circuits; below, examples of finished hybrid circuits—forms of RTL (resistor-transistor logic) flip-flops. In both cases, thin-film technique has been combined with discrete components.

Circuits are getting tinier—being made in one or two steps.... More information about this fascinating frontier of modern electronics

MICROELECTRONICS (or MICROCIRCUITRY) now describes two basic techniques for fabricating entire circuits—transistors, resistors and capacitors—in a single package no larger than a postage stamp.

How is it done?

In one technique, metallic films are deposited on glass substrates, resulting in tiny circuit patterns on wafers the size of a contact lens. This gives us thin-film circuits. The second method produces solid-state semiconductor circuits by diffusing chemicals into pinhead-size silicon wafers in the same way that transistors are made.

A third approach now being tried in the laboratories is a combination of these two basic ones. Thin-film passive components are deposited on the surface of silicon chips that contain active devices such as transistors.

The thin-film approach is closest to old-time conventional circuitry. Thin-film circuit elements—separated from the integrated microcircuit and individually packaged—readily become conventional discrete components, such as the film resistor, for example.

Not only are the components of thin-film circuitry like conventional ones physically; circuit design is much the same. We can translate directly from conventional circuit design to microcircuitry with thin films.

But thin films have at least three striking advantages over conventional circuitry: miniaturization, performance and reliability. An entire thin-film circuit, such as a flip-flop, can be packaged in one TO-5 transistor case. Thin-film technique produces higher quality resistors and capacitors than can be made by semiconductor methods. (Thin-film
resistors have been made with tolerances as close as 0.4%.) Reliability becomes greater as deposited joints are substituted for soldered or welded connections. For example, a resistor in a thin-film circuit can be formed as an integral part of the circuit, rather than with joints between discrete components.

To introduce active elements to the thin-film circuit, semiconductors must be attached to the passive thin film. Active thin-film elements are being worked on in the laboratory, but have not yet been proved feasible.

Making thin-film microcircuits

Philco uses sputtered tantalum for fabricating resistors, capacitors and conductors in thin-film microcircuits.

Sputtering is a process based on an electric discharge between two plates in a gas (generally argon) at low pressure. Ionized gas atoms are accelerated to the tantalum cathode by a high-voltage field and knock off tantalum atoms. These diffuse to the glass substrate on the anode. Sputtering wastes little material, and the deposits adhere excellently. Uniform deposition is possible over large areas (3% sheet resistivity variation over a 2 1/2 x 3-inch substrate).

Gold is afterward deposited on the tantalum to increase the conductivity of the conductors and for connections to the package and active elements. A thin layer of chromium is placed between the tantalum and the gold. This chromium layer acts as a glue to bond the layers together. Capacitors are formed by anodizing the lower tantalum layer. This produces an oxide layer (Ta2O5) on top of the tantalum. This becomes the dielectric. The capacitor is completed by depositing a gold layer on top of the oxide. Resistor areas (bare tantalum) are also anodized to form an oxide layer which acts as a protective skin over the resistor. The active elements—silicon transistors and diodes—are added in the form of pretested chips. Simple photographic mask changes during the photoengraving make the fabrication process more flexible. Fig. 1 shows resistor-capacitor construction and an added active element (transistor).

In the Philco process, a vacuum chamber is used only to produce the thin films. The circuitry is etched externally with high-resolution photolithographic masking. This eliminates the problems of mechanical masking. The high-resolution photoengraving, plus the high heat-handling capability of refractory tantalum, permits high density microcircuitry (more circuitry per unit area). Photoengraving also makes it possible to design and lay out more intricate patterns rapidly at lower setup cost than mechanical masking. The masking steps proceed as follows: First, the substrate with its initial tantalum layer is photoetched and the tantalum removed everywhere except where a resistor, capacitor or interconnection is to be formed. Then a second photo-mask is used to expose the remaining tantalum everywhere a resistor or capacitor is to be formed. This exposed tantalum is then chemically anodized to form an oxide layer. The chromium-gold multi-layer is placed over the entire substrate and a third set of photomasks used to remove the gold except where an interconnection, bonding point or capacitor is wanted.

Hybrid circuits

Many passive circuits may be produced in a multicircuit array, then cut apart to add the active elements and assembled into the package (either a multi-lead TO-5 transistor case or a 2-dimensional, 12-lead ceramic-to-metal package). The photos on the preceding page show a multicircuit array (RTL flip-flop) and assembled units. A seven-resistor precision ladder network is shown in Fig. 2.

The thin-film diode logic commutator for an aerospace application shown in Figs. 3 and 4 is an example of thin-film circuitry. The matrix consists of 96
silicon diodes, 24 tantalum film resistors, and associated conductors and interconnections. The matrix is shown schematically in Fig. 3. The purpose of the finished commutator (Fig. 4) is to switch 24 different information points or input signals into a single output channel sequentially. The control diodes, biased by external control circuits, do the switching. (Input signal swing is limited to ±10v.) For example, if input 1 is to be monitored, the biasing arrangement would be:

![Image of commutator matrix]

1. Diode bank a receives a back-biasing potential (+10v), while diode banks b through f are forward biased (−10v). As a result, input signals 5 through 24 are shunted away out of system through control lines b through f.

2. Control diodes B, C and D are forward biased (−10v) while diode A is back biased (+10v). This results in input signals 2, 3 and 4 being shunted out of the system through B, C and D. Signal 1 then proceeds alone to the output monitor.

Solid-state microcircuitry will be described in a later article.

Fig. 4 - The logic commutator of Fig. 3 ready for insertion in a circuit. It is encased in a potting compound, and its volume is approximately a cubic inch.
LAST MONTH WE FOUND OUT HOW DIFFERENT kinds of projectors work, and some of the mechanical problems they present. This month, we'll look at two more specific mechanisms, what they do and what can go wrong with them. Also, a little lesson in threading and running a machine.

The clutch
Most better-grade projectors are provided with a clutch to disengage the motor from the gear train. This clutch can be used for still-picture projection of a single frame, etc. Some units have an automatic clutch, operated by a trip lever in the film path. If the film breaks or anything jams, the clutch is automatically released, stopping the machine. The projector in Fig. 1 has this arrangement; the trip lever is hidden behind the lens barrel, but the reset lever can be seen directly below the film gate, at the bottom. It is in its tripped position; to engage the clutch, raise it until it catches.

So, if you get a machine in for service with the complaint "The motor runs but nothing else will!" look at the clutch.

Safety shield
As we just said, these machines can be stopped to show only a single frame of the film, or "still." With a high-power projection lamp, stopping a frame of film in the beam of light will result in something like Fig. 2! Something must be done to reduce the intensity of the light. A perforated aluminum shield is automatically dropped in front of the lamp whenever the machine stops. This is inside the lamp housing, and fits in a slide. The top of the shield is bent, to form a "blade" in the stream of air blown through the lamp housing by the cooling fan. As long as the fan is running, the shield is blown up and out of the gate. When the air stream stops, the shield falls before the lamp. Enough light gets through the perforations to show still pictures, but the intensity is reduced to the point where it will not burn the film.
This can be checked easily by aiming the projector at the screen, without any film in it. Stop the motor and watch the screen. If you see the light dim quite noticeably, the shield is working as it should. If dust fouls the slides, sometimes the shield will not be free to "blow up," and the projected picture will be dim. You can check this by running the machine without film, and looking into the lens through dark glasses. If the shield is jammed, you'll see the perforations very plainly. Another method is to throw the machine out of focus, with the beam on the screen. At one point, you'll be able to see the image of the lamp filament, if the shield is out of the way. Usually, cleaning out the dust with a soft brush is enough to cure this trouble. Be careful, though, as the shield is made of very light aluminum, and can be damaged.

**Threading up**

Threading film through an unfamiliar projector can be difficult. Instructions can be found in the instruction book; if it is missing, you may have a hard time. Some machines, as noted, have guide lines, etc. to show the film path. As a general rule, though, you can thread up any "stranger" by following this sequence: Put the full reel (the feed reel) on the front of the machine. The empty takeup reel will be on the back. Start the film over the nearest idler roller, then trace out this sequence—drive sprocket, film gate, under the pressure foot—another drive sprocket—under sound head—drive sprocket—idler—then to takeup reel. There will almost always be two drive sprockets, one on either side of the sound head, plus idlers to keep the film tight, and another drive sprocket above the film gate, or pressure foot. Fig. 3 shows the basic outline of this.

You'll have to open the film gate to slip the film under it. There are two ways of doing this in commercial machines. The lens-barrel, foot, etc., swing open on hinges, as in the machine of Fig. 1, or the lens barrel and foot slide forward, operated by a lever, as shown in Fig. 4. The lens barrel has been removed here to show where the lever is located, as it is hidden when the machine is operating. The gate is open in this picture.

When you close the film gate, be sure that the film is in the groove where it must run; you'll be able to see this clearly. If the pulldown teeth are retracted, you can slide the film slightly up and down to see if it is free.

**Setting the loops**

The most important parts of threading up are getting the film tight over the sound head, and getting the right amount of slack in the loops above and below the film gate. The proper amount of slack is sometimes indicated by ridges on the housing. Fig. 4 shows this, and film threaded with the correct loop.

Drive sprockets always have some sort of latch to keep the film in place. Sometimes this is a spring-loaded tab, sometimes a spring-loaded idler roller on an arm. Both can be seen in several pictures here and in Part I.

After the machine is threaded up, turn the motor on and make a short test run. Keep your finger on the switch! If there is anything wrong, or if the film isn't threaded right, the powerful gearing can break the film instantly! The best clue here is to keep an eye on...
the loops: if either loop pulls down tight, something is wrong. Turn the machine off immediately and find out what! (Incidentally, damaged film can cause this trouble, so be sure to check the film. Take a close look at the section of film running between the drive sprockets. Examine the bottom edges of the sprocket holes. You may find them torn and ragged instead of nice and even. This type of damage may have been caused by incorrect threading or by worn pull-down teeth. We’ll go into this in the next article.)

**Motors and power supply**

Practically all the machines I know use “universal” motors, which will operate on either ac or dc, 117 volts. The larger machines use transformer-powered amplifiers, which must have ac. For this kind of service, the amplifier power plug was pulled, and a dc/ac inverter inserted between the two, as shown. Failure to use the inverter accounted for many a power transformer replacement!

Some projectors use ac/dc amplifiers; the machine seen in Fig. 1 has this circuit. These can be used without the inverters, of course; they use such tubes as 50L6, 35Z5, and so on.

Next month, we’ll examine some of the electronics of sound projectors, and offer some service tips for both mechanical and electronic troubles. TO BE CONTINUED

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**Diagnosis and the Frozen Brain**

By JOHN FITZGIBBON

**FIXED IDEAS CAN REALLY FOUL UP THE**

diagnostic process while you’re repairing TV circuitry. Here’s a good example.

I was fixing up an old Stewart-Warner 9126 for use in some experiments. The horizontal oscillator circuit was quite conventional: 6AL5 phase detector/afc and a 6SN7 cathode-coupled multivibrator with a ringing coil for the horizontal oscillator. How simple can you get? Everything nice and normal.

Horizontal hold acted peculiarly, though. This is the slug in the ringing coil, by the way. When I turned it clockwise, from an out-of-sync state, the picture wouldn’t lock in but flipped rapidly out of sync the other way! Had to back up on it counterclockwise to get it to hold. Even then, I’d get a split picture with blanking bar in the center about every third time.

“Ah-ha!” said I. “This is afc trouble. Everyone knows that such conditions are always caused by afc. Especially since I’ve made the test that they tell you to: shorted the grid of the horizontal oscillator, removing the sync. Then, the oscillator made a single floating picture, pretty stable. This proves that the trouble is in the afc!” (Can you hear the ice beginning to form on my mental processes along about here?)

So, I investigated the afc circuits. times “they” are usually conspicuous by their absence; they’ve gone out for coffee or something. So there I sat with my little soldering iron, all alone.

After a period of time which shall not be discussed, I tentatively decided that there just might be something else wrong, and I’d check the oscillator again. So, I unsoldered the coupling capacitors, grid resistors, grid bypass capacitors, etc., and found them all in fine shape, except for a minor leakage in the .05µf grid bypass capacitor. After I replaced this, I happily turned the set on. Same trouble. I picked up my face from where it had fallen and resumed testing.

Eventually I came to the 3,900-ohm plate resistor, “Everyone knows” that these resistors aren’t too critical; in fact, I’d replaced and changed value on any number of them in the past, without affecting the oscillator performance. Oh, well, I’d checked everything else; might as well check this one. Hmmm. About 7,500 ohms instead of 3,900. Oh, well. Replace it. Turn set on. Works perfectly. Horizontal hold falls out the same on each side; nice smooth bars instead of squeezing as it has been. Hmmm. Go out for coffee.

Return. Set still perking beautifully. Check hold. Fine. Oh, me. What did I do wrong? Answer immediately apparent: I froze up on the diagnosis! At first, my tests and conclusions were OK: the symptoms did point to the afc, because of the way the oscillator was acting with the afc shorted out. However, after the afc checked out good, I should have realized immediately that this was not causing the trouble, and that the oscillator circuit was the only thing left!

Moral: no matter what fixed ideas you have about a circuit, don’t freeze on your first diagnosis. Always be willing to throw that away and make a new one to fit new evidence!
If your old mono tuner has what it takes, this may be the most sensible way

with many FM stations now broadcasting multiplex programs, most audiophiles who haven’t yet converted from mono to stereo FM have a strong urge to do so. They can either buy new multiplex tuners or add multiplex adapters to their present mono tuners. Where the mono tuner has been a dependable servant—with high sensitivity, sharp selectivity, drift-free tuning, low distortion and low noise—the owner is rightly inclined to purchase a multiplex adapter and save money.

If maximum performance is the objective, adding an adapter may not be simply a matter of bypassing the tuner’s de-emphasis circuit and making cable connections. Satisfactory multiplex reception makes greater demands on the tuner than does mono, and your tuner must be in tip-top condition. Further, the tuner and the adapter must be properly mated for good performance and convenient operation. Here the audio technician can be very useful. How useful is illustrated by this case history, which is also a checklist of things to consider in converting to FM stereo.

The customer owned a Browning RV-10A tuner (about 11 years old and one of the finest of its day) and wanted a multiplex adapter that could be tucked away in his equipment cabinet without the need for switching manually between mono and stereo. He chose the Pilot 200 adapter, which has automatic switching. The following steps were taken for maximum performance and operating convenience.

Checking tubes and other parts. A couple of tubes that failed to measure good were replaced. Electrolytics were checked, and all were good. Operating voltages shown on the schematic of the RV-10A were checked. All were correct.

Tuner alignment. The tuner was very carefully aligned. First, using a 10.7-mc signal frequency-modulated at 60 cycles, the i.f. transformers were touched up for a good “flat-top” response curve (Fig. 1), as viewed on scope. The curve should have symmetrical proportions, maximum amplitude consistent with a bandwidth of about 180 to 200 kc. Second, using the same signal, the discriminator transformer was aligned for an S-curve (Fig. 2) with excellent symmetry and linearity and maximum amplitude, as viewed on a scope. The discriminator alignment was touched up by using the test frequencies of an IM distortion analyzer to modulate the 10.7-mc signal, and adjusting the discriminator for minimum IM distortion measured at the tuner’s output jack. Third, using signals of 105 and 90 mc, the rf, oscillator and mixer stages were aligned for maximum gain and for dial calibration. These alignments were then touched up by the IM distortion method.

Removing de-emphasis. FM stations are required to apply a 75-\(\mu\)sec boost to the audio signal, meaning that response is up 3 db at 2,122 cycles and continues to rise at a rate approaching 6 db per octave. (Thus response is up 13.7 db at 10,000 cycles and 17 db at 15,000 cycles.) For flat audio response, the FM tuner must provide 75-\(\mu\)sec de-emphasis. However, the signal fed to the multiplex adapter must be free of such de-emphasis. Therefore, the de-emphasis network of the RV-10A (Fig. 3), consisting of a 75,000-ohm resistor and a 0.001-\(\mu\)f capacitor was removed. Some mono tuners, anticipating stereo, have a multiplex jack connected before the de-emphasis network. Nevertheless, it is a good idea to remove this circuit when feeding a multiplex adapter.

Reducing shunt capacitance. To obtain as much stereo separation (distinction between left and right signals) as the multiplex adapter is capable of, the mono tuner must maintain response after the detector to 53,000 cycles. Therefore it is important to minimize shunt capacitance between the discriminator output and ground. As shown in Fig. 4, the discriminator output of the RV-10A originally ran to a selector switch (this tuner has three input jacks for high-level sources), from there to a volume control and finally via shielded cable to the output jack. This circuitous path introduced a fair amount of capacitance, which was eliminated by running an unshielded lead about 3 inches long directly from the discriminator to the output jack.

The multiplex adapter came with a short, low-capacitance cable for connecting the tuner output to the adapter. A lead about half as long was substituted to reduce capacitance even more.

Remote stereo defeat. For two reasons, the customer wanted a remote control to enable him to defeat the stereo signal and hear the mono signal instead. First, he wanted a ready means of comparing mono and stereo signals. Second, sometimes the adapter is fooled by noise or strong harmonics of a mono broad-
cast into thinking it is receiving the 19,000-cycle pilot of a multiplex broadcast. The result is a rushing, roaring sound that closely resembles Niagara Falls. In theory, paralleling the left and right signals at the stereo preamp can reconstitute the mono signal and cancel the rushing-roaring noise. However, the customer wanted to be able to check theory against practice, and so a remote defeat switch was very easily installed as follows.

Fig. 5 shows the Pilot 200 circuit. It includes an electronic switch that, by changing the voltages across four silicon diodes (D1-D4), permits the stereo signals instead of the mono signal to reach the output jacks of the adapter. The switch is controlled by V3, which is activated by the 19,000-cycle pilot of a multiplex broadcast. To defeat a stereo signal, it was necessary only to run a lead from the grid of V3-b to the now-unused selector switch of the RV-10A and rewire the switch so that in its first position it would act as a short to ground. The lead from V3-b's grid was connected via a phone plug to one of the tuner's unused input jacks, which in turn was wired to the tuner's selector switch.

Stereo indicator. The voltage developed across V3-b's plate resistor when a stereo signal is being received also serves to light an NE-51 lamp, which is at the end of several feet of extension wire. The RV-10A is located behind a wooden panel in the customer's equipment cabinet, and the indicator lamp was mounted behind the same panel. A hole was drilled in the panel and fitted with a "jewel" to let the lamp shine through.

Ac extension socket. The mono tuner should have a switched ac socket from which the multiplex adapter can draw power. Since the Browning RV-10A had no such socket, one was installed at the end of several inches of cord (Fig. 6). The adapter could have been plugged into the switched ac outlet of the customer's preamp, but this would have meant needless operation of the adapter when, say, the phonograph was being used but not the tuner.

Antenna. The customer had been getting clean, noise-free mono reception with a simple folded dipole made of TV ribbon stapled behind his equipment cabinet. But multiplex signals are inherently much weaker than mono and there was noise on stereo programs (unless the stereo defeat was used). Also, there seemed to be increased distortion. We connected the tuner to the customer's TV antenna, and cleaned up both troubles. A dpdt switch was installed so that the owner could connect the antenna to either the tuner or the TV set. He plans to install a separate high-gain antenna specifically designed for FM.

The result is a satisfactory installation in performance and operating convenience. Program material sounds just as clean in stereo as in mono, noise is nearly as low, and stereo separation is excellent. The adapter is automatically turned on with the tuner, and automatically switches to stereo. The remote indicator shows when a stereo broadcast is being received. The customer can restore mono operation either through the stereo defeat switch located in the tuner or by paralleling the left and right channels in his preamplifier.

Pilot's model 200 multiplex adapter - the one used in this conversion.

Fig. 6 - Added ac outlet turned adapter on and off right along with tuner.
By JIM KYLE, KEG-3382

SOME 350,000 POTENTIAL CUSTOMERS IN this nation (more in Canada and eight South American countries) are looking for skilled radio service for both receivers and low-power transmitters.

I'm referring, of course, to the users of Class-D Citizens Radio (General Radio Service, in Canada; Comunicaciones Personales in the Latin-American regions).

You've probably run into some of these potential customers—and possibly you turned their business down either because the circuits looked too strange to you, or you felt you had to have a license to do anything.

The circuits are a bit unusual, yes—but certainly none of them are as tricky as a Synchroguide or a color convergence job. And, contrary to popular belief, you can do almost anything to a CB unit without a license! The only adjustments or repairs for which a license is necessary are these:

1. Any adjustment of the transmitter oscillator circuit which can affect the frequency of the transmitted signal.
2. Any adjustment of the transmitter audio circuits which can cause modulation greater than 100%.
3. On-the-air tune-up of the transmitter final amplifier. However, an unlicensed person can tune up the unit if it is connected to a dummy load instead of to an antenna.

You can see from this that all receiver adjustments, and many transmitter repairs, require no license.

If you do much of this work, sooner or later you're going to have to have that Second-Class Radiotelephone ticket. A future RADIO-ELECTRONICS article will cover the adjustments for which you need a license, and how to get one.

What you're up against

Almost all CB units in service today are transceivers (combination transmitter-receivers). Transmitter and receiver share the same audio circuits and power supply.

Let's look at the transmitter first. Most CB transmitters have either two or three stages. The first one, in all cases, is the oscillator. This is always crystal-controlled and usually uses one of the three circuits shown in Fig. 1.

The major difference between a CB rig's oscillator and any other crystal oscillator is the trimmer, C. Not all units include this trimmer, but most do. Its purpose is to adjust the crystal frequency to exact tolerance (FCC regulations allow only 1,300 cycles error in frequency). Unless you have a license and proper equipment to measure frequency, don't disturb that trimmer!

The oscillator may drive the final amplifier directly, or it may drive an intermediate buffer stage which in turn drives the final. The major difference between the buffer and the final is that the final is modulated. Fig. 2 shows a typical final amplifier circuit.

TV vertical output tubes, almost universally used for CB transmitters, have the dual advantages of being rugged and inexpensive. You probably already have all the popular ones in stock. (Occasionally, a set will pop up using an audio output tube instead—in the early days the 6AQ5 was popular, but the 6C8 leads now.)

The receiver is almost identical with a standard ac-dc circuit with a few exceptions. Many CB units have crystal-controlled oscillators on the receiver as well as the transmitter. This makes tune-
up easier as well as operation! Almost all have some sort of automatic noise-limiter (anl) circuit. Most also have a squeel, but this belongs in the audio circuit. Many include S-meters.

**Automatic noise limiters**

The anl circuits are designed to block ignition noise pulses while allowing the desired audio to pass through. All of them are based on the idea of passing the audio signal through a biased diode, then having any strong noise pulse turn the diode off momentarily to block the audio path. Bias from the avc line is used for the diodes; this makes it “automatic” since the bias level is proportional to the strength of the incoming signal.

A typical anl circuit is shown in Fig. 3. However, this area is one in which much variation still exists and you'll see many circuits which look nothing at all like this one!

In Fig. 3, half of the 12AL5 detects the incoming signal and develops a negative voltage across R20, R22 and R23. Avc is taken off through R21. The audio signal and a portion of the negative voltage are taken off from the junction of R22 and R23, and applied to the plate (pin 7) of the other half of the 12AL5.

The cathode of this half of the diode (the noise limiter) is connected through R24 to the avc line. With no signal applied, the plate is about half a volt more negative than the cathode. With enough signal to develop 10 volts avc, the plate gets only about 2 volts more negative than the cathode, so the diode will conduct. Actually, it will conduct with any usable signal since the cathode gets full avc voltage while the plate gets only about half the avc voltage. Both are negative to ground but the cathode is more negative than the plate.

However, the avc voltage supplied to the cathode is filtered by C25, and, if a fast noise pulse comes along, the cathode voltage will not change. The plate voltage, not being filtered, will go highly negative. This cuts off the diode, and no audio can get through. As soon as the noise pulse is past, the plate returns to normal and the audio once more passes through.

The S-meter is nothing more than a built-in vtm measuring the voltage on the avc line. Often, to save parts, it uses an i.f. tube as its active element, comparing the screen voltage of this tube to a fixed value (frequently the cathode volt-

age of the audio output tube).

As the avc level rises with a stronger signal, the screen current to the i.f. tubes will be reduced and the resulting screen voltage will rise. A meter connected from the screen to a fixed positive voltage will read this rise in voltage.

S-meter circuits can be headaches--S-meter and hobbyist users of CB equipment love nothing better than comparing S-meter readings. Naturally, no two S-meters will read alike due to natural differences in tubes, design and circuit tolerances. About the only thing you can do for this problem is to check out the circuit, make sure it is working, and explain the facts of “tolerances” to the unhappy owner!

**Getting down to business**

Let's look at some concrete ways of making money out of CB — how to troubleshoot it.

These are the tools and test equipment you'll need:

1. A good signal generator, well shielded, preferably with calibrated microvolt attenuator. It must cover the range 26-28 mc, and should cover frequencies from 175 to 1800 kc.

2. A power output meter. This may be combined with an swr bridge, as in the Cescos Transcheck, Seco Antenna Tester, and Globe Tenna-Meter.

3. 20,000-ohms-per-volt vom with standard and needle probes.

4. Vtm of any standard type. No special probes.

Helpful but not absolutely necessary at the start is a tube tester (you probably have one anyhow). Also helpful at times but actually rarely needed is an oscilloscope.

As in all service work, the first step is to find out what symptoms the customer noticed.

If nothing at all works, the problem is probably in the power supply. Standard troubleshooting techniques apply to the ac portions of the power supplies; standard auto-radio techniques apply to the mobile-radio parts of it.

If the complaint is poor reception but transmitting performance is fine, realignment and receiver checkout are indicated. This also follows standard ac-de practice, except that squeel controls, if present, should be turned wide open so you can hear what you are doing.

The complaint most likely to give you headaches at first is “poor transmission but the receiver works fine.” This indicates troubles in the transmitter, of course. Here’s how to check them out most rapidly.

Connect the dummy load and power meter to the antenna connector on the unit (Fig. 4), turn it on and let it warm up. Key the transmitter by pressing the microphone button and read output power. A reading anywhere between 2½ and 4 watts is normal for “full-power” jobs, with the average about 3 watts.

If the reading is low, connect the vtm (set to read —dc volts) to the control grid of the final power amplifier tube and key the rig again. Normal read-

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**Fig. 3—Anl circuit of Globe CB-200; many others are similar series-limiters.**

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Here, power meter is inserted between transceiver and antenna, as shown in Fig. 4. If transmitter checks OK, trouble is narrowed down to receiver or audio.
ing here will vary, but should be about 
-20 volts.

If this reading also is low, take a
reading at the control grid of the oscil-
lator tube with the transmitter keyed on.
This one should be between -5 and 
-10 volts with most sets.

If it's too low, substitute another 
transmitter crystal and see if it moves up. Frequently, a crystal will “age” and lose some of its activity. That same crystal, incidentally, may perform per-
factly in another set!

If replacing the crystal does not 
bring output up, substitute another oscil-
lator tube. Testing will show you noth-
ing—substitution is the only reliable test 
for an rf oscillator.

If this, too, fails, measure the vol-
tagage at the plate of the oscillator in both 
receive and transmit. Transmit voltage 
should be lower than receive, and both

![CB Transceiver](image)

Fig. 4—Hookup for measuring CB transceiver output power. Heath "Canenna" makes good dummy load (see June 1963 
issue, p. 66), or use other non-inductive 
50-ohm resistance. Avoid using light 
bulbs. Some power meters contain built-
in dummy loads.

should be about 250 to 350 volts. (Some 
sets remove high voltage from transmitter 
tubes in "receive"; with these, proper reading in "receive" is zero volts.)

If oscillator plate voltage is 
less than 250, check the power supply (a few 
sets operate as low as 200 volts; with these, naturally, oscillator voltage will 
also be about 200). If there is more than 
about 10% difference between supply 
voltage and voltage at the plate, look for 
a defective component in the circuit.

If voltage at the final-stage grid is 
proper but output is still low, measure the 
voltage from plate to cathode of the 
final tube. It, too, should be around 300 
(or within 10% of the supply voltage). 
Also measure the current by breaking 
the lead to the plate (Fig. 5) and insert-
ings the vtm, set to the 100-ma range. 

If this reading is less than 4 watts, 
substitute another tube. If this doesn't help, trace the screen circuit for 
defective components.

Like everything else electronic, 
most CB troubles are caused by defective 
tubes. A close second is the aging crystal.
Both, fortunately, are easy to check by 
substitution.

About service data: the best source 
of up-to-date service data on this equip-
ment is the manufacturers themselves. 
The most recent count shows more than 
100 manufacturers in the field, and only 
about 10% of them are represented in the data 
services. But you'll find almost all manu-
facturers eager to provide data on 
their equipment.

The specialized test equipment is 
easy to use. For example, on the Seco 
Antenna Tester, to measure output

![Diagram](image)

Fig. 5—Measuring dc input power. Break 
plate circuit and insert 0-50 milliammeter 
or current range of vtm. Measure vol-
tagage between plate and cathode, not plate 
and ground.

Keep the power output meter in the 
line when tuning the plate circuit. It's 
easy to load up to 5 watts input with 
the circuit misadjusted so that only 1 or 
2 watts rf get out!

If you find it impossible to load to 
5 watts, substitute another tube. If this 
doesn't help, trace the screen circuit for 
defective components.

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most CB troubles are caused by defective 
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![Diagram](image)

Fig. 1

Minimizing 
The 
Vtvm Pointer Shift

The zero setting of most service 
vtvm's shifts as the range selector is 
switched. Resetting the zero is a nuis-
ance; not resetting it gives inaccurate 
measurements.

The shift is caused by "contact po-
tential" grid current flowing through 
the high-resistance voltage divider 
(Fig. 1). Since only one grid circuit

contains this divider, while the other is 
grounded, changes in voltage drop un-
balance the meter circuit as different 
resistances are switched in. The contact 
grid current through V1-b remains 
constant—that through V1-a varies as the 
range selector is switched to progressively 
lower voltages, thus switching more 
resistance into the grid circuit. In some 
vtvm's the V1-b grid goes to ground 
through a high-value resistor. Grid cur-
current is still constant, of course, though 
may not differ from V1-a as much as 
with the grid grounded direct.

To insure equal drops on both 
sides, use a two-pole range selector and 
build an exact duplicate of the divider 
for the other side of the vtmv bridge 
(Fig. 2). Now the vtmv will stay bal-
anced at any setting of the selector, 
since each grid circuit always contains 
the same resistance.—R. M. Centerville

![Diagram](image)

Fig. 2

RADIO-ELECTRONICS
SPACE STATION DESIGN won a $400 prize from NASA Inventions and Contributions Board, and for its inventor, R. A. Berglund. The hexagonal model at left represents the station in space. The rocket-like object on the table is the same type of space station as it would appear when ready for launching.

SOLAR-POWERED BOAT uses 40 solar cells to run its small motor, moving majestically through the water under radio control on sunny days. The sun ship was built by the Rev. Robert W. L. Mark of Hawley, Pa., known to Radio-Electronics readers as author of articles on the old one-tube Twimplex circuit.

NEW LASER is small enough to put in a coat pocket. About the size and shape of a frozen juice can, its signals can be detected 30 miles away. Raytheon developed the device and is testing it with the idea that it might be used by distressed boatmen and downed pilots to signal their position. It is shown above a small German power supply with which it was used, and which will fire it about 50 times before battery recharging is needed.

ELECTRON BEAMS DRILL HOLES in .005-inch thick tungsten sheet. Only .0008 inch in diameter, these holes are drilled by the same electron beams that occasionally burn the screen of a TV tube. In short pulses of tremendous power, the beams can vaporize the most heat-resistant materials and produce almost incredibly small holes. A human hair is shown for comparison. The experimental device was developed by Westinghouse.
A LOT OF OUR MAIL ASKS, "CAN I REPLACE THE | CRT IN AN OLD --- WITH A | (10') (110') --- TUBE?" Fill in types and | and names yourself. Conversions such as | this fall into three classes: easy, difficult | and impossible. As a general recommendation, | I'd say that you should never attempt a | conversion of this kind unless you're thoroughly familiar with the | circuits and realize how much trouble it's going to be!

Easy conversions are those where the tubes have the same deflection angle—for instance, converting from a 17-inch 70° to a 21-inch 70° tube. Actually, we don't need much sweep to cover the added distance, for this will be surprisingly small—only about 2½ inches, horizontally.

If the set in question is one of those old "conservatively designed" jobs with ample power reserves, the job can be fairly simple. All we have to do is put the sweep circuits into first-class condition, and the extra deflection is easily obtained. However, if the set happens to be one of the "marginal" types, of the cheaper group, where every tube in the set is being driven to within an inch of its life (thus shortening said life tremendously!), you're probably going to have much trouble and woe! You know the type I mean; you've seen enough of them. The only answer to conversion questions for these sets is a firm "No!"

Conversion of these types would mean completely rebuilding the entire sweep circuit, and also the power supply! The cost of rebuilding such chassis would pay for a new color set, not only the chassis itself, but also the power supply! Everything else would have to be replaced, too. Obviously, this is prohibitive, except in cases where there's your first important factor: the price of the chassis.

Miller 71-OSC or any similar universal coil. This is tapped so that it can be used in almost any oscillator circuit, and has an adjustable core for tracking. (If it won't oscillate, reverse one of the windings—either one, but not both!)

Half inch more width
I've replaced the 12LP4 on an old Majestic TV with a 17BP4B, and it works fine. The only trouble now is I still need about ½ inch of width on each side. I've made some changes in the circuit: changed the screen resistor, and raised the B-plus voltage, etc. Any ideas?—J. G., Quincy, Mass.

You might try a few more tricks to get that last little bit of "stretch": add a small capacitor across the damper tube, about a 100–150 pf, 6 kv. Shunt the primary winding of the flyback transformer. We'd need 25% more power in the vertical sweep circuit to sweep the 90° tube, compared to the 70° tube. The horizontal circuit will need 25% more power. If the low-voltage power supply will bear up under this additional drain, we're in. We can get more power in the sweep circuits by changing tube types. For example, 6BQ6's can be replaced by the more powerful 6DO6's, and 6F6's in the vertical output by 6V6's, and so on.

To find out about how much power we can draw from the power transformer itself, look up the recommended replacement in a transformer catalogue and note the current rating of the high-voltage secondary. This is the limiting factor in all conversions. If the original transformer had a current-supply capability of 200 ma, and calculations show that we'd need 250 ma for the new tubes, the only answer here is replacement of the power transformer.

Yokes can usually be changed with ease. Find out the inductance of the original yoke. For example, if the yoke had a 10-mh horizontal and 45-mh vertical inductance, get a catalogue and look up a 90° yoke which has approximately the same inductances. You'll have about a 10% tolerance here, especially if the chassis has both horizontal linearity and width adjustments. Many older sets did use these handy controls, and they are always helpful in making the final adjustments after the new tube has been installed.

Conversions from very old sets to very new tubes isn't recommended. For example, I doubt if it would be possible, let alone practical, to convert from a 54° tube to a 115° type! The added sweep power requirements would make this prohibitive, except in cases where the technician "just wants to see if he can do it" and has an almost unlimited supply of nonworking cash type money!

Emerson oscillator coil
The oscillator coil in an old table-model Emerson radio is open. No model number left on chassis or cabinet, of course! Tube line up: 3525, 50L6, 12SQ7, etc. Can you tell me where I could find a replacement coil?
—J. M., Cranford, N. J.

I'm sorry to say that I can't pin this model down for you, since the number of Emerson radios with that tube lineup is almost without number! However, the chances are that it used a standard tickler-feedback oscillator circuit, since most of them did. See Fig. 1.

You can replace this coil with a
Servicemen and the public long wanted it, but were told they couldn’t have it—a transistorized TV antenna preamplifier with the overload capacity to handle local signals without sacrificing the gain that brings in distant stations.

But Jerrold did what couldn’t be done. With the new twin-transistor SUPER POWERMATE, you have, for the first time, a transistor preamplifier with the high gain and low noise figure that made the original Jerrold Powermate famous—plus an unprecedented overload capability for local-signal situations. SUPER POWERMATE offers a gain range from 15.5db with 700,000µv max. output at Channel 2, to 11.3db with 200,000µv max. output at Channel 13. There are no tubes or nuvistors to replace. And frequency response is fantastically flat—a boon to color TV.

Sell new SUPER POWERMATE, the all-channel antenna preamplifier with G/O—the industry’s best Gain/Overload capability. List $44.95. See your Jerrold distributor or write Jerrold Electronics, Philadelphia 32, Pa.
(6BG6 plate tap to next tap) with about a 20-pF 5-kv capacitor.

One last resort might be to replace the yoke with a 70° type. The original yoke is a 53° type, and the extra bit of deflection might do it. I believe a Stan-
cor DY-8 should do the trick: this is exactly the same inductance as your original yoke (8.5 mh horizontal, 55 mh vertical) but is a 70° type. There are several others by other makers with the same values. Try any of these.

Streaking and horizontal bend

In a RCA KCS-136 chassis, there is an awfully short-time-constant inter-
mittent. It shows up as a streaking in the picture, usually followed by a horizontal bend, like an "age bend." This clears it-
self in a few seconds, especially if you touch a test prod or scope lead anywhere in the circuit.—R. P. M., Fayetteville, Ark.

This is probably due to an inter-
mittent bypass capacitor. Try replacing both the .001- and 0.22-µf age bypass capacitors on the video i.f. printed cir-
cuit board, as seen in Fig. 2. Although we haven't caught them doing it, they must be opening up to cause this kind of symptom.

Narrowing in Zenith 24G26

The last question I asked was about a Zenith, and your answer proved very helpful. Now, how about another one? [Advertisement—Editor.] This is a 24G26 chassis. Everything has been checked, the width control is at maxi-
mum, and the horizontal drive control also at maximum. Only then can I get
the screen filled. The flyback is quite noisy and seems to be running warm, the insulation is peeling. If this isn't enough, after warm-up I get white flashes and streaks in the picture, bad horizontal stability. This is intermittent, too! Shows up after the set has been on for about 10 minutes. Sometimes the thing will run for 3 or 4 hours.—N. J., Long Island City, N. Y.

The symptoms you give are typical of those caused by one of the two 6BQ6 horizontal output tubes in this series developing a bad case of grid emission or screen emission, or possibly some gas, or all three simultaneously.

The slow shrinkage, and the flashing and streaking, together with the hot flyback, all point to this cause. By the
way, you said that the tubes had been checked. I ran into a bad case of this same complaint the other day, and checked the tube just out of curiosity. It tested perfect: no gas, no emission, but in an "in-the-circuit" checker, it plainly showed screen emission! So, the best and most practical test here is re-
placement.

The heating of the flyback also points in the same direction. If you
measure the plate current, you'll prob-
ably find it running around 250 ma for the two tubes; 220 ma should be the
maximum. I'd also replace the 6W4 damper with a 6AU4, because of the much higher heater-cathode break-
down rating. Also, check the p-p voltage of the drive signal which should be at least 100 volts and could be 125
volts without hurting anything.

Silvertone swap: 17HP4 to 17BP4

Can I change the 17HP4 in my Silvertone TV set to a 17BP4? I know the 17HP4 is an electrostatic-focus tube, and the 17BP4 is magnetic-focus, but I've got a spare 17BP4, and it's my set—A. R. E., Key West, Fla.

Yes, I think you can make this change, if you don't mind a little jiggery-
pokery with the focus circuit in the set. The 17BP4 specifies an EIA No. 109 focus coil with a current of 100 ma for

Fig. 2—Open age bypass capacitors (circled) can cause streaking and bend-
ing of picture.

Microphone hum

I have a good make tape recorder, which works fine as long as I use the short mike cable which came with the
unit. When I connect a longer mike cable, to use it in another room, I get a terrific hum. I'm using a crystal mike on the extension. I'd like to use about 50
feet of mike cable on this. Do you think I need a preamp?—W. F., Defiance, Ohio.

No, I think you need a better ground on the shield of that extension cable. Since the machine works OK with the
original mike, this hum must be due to stray pickup from the longer cable. Almost invariably, this is due to a poor or even an open ground connection on the
shield braid.

You can use microphone cable up to 100 feet without too much trouble. If you use the small-size high-capacitance type known as lapel-mike cable, you'll get a fairly heavy signal attenuation due to the added shunt capacitance across the
input. So, I'd recommend using the larger standard cable, for less signal loss.

Fusible resistors

Are fusible resistors designed to blow at a specific current rating? If so, how is this determined? Why are they made in such funny values: 4.7, 5.6 and 7.5 ohms?—J. M., Webster Groves, O.

The fusible resistor serves as a com-
bine fusion and surge resistor in most applications. It is a special type of wire-
wound resistor, made of resistance wire with a definite current-carrying capacity. In normal use, it actually runs at about 90% of its rating.

The wattage at which it blows is determined by the current through the
resistance used. To increase the blowout point, we'd use a
smaller resistor: less wattage dissipated. The "funny values" are simply preferred
numbers, used for most resistors.

Converting KCS-68E to 24-inch CRT

One of our customers wants us to
convert his RCA 21T159-DE, using the
KCS-68E chassis, to use a 24- or 27-inch picture tube. I would prefer a short 90° or 110° tube.—J. H. G., Arlington, Va.

I'm not too optimistic about your proposed conversion to either the 24-or
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The basic defect is obviously one which is affecting the frequency. I'd say, from the waveform. This will upset the time constant of the horizontal output, damper, and yoke circuit, and keep the high voltage from developing. It must be some part (probably a capacitor) opening up due to an invisible break in the pc board, because the frequency goes up.

Silvertone with squeal and "fuzz"

I have a Silvertone 100-210 TV which has an unusual horizontal sweep trouble. The raster is fuzzy and streaky, almost completely blacked out at the left side, and brighter at the right. The flyback squeals, and there is no boost voltage. Waveshapes around the circuit look OK, but they are a little thick and fuzzy-looking.-W.E., Toledo, Ohio

Your horizontal oscillator is off frequency; this is the customary cause of this squeal. However, since you have other symptoms (no boost voltage, etc., and most especially those "fuzzy waveforms" around the horizontal stages), I'd check some filter capacitors first.

Open or weak electrolytics will cause feedback in the wrong places, and can cause off-frequency operation of the horizontal oscillator. C1, the 40-µf input filter capacitor, has been known to cause this. Check it first.

END

 Correction

There is an error in the wiring of board 1 in Fig. 4 of the article "Build an Audio Sweep Generator" on page 28 of the September issue. R2 is incorrectly connected in the drawing.

Remove the connection between points 6 and 8 in the top row (counting from left) Connect R2 there instead. Close the gap between point 7 and the junction of C2 and R3, Pin 1 of V1 and one terminal each of C2, R3 and C3 are now common. The right-hand ends of RFC1 (left) and RFC2 (right) go to ground through R2.

We thank Frank J. Stein, of Santa Ana, Calif., for catching the wiring stinkers.-Allen F. Kinckiner

L-C-R Circuit

The diagram shows that the load across an ac generator is a 100-ohm

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Three puzzles for the student, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especially interested in service stinkers or engineering stumper on actual electronic equipment. We get so many letters we can't answer individual ones, but we'll print the more interesting solutions ones the original authors never thought of.

Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York 11, N. Y.-10011.

Answers to this month's puzzles are on page 68.

An Unusual Twist

A TV technician was working with an old set, when a camera-toting friend walked in. He quickly focused close up on the receiver's screen and got the picture below.

What caused this unusual twist?
resistor, a 2-mh inductance and an 80-pf capacitor connected in series. The generator produces 300 volts at 398 kc, and the current flow through each element in the series circuit is 3 amperes. Voltmeters B, C and D are connected to measure the voltage drop across the reactive elements in the circuit. Voltmeter A measures the voltage drop across the 100-ohm resistor. Can you determine the reading on each voltmeter?—Kendall Collins

**Bewildering Blinker**

The circuit shown seems straightforward enough, but does something unusual. When the Variac is set at some critical potential around 100 volts, the 60-watt light bulb blinks at the rate of about one blink per second.

I defy you to tell me why! I had to muddle over it for quite some time to find a possible answer. Is something oscillating. If so, what? Try building it if you don’t believe that it will work. All the parts are standard and are listed below.—George R. Wisner

1. Variac or other source of variable ac from 90 to 125 vac.
2. 60-watt light bulb of standard home type.
3. L, 2.5-henry choke (one from an old radio will do).
4. C, 4-mfd oil-filled capacitor (electrolytics won’t work).

**New Techniques Make Fantastic Vacuum**

Thin films, only 10 atoms thick, are being grown by scientists at the Westinghouse Research Laboratories in research on the physical properties of thin films, which are becoming increasingly important in electronics.

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ANSWERS
(Questions are on page 40)

1. In electronics we recognize two Kirchhoff laws. The first states that "The sum of currents flowing toward any junction is equal to the sum of currents flowing away from that junction." The second law goes like this: "The algebraic sum of voltages around any closed path in a circuit is zero." *

2. The relationship between current, resistance, and dissipated energy—the familiar \( V = IR \) expression—is known as Joule's law.

3. Poynting's law, relatively obscure to most of us, deals with transfer of energy in electromagnetic fields and is important in microwave engineering. It states that the transfer of energy can be expressed as the product of the values of the magnetic field and of the components of the electric field which are perpendicular to the magnetic field, and that the flow of energy at any point is perpendicular to both fields.

4. Lenz' law is important wherever alternating current flows, from 60 cycles to rf. So fundamental is it that it might almost be called the alternating-current counterpart to Ohm's law. The law deals with the change in flux caused by the motion of one of two mutually coupled coils, and the direction of current in one of them, as follows: "If a constant current flows in a primary circuit (A) and if by motion of A or the secondary circuit (B), a current is induced in B, the direction of induced current will be such that, by its electromagnetic action on A, it tends to oppose the relative motion of the circuits." In other words, "Counter electromagnetic motive force." But if you don't like the way this was stated, blame J. Clerk Maxwell, the famous physicist, for that is how he expressed it. Why the ac counterpart to Ohm's law? Simply that if a man knows Ohm's law, he knows ac.

5. Neuman's law deals with mutual inductance (hence the reference to i.f. transformers) when no magnetic material is present. It states that \( M \) (mutual inductance) is a constant for a given relative physical position of the coils, and independent of the fact that the current flows in one or the other, and of frequency, current and phase. It is an "appendix" of the law of conservation of energy, which will be overthrown when we move through space at greater speed than light!

6. Wien's law, better known as Wien's displacement law, shows that the wavelength of maximum radiation intensity is inversely proportional to the absolute temperature of a black body, and that the intensity of radiation at this maximum wavelength varies as the fifth power of the absolute temperature. Infrared detection techniques, hinging on the facts known about "black bodies," are intimately concerned with Wien's displacement law.

7. Helmholtz' law describes the curve of increase of a current when a circuit with \( R \) and \( L \) is suddenly closed. Thus: \( I = 10(1 - e^{-t/R}) \), which is a familiar curve to most electronics workers. (It is also related to the discharge curve of a capacitor, but this was not stated by Helmholtz.)

8. Wiedeman, Franz and Lorentz, all physicists, have a law which states that the ratio of electrical conductivity and thermal conductivity at a certain temperature is independent of the conductor material! Sounds hard to believe, but it is true.

9. Faraday, most famous of historical experimenters, stated in his law that if there is any closed linear path in space, and the magnetic flux in this path (surrounded by the path) varies in time, the emf induced in the path is equal to the negative rate of change of the flux in lines per second. This can only be expressed with calculus in formula form, so we will skip that part. But it is a fact that the importance of this discovery was not practically applied in radio for almost a century!

All of which just goes to show that there are many facts about nature and the world around us that we can use to good advantage in our daily work with electronics, without giving much thought to the great discoverers of science, who had powers of observation and deduction, and the ability to state them as "laws of nature." END

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SPECIFICATIONS—Amplifier: Power output per channel (Health Rating): 30 watts/8 ohm load, 15.5 watts/16 ohm load, 9 watts/4 ohm load. (HEHM Music: Power Output: 31 watts/8 ohm load, 18 watts/16 ohm load, 16 watts/4 ohm load @ 0.7% THD, 1 KC. Power response: 1 db from 15 to 30 KC @ rated output; ±2 db from 10 Ks to 40 Ks @ rated output.) Input impedance: Mag. phono, 100 K ohms; Aux. 1, 10 K ohms; Aux. 2, 10 K ohms. Power response: 1 db from 15 to 30 KC @ rated output; ±2 db from 10 Ks to 40 Ks @ rated output.) Input impedance: Mag. phono, 100 K ohms; Aux. 1, 10 K ohms; Aux. 2, 10 K ohms. Channel separation: Less than 1%. Overall dimensions: 17 1/2" L x 5 1/2" H x 14 3/4" D.

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Transmitter Fits in a TOOTH!

Tiny FM transmitter uses 1 transistor

By B. R. D. GILLINGS*

WITH MINIATURE COMPONENTS PLUS A little care and patience in assembly, it is possible to make a tooth-sized radio transmitter that can broadcast signals 15 feet or more. The transmitters described here were developed for dental research, but with a little imagination similar devices could be used for a variety of routine biological applications.

Dentists have long been interested in how the teeth meet. Recent research has made it increasingly obvious that very little is known about it. When, for example, a filling or tooth is a little too high, no one can say whether the patient is likely to hit the high spot more often to wear the area away, or whether he will avoid closing his teeth on the spot because it irritates him.

One of the difficulties in investigating normal or abnormal occlusion (abnormal occlusion: irregularly arranged teeth which do not meet properly) is the upsetting effect of observation on the patient's behavior. Attaching wires or gages to various parts of his teeth or face is also likely to disturb him, consciously or unconsciously, and cause an abnormal reaction. This difficulty has, to a great extent, been solved by a tooth-sized radio transmitter.

In 1961, two scientists, Brewer and Hudson, working for the United States Air Force, got things started. They built a miniature radio transmitter (a simple 40-kc oscillator with three resistors, two capacitors, a transistor, a coil and a 1.4-volt mercury cell). (See Fig. 1). It was fitted into an upper artificial denture to determine how frequently the subject contacted his teeth while at rest and while eating. By an ingenious arrangement of triggering contacts, consisting of gold teeth, the two men were able to obtain counts for the number of tooth contacts made in different positions of the jaws. Since the radio transmitter was completely enclosed in the denture, the measuring technique did not interfere with the subject's normal behavior when wearing a full denture.

Useful though this technique is, it does not solve the problems of subjects who have all, or nearly all, their own teeth. It is highly likely that occlusal contact patterns and responses in these subjects are entirely different from those of full denture wearers.

The transmitter used in the full denture was not small enough to be used in the mouths of people who had their own teeth. In many suitable subjects who had one or two teeth missing, especially molars, and there was a possibility that a transmitter the size of one tooth could be fabricated to study these subjects.

R. H. Dilworth, who developed the pocket personal radiation monitor now in production for the Atomic Energy Commission, and W. Greatbatch, who developed the artificial Pacemaker for the heart, were consulted regarding suitable circuitry and sources of supply of components. Following their suggestions, we were able to construct our first radio transmitter. The circuit is shown in Fig. 2. It is a keyed oscillator that broadcasts an unmodulated signal at about 3 mc.

How it is built

Before the components are hooked up, all leads should be lightly tinned, so they can be soldered with one touch of the iron. (The small components are easily damaged by excess heat.) To conserve space, trim or sand off excess insulation on the capacitors, particularly around the leads (Fig. 3-a). Before making a soldered joint, the leads must be bent together and any wire not needed for a later step cut off. This not only reduces the bulk of the joint and the amount of heat needed to solder it, but also prevents movement should another joint have to be made at the same point. A phosphoric acid flux must be used when soldering to the stainless steel battery case. If the case gets hot, the battery will be ruined. A quick touch is all that is needed.

Once a joint is made, it is almost impossible to disassemble. Because the components are so easily damaged, particularly when bending the leads, the units should be tested each time a joint is made. The rejection rate through component failure during assembly is high, and you will probably ruin your first attempt sometime near the end.

*Faculty of Dentistry, University of Sydney, Australia.
NEW! Low-Cost All-Transistor, All Mode Stereo Tuner and Matching 40-Watt Stereo Amplifier

Cooler, faster operation...lower power consumption...longer life...and the clean, quick realism of "transistor sound." You'll enjoy all this and more with Heathkit's newest All-Transistor Stereo "Twins." Compact, low-silhouette styling magnificently fashioned in rich walnut cabinets neatly fits this handsome pair into a "proud place" in any hi-fi stereo system. Add to this extruded brushed gold-anodized aluminum front panels that serve practically to conceal secondary controls and decoratively to enhance over-all beauty. The AA-22 Amplifier provides 40 watts of continuous power at ±1 db from 15 to 30,000 cps with no fading, no faltering...just pure solid sound! The AJ-33 Tuner offers selection of AM, FM, or FM Stereo to please any listening preference. Check both unit's features and discover why Heathkit leads in Transistor Stereo. The price? A great value, you'll agree...$99.95 each!
We have found that the best approach is to work from an assembly board. The components are wired together temporarily on the board, using a stock coil approximately the size of the coil, which will be wound as the last step around the finished unit. All leads are left uncut until it is decided whether they will be needed for a later step. The components are removed from the board as they are assembled, and the package is wired back on the board with the remaining components to test it after each connection is made.

We usually start with C1 and solder R1 across its two leads (Fig. 3-b). One of these leads is now the positive battery connection. The other goes to one end of R3 and the base of the transistor. R3 is now soldered in place alongside C1 (Fig. 3-c). Then R2 is soldered the same way on the other side of C1 (Fig. 3-d). Now C3 is soldered to the free end of R2 (Fig. 3-e) so it is lying flat on C1, but with the leads facing in the opposite direction. The free lead is left long, as it will connect to the center tap of coil L. The transistor (Q) is now positioned at the top end of C1 and its emitter lead soldered to the junction of R2 and C3. C4 is now positioned on the opposite side of C1, and one lead soldered to the free end of R3 (Fig. 3-f).

The lead from this joint is left long. It will be connected through the switch to the negative side of the battery and the bottom of the coil. The transistor's collector lead is now bent back and soldered to the free lead of C4. Bending the transistor wires calls for extreme care, as the unit is easily damaged, especially if the leads are rotated during bending. This lead is left long, as it will connect to the top of the coil.

The base lead of the transistor is now bent in a wide sweep across either C3 or C4, whichever is the more convenient, and soldered to the junction of C1, R1 and R3. The excess wire can now be clipped from this joint. C2, a 0.1-µf capacitor, has not been included. However, it may be essential with some batteries to prevent oscillation.

The package is now wired, except for the coil and battery connections. At this time the unit is easily damaged, especially if the leads are rotated during bending. This lead is left long, as it will connect to the top of the coil.

The inductor

A thin celluloid form is wrapped around the package, and the coil wound on it with Formvar-coated fine copper wire. Placing the electronic package inside the coil may affect its performance. It is helpful to have half a dozen or so coils already wound for test purposes. The coil may be layer- or scramble-wound, according to the purpose for which the unit will be used. Coil connections should be left long for testing, and be clipped short and soldered to the appropriate lead as the final step in assembly. All leads except the battery connections are next trimmed off. The coil is coated with dope and the package potted.

The battery and switch are connected last. We use a very simple switch, the poles of which consist of two gold bars insulated from each other. The switch is held in a plastic tooth filling or plastic tooth, depending on the space available, and wired into the negative lead. To operate the switch, a small gold pin is compressed in an opposing tooth, so when the jaws are in contact in the particular position we are investigating it shorts the two gold bars, completing the circuit.

Since battery life is not important in our application, we put the battery in the package. For other purposes it might be wise to make the battery readily accessible.

The signal is received as a hissing noise. We use a marine-band portable radio 3 to 6 feet away. A more elaborate receiver could detect the signal 15 or more feet away. The signal is fairly directional and the strength of the received signal may vary as the head is turned. The packaged unit is susceptible to capacitance effects, caused by the movements of the lips and tongue. They can be minimized by placing the coil so its open ends point to cheek and tongue.

The transistor compared to an ordinary paper match. At the right is the complete transmitter. At the left is the transistor minus its coil.
Introducing The FIRST In A New Series of Deluxe Heathkit SSB Amateur Radio Gear!

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SPECIFICATIONS-Frequency range (megacycles): 3.5 to 4.0, 7.0 to 7.5, 14.0 to 14.5, 21.0 to 21.5, 28.0 to 28.5, 28.5 to 29.0, 29.0 to 29.5, 29.5 to 30. Intermediate frequency: 3.395 megacycles. Frequency stability: 100 cps after warmup. Visual dial accuracy: Within 200 cps on all bands. Electrical dial accuracy: Within 400 cps on all bands. Backlash: No more than 50 cps. Sensitivity: Less than 1 microvolt for 15 db signal plus noise-to-noise ratio for SSB operation. Modes of operation: Switch selected; LSB, USB, CW, AM. Selectivity: SSB: 2.1 kc at 6 db down, 5.0 kc at 60 db down (crystal filter supplied). AM: 1.75 kc at 6 db down, 5.0 kc at 60 db down (crystal filter available as accessory). CW: 1.000 kc at 6 db down, 2.5 kc at 60 db down. Crystal filter available as accessory. Spurious responses: Image and IF rejection better than 50 db. Internal spurious signals below equivalent intermodulation input of 1 microvolt. Audio response: SSB: 300 to 2600 cps nominal at 6 db. AM: 500 to 3000 cps nominal at 6 db. CW: 800 to 1200 cps nominal at 6 db. Antenna input impedance: 50 ohms nominal. Muting: Open external ground at Mute socket. Crystal calibrator: 100 kc crystal. Front panel controls: Main tuning dial; function switch; mode switch; AGC switch; band switch; AF gain control; RF gain control; preselector; phone jack. Rear panel connections: Accessory power plug; HF antenna; VHF (2 antenna: VHF p2 antenna; mute; spare: anti-trip: 500 ohm; 8 ohm speaker; line cord socket; heterodyne oscillator output; LMO output; BFO output; VHF converter switch. Tube complement: (1) 6BZ6 RF amplifier; (1) 6AU6 heterodyne oscillator output; LMO output. BFO output; VHF converter switch. Power supply: Transformer operated with silicon diode rectifiers. Power requirements: 120 volts AC, 50/60 cps. 50 watts. Dimensions: 14.3" W x 6.9" H x 13.1" D.

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November, 1963

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The hiss produced when a contact is made is sometimes hard to distinguish from noise, particularly when the band is noisy, such as late at night. (On occasion we have found ourselves on the same band as WWV and the captains of Mississippi river boats.) To circumvent this problem we used the modified circuit in Fig. 4.

Self-blocking was introduced at an audio frequency so the signal could be more easily recognized. This approach produces a bonus in the form of a very broad band of transmission, in contrast to the narrow band of the continuous-wave oscillator circuit. Loss of reception because of signal drift is eliminated, although the audio frequency does vary with temperature, the note rising when it increases. This circuit is much better for our purpose, since it not only solves the problem of drift caused by temperature variation or capacitance, but also makes the signal unmistakable. If anything, it is easier to construct and, happily, requires fewer components. The signal produced makes it simple to send Morse code by clenching the teeth—quite simple, but baffling to any unsuspecting radio receiver operator who happens to be nearby.

There are disadvantages in the design of this self-blocking oscillator too. The coil is extremely susceptible to loading—a serious problem, since the components are placed inside it. The range of transmission is also reduced considerably, sometimes to as little as 2 feet or so. If the unit will not self-block, the coil should be layer-wound and on a larger diameter (higher Q). If range is not a consideration, the circuit should be most versatile, since the audio frequency can be altered within wide limits by varying the values of the resistors and capacitors in the circuit.

Applications

For the purpose for which it was designed, the tooth-sized radio transmitter has proved extremely useful. In one series of experiments, nightly recordings of occlusal contact patterns were recorded on tape. By playing the record back, it was possible to make a chart (at right above) showing the duration of tooth contacts at various times.

Additional information on the subject's coughing and swallowing habits was recorded simultaneously by using a throat microphone and a 2-channel tape recorder. In this way it was possible to find out whether the tooth contacts were associated with periods of swallowing activity, wakefulness, coughing or snoring. Units have also been used to follow the behavior of the teeth and jaws while chewing various foods.

Other uses for such small units might be found. It is possible to measure large temperature variations with the units now, and they could be made even more efficient and sensitive by using thermistors. A low-impedance hearing-aid microphone inserted between the negative battery lead and the bottom of the coil turns the unit into an efficient speech transmitter. A simple copper-zinc couple immersed in a dilute acid, or even saliva, provides enough power to operate the unit, which would solve battery problems in some applications. A little inspired fiddling with the basic circuit should make possible broadcasting speech, temperature, pressure, pH and conductivity. It's simply a matter of employing suitable transducers.

Available materials

It is unlikely that any research worker or experimenter would want to make a Chinese copy of this transmitter, so no parts list in the ordinary sense is given. But the materials, though available, are sometimes hard to locate, therefore the list under Fig. 3 may be helpful.

Stereo Alarm for MPX Adapters

An audible indication of stereo multiplex transmissions can be obtained by simple modifications to the Knight KS-10, Lafayette KT-220 and similar multiplex adapters. This can be done by switching a capacitor across a portion of the 19-kc oscillator coil so the oscillator loses sync by an audible frequency difference.

A .005-μf capacitor connected from ground to the junction of C6 and the tap on the coil (see diagram) will produce a distinct note of about 1,000 cycles when a stereo transmission is tuned in. You may have to readjust the tuning slug to compensate for stray capacitance when the capacitor is switched out for listening.

The gain at 50 cycles can be increased about 4 db by disconnecting the 100,000-ohm resistors between the left and right output jacks and ground when they are not needed as grid returns or input loads for the following amplifiers. These resistors are R24 and R25 in the KS-10 and R3 and R25 in the KT-220.

—Ben Johnson
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IT ALL STARTED A MONTH AND A HALF ago with a call on an RCA KCS-40A with no video and no sound—just a white raster. I turned the set on and saw picture and sound both come on and within seconds slowly fade away. Without turning the set off, I started changing tubes one at a time, working from the video output stage right up forward. Nothing seemed to happen until I pulled out the 6J6 oscillator and stuck in a new one. The picture and sound pushed through. Satisfied, I picked up my bag and left.

Two weeks later I was back for the same complaint. I followed the same technique—changed the 12AU7 output tube first and worked my way up front. Again, the moment I changed the 6J6, the picture and sound boomed in. When the 6J6 just removed was reinstalled, the set worked perfectly.

I was sure we had local oscillator trouble so I took the set to the shop. An off-value resistor, perhaps, in the 6J6 plate load, I thought. So the first thing I did on the bench was make resistance measurements. All OK. I set the chassis up to operate and then began my long vigil. For one whole week I waited for that set to fade. I operated it hot, I operated it cold. I raised the line voltage, I lowered it. Nothing I could do induced the receiver to act up the way it did in the customer's home. Picture and sound stayed perfect.

I delivered the set and crossed my fingers. I might have saved myself the trouble because I was back again 2 days later. Same complaint. I picked up my bag and left.

Discouraged but not yet defeated, I took the chassis back again. This time I loaned the customer a portable set that had been sitting around the shop, unclaimed, for the past twelve months. This way I planned to allow myself more time.

Sure enough, when I set up the chassis on the bench I found myself right back where I'd started. The set worked perfectly for days. I thought of replacing the entire tuner, but found these tuners were no longer available. So I was stuck with the repair whether I liked it or not.

Checking this receiver became my main preoccupation for the next 2 weeks. Every time I walked into the shop I'd turn the set on and wait for something to happen. But nothing ever did. I rapped it and tapped it and cooked it and covered it—everything short of kicking it—but she played on and on. I ran it horizontally, ran it vertically. No use, I was licked.

It was on a rainy Thursday morning while I was searching my memory trying to remember what incidents in my life had directed me into television servicing when fate dealt me its cruelest blow. In came the portable-set owner asking me to deliver her set on Saturday.

I had reached my end and on Friday morning I decided to quit. I gave the receiver a couple more tries and called the customer on the phone to make an appointment to deliver it. Just before I dismantled the bench setup, I turned the switch on for one last try and, by the beard of Allah, the picture and sound quietly faded away!

I had already had the 6J6 plugged into a test socket so I immediately took voltage measurements. Much to my surprise the grid read 6 volts negative, indicating that the tube was oscillating. For the first time I began to suspect other trouble.

As I prepared for my next tests, the thing I dreaded most happened. Into the shop walked a little old lady with a radio tucked under her arm.

"Would you kindly check this for me? I wouldn't care to leave it, it's the only one I have. In these times one gets so to depend on a radio to get the latest..."
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NOVEMBER, 1963
news what with so much happening all over the world and so much trouble here and there and... My, how fast you work."

Fast, indeed, but not fast enough, for as I stood there nervously fumbling with the radio the sound on the TV receiver behind me blasted through. "Of all the luck," I mumbled.

However, there was still a spark of hope. For the first time since I got entangled with the set, it suddenly became predictable. If I allowed the set to cool off a while and then turned it on again, the picture would fade away and let me have another go at it. But I had to work fast. If I hesitated too long, everything would bounce back.


Each little disturbance would snap the picture back in place and each time it did I was afraid that I'd had it. But my luck was still holding out. Every time I let the set cool off a while and then turned it on again, it gave me another chance.

Finally, after 30 minutes of touch-and-go troubleshooting I came to a conclusion. I thought I had a bad 6SN7 age rectifier tube, but I was afraid to even go near it for fear that one reckless mistake might snap the set back to normal and leave me in doubt for the rest of my electronic life. But I had no choice. All checks assured me that this tube was the troublemaker, so I got ready for the do-or-die finale. I turned the set on, waited for it to fade, and then, like the diamond cutter who raises his cleaver after weeks of fastidious planning, I raised my screwdriver and delivered the master stroke. I hit the tube, the picture shot in, the sound blasted through and I fainted. That was it!

An Unusual Twist
A second photo taken by the photographer answers both questions. The technician was using a degaussing coil to demagnetize the monochrome metal picture tube. The unusual twist was due to the flux of the degaussing coil affecting the beam deflection. It might be said that the unusual twist was due to a crazy-mixed-up deflection beam.

L-C-R Circuit
The voltage across a single reactive element in a series circuit carrying ac can have a greater effective value than that of the applied voltage. Since the current in each part of the circuit is 3 amps, the voltage drop across the inductance, and hence the reading of voltmeter D, can be calculated:
\[ E = I \times L = 3 \times 5,000 = 15,000 \text{ volts.} \]

The voltage drop across the capacitance, and hence the reading of voltmeter C is:
\[ E = I \times C = 3 \times 5,000 = 15,000 \text{ volts.} \]

The inductive and capacitance voltage drops are equal in magnitude and 180° out of phase; so their vector sum is zero. This is shown by voltmeter B, which reads zero volts. The voltage drop across the resistor, and hence the reading of voltmeter A, is \[ E = I \times R = 3 \times 100 = 300 \text{ volts.} \]

Bewildering Blinker
This is what I think is happening. If you have a better solution, let's hear it! This circuit is merely a simple series-resonant device with the L and C combination resonant at about 50 cycles when zero current is flowing. When current flows through the circuit, the inductor's inductance decreases with increasing current due to saturation of its iron core.

Hence, at a critical current, determined by the Variac, the circuit moves its resonant point toward 60 cycles and the lamp grows brighter. But as the lamp becomes brighter its resistance increases, the L-C series circuit goes out of resonance, and the light dims. Upon dimming, the lamp's resistance decreases and starts the cycle again.

Without stretching one's imagination, it is plain to see that we have a negative-resistance oscillator constructed out of seemingly passive elements.
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Experimental research on behavior of passive repeaters for microwave radio links
COLAVITO & D'AURIA, ITALY

Some observations on V.L.F. standard frequency transmissions
THOMPSON, ARCHER, HARVEY, AUSTRALIA

Space-charge limited solid state devices
G. T. WRIGHT, ENGLAND

Hall effect gyrators, isolators and circulators of high efficiency
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The zero-beat can give accuracies of better than .01% in a similar manner. The highest frequency band can be adjusted by squeezing or stretching the coil. You need calibrate only one frequency on each band. The signal tracer and audio generator need no calibration.

The audio generator is used to modulate the rf generator (see Fig. 1). There is no separate audio output jack, but the audio signal can be easily obtained. Just connect the rf/i.f. demodulator probe to the rf output jack and switch to mod. This gives an audio signal output even though the demodulator circuit is connected backward as far as normal signal flow is concerned.

When the demodulator probe is connected to the input of the audio preamp, it can be used to trace an rf or i.f. signal provided by the generator portion of the instrument.

Switch the probes from their respective jacks and the demodulator circuit is connected backward as far as normal signal flow is concerned.

The Olson KB-141 audio and rf signal generator and signal tracer comes with probes and cables.
The Big Plus—Uniline Sound Columns

Performance is the big plus when you install University Uniline Sound Columns. Unlike conventional columns, Uniline employs specially-designed speakers with higher power handling capacity. "Acoustic-Tapering — another University exclusive, prevents excessive high frequency beaming and assures a uniform sound volume within its fan or beam. The result—higher intelligibility, optimum sound dispersion at all frequencies, greater listening comfort. All individuals hear the same sound! The table below shows complete specifications for all Uniline Sound Columns, including the new weatherproof model CSO-6 for outdoor installation. For complete PA Loudspeaker Catalog, write Desk J-11.

<table>
<thead>
<tr>
<th></th>
<th>UCS-6 Full Range Music and Speech</th>
<th>CS-4 Full Range Music and Speech</th>
<th>CS-3 Music and Speech</th>
<th>CSO-6 Full Range Music and Speech</th>
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<tr>
<td>speakers</td>
<td>6 extended range 8&quot;</td>
<td>4 extended range 8&quot;</td>
<td>8 special multi-design</td>
<td>6 extended range 8&quot;</td>
</tr>
<tr>
<td>frequency range</td>
<td>55—17,000 cps</td>
<td>70—17,000 cps</td>
<td>150—10,000 cps</td>
<td>55—17,000 cps</td>
</tr>
<tr>
<td>power capacity</td>
<td>150 watts IPM*</td>
<td>80 watts IPM*</td>
<td>25 watts IPM*</td>
<td>150 watts IPM*</td>
</tr>
<tr>
<td>impedance</td>
<td>16 ohms</td>
<td>8 ohms</td>
<td>16 ohms</td>
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<tr>
<td>horizontal angle</td>
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<td>120°</td>
<td>120°</td>
<td>120°</td>
</tr>
<tr>
<td>dimensions</td>
<td>59¾&quot; x 10¾&quot; x 9¼&quot;</td>
<td>40½&quot; x 11&quot; x 9¼&quot;</td>
<td>48&quot; x 7½&quot; x 8¾&quot;</td>
<td>60¼&quot; x 11¾&quot; x 7¾&quot;</td>
</tr>
<tr>
<td>shipping wt., lbs.</td>
<td>61</td>
<td>46</td>
<td>33</td>
<td>61</td>
</tr>
</tbody>
</table>

*Integrated program material.
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Another jack allows the cascode preamplifier of the audio stage to be used as a separate preamplifier—to feed scopes, vtvm's or other devices that need increased signal level.—Elmer C. Carlson

Fig. 1—Circuit of Olson's KB-141. It uses several premium tubes, one as cascode preamp.

probe will now provide an audio signal for injection into an amplifier, and the “direct” probe can be used to signal-trace. You will hear the audio signal from the speaker mounted in the top of the case.

FOR YEARS, TOP HONORS FOR THE MOST useful radio and industrial servicing instrument have been shared by the 11-megohm vtvm and the 20,000-ohms-per-volt multimeter. Now, both are being challenged to a winner-take-all battle for superiority by the new Triplett 630-NS multimeter, one of the latest additions to the famous line of Series 630 testers.

The 630-NS is a dual-sensitivity instrument measuring up to 3,000 volts dc at 200,000 ohms per volt and up to 6,000 volts at 100,000 ohms per volt. Ac voltages in the same ranges are measured at 20,000 and 10,000 ohms per volt, respectively. The basic full-scale dc voltage ranges are 0.6, 3, 12, 60, 300 and 1,200.

The instrument operates much the same as other vom's. Besides the usual controls, there is a two-position slide switch. One position is marked V—Ω—A and the other V—A/2. In the V—Ω—A position, the full-scale voltage or current is that indicated by the range selector and voltages are measured 100,000 ohms per volt. Throwing the slide switch to V—A/2 cuts the full-scale voltage or current range in half and increases the voltage sensitivity to 200,000 ohms per volt.

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Model 360 V O Matic Automatic VOM
Model 375 Dynamatic Automatic VTVM
Model 1076 Television Analyst
Model 445 CRT Rejuvenator Tester

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Export: Empire Exporters, 253 Broadway, New York 7, U.S.A.

NOVEMBER, 1963
Fig. 2—Partial schematic of multiplier string in Triplett 630-NS. Switch S doubles sensitivity, halves range.

setting the slide switch, all current and voltage readings can be made on the upper half of the scale, where accuracy is greatest.

**How sensitivity selector works**

Let's see how the dual-sensitivity circuit works, Fig. 2 shows how the basic voltage measuring circuit works. The ranges shown on the range switch are full-scale values measured at 100,000 ohms per volt with the slide switch, S, in the V-A/2 position. In this case, R2 shunts the meter movement to reduce the basic sensitivity to 100,000 ohms per volt and R1 is a part of the multiplier string. Sliding the switch to the V-Ω-A position increases sensitivity to 200,000 ohms per volt and reduces the lowest range to 0.3 full scale and the highest to 600 volts, by removing shunt R2 and shorting out R1. The 30,000 ohms resistance of the meter replaces R1 in the multiplier string.

The principal advantage of the 630-NS is its unusually low loading on high-impedance circuits. Let's take a look at the simple 22-megohm voltage divider in Fig. 3, such as you might find in keyed-agc circuits, and see how a meter's input resistance affects accuracy as we measure the voltage across R2.

First we will use an ordinary 20,000-ohm/volt meter on its 250-volt range. The meter's 5-megohm input resistance shunts R2 and reduces R2's effective resistance to 3.437 megohms. Current through the string increases and the voltage across R2 and the meter drops to 35.4—less than half its actual value. With an 11-megohm vtvm, the effective value of R2 is reduced to 5.5 megohms and the voltage drops to 49.5—still a considerable error.

Now, let's see what we can do with the dual-sensitivity 630-NS. Normally, we would set the range switch to 300 and the sensitivity selector to V-A/2 for 150 volts full scale at 200,000 ohms per volt. The meter's input resistance is 20 megohms, and the voltage across R2 rises to 62.4. On the 600-volt range (1,200 divided by 2) the input resistance is 120 megohms and the voltage rises to 71.5. This is laboratorylike precision, considering the accuracy of the other instruments cited in this example.

Other advantages of the 630-NS with its 5-pa, 150-mv movement can be seen by comparing its lower voltage and current ranges with the basic Triplett 630—one of the long-time standards in 20,000-ohms-per-volt instruments. For example, the first three voltage ranges on the 630 are 3, 12 and 60. On the new 630-NS, they are 0.6, 3 and 12 or 0.3, 1.5 and 6, depending on the sensitivity required or the magnitude of the voltage being measured.

Suppose that we want to measure the voltage between base and emitter in the circuit in Fig. 4. With the 630 or similar 20,000-ohms-per-volt instrument, our best bet would be to measure the
voltages on the individual elements and hope that our old eyes are sharp enough to differentiate between 0.6 and 0.7 volts—two divisions well down on the scale.

With the 630-NS, we set it to 0.3 volt full scale and measure the voltage between base and emitter in one operation. Accuracy and readability are much greater because 0.1 volt now covers a third of the scale.

New movement

A not-so-obvious advantage is the ruggedness of the new meter movement. The old hairsprings, pivots and jeweled bearings have been eliminated. Bearings and pivots in portable instruments take quite a beating. Friction increases with age and accuracy is impaired.

In the new "suspension-band" meter the moving coil is suspended by a pair of platinum wires finer than a human hair. They support the coil assembly, carry current to it and provide the torque to return the needle to zero. They work a bit like automobile torsion bars.

I cooked up all sorts of tests to compare the 630-NS with the vtvm and 20,000-ohms-per-volt meter so I could go on and on raving about the 630-NS and the new breed of multimeter that is sure to follow. It provides greater accuracy through lower circuit loading and a wider choice of ranges. Its mirror scale eliminates errors caused by parallax. I feel that the added versatility of the 630-NS is well worth the price differential—around $40—between it and a comparable 20,000-ohms-per-volt instrument. It won’t replace the vtvm on the bench, but it comes pretty close to it.

—Robert F. Scott

SPECIFICATIONS

Dc volts—0—0.3—0.6—1—2—3—4—5—6—7—8—9—10 at 100,000 ohms/volt
0—0.15—0.3—0.6—1—2—3—4—5—6—7—8—9—10—11—12 at 200,000 ohms/volt
Ac volts—0—0.3—0.6—1—2—3—4—5—6—7—8—9—10—11—12—13 at 10,000 ohms/volt
0—0.5—1—2—3—4—5—6—7—8—9—10—11—12—13—14 at 20,000 ohms/volt

Db—10 to +77 in 10 ranges
Dc microamperes—0—0.5 at 200 mv; 0—0.5 at 150 mv; 0—1 at 100 mv
Dc milliamperes—0—0.5 at 150 mv; 0—1 at 100 mv
Dc amperes—0—0.5 at 150 mv; 0—1 at 100 mv

C-25K(Kit): $19.95
C-25W(Factory Wired): $32.95

DC to 5MC-S-55(Kit): $99.95
S-55W(Factory Wired): $155.95

G-30K(Kit): $32.95
G-30PCK(Semi-Kit): $39.95
G-30W(Factory Wired): $44.95

ST-55MXK(Kit): $109.95
ST-55PAMXK(Semi-Kit): $139.95
ST-55MXW(Factory Wired): $159.95

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A transistor can expire quietly while you're checking to see if it's good. But with a little care, you can use your ohmmeter.

By GENE MADISON

You've heard these vague warnings of dire consequences if you check transistors with an ohmmeter. Since the vom is probably the most often used test instrument, it would be nice to know if we can use it safely for transistor checking.

The table will show you what astonishing amounts of current flow through a resistance being measured with a conventional vom. Voltages, too, can be high. Further, the red test lead is not always connected to the positive side of the internal battery. The table shows only three popular meters. If you have a different one, make up a chart like this for it. You may be surprised.

Generally, an ohmmeter range that produces not more than 1.5 volts open circuit and 1 ma short circuit is safe for any transistor made, no matter how you connect it to the meter. The asterisks in the table next to certain ranges show which are safe to use under almost any circumstances.

What can you find out?
Let's see what we can learn about a transistor with an ohmmeter's "safe" range. All the following checks should be made with at least two of the three transistor leads disconnected from the circuit, and power off. Which leads you disconnect doesn't matter. The polarities are given here for p-n-p transistors; for n-p-n just reverse the test leads. (Remember to find out what the polarity of your meter is.)

Small-signal germanium: Positive lead on emitter, negative on base. About 300 to 400 ohms. Move negative lead to collector. About 10,000 to 50,000 ohms. If either reading is near zero or near infinite, transistor is bad.

Germanium power: Emitter-to-base resistance can be as low as 30 to 50 ohms; emitter-to-collector, a few hundred ohms. These types can handle ohmmeter-type currents without damage, so short momentarily between base and collector to see if that causes a sharp drop in resistance between emitter and collector. It should.

Silicon: Emitter-to-base resistance will be between 1,000 and 2,000 ohms. Emitter-to-collector resistance may be so high that it has to be measured on next higher "safe" range.

These are simple "go-no-go" checks. But an ohmmeter can also distinguish p-n-p and n-p-n transistors and identify their leads. Here's how.

Using a "safe" range, try various connections until you find a lead that measures about the same resistance to each of the other two. This is the base. If the resistance is about 400 ohms, you have a germanium transistor; if it's about 1,500, you have silicon. If you connected the positive ohmmeter lead to the base and reverse this information, the transistor is an n-p-n; if negative, it's a p-n-p. Now connect the ohmmeter to the remaining two leads and note the resistance. Reverse the leads and read again. Whichever connection gives you the lower reading is the one you want now.

If you found that the transistor was a p-n-p, the positive meter lead is on the emitter and the negative one on the collector. For an n-p-n, just the reverse is true.

Another test
Though an ohmmeter will not replace a good transistor tester, it can help you determine the relative dc beta of several transistors of the same type. For n-p-n transistors, hook the positive meter lead to the emitter, the negative to the collector, and leave the base lead completely free. The lower the resistance, the higher the dc beta. You can match transistors this way, or pick out the best from a group. It is actually an indirect measurement of Ie or collector-to-emitter leakage.
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Dorst Elected NATESA President

Chicago - Larry Dorst, Flint & Dorst, Inc., Milwaukee, has been elected NATESA president. He succeeds Irv Toner, Toner Radio & TV, East Aurora, N. Y.

Also elected at the NATESA annual convention was Earl Steffes of Kansas City, Mo., as secretary general, succeeding Dorst.

Harold Q. Eales, Eales Television and Radio Service, Oklahoma City, was re-elected treasurer, and Frank J. Moch was named executive director.

Regional officers elected are: eastern region, Richard Ambrose, Norfolk, Va., vice-president, Tom Hudson, Lynchburg, Va., secretary; east central region, Lyle Green, Oak Park, Ill., vice-president, Andy Archie, Nashville, secretary; western region, Alan B. Pickel, Las Cruces, N. M., vice-president, H. Hewson, Tigard, Oregon, secretary; west central, Bill Childs, St. Joseph, Mo., vice-president, C. Thole, St. Paul, secretary.

Moch, Piette Speak at NATESA Annual Convention

The underpricing of TV service and the prospect of forming dealer-service co-ops were two prime topics at the annual convention of the National Alliance of Television and Electronic Service Associations in Chicago, August 22-25.

Will Piette, owner of Factory TV Service, Milwaukee, told fellow service dealers that “TV service is underpriced. The fear of gypping the customer... is already a conditioned reflex,” he said. Thus, Piette pointed out, hurts the dealer.

Moch called his plan “super service.” Each man in such a co-op will do only what he is best qualified to do, and collectively the needs of the market will be satisfied. Local members of service organizations, he said, should band together for these ends. He recommended co-op advertising, buying and promotion.

With such an approach, Moch pointed out, many costs will be lower because of volume buying, reduced travel and advertising costs.

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Now you can instantly match up your base antenna to work mobile and vertical bases or horizontal base beams by simply switching from vertical to horizontal polarization through separate coax feeders. The dual-direction versatility of the "Match-Maker" will give you a powerful 7 db. forward gain. Switch to the horizontal beam and you get a 6 db. forward gain. Either way, you get a 15 db. front to back ratio.

Everything about the "Match-Maker" is rugged. Sturdy, heat-treated aluminum boom and elements plus oversize clamps to hold elements firmly in place give it the structural strength to withstand 100 mph winds. Only 123/4 high with a boom length of 10", it weighs an easy-to-handle 24 lbs. If you're interested in VSWR, it's 1.5:1 or less, either horizontally or vertically. 50 ohms, gamma matched. All components are color-coded for simple, fast, accurate assembly.

Wisconsin Service Bill Defeated

Madison, Wis.—A bill to license Wisconsin TV technicians by examination has been postponed indefinitely by a 51-37 vote in the state assembly. The measure also proposed advertising and promotion standards.

Service Dealers Briefed On California Repair Bill

Los Angeles - California officials met with TV service dealers and technicians here to explain how the new state law, aimed at preventing radio-TV repair abuses, will be administered.

The much-argued bill became law November 1963
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Winegard Colortrons deliver today’s finest color reception, give a new picture quality to black & white. And Colortrons are rugged. High tensile aluminum tubing for rigidity and stability…insulators with triple moisture barrier…Gold Anodized for complete corrosion-proofing. Winegard Gold Anodizing is the finest in the industry—not an inexpensive stain that fades out in a few weeks, but a bright Gold that lasts for the life of the antenna.

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standard of excellence in the industry

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OR
BLACK
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Has highest output — up to 1,200,000 microvolts
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Nothing on the amplifier is exposed to the elements — even the terminals are protected. Colortron comes complete with an all AC power supply with built-in 2 set coupler. Colortron model AP-220N 300 ohm input and output $39.95 list. Model AP-275 300 ohm input 75 ohm output $44.95 list.

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Colortron Antenna Model C-41 Gold Anodized — $24.95
Stereotron Antenna Model SF-8 For long distance FM reception $23.95

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in July. It requires all radio and TV repair firms to register with a state office, sets down certain advertising restrictions, makes a repair estimate binding on the repair firm (if one is made), and provides for itemized invoices.

Another new law, effective only in Los Angeles county, and also explained at the meeting, combats "setnapping"—holding a repaired set for "ransom" (charges in excess of an estimate), or attaching a lien to it.

Reaction to the law remains mixed and vociferous, even outside California. Howard Wolfson, Secretary of Associated Radio and TV Servicemen, Inc., Chicago, said in a letter to Home Furnishings Daily that the law is "another example of legislation designed to increase the burden of small service men, and pave the way for similar control in other fields."

Wolfson went on, "There isn't a repair job which can be estimated to the penny...service men will submit high estimates, thus losing business because of the opposition to those inflated guesses." He contended that technicians will be forced to install used parts to keep repair costs down and within the estimate.

New Virginia NATESA Chapter

Danville, Va.—A new technicians' association here known as VEA-Danville (Virginia Electronics Association) has become affiliated with NATESA, Jimmy Thomasson is president, T. R. Hughley vice-president and Lewis Adams, NATESA director.

NATESA reports that this is its eighth new affiliate in less than a year.

CSEA Elects Officers

Los Angeles—Emmett Mefford is the new president of the California State Electronics Association, a group of some 600 TV and electronic repairmen.

Mefford, formerly vice-president, fills the vacancy left by the death of Clair Lanam in July. Ralph Johonnot succeeds Mefford as vice-president. Johonnot was vice-president last year.

James Wakefield of Fresno is again CSEA executive secretary.

FTC Cites "Undisclosed" Used CRT Bulbs

The Federal Trade Commission acted recently to order tube manufacturers to stop misrepresenting CRT's using reconditioned envelopes as "new."

One company, Westinghouse Electric Corp., offered in its defense extensive, uncontradicted proof that the used envelopes were processed just as scrupulously as new ones. But, said FTC examiner Joseph W. Kaufman, even if the used bulb were just as good as a new one, a customer would be entitled to a new one if he expected it.

He noted that, when tubes are sold without any disclosure to the contrary, they are assumed by the general public to be new.

Burglarproofing Notes

From Electrical Merchandising Week, these anti-burglar hints:

1. If you have an alarm system, be sure it is functioning and is not easily fooled. Write to the manufacturer for information on newer systems.

2. Check with local police to see if the "scheduled check" is still used in your town. If so, try to persuade them (with the help of other businessmen in your town) of the "surprise" advantages of the unscheduled check now used in many towns.

3. Install security bars and frames inside the windows. Anything outside is fair game for burglars.

4. If your building has a skylight, cover it (from inside) with a steel security frame or heavy wire mesh.

5. Find out from a locksmith the advantages of a "dead-lock" mechanism for your doors.

6. Put night lights around the building and on the roof. Lights inside, if your building has windows on the street, will make it harder for a burglar to work unnoticed.
STEREO RECEIVER, Award T47000X. FM stereo and AM tuners, dual preamplifiers, 70-watt stereo amplifier on single chassis. Stereo logic circuit switches FM tuner to stereo when station begins to broadcast stereo. FM tuner frequency response 10-35,000 cycles ±1 db. Tuner has stereo and AM tuners, dual preamplifiers, 70-watt stereo amplifier on single chassis. Stereo logic circuit switches FM tuner to stereo when station begins to broadcast stereo. FM tuner frequency response 10-35,000 cycles ±1 db. Tuner has stereo playback preamp circuitry. Comparison switch for monitoring off tape or program source. Delivers 2-volt output to music system. Record-playback response 30-18,000 cycles at 7.5 ips. Sound-on-sound recording for multiple recording effects, built-in filter for FM multiplex recording. Separate record-playback volume controls, indicator light, professional VU meters, digital counter, head shift control, 2-speed selector switch, automatic tape shut-off. Available models RMQ, quarter-track record, play; ERQ, half-track record, quarter-track play. Viking of Minneapolis, Inc., 9600 Aldrich Ave. S., Minneapolis, Minn. 55420.

TRANSISTORIZED PA AMPLIFIERS, models 3000, 6000. Tunable anti-feedback. Three mike channels for separate or simultaneous use, for high- and low-impedance miles. Two inputs allow use of unit with tuner, tape recorder, auxiliary equipment. Controls for master gain, individual mike gain, auxiliary fader-type gain, tunable anti-feedback, bass and treble, tunable filter, scratch filter, Power: output 30 watts rms, 42 watts peak; 60 watts rms, 84 watts peak. Response 20-20,000 cycles ±2 db. Harmonic distortion less than 2%. Output impedances 4, 8, 16, 500 ohms; 25, 30, 70.7 volts. 117 vac, 50-60 cycles. Automatic overload protection. R & K Mfg. Co., Div. Dynascan Corp., 1801 W. Belle Plaine Ave., Chicago 13, Ill.

PERSONAL HEADSET RECEIVERS, Model 100. Moving-coil drivers with plastic diaphragms in acoustic chambers for direct coupling between transformers. Music power 44 watts. Frequency response ±1 db, 20-20,000 cycles. Harmonic distortion 1%. Hum and noise: Tuner, -74 db; magnetic phone, -54 db. Tone controls ±10 db. Inputs: Tape head, magnetic phone, ceramic phone, tuner. Auxiliary outputs: Tape recorder, 4-16 ohms speaker impedance. Lafayette Radio Electronics Corp., 111 Jericho Turnpike, Syosset, N. Y.

36-WATT STEREO AMPLIFIER, model 2056. Classic Series. 26 watts IFH music, 28 watts continuous power stereo, 1M distortion (each channel) 2% at 14 watts. Harmonic distortion (each channel) 0.5% at 10 watts. IFH power bandwidth at rated continuous power, 1% harmonic distortion: 30 cycles-20 kc. Frequency response ±1 db 15 cycles-40 kc. Speaker output 4-16 ohms.

Inputs: magnetic phone, adapted ceramic phone, stereo tape, tape, audio, 2-3 mV, 2.3 mV phono, 250 mV others. Noise 65 db down on phono, 80 db down on others. EICO Electronic Instrument Corp., 9600 Northern Blvd., Long Island City 1, N. Y.

STERECORDERS. Model 777-S-4 records 4-track stereo, 4-track monophonic, plays back 2- and 4-track stereo and mono. Model 777-S-2 records 2-track stereo, 2-track mono; plays back 2- and 4-track stereo, plus mono. Both Sony models all-transistorized, have 3 separate heads, 3 motors, all-solenoid activated mechanism, work vertically or horizontally. Speeds 71/2, 33 1/2. Sony mixing of mike and line, sound-on-sound recording, remote control for all models, monitoring of source or tape. Superscope Inc., 8150 Vineyard Ave., Sun Valley, Calif.


N O V E M B E R, 1 9 6 3
reproduced sound and ear. Polyvinyl chloride ear cushions used. Frequency range 20-15,000 cycles. Response 33 dB, 20-100,000 cycles. Distortion 0.2% at 100 phon level over useful range. Sensitivity (per phone) 200 pha/volt at 1 kc. Max. power input 1 watt per phone. Nominal impedance 8 ohms.


PA SYSTEM, Diplomat, Powered by 15 flash-light batteries. Attache case contains all-transistor 25-watt amplifier, 6 x 9 speaker, dynamic omnidirectional mike with lavaliere cord and 10 feet of cable, 40 feet additional cable to permit separation of loudspeaker and amplifier. Two inputs, two outputs for use with additional loudspeakers.


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NARROW BAND ANALYZER, model 2107. For analysis and linear measurements. Audio-frequency analyzer, constant percentage-bandwidth

Micro-TV model 5-303W or 8-inch model 8-301W. Available with carrying case and antenna, 13 oz. Power automatically supplied from TV set.-Sony Corp. of America, 580 5th Ave., New York, N. Y.

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AMPLIFIED COUPLER, model TA-66. Indoor Super-Powermate. Two-transistor unit amplifies and feeds TV signals to up to 4 TV sets from single antenna. Gain: low band, 7.5 db, output 180,000 µtv at each of 4 output terminals; high band, 5.6 db, output 100,000 µtv at each outlet. Noise figures 4.2 db low band, 8.3 db high band. Isolated power supply.—Distributor Sales Div., Jerrold Electronics Corp., 15th & Lehigh Ave., Philadelphia 32, Pa.


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Clock Radio Knobs

If you own a clock radio or are often called upon to repair them, you know how easily the clock control knobs can get lost. A quick professional-looking replacement can be made by cutting a 3/4-inch length of 3/4- to 3/8-inch-diameter plastic rod and drilling a hole the same diameter as the frequency, and a moving weave on telecasts not tied down to the power frequency. On weak signals, the picture jitters and rolls, and a vertical bar hangs in the middle of the screen.

This is caused by a partial short in the 3-cyl 50-volt electrolytic across the filter choke. At 25 cycles, this resonates with the choke, presenting a high impedance to ripple. At 60 cycles, it can be more of a nuisance than a help if it fails. Removing it cures the complaint.—D. K. Vanderwater

RCA Color: 800, 900 Series

Frequent failure of the 6DQ5 horizontal output tube in these sets can be caused by an intermittent where the 6CG7 horizontal oscillator PC board connects to chassis ground. Oscillator heater failure removes drive to the 6DQ5, causing excessive dissipation.

If the 6CQ7 heater is lit, try wigwagging the tube to find the intermittent. The best cure is to resolder all four ground lugs on the horizontal oscillator board.—Arthur R. Richman
control shaft to a depth of ½ inch down the center of the new knob. For slotted shafts, cut a small rectangle from a tin can. It should be ½ inch long and slightly wider than the diameter of the hole. Heat it with your soldering gun and, using needle-nose pliers, force it into the hole of the new knob. Finally, no matter what type of shaft, fill the hole with cement and press the knob onto the shaft. A dot of red fingernail polish serves as a pointer.—Ronald S. Newbower

**Squirrel Behind the Bars**

The customer telephoned, reporting two black lines on his television screen. He also declared that the sound was mixed with a frying noise which drowned out the announcer's voice.

The technician put in several unrewarding minutes checking the set without locating an offending component. Not to be discouraged, he fired up the portable TV set reserved for such baffling occasions. The lead-in was secured and a check on the same black lines appeared on the portable screen. A check on some neighbors' sets firmly established the existence of a strong 120-cycle radiation along the street.

The technician mounted his truck and turned on the car radio. The noise drowned out all, but the local broadcast station. After a false start in the wrong direction the point of highest noise intensity was located at a hydroelectric distribution pole a half block from the customer's home.

Inspection revealed that a squirrel had climbed across an insulator bearing a primary line. The squirrel's tail was lying on the cross arm of the pole which was freshly watersoaked by overnight rains. The final repair of the neighborhood problem was in sight. The power company was called and the squirrel borne to his last resting place. TV reception returned to normal.—D. K. Vanderwater

**No Sound in Ac-Dc Five-Tuber**

The trouble was no output on a five-tube ac-dc radio. A slight hum at the speaker was detectable. Tubes were OK. Signal substitution at the grid (pin 5) of the 50C5 output tube revealed normal output. After investigation, I noticed the coupling capacitor from the first audio was connected to pin 2 of the 50C5, and the 50C5 grid resistor was connected to pin 5. Playing a hunch, I removed the tube and found no continuity between pins 2 and 5. The cause of the trouble was obvious. The connection in the tube itself was open. A piece of wire from 2 to 5 on the socket cured the trouble for all time.—Sidney Claire

**Snow on the Beach**

A set in the lobby of a Miami beachfront hotel showed a lot of snow. A new 6BZ7 rf amplifier didn't help. I decided to inspect the antenna.

It was a V (conical), well installed. Connections and lead-in were good. No sign of trouble.

Returned to the lobby, checked tubes and connections again. All OK. Tried an indoor antenna—no better.

On a moment's inspiration I put the ohmmeter leads across the lead-in: only about 100,000 ohms, where it should have been infinity!

Back up the ladder to the antenna. The wooden cross braces on the antenna V's were damp with salt spray—shorting out most of the signal.

A new and different antenna corrected the trouble. And I made a mental note not to use that kind near the ocean again.—H. R. Holtz

YOU CAN DO THIS WITH EUPHONICS' REVOLUTIONARY NEW 'SOFT-TOUCH' CARTRIDGE

The new U-11R Soft Touch Cartridge and Mounting brings new safety to records and stylus. When tone arm is accidentally hit, depressed or dropped, stylus lifts clear of record surface.

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will be made on the new all-transistorized Norelco Continental 401" Stereo Tape Recorder, the only recorder using the newly developed AC107 transistors in its two preamplifiers. The AC107 is the only transistor specifically designed for magnetic tape head preamplifiers utilizing specially purified germanium to achieve the extraordinary low noise figure of 3 db, measured over the entire audio band (rather than the usual single frequency). This noise figure remains stable over large collector-emitter voltage swings and despite large variations in source resistance.

Hear the new transistorized Norelco Continental '401' 4-track stereo/mono record and playback + 4 speeds: 7½, 3½, 1½ and the new 4th speed of ½" which provides 32 hours of recording on a single 7" reel + fully self-contained with dynamic stereo microphone, two speakers (one in the removable cover for stereo separation), dual preamps and dual recording and playback amplifiers + self-contained PA system + mixing facilities + can also play through external hi-fi system + multiplay facilities.


Silicon bridge rectifiers

The drawing shows the physical and electrical configurations of a new series of miniature encapsulated silicon full-wave bridge rectifiers, designed to replace the four separate diodes usually used. A number of high-fidelity amplifiers are now using bridge rectifiers, and should one or more of the diodes fail, it may be more economical to replace the entire bridge with one of these. There are eight versions, for rms ac input voltages from 95 to 470 volts, and corresponding dc outputs (into capacitive filters) of 94 to 525 volts. Maximum capacitive-load output current is 1.3 amps, or 1.8 into a resistive load. The bridges will operate up to 140°C. Maximum forward voltage drop at 25°C and peak current is only 1.2 volts per rectifying element—or 2.4 volts total. The devices are made by International Rectifier Corporation.

2N2654, 2N2671, 2N2672

The appearance on the market of these three transistors demonstrates just how routine the use of transistors for higher-frequency amplification has become. The 2N2654 is a germanium PADT high-gain vhf transistor designed especially for "mass-produced, high performance FM radios" (quoted from the manufacturer's release). Cutoff frequency is 250 mc, and power gain at 100 mc is 18.8 db. Best of all is the price: $0.85 in 1000-up quantities, and about $1.30 singly.

Another recent device is the 2N2671 (from Amperex, as are the other two in this item), which is "an economy, low-noise FM transistor" with a 14-db power gain at 100 mc and an 8-db noise figure. Amperex claims that it will work at as low as 3 volts. It goes for only $0.50 in quantities of 1,000 or more.

Less spectacular (and cheaper, too) is the 2N2672, a "universal AM-short wave transistor", for rf and i.f. stages in receivers for standard AM broadcast and short waves to 6 mc. Like the others, one of its most attractive features is its low feedback capacitance: 1.5 pf for this one. High current gain, too—about 150. It is priced at $0.40 in 1000-up quantities.

Tiny light sensor

This is a very-miniature photoresistive (or photoconductive, if you like) light sensing device, ¼ inch in diameter and less than ½ inch high. Texas Instruments, manufacturer of the device, claims it to be the smallest of its kind commercially available. The sensor, called the LSX 600, is designed to be fitted directly into a ½-inch hole in a printed circuit board. Two simple soldering operations connect it. Suggested applications include character recognition, tape and card reading...
NOVEMBER, 1963

TERMS: 25% deposit must accompany all orders, balance C.O.D. Orders under $5: add $1 handling charge plus postage. Orders over $5: plus postage. Approx. 8 tubes per 1 lb. Subject to prior sale. No C.O.D.'s outside continental U.S.A.

N O V E M B E R  ,  1 9 6 3
and velocity indicators. Dark current is typically 10 µA at 100°C, light current about 1 ma. Power dissipation is 50 mw. The photo shows a fascinated moth inspecting the sensor. TI wants you to notice the size of the sensor compared to the size of the moth’s eye. Perhaps he is considering a replacement?

**Integrated reference amplifiers**

Some gentlemen at General Electric have come up with what seems like a fine idea: they have combined a voltage reference device with a dc amplifier. Specifically, they have put in one TO-5 package a Zener diode junction and a transistor–semiconductor analogues of the gaseous voltage-reference tube and (usually pentode) amplifier in so many tube regulated power supplies.

---

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noteworthy Circuits

Industrial Tone Alarm

Here is an inexpensive, easily built, oscillator-audio amplifier that packs a hefty wallop and is rugged enough for industrial use. It lends itself well to a host of applications where a triggered tone alarm is required to attract attention. For example, in areas such as go-no-go gaging or nondestructive testing, a pair of contacts on the actuated relay, connected across jack J, will complete the speaker circuit, producing a loud tone.

R3 is an L-pad speaker volume control and also provides a load across T2's secondary when the speaker is disconnected. The unit runs continuously but sounds an alarm only when a pair of external contacts connects in the speaker. An alternative to speaker switching would be switching transistor Q2 in and out. Keying the oscillator produces a slight chirp. Other methods of switching will occur to you.

The alarm is constructed on a 5 x 6 x 1-inch utility box with chassis.
Reverberation in a Car Radio

Add the Motorola Vibrasonic unit to a car radio and you have reverberation. At the heart of the two-transistor reverberation system is an input and an output transducer separated by a delay line made of two precision-wound springs. The input transducer receives the audio signal from the radio output and converts it into a mechanical rotary motion. This motion is transmitted via the springs, which introduce a specific delay, to the output transducer that converts the rotary motion back into an electronic signal. This delayed signal is then amplified and fed to the car’s rear-seat speaker.

The diagram (right) shows the circuit. Audio from the auto radio is fed the Vibrasonic input through coupling transformer T1. R1 protects the input transducer against overloads at high signal levels. R2 is the Vibrasonic level and rear seat speaker fader, controlling the input to the system.

When R2 is at the center of its rotation, the audio signal is grounded. If the control is turned clockwise from this center position, the audio signal is fed to the delay line. Counterclockwise rotation feeds the audio through R3 and the output transducer to the amplifier, bypassing the delay circuit.—Warren Roy

Heathkit Multiplex Adapter

Would you like to modify your Heathkit AC-11 FM multiplex adapter so the pilot carrier does not beat with the tape recorder’s bias oscillator when recording a stereo broadcast? It’s easy. You simply install a 19-kc filter in the adapter’s output circuits.

Fig. 1 shows the cathode-follower...
output stages in the AC-11. Fig. 2 shows one of the output stages with the 19-ke filter added.

Order two Heathkit No. 45-48 19-ke coils. Connect a coil and 200-pf capacitor in parallel between the bottom end of each 2,200-ohm cathode bias resistor and lug 3 on the output level control as in Fig. 2. Replace the .005-uf capacitors across the level controls with .002-uf ceramics.

Caution: Mount the coils horizontally so they won't pick up hum from the power transformer. Insulate all leads and keep them as short as possible.—P. D. Ross

END
try this one

Coupler for Phono Pin Plugs

Two cords with phono pin plugs can be quickly and easily joined together with this shielded adapter.

You will need a 1-inch length of brass, copper or iron pipe (inside diameter at least 1/4-inch), and an outside diameter of about 3/8-inch. (I used a 1-inch length of threaded brass nipple, known to electricians as "1/4 pipe nipple" and sold at most electrical supply counters.) You will also need two single-hole-mounting phono pin jacks (imported units sell for as little as 8¢ each).

Assemble the coupler as shown in the photo.

Top: Cut a 1 1/2-inch length of flexible insulated wire and solder one end to the center lug of the left-hand jack.

Then solder the jack securely into the end of the brass tube. Solder the other end of the wire to the center lug of the right-hand jack and solder the jack into the remaining end of the tube. The soldering is not difficult—simply run a little solder all around the ends of the tube where the jacks join the tube.

Center: The coupler ready for use.

Bottom: The coupler barrel is wrapped with tape to improve its appearance. Two cords with phono plugs are shown plugged into the coupler.

Jumper for Series-String Sets

When you troubleshoot, say, a video if. in a series-heater set by bypassing the stage with a capacitor, you have to remove the tube. This of course kills the heaters.

To get around this dilemma, find a defective 7-pin miniature tube with a good heater, and cut off all but the heater pins (3 and 4). Replace the pulled tube with this dummy to complete the heater circuit.

Be sure that the heater rating of the dummy is the same as that of the tube you're replacing. In fact, why not accumulate a set of dummies for this kind of troubleshooting?—E. L. Deschambault

Inexpensive Photocell Housing

The transparent plastic bubble in which experimenter type International Rectifier Corp. photocells are sold makes an excellent dome enclosure for uncovered cells such as the B2M selenium unit and thin-wafer silicon cells. This bubble is almost hemispherical, 2 inches in diameter and 3/4 inch high. It has a flat 1/16-inch lip around its base.

Using a razor blade, carefully remove the bubble from the card to which it is glued. Then mount your cell on a 2-inch diameter disc of thin plastic. (Wafer cells may be cemented to the disc; the B2M requires a short 6-32

Pay-TV Accepted in Hartford

Hartford, Conn.—Local residents have apparently accepted subscription TV as another entertainment medium, according to Home Furnishings Daily. For more than 2,600 homes in the Greater Hartford area such programs are regular fare, and they pay about $6 a month to watch them.

Hartford launched pay-TV over uhf channel 18 late last year after FCC authorization to conduct a 3-year experiment to test pay-TV's feasibility.

New installations of the Zenith decoders are being made at the rate of about 75 per week, and station operators are reported as "very pleased." Installation costs $10, and after the first 3 months (which are rent-free) a weekly rental of $75 goes into effect.

Beyond that, clients pay only for what they watch. Rates vary from 25¢ to $3 per program, with the average about $1 to $1.50. The station offers 30 hours free and 30 hours pay TV a week. Credit is given toward rental charges, based on the number of pay programs watched. Programs now consist chiefly of new movies and live sports events.

Service technicians and TV dealers in Hartford appear to be reacting favorably to the new service, HFD reported.
ANYONE can build a professional FM stereo tuner with a new Scott Kit

Scott's exciting new kit building techniques make it possible for anyone to build a high-quality FM Stereo Tuner. Special alignment procedures make it possible to obtain high sensitivity without the need for expensive test equipment. A major innovation is the full-color instruction book, showing each step in the assembly. Even at the hands of a novice, every tuner kit will meet or exceed published specifications.

Prices start at $99.95. There are 5 sensitivity of 3.5 Av, uses new corn-

2.2

Two tuner kits are available. The LT-110, at $164.95 features sensitivity of 2.2 microvolts, pre-wired multiplex section and famous Sonic Monitor. The economical LT-111 at $119.95, with sensitivity of 3.5 Av, uses new compacton tubes for ease of assembly. There are 5 additional kits available from Scott. Prices start at $99.95.

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MAY 1963

N O V E M B E R, 1963

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At extremely low temperatures, germanium is an insulator. Placed in a magnetic field and biased by dc, the semiconductor begins to pass current. Doping the semiconductor unevenly makes some parts begin to conduct before others, and the transition from insulator to conductor occurs gradually.

The 200-volt dc power supply biases the semiconductor and also passes current through L2 to create a magnetic field. This field is modulated by signal flow through L2. Magnetic core and semiconductor are immersed in liquid helium (4° K). Varying the effective field at the semiconductor changes its resistance, producing corresponding changes in the output voltage.

**Signal Identification**

*PATENT No. 3,092,732*

Richard E. Milford, Glendale, Ariz.

(Assigned to General Electric Co.)

This circuit determines which of several signals is the most positive. Only two signals are shown here, but as many as 14 or more may be applied, each to its own stage. Signals may vary between -5 and 6 volts, for example. Normally the gate conducts, so 6 volts appears at lead A to block each signal stage.

To identify the desired signal, a positive pulse is impressed to block the gate. Then -14 volts appears at A.

Now consider a most-positive signal, S, applied to other signal stages.

**Input**

**Output**

**Stage 1**

**Stage 2**

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NOVEMBER, 1963
The core is actually a magnetic bridge that may be redrawn (Fig. 2) in the form of the more familiar electrical bridge. Reluctance is drawn as resistance, magnetomotive force as voltage. When the variable arm is adjusted for balance (the gap screw), the flux (current) through the bridge paths are such that no mmf (magnetomotive force — voltage, in this analogy) can appear across the read coil.

Since the write coil cannot affect the read coil, the only output from the latter will be from the tape.

Glide-Path Indicator

**PATENT No. 3,049,667**

Samuel L. Broadhead, Jr., Cedar Rapids, Iowa, and Arthur L. Kemper, Marion, Iowa. (Assigned to Collins Radio Co, Cedar Rapids)

This guidance system depends upon two tones: 90 and 150 cycles. An airplane pilot knows his exact position in flight from the relative strength of these frequencies. Network 1 is inductive below 150 cycles, and C1 is added to resonate it to 90 cycles. Network 2 is capacitive above 90 cycles, and L is added to resonate it to 150 cycles. The signal is essentially 90 cycles at A, and 150 cycles at B.

The rectified signals flow through M1 in opposite directions. This meter has a zero center, so its deflection shows which tone predominates and by how much. M2 is a voltmeter with a colored flag which shows only if the signal strength is high enough for reliable operation. Thermistor R2 stabilizes the circuit. C2 is an rf bypass. R1 compensates for the nonlinearity of iron-core conductor L.

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- Insure maximum gas economy and quiet engine running. Read the exact RPM while the engine is in neutral position. Then adjust the carburetor in conformity with the car manufacturer's recommendations.
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NOVEMBER, 1963

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Written by two respected engineers in the field. About one third of the book is devoted to electronic design for radio astronomy. Radio telescopes and interferometers each get a long chapter, VECTORS AND PHASE ANALYSIS, by Alan Andrews. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5 1/2 x 8 1/2 in., 128 pp. Paper, $2.95.

A self-study course on vectors as used for calculations, including practical examples and answers, and a table of trig functions.


A compilation of useful schematics, construction hints and operating data on ham and CB equipment. Many items are unusual and hard to find elsewhere. Transistor and CB listings, plate characteristics, useful schematics are included. END


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