Electronics World

APRIL, 1964
50 CENTS

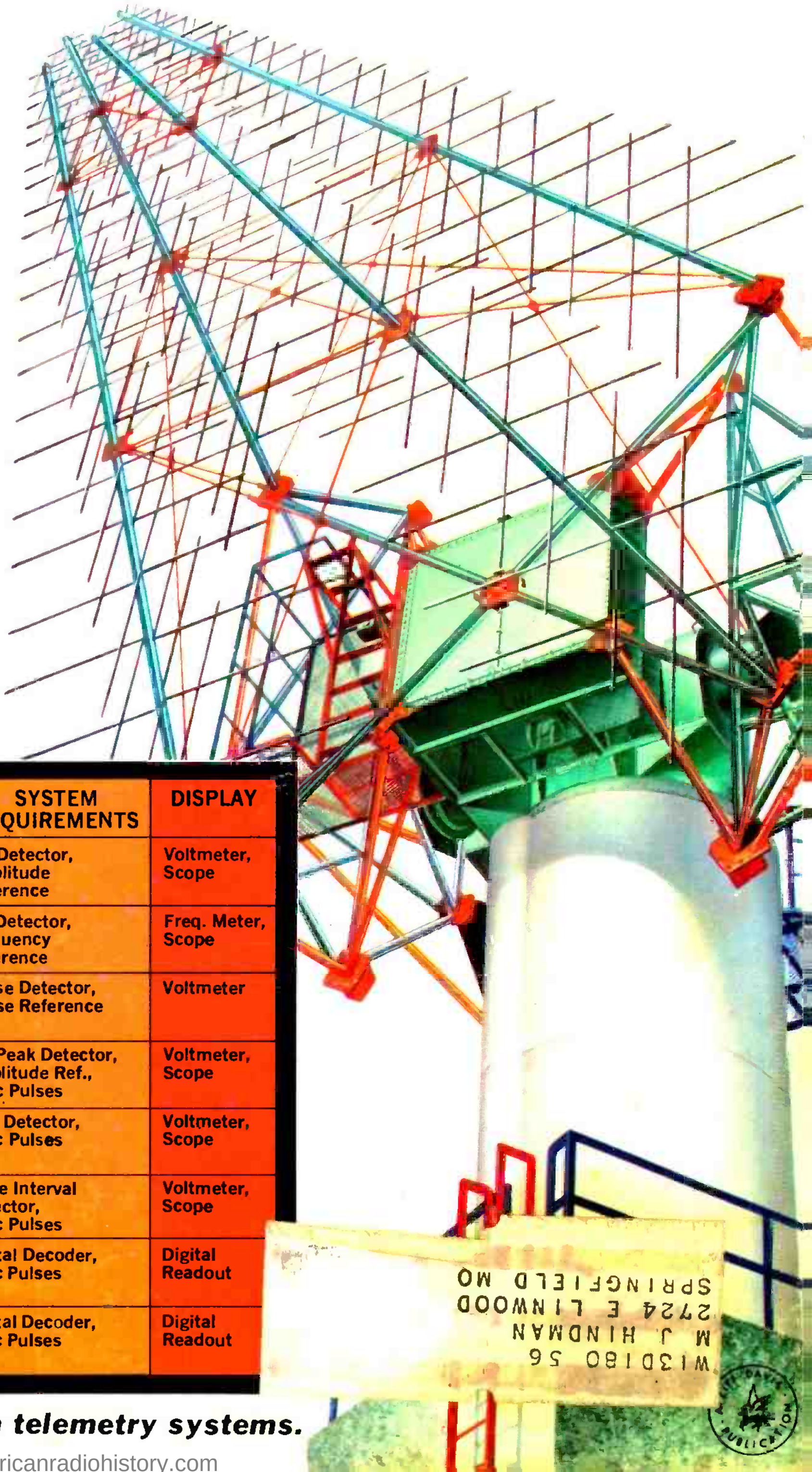
Operation of MAGNETIC CORE COMPUTER MEMORIES

Circuit analysis of ELECTRONIC SIREN/MOBILE P. A. SYSTEMS

HIDDEN TV TEST SIGNALS

Construction of: SINGLE-FREQUENCY RECEIVER for MARS-CAP-WWV-or Ham Radio

TELEMETRY SYSTEMS and TECHNIQUES



TYPE OF MODULATION	MULTIPLEX SYSTEM	WAVEFORM	SYSTEM REQUIREMENTS	DISPLAY
AM Amplitude	Frequency Division, Analog		AM Detector, Amplitude Reference	Voltmeter, Scope
FM Frequency	Frequency Division, Analog		FM Detector, Frequency Reference	Freq. Meter, Scope
PM Phase	Frequency Division, Analog		Phase Detector, Phase Reference	Voltmeter
PAM Pulse Amplitude	Time Division, Analog		AM Peak Detector, Amplitude Ref., Sync Pulses	Voltmeter, Scope
PDM Pulse Duration	Time Division, Analog		P.D. Detector, Sync Pulses	Voltmeter, Scope
PPM Pulse Position	Time Division, Analog		Pulse Interval Detector, Sync Pulses	Voltmeter, Scope
PCM Pulse Code (RZ) (Return to Zero)	Time Division, Digital		Digital Decoder, Sync Pulses	Digital Readout
PCM Pulse Code (NZR) (Non-Return to Zero)	Time Division, Digital		Digital Decoder, Sync Pulses	Digital Readout

Types of modulation and waveforms used in telemetry systems.

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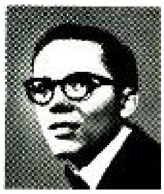
These Men Trained for Success with NRI—YOU CAN, TOO

"I want to thank NRI for making it all possible," says Robert L. L'Heureux of Needham, Mass., who sought our job consultant's advice in making job applications and is now an Assistant Field Engineer in the DATAmatic Div. of Minneapolis-Honeywell, working on data processing systems.

His own full-time Radio-TV Servicing Shop has brought steadily rising income to Harlin C. Robertson of Oroville, Calif. In addition to employing a full-time technician, two NRI men work for him part-time. He remarks about NRI training, "I think it's tops."

Even before finishing his NRI training, Thomas F. Favaloro, Shelburne, N.Y., obtained a position with Technical Appliance Corp. Now he is foreman in charge of government and communications divisions. He writes, "As far as I am concerned, NRI training is responsible for my whole future."



"I can recommend the NRI course to anyone who has a desire to get ahead," says Gerald L. Roberts, of Champaign, Ill., whose Communications training helped him become an Electronic Technician at the Coordinated Science Laboratory, U. of Illinois, working on Naval research projects.

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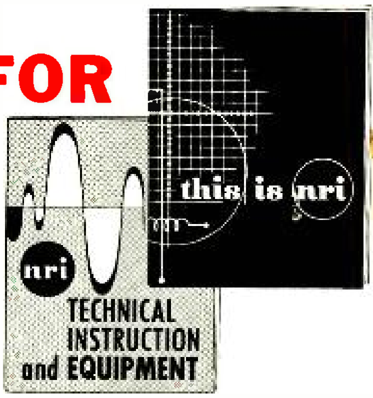
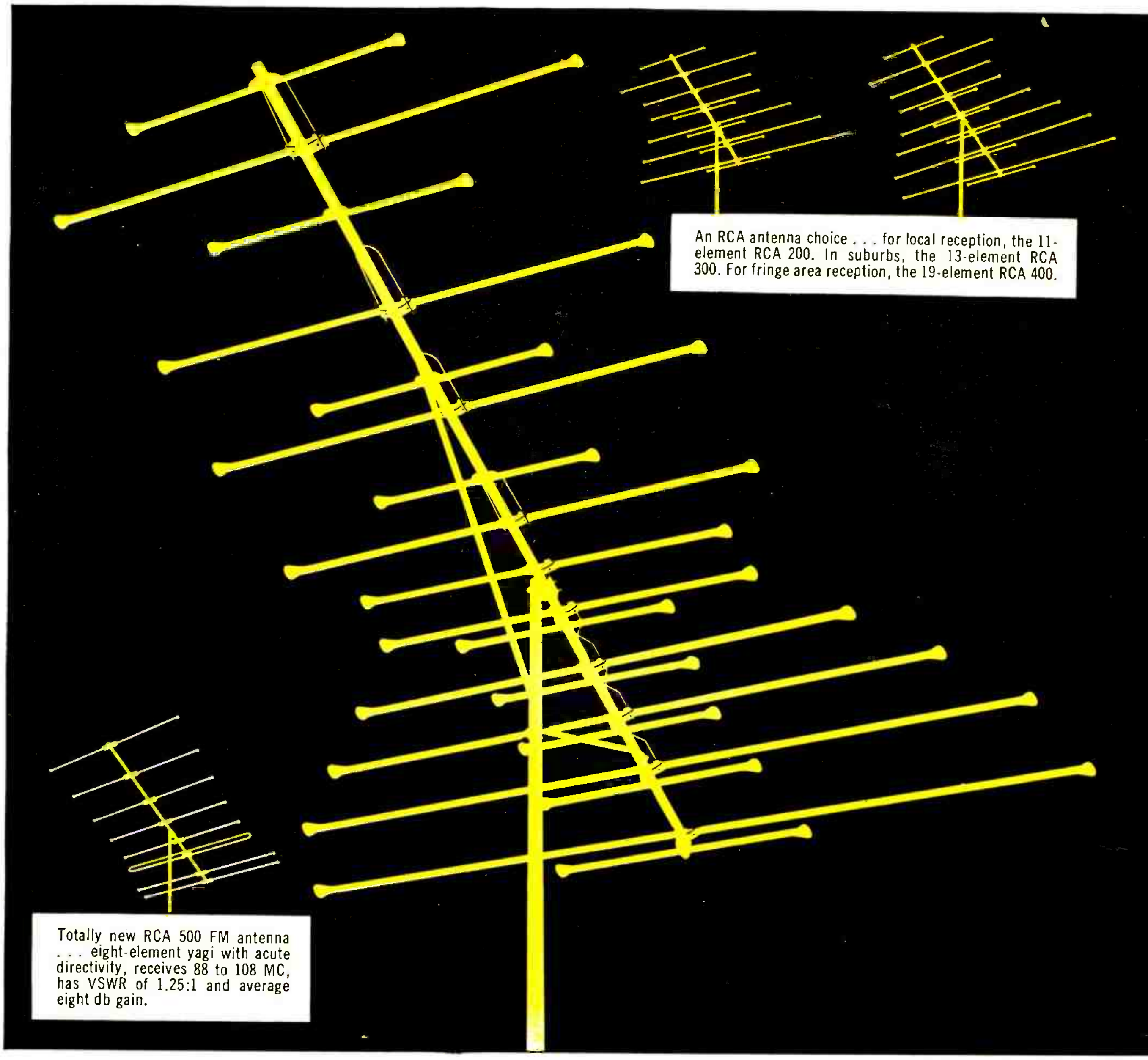


Read the story of NRI's 50 years of pioneering and leadership in training men at home for careers in Electronics. Read about NRI's philosophy of training; its reputation among leaders of the Electronics industry; read about our specialized instruction plans and see pictures of equipment you get. Whatever your age or status, the continuing increase in career opportunities in the ever-growing, ever-changing Electronics industry should interest you. Mail the postage-free form today.



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Totally new RCA 500 FM antenna . . . eight-element yagi with acute directivity, receives 88 to 108 MC, has VSWR of 1.25:1 and average eight db gain.

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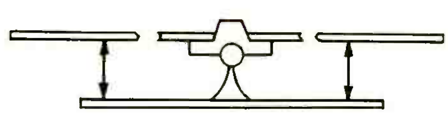
RCA's electro-lens director system absorbs maximum incoming signal power, gives extremely high gain across the VHF band, offers excellent forward gain on the front end.



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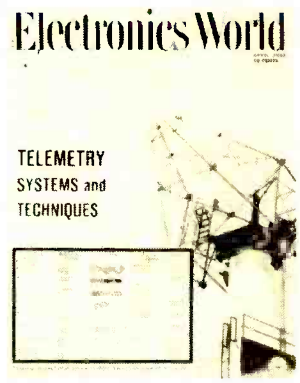
CONTENTS

APRIL 1964
VOL. 71, No. 4

MONTHLY FEATURES



THIS MONTH'S COVER shows a monopulse antenna array, developed by Collins Radio Co., that can be used to track and monitor voice and telemetry signals from low-level earth satellites. Array consists of eight log periodic dipoles that operate in the 30- to 300-mc. frequency band. Frequency independence of the monopulse characteristic is achieved by tilting the log periodic antennas toward each other to maintain constant spacing in wavelengths between element phase centers. To learn more about telemetry, see the article "Understanding Telemetry" in this issue. (Illustration by Otto E. Markevics.)

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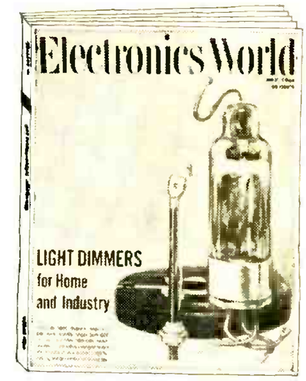

TAPE RECORDING EQUALIZATION
Herman Burstein provides the audiophile with answers to such questions as why equalization is needed, what equalization alternatives are in terms of providing bass and treble boost either in recording or playback, the pros and cons of such alternatives, and the relationship of equalization to distortion and signal-to-noise ratio.

USING TRANSISTORS IN A HIGH-QUALITY AMPLIFIER
The design parameters and circuit operation of Fisher Radio Corp.'s new Model TX-300 solid-state integrated stereo amplifier are discussed by F.L. Mergner. The philosophy behind this new design is also covered in considerable detail.

INSTITUTIONAL RADIO-TV INTERFERENCE
Part 1 of a two-part series which details various methods of reducing interference to radio and TV sets in institutions having many electrical noise sources. These include hospitals, military barracks, correctional institutions, schools, and college dormitories, among others.

ELECTRONIC TACHOMETERS
Since these important auto accessories are rarely offered as standard equipment, most car owners install one of the units offered by various manufacturers. Jim Kyle's article deals with the operation and calibration of relay-type and transistor-type units, with photos of a number of commercial tachs.

LIGHT DIMMERS FOR HOME AND INDUSTRY
Intensity controls for incandescent lamps have come a long way from the early resistive types. Today, modern solid-state electronic controls use SCR's and solid-state switches to perform the job. Fred M. Wolff of Century Lighting offers an over-all survey of these techniques.

FREQUENCY-CONTROL CRYSTALS IN COMMUNICATIONS EQUIPMENT
In an attempt to clear up many misunderstandings with regard to crystals and their uses, R.L. Conhaim offers a compendium of basic considerations which those who use and service communications equipment will find helpful.

UPDATED IGNITION SYSTEM
A redesigned and improved version of a circuit published in August 1962, taking advantage of the new, specially designed ignition-system transistors.

All these and many more interesting and informative articles will be yours in the MAY issue of ELECTRONICS WORLD . . . ***on sale Apr. 21st.***

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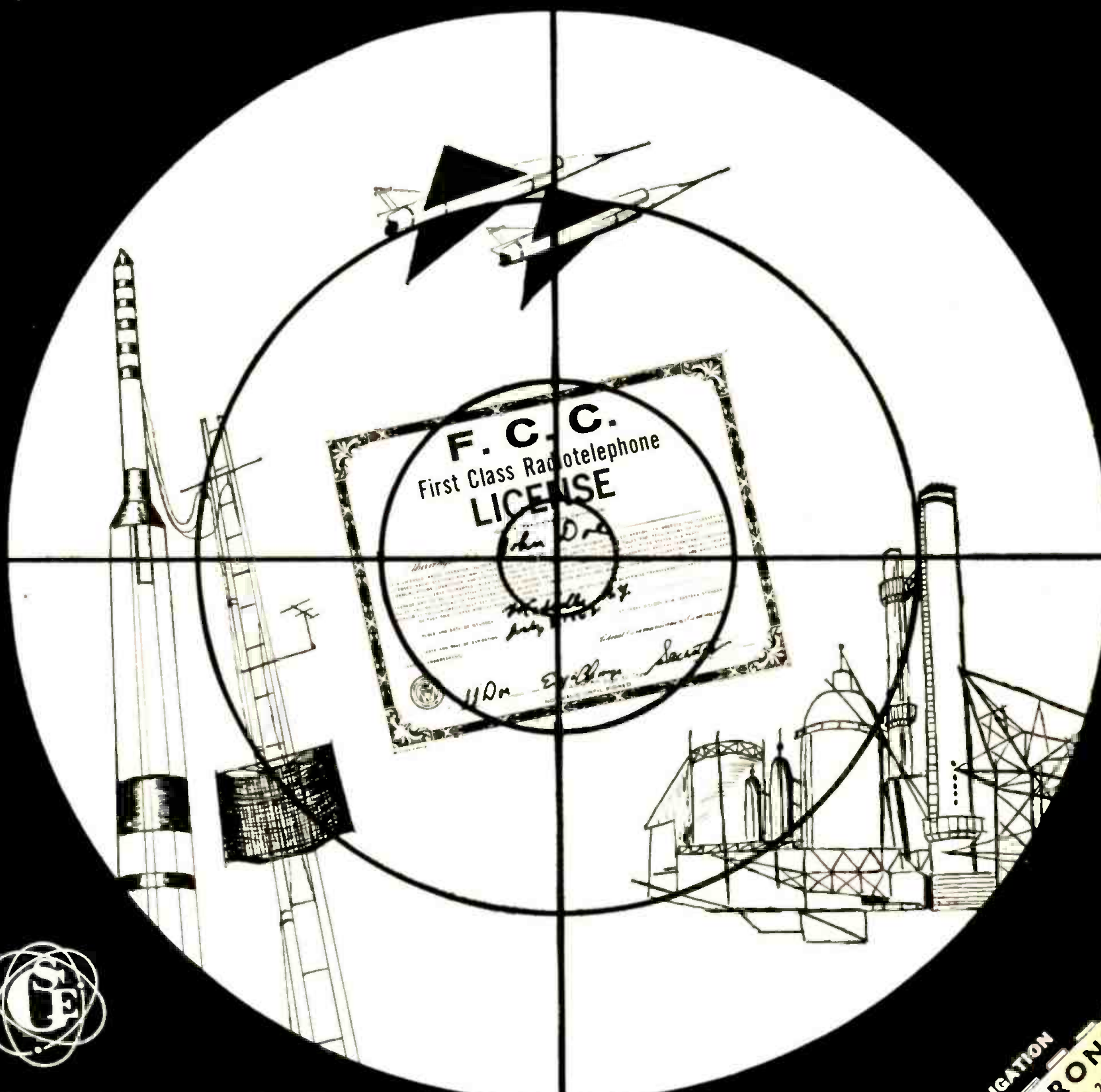

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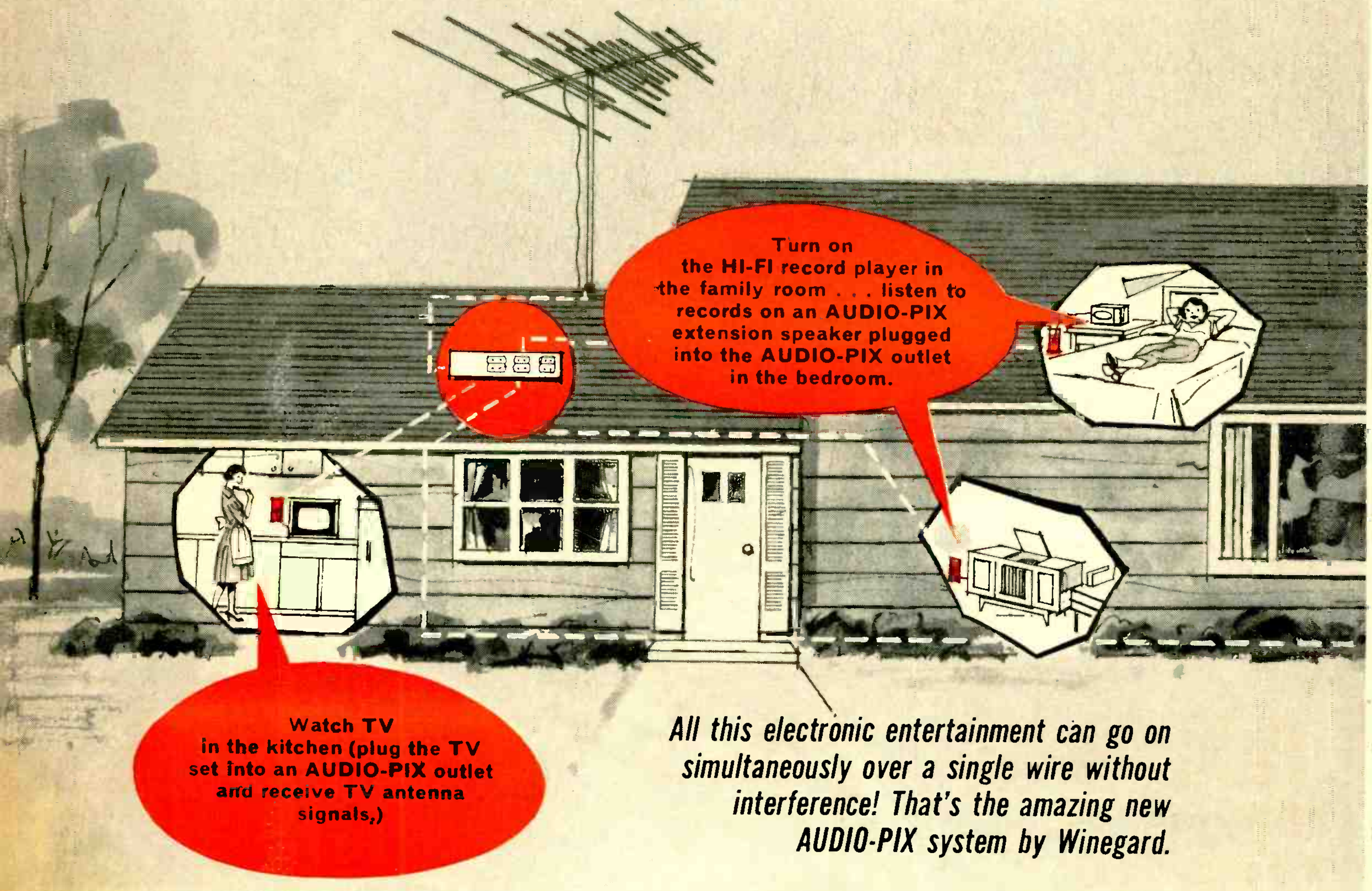
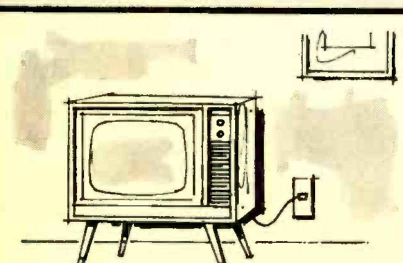
NEW IDEA

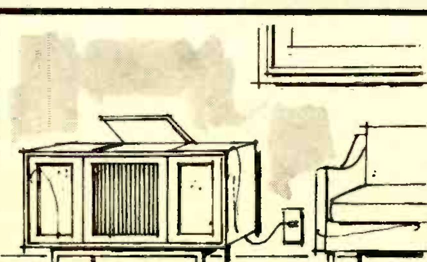
Winegard Introduces An Amazing New Home TV and Music Outlet System



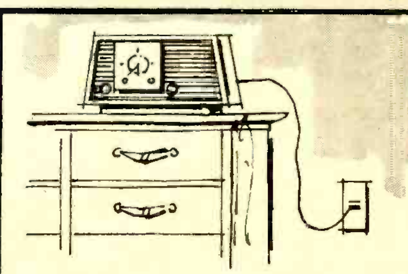
All this electronic entertainment can go on simultaneously over a single wire without interference! That's the amazing new AUDIO-PIX system by Winegard.



Plug TV set into any AUDIO-PIX outlet. Run one or more sets simultaneously from a single antenna.



Run a HI-FI (record player, FM or AM, or tape recorder) and feed the sound into the system to be picked up at any AUDIO-PIX outlet.)



Plug an FM receiver into the AUDIO-PIX. The AUDIO-PIX serves as an FM antenna signal source, and at the same time automatically feeds the FM sound back into the system to the extension speakers.

AUDIO-PIX delivers TV, FM or HI-FI

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Start selling AUDIO-PIX to your customers now. Write for spec sheets or ask your distributor.

*Pat. Pend.

Winegard ANTENNA SYSTEMS

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CIRCLE NO. 135 ON READER SERVICE PAGE

For the record

WM. A. STOCKLIN, EDITOR

DEW LINE COMMUNICATIONS

MILLIONS of dollars worth of communications equipment—but not a single phone booth within hundreds of miles. This about sums up what we saw on a recent trip across the DEW (Distant Early Warning) Line. As a guest of Col. G. R. Bickell, Vice Commander of the 26th Air Div., USAF, and Col. R. E. Bouman, Commander, Det. 1 of the 26th Air Div., we had the opportunity of accompanying Air Force personnel on their routine, bi-monthly inspection trip across the DEW Line—from Base "DYE IV" near Kulusuk on the east coast of Greenland to Base "POW" at Point Barrow, Alaska. Although the entire trip from Stewart Air Force Base in Newburgh, N.Y. and return covered 9230 statute miles, the DEW Line itself extends about 3290 statute miles, paralleling the Arctic Circle. It is a treeless wilderness of snow and ice with temperatures down to −65° at least eight to nine months of the year.

It is almost impossible to imagine the hardships endured by the original construction crews when the bases were built. There were no conveniences and tents were used for housing. Today, only one problem exists—that of isolation. Being away from home and family isn't easy for many of those stationed at the 33 main sites that make up our Distant Early Warning network.

The original intent was for the DEW Line to serve solely as a detection system—to warn of any enemy aircraft attempting to cross the North Pole in a sneak attack on Canada and the United States—to prevent another Pearl Harbor. It has served this purpose well and will be required for many years into the future. The search radar system will become outdated only when piloted aircraft cease to be a military threat. Like any military weapon, advances in technology must obsolete the old as new weapons are developed. Missiles and rockets will perhaps someday obsolete the DEW Line as an early warning system.

But the DEW Line is more than just an early warning system. Even today, it is one of the most outstanding communications networks in the world. It is part of a chain that links the Aleutians, Canada, Greenland, Iceland, and then all across Western Europe. Other connecting links from the center of the DEW Line extend south through Canada and again to the States. Still another link from Northern Alaska follows Western Canada to the States.

The equipment is mostly new and modern, and the remaining old equipment is being replaced. All east and west links are *via* u.h.f. tropospheric scatter, while some north and south networks employ v.h.f. ionosphere scatter. Reliability is estimated at better than 99%. Our Strategic Air Command headquarters near Omaha has direct communications to several points on the DEW Line. NORAD headquarters at Colorado Springs also has completely interconnecting facilities.

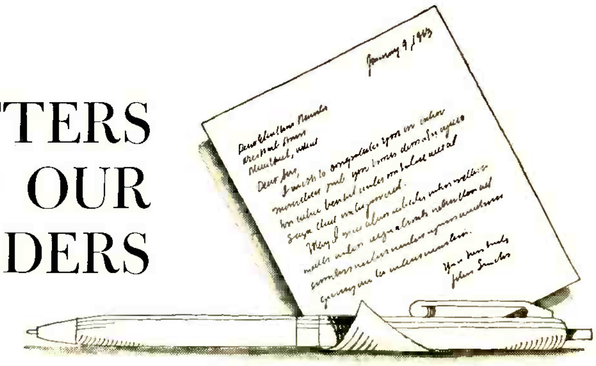
Whether this will open the Arctic areas to civilization is relatively unimportant right now. The significance is in knowing that the most extensive and reliable communications system possible is available to our military forces. There are still other advantages, since many of the DEW Line sites serve as weather stations, funneling data directly to our weather bureaus in the States.

We should not overlook the commercial and military air traffic that crisscrosses the polar area. Several commercial lines, particularly those connecting Los Angeles and San Francisco to Europe follow the Polar Route. The DEW Line, at present, tracks 200 to 600 aircraft per month. Most of these are military, but if our Air Force is to operate world-wide, radar facilities, beacons, and communications are most important.

Some day in the distant future the Dew Line will become obsolete as a distant early warning system, but the facilities can be expanded for various other purposes and become even more vital as time goes on. ▲

The story of the men who service, maintain, and operate the electronic equipment will be covered in next month's issue. All of the electronic work—even the new installations—is handled by Federal Electric Corp., a subsidiary of ITT.

LETTERS FROM OUR READERS



GROUNDS IN BRAZIL

To the Editors:

John Frye's article on grounds in the October issue recalls some of the grounds I encountered in various radio receivers when I first came to Brazil from Chicago some 30 years ago.

A great number of the radios at that time were Dutch *Phillips*. They always depict a ground on the back cardboard cover as a water pipe with a faucet connected to the pipe and a line indicating a wire from the pipe to the ground terminal of the radio. Hence, customers wanting to ground their radios, would sometimes hang a piece of pipe, complete with a faucet, connected by a wire to the ground terminal of the radio. Another ground was a can of dirt on the floor, with a piece of wire connected to the ground terminal of the radio.

Most of these have disappeared today. But one item remains; a ground to a waterpipe here is *not* a ground. Grounding to a water pipe here in Salvador will produce an electric shock throughout an entire building due to the high resistance of our water-pipe connections.

James H. Hill
O Americano
Salvador, Bahia, Brazil

° ° °

U.H.F. RECEPTION

To the Editors:

The article on u.h.f. reception in the November issue was interesting. Last summer, I found that the reception of u.h.f. TV is not always confined to short distances, however. During hot and calm weather, particularly at night, very good reception is possible up to 150 miles and even farther from the station.

In the early morning, up to a few hours after sunrise, I have received WFIE-TV in Evansville, Indiana with a fair-quality signal. I live about 40 miles southwest of Chicago or about 250 miles from Evansville. The power of the station has little bearing on the quality of reception in some cases. WMBD in Peoria, Ill., 100 miles away, is rivaled in signal strength by WCHU in Champaign, Ill., 120 miles away, often in the summer even though WMBD has a much greater effective radiated power. WICS, Springfield, Ill. and WTVP, Decatur, Ill., both 135 miles from here, have given me good reception in the early morning and late evening hours of hot summer days. Upon occasion these two stations provide good signals in the daytime.

My v.h.f. antenna gave results comparable to a single-bay u.h.f. antenna of the bow-tie type and showed what seemed to be an omnidirectional pick-up pattern. My v.h.f. antenna is a two-bay conical type about 18 feet above ground level. The u.h.f. antenna I use is an 8-bay bow-tie type 22 feet above ground. I also use a u.h.f. converter with a booster stage built into it.

Ronald Boese
Joliet, Illinois

° ° °

EUROPEAN TUBE NUMBERING

To the Editors:

Referring to the item "European Receiving-Tube Numbering System" published in the November issue, I should like to point out that this system applies to receiving and amplifying tubes only and should not be employed with other types (cathode-ray tubes, voltage stabilizers, etc.). This restriction is not apparent from the text of the article.

In addition, it may be interesting to note that the numbering system for special tubes (reliable, ruggedized, long-life tubes, tubes for computers) is similar to the one described, the same key being used; however, the figures are placed between the letters, *e.g.*, E80F, E90CC, E80CF.

Jose C. Dias
Porto, Portugal

° ° °

BACKGROUND-MUSIC MULTIPLEXER

To the Editors:

This is in reply to an interesting letter from a reader relating some of his experiences with my SCA Background Music-Multiplexer from the December Electronics World.

1. *On the matter of audible crosstalk:* It is quite possible, though not at all likely, that crosstalk may originate at the FM station. Two general deficiencies in the multiplexer may produce it also. These are inadequate limiting due to a weak signal and poor discriminator balance. The test point voltage requirement of about 20 volts rectified signal should be checked. Leak-through signal from

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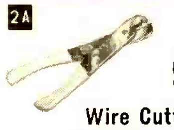
2A 
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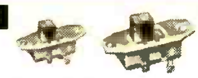
3 
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7A 
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8 
3 9-Volt Batteries ONLY 59¢
Quality long-lasting replacements for Burgess 2U6, RCA VS323, Eveready 216 and others. Lowest price; from Japan. 6 oz. Pkg. of 3. No. 55 J 147.
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9 
Bargain Phone Plugs 3 for 78¢
Standard ¼" plugs for extensions, speakers, headphones, monitoring equip.; 2 cond., unshielded. Pkg. of 3. 12 oz. Specify red or black handle. No. 39 A 020.
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Famous-brand Zener diodes, from miniature mw. units to stud-mounted 10-amp. types. 3-30 v. range. With diagrams. Pkg. of 12. 7 oz. No. 39 A 008.
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11 
50 Tubular Capacitors ONLY 98¢
Wax-impregnated capacitors; ranges from 100-600 WVDC in popular values. Various sizes. All values and working voltages marked. Pkg. of 50. 12 oz. No. 39 A 385.
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12 
5-inch Round Speaker ONLY 98¢
Quality PM replacement; good fidelity. Power cap. 3.5 watts. Imp. 3.2 ohms. Magnet weight 0.53 oz. EIA mounting dimensions. 12 oz. No. 39 A 009.
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13 
12" Hi-Fi Speaker ONLY $5.85
Wide-range; with hi-frequency whizzer cone. 12 oz. magnet; 40-14,000 cps; cap. 25 watts; imp. 8 ohms; standard mountings. 7 lbs. No. 39 AX 742.
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2-Set Coupler ONLY 98¢
Transformer-type TV-FM coupler. Permits operation of 2 TV or 2 FM sets (or one of each) from a single antenna. Size, 3¾ x 1 x 1¾". 3 oz. No. 39 A 760.
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15 
100 Terminal Strips ONLY 98¢
Less than a penny each! Brown bakelite strips, all ⅜" wide. Assorted length—1 to 6 terminals per strip; mixed lug and solder types. 12 oz. Pkg. of 100. No. 39 A 582.
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16 
ONLY 98¢
Handy Mini-Tester
Pocket-size neon-type voltmeter; measures AC/DC from 65-800 v.; determines grounded side of line. 4 oz. No. 58 A 426.
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17 
SAVE! Famous Name 1½-Mil Mylar Tape Buy
3 7" REELS FOR $2.88
1200 ft. reels of tape at only 96c per reel! Minimum tape-head wear; guaranteed splice-free. Pkg. 3 reels. 1½ lbs. No. 80 R 705.
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18 
Crystal Lapel Mike ONLY 98¢
Amazing buy high-impedance crystal mike. 60-5000 cps; output, −50 db. Plastic case; fits hand, clips to lapel or pocket. From Japan. 6 oz. No. 39 A 881.
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19 
300-Ohm Twin Lead
FULL 100-FT. HANK, ONLY 98¢
For VHF-TV or FM. Less than 1c a foot! 100-mil web thickness; all-weather low-loss polyethylene jacket. No. 22, 10-strand wire. 2 lbs. No. 39 A 011.
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20 
4 Popular Allied Books ONLY $1.75
Books include: **Electronics Data Handbook, Dictionary of Electronic Terms, Getting Started in Electronics, Understanding Transistors.** Pkg. of 4. No. 37 K 804.
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21 
"Juke Box" Speaker Cable
100 FT. COIL ONLY 98¢
Less than 1c per foot! Two parallel No. 24 gauge conductors, 7x32 stranded, 1 tinned, 1 bare .058x.115" O.D. Clear vinyl insulation. 100-ft. coil. 10 oz. No. 39 A 859.
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22 
R.C.A. Receiving Tube Manual ONLY $1.00
Lists characteristics, operating conditions, usage and applications of all current RCA receiving and picture tubes. Invaluable to everyone in electronics. No. 37 K 575.
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23 
40-Watt Germanium Power Transistor ONLY 87¢
PNP alloy-junction type rated at 15 amps @ 30 volts. Pwr. dissip., 40 watts—ideal for P.A. and hi-fi amplifiers. Replaces Delco 501, Bendix 2N278, 2N173, etc. 3 oz. No. 39 A 634.
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24 
100 Assorted ½-Watt Carbon Resistors ONLY $2.98
Insulated resistors of well known quality brands. Tolerance, ± 10%. Guaranteed values (ohms), 2 each; 10, 12, 15, 18, 27, 39, 82, 120, 150, 180, 270, 390, 470, 560, 680, 820, 1000, 1200, 1800, 3300, 3900, 5600, 8200, 10K, 12K, 18K, 22K, 33K, 39K, 56K, 82K, 100K, 120K, 180K, 330K, 390K, 470K, 560K, 680K, 820K, Megs: 1.2, 1.8, 2.2, 2.7, 3.9, 4.7, 8.2, 12, 15, 18. Pkg. 100. 5 oz. No. 39 A 697.
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Ship me the items circled below in quantities shown:

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2A	____	6	____	10	____	14	____	18	____	22	____
3	____	7A	____	11	____	15	____	19	____	23	____
4	____	8	____	12	____	16	____	20	____	24	____

NO COD's PLEASE: $__________ enclosed
(Please include postage; remit 15¢ per item ordered)

Name ______________________
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City ______________ Zone _____ State ______ the oscillator should be small as this will impair limiting action. Constructors should check to see if any of the discriminator bridge components are outside commercial tolerances, particularly poorly matched diodes. Finally, misalignment of the FM tuner will produce crosstalk.

2. *On the desirability of a squelch*: In past years, many FM stations cut the SCA subcarrier between selections to operate a mute circuit in the subscriber's equipment to silence the system. If your favorite stations still follow this practice, a squelch may be desirable. A simple way to add relay-operated muting is to let tube $V3$ operate the relay by replacing resistor $R11$ with a 6000-ohm relay coil. Limiting will still be good at about 90 volts plate voltage and the relay current will vary from about 3 to over 5 ma. as the subcarrier is switched on and off at the transmitter. The contacts of the relay can ground or unground the audio output as required.

3. *On possible overload of power transformer T6*: At a supply voltage of 115, the tube heaters draw 0.8 ampere at 5.8 volts, the reduced cathode emission improving limiting and tube life. The large heat sink provided by the chassis holds winding temperatures well below commercial limits even for equipment which is operated continuously.

4. *On the tap of the input transformer T1*: The tap should be nearer the ground end as shown. This is not essential, but it is very desirable to provide greatest signal voltage step-up to the mixer grid from the low-impedance transistor output circuit. The 630-turn coil is tapped at 135 turns from the outside or grounded end, thus providing a correct step-up ratio of about 3.2 to 1.

ROBERT W. WINFREE
Decatur, Ga.

* * *

TV INTERFERENCE

To the Editors:

I am a full-time serviceman and have encountered TVI from various sources, including amateur radio. But, I have found that a simple high-pass filter will not always do the job. I imagine the local TV service shops (encountered by W. P. Pence, as reported in the Dec. "Letters" column) have had similar experience. So instead of stocking a variety of filters and doing a lot of experimenting in front of a disgruntled customer, they have taken the easy way out. This is to quit trying and to pass the buck to others.

I have also found that amateurs are very seldom the cause of TVI here. We have had a much more serious problem with a local paper manufacturer who has an r.f. sealing machine. This radiates such a strong signal that it covers half of the town.

GLENN TRIBBEY
Tribbey's TV Service
Menominee, Mich. ▲

And beyond compare it is. There's simply no other way to describe the new Caravelle. It's unique in the stereo tape recorder field. Only the Caravelle has six heads. (Lets you record or play in both directions continuously without flipping reels.) Reverse-o-matic® plays any tape automatically to and fro for as long as you wish. Simple, too. Easy push button operation. Built-in echo control, sound on sound control, twin speakers, three motor system, center capstan drive. And there's more. In fact, we have a brochure crammed with facts. Send for it. You'll be amazed that the incomparable Caravelle gives you so much for less than $399. For details and name of nearest dealer write to Concertone, Box 3866, South El Monte, California.

CONCERTONE

CIRCLE NO. 108 ON READER SERVICE PAGE

This *Weller*®

Heavy Duty Soldering Kit

has a professional

240/325 WATT

Dual Heat Gun

No other soldering set offers you such versatility. The heavy duty Weller gun is the same professional tool used by technicians. Two trigger positions let you switch instantly to either 240 or 325-watt heat. In this single tool you have a choice of heat to suit the job, and tip temperature high enough to handle the tough ones. Instant heat saves time and current.

Kit includes 3 different tips for soldering, cutting, sealing and smoothing; tip-changing wrench and supply of solder. Everything is in a sturdy plastic carrying case. Model D-550PK. Weller Electric Corp., Easton, Pa. **$12.95** LIST

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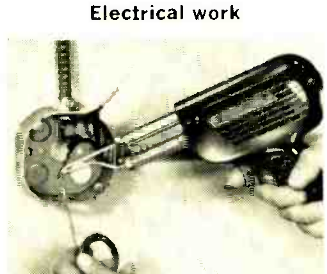


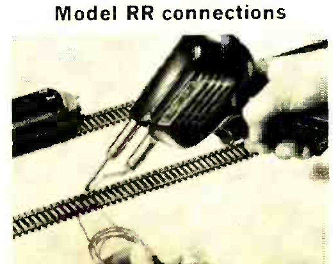
Repairing plastics

Sealing plastic bags

Appliance repairs

Metal work

Model RR connections



Cutting plastic tile

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Please use the coupon at the bottom of this page to obtain more information about products advertised in this issue.
Simply circle the number on the coupon that corresponds to the number at the bottom of the advertisement in which you are interested.

Additional information on items mentioned in **"New Products," "Hi-Fi Product Report,"** and **"Test Equipment Product Report"** can also be obtained by following this same procedure.

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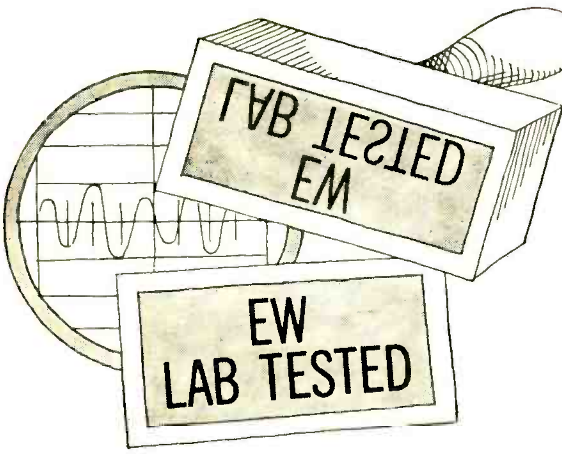
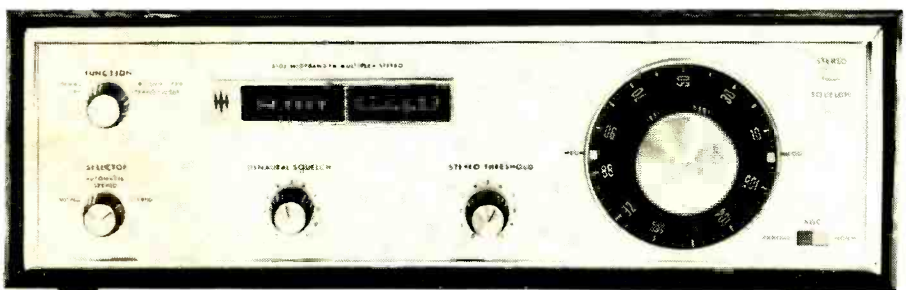


HI-FI PRODUCT REPORT

TESTED BY HIRSCH-HOUCK LABS
Scott 310E FM-Stereo Tuner
Burgess Test Tape

Scott 310E FM-Stereo Tuner

For copy of manufacturer's brochure, circle No. 43 on coupon (page 15).

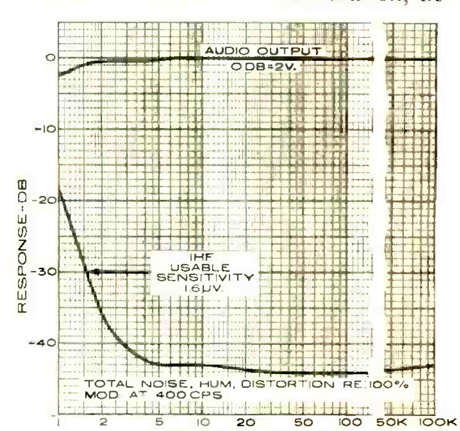


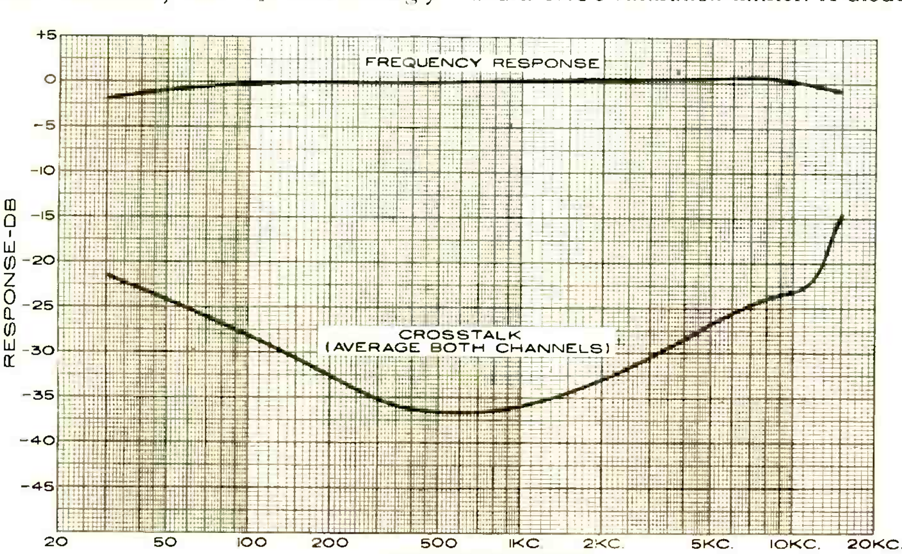
SINCE the original *Scott* 310 tuner was introduced some seven years ago, the 310 series has been identified with the highest caliber of FM-tuner performance. A number of design improvements, including the addition of multiplex circuits, have resulted in the new Model 310E.

The features which made the early 310 tuners so outstanding have contributed greatly to the stereo performance of the 310E. The company was a pioneer in using flat-topped, steep-skirted i.f. amplifiers followed by wide-band limiters and a ratio detector. This combination resulted in non-critical tuning, low distortion, and an outstandingly low capture ratio. The importance of low capture ratio in reducing multi-path distortion in mono FM reception has not always been fully appreciated, but this is a major factor in obtaining good FM-stereo reception.

The 310E, like the company's other FM tuners, has a shielded, silver-plated front-end. A 6BS8/6BQ7A cascode r.f. amplifier drives the pentode section of a 6U8 as a mixer. The triode section of the 6U8 is the oscillator. There is virtually no drift from a cold start, or with line voltage variations, so a.f.c. is not needed. Three 6AU6 i.f. stages are followed by a 6BN6 gated-beam limiter and a 6AU6 saturation limiter. A diode at the 6BN6 input supplies a.g.c. voltage to the r.f. stage and the first i.f. amplifier stage.

Following the germanium diode ratio detector is a stage which separates the 19-kc. pilot carrier from the composite stereo demodulated signal for further processing. The pilot signal is amplified and doubled to synchronize a 38-kc. oscillator. The oscillator actuates two four-diode switches, which operate on the composite signal. The outputs from these switches are the left- and right-channel signals, which are amplified, filtered to remove SCA modulation, de-





emphasized, and again amplified before going to the output jacks.

The 310E has a novel, relay-controlled interstation squelch circuit and another relay-controlled automatic stereo switching system. The squelch relay is operated by interstation hiss, which is rectified in a voltage-doubling circuit and combined in opposition to a d.c. reference voltage on the grid of the relay-control tube. The rectified noise voltage actuates the relay which grounds all audio outputs. When a signal is received, the noise drops and the relay shuts off, restoring the audio output signals. The threshold level at which the squelch operates is controlled by a front-panel control. A green light on the panel indicates when the tuner is in a muted condition.

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Extra protection. Extra-dependable service. And extra profits. That's ***real*** *leadership. And that's why so many dealers are finding it pays to focus on Channel Master as their first choice in tubes.*

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CHANNEL MASTER ELLENVILLE NEW YORK

The automatic stereo switching operates in a similar fashion, except that the 19-kc. pilot carrier is rectified to operate a relay which disconnects the output circuits from the multiplex section when the pilot carrier is absent, or falls below a level determined by a front-panel control. In the mono mode, both outputs are paralleled and connected to an amplifier stage ahead of the multiplex demodulator. A green light on the panel indicates the reception of a stereo signal.

The stereo selector switch on the panel has three positions: "Mono," "Automatic Stereo," and "Stereo." Normally, the "Automatic Stereo" setting is used. In "Mono," the stereo circuits are disabled entirely. In "Stereo," an output will be heard only when a stereo signal is received. This is a unique feature of the 310E and is quite handy when rapidly scanning the FM band for a stereo broadcast.

In our preliminary listening tests, it was immediately evident that this was an exceptionally sensitive tuner. Satisfactory stereo reception was obtained from stations 50 miles distant, using an electronically boosted indoor antenna in a basement listening room. This is a feat we have not thus far matched with any other tuner. The sound quality was as clean, quiet, and distortion-free as we have ever heard from an FM tuner, either mono or stereo. The squelch and automatic stereo circuits did not operate properly at first, but after re-adjustment of the chassis-mounted controls for both circuits they worked very well. Our only criticism of these otherwise very effective circuits was the clicking noise of the relays and flashing green lights as the receiver was tuned. There was also some annoyance from the automatic switching from stereo to mono as signals faded or fluttered. Although the switch-over was smooth, the relays were quite audible.

Our lab measurements confirmed the manufacturer's impressive claims for the 310E. The IHF usable sensitivity was 1.6 μv. (rated 1.9 μv.). The frequency response was ±1 db from 50 to 15,000 cps, down 1.7 db at 30 cps. Stereo channel separation was better than 20 db from 30 to 12,500 cps. These figures represent the best results that could be obtained in laboratory use. In ordinary listening, depending only on the tuning meter, the separation might be degraded by about 10 db. This is still more than sufficient for all practical purposes.

The sub-channel filter, controlled by a front-panel switch, reduces separation to 23.5 db at 400 cps and to 3.2 db at 10,000 cps. It reduces noise appreciably when receiving weak stereo signals. The stereo noise filter, on the same switch, does not affect separation, but rolls off the high-frequency response by 6.5 db at 10,000 cps. The capture ratio was 3 db (rated 2.2 db). Accurate measurements of very low capture ratios are difficult and were further affected by the operation of the squelch relay which introduced some uncertainty in our measurements. The FM hum modulation was 60 db below 75-kc. deviation, approximately the residual hum of our signal generator.

It is difficult to find fault with this tuner, apart from the relay noise. It is one of the truly outstanding FM-stereo tuners we have tested. It is hard to imagine a more flexible, easy to tune, and sensitive device. Its operating refinements require considerable circuit complexity and this is far from cheap. The price of the *Scott* 310E tuner is $279.95, less case. ▲

Burgess Test Tape

For copy of manufacturer's brochure, circle No. 44 on coupon (page 15).

THE *Burgess* test tape is designed to meet the needs of tape recording hobbyists that certain test records do for the record-playing public. It is entirely non-technical and is obviously aimed at the newcomer to tape recording.

The tester is a 1200-foot reel of 1½-mil acetate-based tape. One side is recorded at 7½ ips, the other, with identical material, is recorded at 3¾ ips. The back of the carton describes briefly the various test sections and the times at which they occur. It is a half-track mono recording which can also be played on quarter-track stereo machines.

The opening section introduces the concept of standard recording level, using a simulated oboe tone. The voice announcement points out that the playback level control should be able to completely shut off the sound from this section. The frequency response is checked by a sequence of bell tones for the mid-frequencies and by a series of cymbal clashes for the high frequencies. In each range, ten sets of alternate tones are presented, with the first having full frequency range and the second having the highs cut off at some point. The high-frequency cut-off is successively increased, from a point which should be apparent on even the poorest recorder, to the last tone which taxes the abilities of the best home machines and playback systems for its detection. The actual values of the cut-off frequencies used are not given.

The middle and low frequencies are dismissed with a brief illustration and the comment that a recorder which reproduces the upper frequencies will always pass the lowest ones. This, of course, is not strictly true, but will suffice for the non-critical listener. A bal-

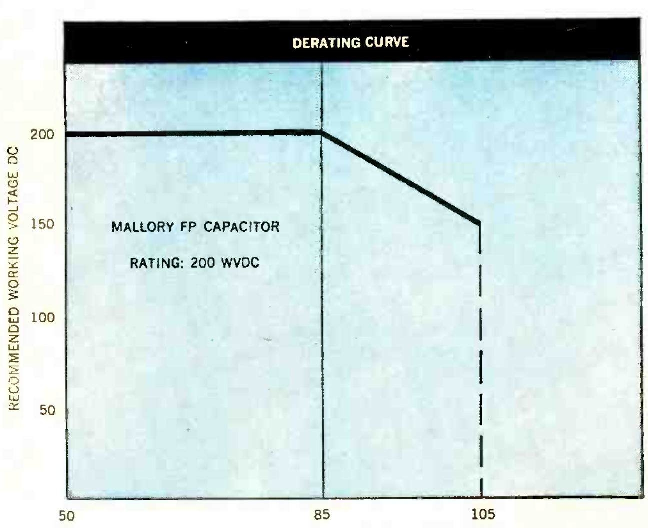
(*Continued on page* 84)

P. R. MALLORY & CO. Inc.
MALLORY

Tips for Technicians

Mallory Distributor Products Company
P.O. Box 1558, Indianapolis 6, Indiana
a division of P. R. Mallory & Co. Inc.

About voltage ratings on electrolytics



Maybe this has happened to you. You've got to replace a 10 mfd electrolytic capacitor. On its label, loud and clear, you read 200 volts. You look on your shelf. No 200 volt units in sight—but there's one that says 10 mfd 300 volts. Question—can you use it, and if so, will it reform itself and become a 200 volt capacitor when used at the lower voltage?

Answer—you can, and it won't.

The reforming of electrolytics to lower voltage is an idea held over from the ancient days of wet electrolytics, which had a tendency to adjust themselves to the voltage at which they were being used. This doesn't happen with modern electrolytics, especially the way Mallory makes them.

You can rely completely on the voltage rating you read on a Mallory capacitor's label. We've built in the safety factors *before* we print the voltage rating on each capacitor. This means you can use a Mallory capacitor right up to its rated DC working voltage, at rated ambient (this is 85° C. for FP's, WP's and TC's) without worrying about premature failure or call backs. And you have inherent extra muscle to withstand the usual surge voltage above rated value. Conversely, you can *always* use a Mallory capacitor *below* its rated voltage when convenience demands it; you're just buying some extra reliability at a bargain price.

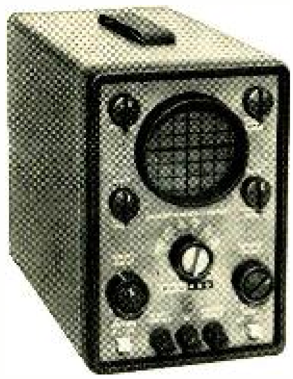
When necessary, you can use Mallory electrolytics at temperatures beyond 85° C. You won't get as long life, and you'll need to run them below rated voltage. No hotter than 105° C., please, and no higher then 400 volts. The chart at left gives you typical temperature derating data. If you run into higher temperatures, you really need one of our fine tantalum capacitors.

The best way to make sure you get the electrolytics you need is to see your Mallory distributor. He carries a complete line of all ratings of Mallory FP, WP, TC, TT and wax tubulars. Right now, he is featuring a new dealer cabinet that gives you a compact, convenient working stock of most popular FP types. See him soon—make him your headquarters for all your parts requirements.

Build your own top quality Eico Kits and save up to 50%

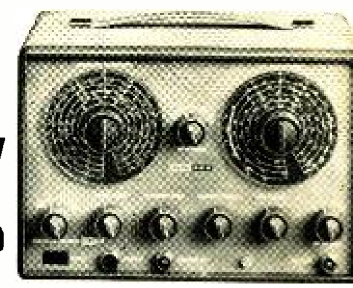
New Tape Deck

Eico Classic 2400 stereo/mono 4-track tape deck, 3 motors. Kit $199.95; wired $269.95 (Incl. oil finish walnut base)



New 3" Portable Scope

Eico 430 General Purpose 3" Scope. Flat-face CRT with mu-metal shield. Kit $69.95; wired $99.95

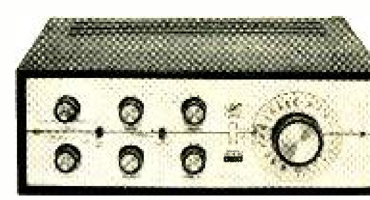


New Color and B&W /FM Sweep Generator

Eico 369 TV/FM Sweep generator, with built-in post injection marker adder. Kit $89.95; wired $139.95.

New CB Transceiver

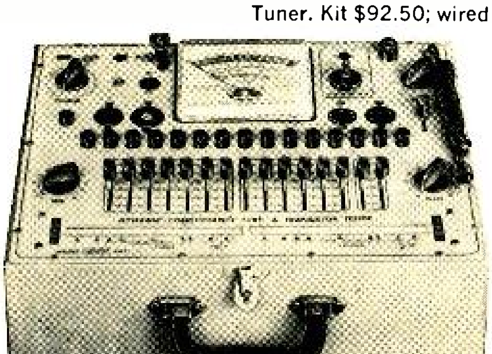
Eico 777 dual conversion 6 crystal-controlled channels, 5-watts. 3-way power supply. Kit $119.95; wired $189.95



New Stereo Rcvrs.

Eico Classic 2536 36-watt FM-MX Stereo Receiver. Kit $154.95; wired $209.95 (Incl. F.E.T.)
New Stereo Tuner Eico Classic 2200 FM-MX Stereo Tuner. Kit $92.50; wired $119.95 (Incl. F.E.T.)

New Stereo Amplifiers Eico Classic 2036 36-watt. Kit $79.95; wired $109.95. Eico Classic 2050—50-watt stereo. Kit $92.50; wired $129.95. Eico Classic 2080 80-watt stereo. Kit $112.50; wired $159.95.



New Tube Testers

Eico 667 Dynamic Conductance Tube & Transistor Tester. Kit $79.95; wired $129.95. Eico 628 Tube Tester. Kit $44.95; wired $59.95

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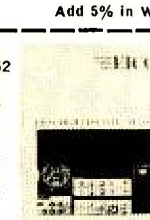
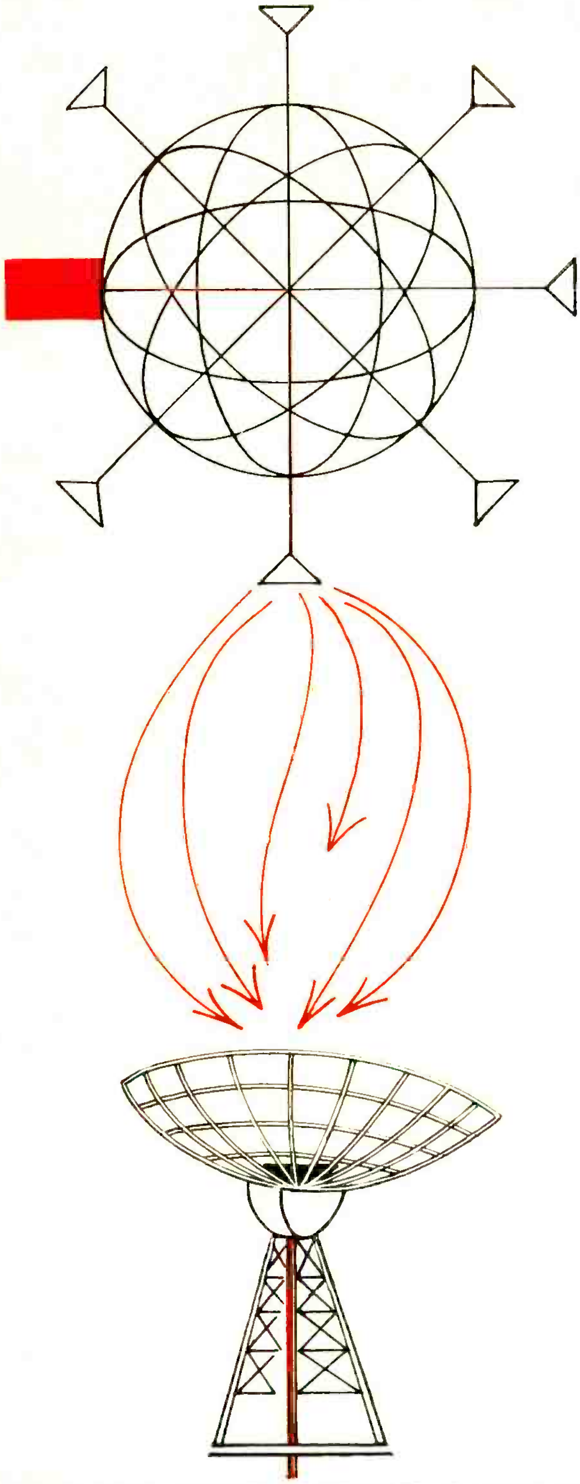


UNDERSTANDING TELEMETRY

By WALTER H. BUCHSBAUM

Telemetry systems range from a simple AM method with a single dial read-out to complex systems that enable one computer to "talk" to another. This article covers the basic elements of some of these systems and explains how each works.



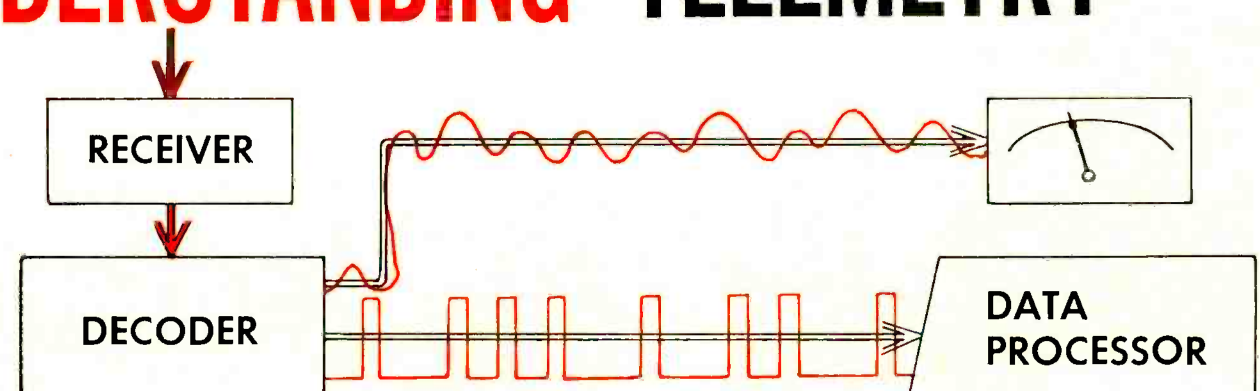
ANYONE watching the space shots of our astronauts must have been impressed by the information available at ground stations, even without any word from the astronaut. Glenn's flight was a particularly spectacular example because ground control knew that his heat shield had come loose while the astronaut himself only learned of his great danger after it was all over. During Cooper's flight, a critical portion of the re-entry guidance system failed. Due to the superb telemetry equipment, both in the spacecraft and on the ground, monitoring personnel were immediately made aware of the difficulty. They, in turn, notified the astronaut who then took the necessary steps to effect a successful re-entry. This was possible because well over a hundred different items within the Mercury spacecraft are telemetered automatically, accurately, constantly.

The concept of telemetry developed back in the 1800's with the first practical device being used by public utilities just prior to World War I. The advent of high-speed aircraft, missiles, and satellites greatly accelerated the development of this fast-growing science.

Almost all industries use some form of telemetry to monitor a wide variety of industrial processes. Some of these plants are spread over large areas, with some operations often taking place many miles from the central station. Yet telemetry can instantly notify the monitoring station if anything goes wrong so that corrective measures can be taken. Telemetry is not limited to space vehicles or industry. One interesting use was the case of a man stricken with a heart attack while working in Central Africa. His personal doctor was located in Los Angeles. A local doctor, working with an electronics specialist, telemetered the patient's heartbeat *via* a radio-telemetry system to an electrocardiograph located in the doctor's office in Los Angeles. The doctor then made the necessary diagnosis and prescribed treatment. Use of modern telemetry techniques saved the patient's life.

Telemetry, a combination of Greek and Latin words meaning "measuring at a distance," is not concerned with the measurement itself, nor with the ultimate use of the transmitted data—but just the *method* of transmission.

Telemetry was a $65-million market in 1963. This fact



alone makes it worthwhile for anyone interested in electronics to understand at least the principles of telemetry. Since this is still a very young field and promises to grow considerably, it also offers good job opportunities to anyone working in electronics. While no article can make its reader an expert in telemetry, a basic understanding of the techniques and various problems will be imparted.

Modulation

The first step in the design of a telemetry system is the conversion of the desired information into a form capable of being transmitted to the control center. If, for example, temperature variation is to be transmitted, any temperature-sensitive device that can change the frequency of an audio oscillator can be used. This oscillator might, in turn, modulate a radio transmitter. Such a device can be a thermistor whose electrical resistance changes with temperature, or a thermocouple that generates a voltage proportional to temperature change. Referring to Fig. 1, when the thermistor is exposed to 100° temperature, the audio output frequency is exactly 1 kc. Similarly, if the temperature is 120 or 80 degrees, the audio output frequency would become 1200 or 800 cps respectively. Using a thermocouple, a voltage-controlled audio oscillator can be used to produce the same results.

An audio frequency meter, calibrated in degrees of temperature rather than frequency, can be used at the receiver to directly indicate the temperature existing at the remote point.

The 1-kc. audio oscillator in Fig. 1 could also be used at a fixed frequency with the output amplitude controlled by the temperature-sensitive device. The amplitude would then vary according to the temperature and is similar to the amplitude modulation used in AM radio.

There are only three basic methods of modulating a carrier; a change in amplitude, a change in frequency, or a change in the carrier phase. This latter type (phase modulation) requires that a reference signal be sent along to tell the receiving station what the reference phase is. Phase modulation is used in transmitting TV color information on a 3.58-mc. color subcarrier which is interleaved with the luminance video signal.

In some sophisticated telemetry systems, phase modulation plays an important role, especially when many different items must be metered and data on them transmitted by a single transmitter. Such is the case in color-TV, where the brightness signal is transmitted as amplitude modulation, the sound as FM, and the color as phase modulation.

Pulse modulation, or rather pulse coding, plays a very important part in telemetry, and is used to modulate the r.f. carrier in either AM, FM, or PM.

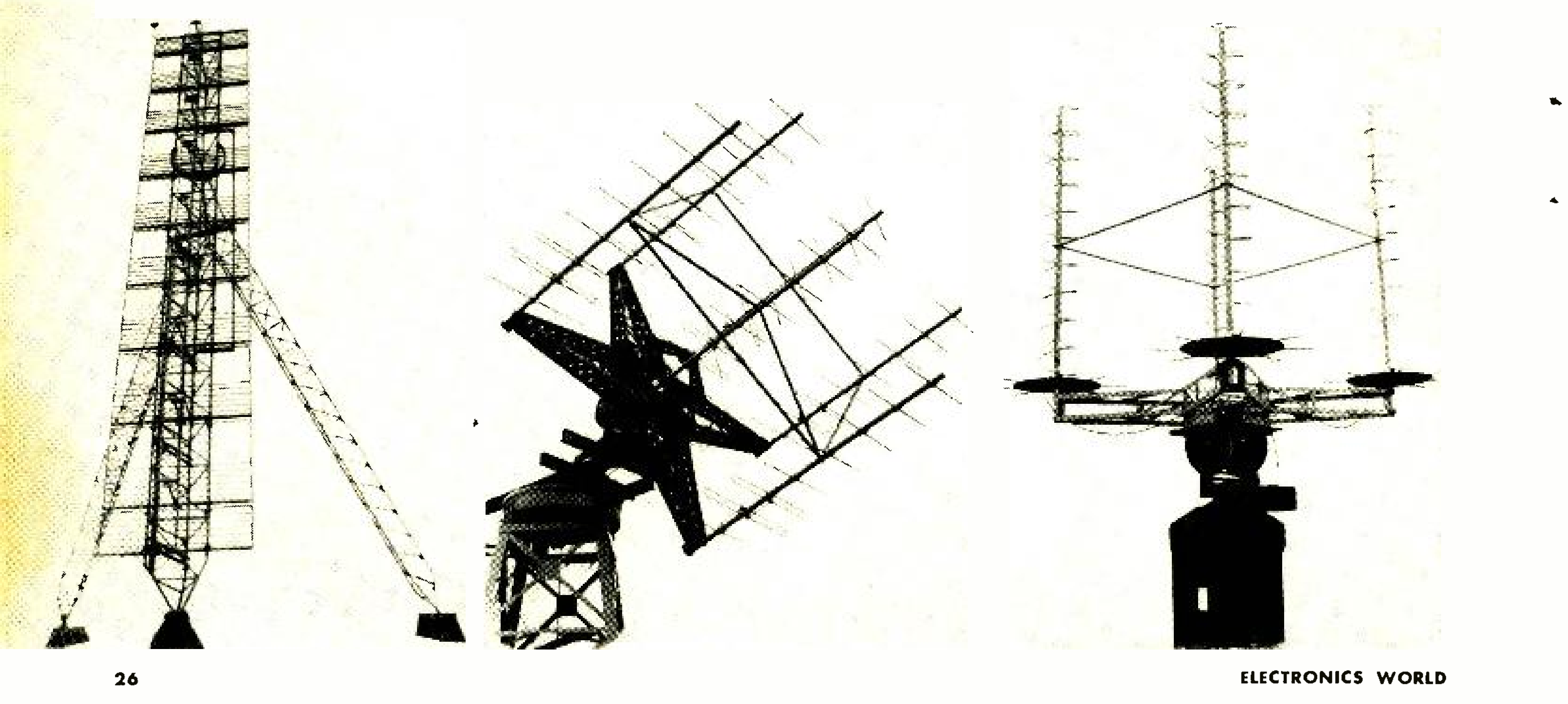
Analog or Digital Systems

In our first examples, the frequency or amplitude variations corresponding to temperature variations was an analog process. This is quite different from a person reading the meter, translating the position of the pointer into a number, and then phoning that number to the central office. When we deal with a discrete number instead of an analog quantity, we consider this a digital system. In recent years, the trend in telemetry has been towards digital systems partly because of the reliability of such transmissions, and partly because such codes can be handled directly by the digital computers which often use in the processing of such telemetered data.

Analog telemetry depends on the transmission and reception equipment for its accuracy, as indicated by the earlier example of the 1-kc. oscillator. The encoding equipment must be carefully calibrated so that when the temperature is exactly 100°, the oscillator frequency is exactly 1 kc. and, similarly, the frequency meter at the receiver must read the frequency accurately. Any drift in the encoder or in the frequency meter will result in wrong temperature readings. The same fundamental limitation applies to all types of analog telemetering.

Digital coding techniques are free from this type of drift. A good example of a simple digital system is the water level indicator illustrated in Fig. 2. As the water in the tank rises, the float successively connects contacts *A*, *B*, *C*, or *D* to ground. Each of the sensing contacts goes to one stage of a digital shift register and if the contents of this register are shifted out once every second, the resulting train of pulses can set a shift register located at the remote indicator. Indicator lights connected to the remote shift register will directly indicate the water level. If *A*, *B*, *C*, or *D* are equivalent to the 10, 11, 12, or 13 ft. mark, a direct numerical read-out is provided. While we know of no installation using such a simple system, this example illustrates the basic difference between analog and digital systems.

Telemetry antennas can assume many varied shapes. The three shown are made by Taco, a subsidiary of The Jerrold Corp.



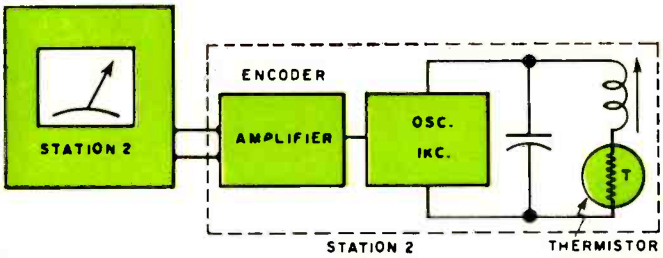


Fig. 1. In this simple telemetry system, a thermistor is used to control the output frequency of the encoder oscillator.

Multiplexing

In our first example we have shown that a central station can receive data from a temperature-sensing device over an electrical link. When several remote points are close together, it is wasteful to run separate lines to each of them. When these remote points are all on a rocket or spacecraft, separate links for each become impossible. For this reason we resort to a well-known technique called multiplexing which permits us to send many different data over a single line or radio channel. Multiplexing is used in many commercial communications systems. A simple frequency division multiplex system used in telemetering is shown in Fig. 3. Although only three sensors are shown, any reasonable number can be accommodated. We have assumed that the sensors are in the form of devices whose characteristics vary according to pressure, humidity, temperature, or any other parameter we wish to measure. These devices control the output frequency of three separate oscillators, each over a 50-kc. range above and below the center frequency. The output of the three oscillators (subcarriers) are passed through a linear mixer and then used to frequency modulate the 220-mc. r.f. carrier. This results in an r.f. signal having a bandwidth of 450 kc. that carries all the information simultaneously.

At the receiver, the carrier is removed and the subcarriers are separated by three filters. Three FM detectors then produce a varying d.c. potential that corresponds to the original quantities of pressure, humidity, or temperature. Simple voltmeters can be calibrated to indicate the telemetered quantities. This type of system uses FM both on the subcarrier and the r.f. carrier and is therefore designated as FM/FM. It is strictly analog and reading accuracy depends on the stability of the subcarrier frequency and the calibration of the indicating meters. If, as in a typical spacecraft, as many as 100 different types of data are to be transmitted, the bandwidth of the r.f. carrier will increase substantially. As much as 10 mc. might be required and this is not desirable because r.f. spectrum space is limited, broadband transmitters and receivers are expensive, and noise, the great enemy of all radio communication, increases with bandwidth.

Another method of multiplexing, called time division, is simply a means of reading one instrument at a time. Fig. 4 shows a time-division multiplex system based on the same three sensors and subcarrier oscillators. Here, a switch connects each oscillator to the modulator in turn, with each at the same 100-kc. center frequency. The resultant 220-mc. r.f. carrier will be frequency modulated over a 100-kc. band, but amplitude modulated in the same time steps as the switch moves from oscillator to oscillator. Even though a hundred sensors are used, only 100-kc. bandwidth is required. The indicating meters at the central station will now read only the sensor data from a particular oscillator for the short time period that the switch is connected to it.

The data are now separated by synchronizing the remote and local switches. If the switch operates faster than the sensor data can change, no information will be lost. Time division multiplexing appears much simpler than the triplicated modulators, filters, and FM detectors used in FDM (Frequency Division Multiplex), but we have so far neglected the meaning of the dotted line labeled "Synchronized."

It is essential that the switch at both receiver and transmitter move in exact synchronism so that the meters read the correct sensor output. This synchronization can be accomplished by sending a sync pulse before each switching step and a special *start* pulse whenever the switch is either at the first or last position. This is similar to the use of sync pulses in TV to control the vertical and horizontal scanning rate.

The switch is usually called a commutator and may be an electro-mechanical type, such as a stepping switch, or it may be all electronic. Either way, synchronization is as important to the accuracy of TDM as frequency and meter calibration are to frequency division multiplex.

Pulses in Telemetry

We have seen from the example of the TDM system that

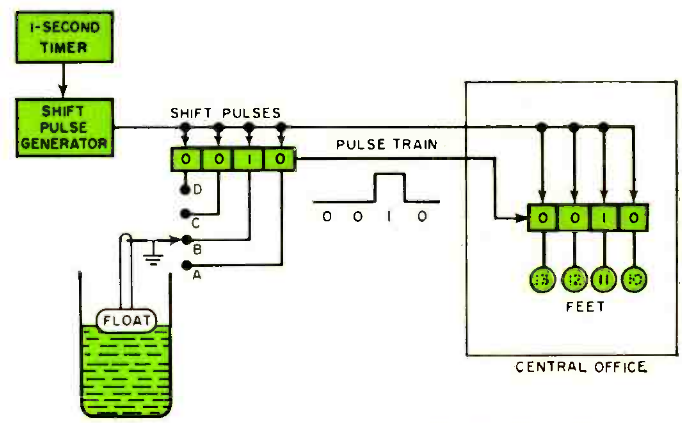


Fig. 2. One example of a simple digital telemetering system.

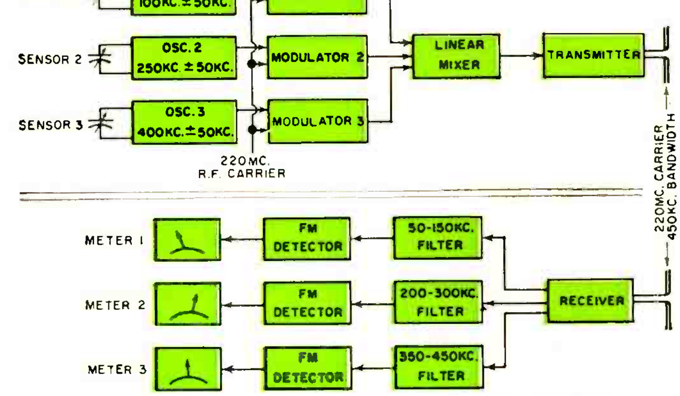
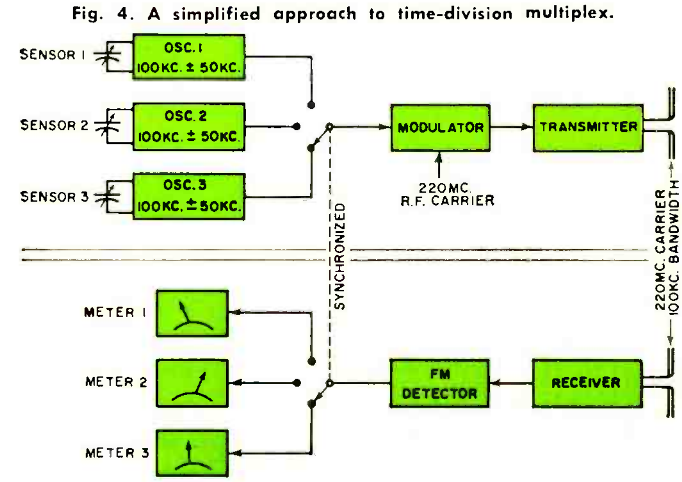


Fig. 3. Simplified system of frequency-division multiplex.

Fig. 4. A simplified approach to time-division multiplex.



the switching itself results in data pulsing and it is a fact that all TDM systems are basically pulse-coding techniques. One of the great advantages of pulse techniques is that much more information can be transmitted over a narrower frequency band and much better noise immunity is obtained. Information theory, a science in itself, shows mathematically the many advantages of pulse modulation, but an example from our daily life will illustrate the basic principles. When we look for a particular TV program in the newspapers, we may have to scan through the whole listing until we find the program we are interested in, but when we know that this TV program starts at 9 p.m. we just look at the few lines describing the programs at that time. Similarly, the detector portion of the telemetry receiver need only *look* at the known pulse intervals for the encoded information.

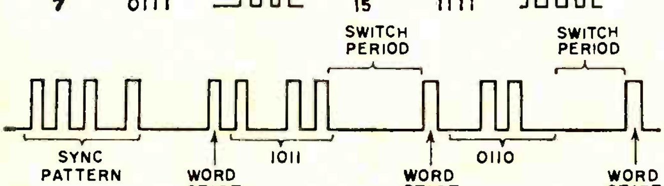
Four possible methods of pulse modulation exist and all are used to some degree in telemetry. The table shown on the front cover shows a summary of modulation methods with special system requirements and displays. Note that all pulse modulation systems are indicated by a three letter abbreviation and all use TDM.

The amplitude, length, or duration, of a pulse and the spacing between pulses can be used to carry information. Actually, the difference between PDM and PPM is only one of format because in both systems the analog information takes the form of time between two events. The fourth method of modulation, pulse code modulation (PCM) is the one that really opens up a new field and is of great importance in telemetry.

PCM depends on the presence or absence of a signal at a certain time to transmit a number. Usually the binary system, which also constitutes the language of digital computers and data processors is used. As in any pulse modulation or TDM, a synchronizing or clock signal must be transmitted along with the information to tell the detector when to look for the presence or absence of a pulse. In most telemetry systems, the clock signal is a multiple of the commutator or switching frequency so that receiving the clock signal is sufficient synchronization at the central control station. A complete study of PCM would require several volumes of a thick book, but for the present purpose it is enough to know that, in addition to synchronizing signals, the beginning or end of each set of numbers, or words, must be indicated in some way. This is usually done by sending a special pattern of *zeros* and *ones* which is decoded as the start signal. We should also mention that there are the return-to-zero (RZ) and non-return to zero (NRZ) methods of coding as illustrated in the front-cover table. The latter seems more popular in recent years. While space does not permit a complete discussion of binary coding and binary arithmetic, Fig. 5 shows

Fig. 5. Binary PCM (return-to-zero mode) method of coding.

DECIMAL	BINARY CODE	WAVE FORM	DECIMAL	BINARY CODE	WAVE FORM
0	0000		8	1000	
1	0001		9	1001	
2	0010		10	1010	
3	0011		11	1011	
4	0100		12	1100	
5	0101		13	1101	
6	0110		14	1110	
7	0111		15	1111	



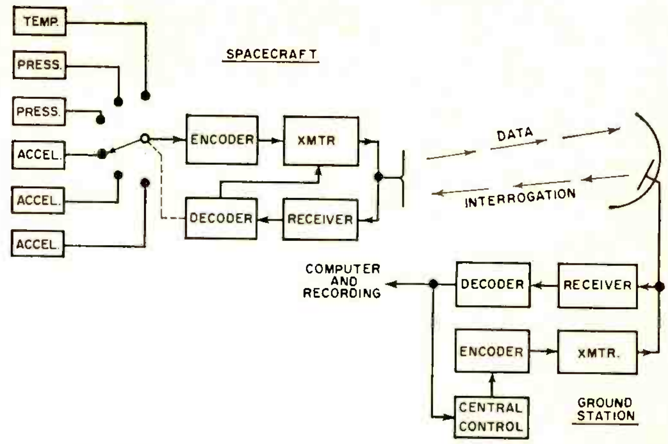


Fig. 6. Basic elements of a spacecraft telemetering system.

the basic method and an example of how it is used in this particular application.

Typical Systems

Since it would be wasteful for a satellite to use transmitter power during every portion of an orbit, even when the craft is not in telemetering contact with a ground station, the telemetering system transmits only when directed to do so by the ground control station. Fig. 6 shows, in much simplified form, the basic elements of a typical telemetering system designed for a space capsule or satellite.

At the ground station, a powerful transmitter and very sensitive receiver are used, together with a directional antenna, pointed towards the spacecraft. The encoder and decoder of the ground station are similar to the respective units in the spacecraft, except for size and code arrangement. Because the spacecraft is moving with respect to the ground stations, its antennas are either omnidirectional or at least broadly beamed earthward. Its receiver and transmitter are less sensitive or powerful because of volume weight and power limitations. The spacecraft's receiver is always in operation, ready to receive the planned interrogation from earth. Usually the interrogation is in the form of a binary pulse code that selects the data to be transmitted. The code also turns the transmitter on. Different codes are interpreted by the spacecraft's decoder to perform a number of different tasks. Thus, in the U.S. Venus probe, the interrogation signals caused transmission of radiometer and magnetometer readings at the time the Mariner spacecraft was closest to Venus.

When malfunctions in the decoders of the Telstar I and Relay I satellite were recognized by the lack of proper response to certain interrogations, the engineers changed the interrogation codes to bypass the defective decoding stage and get the system working again.

A good example of a sophisticated telemetering system is the one used with Tiros, the weather satellite. This unit contains a TV camera that observes the earth's cloud cover and records the pictures on magnetic tape. When the satellite is interrogated by a ground station, it transmits the television video signal by playing back its tape recording. On the ground, the pictures can be photographed or tape recorded again. After playing back the video information for the ground ground station, the satellite is ready to record again.

Telemetry started as wire communication between man and remotely located instruments on earth, but has now progressed to a means of bringing data from space to automatic equipment on earth. As man extends his dominion into the realm of the moon and the planets, telemetering will be the essential link between spacecraft, satellites, robot exploration devices, and the whole range of gear which yesterday existed only in science fiction, but which will shortly emerge as actual hardware from our laboratories. ▲

RESISTOR POWER-RATING NOMOGRAM

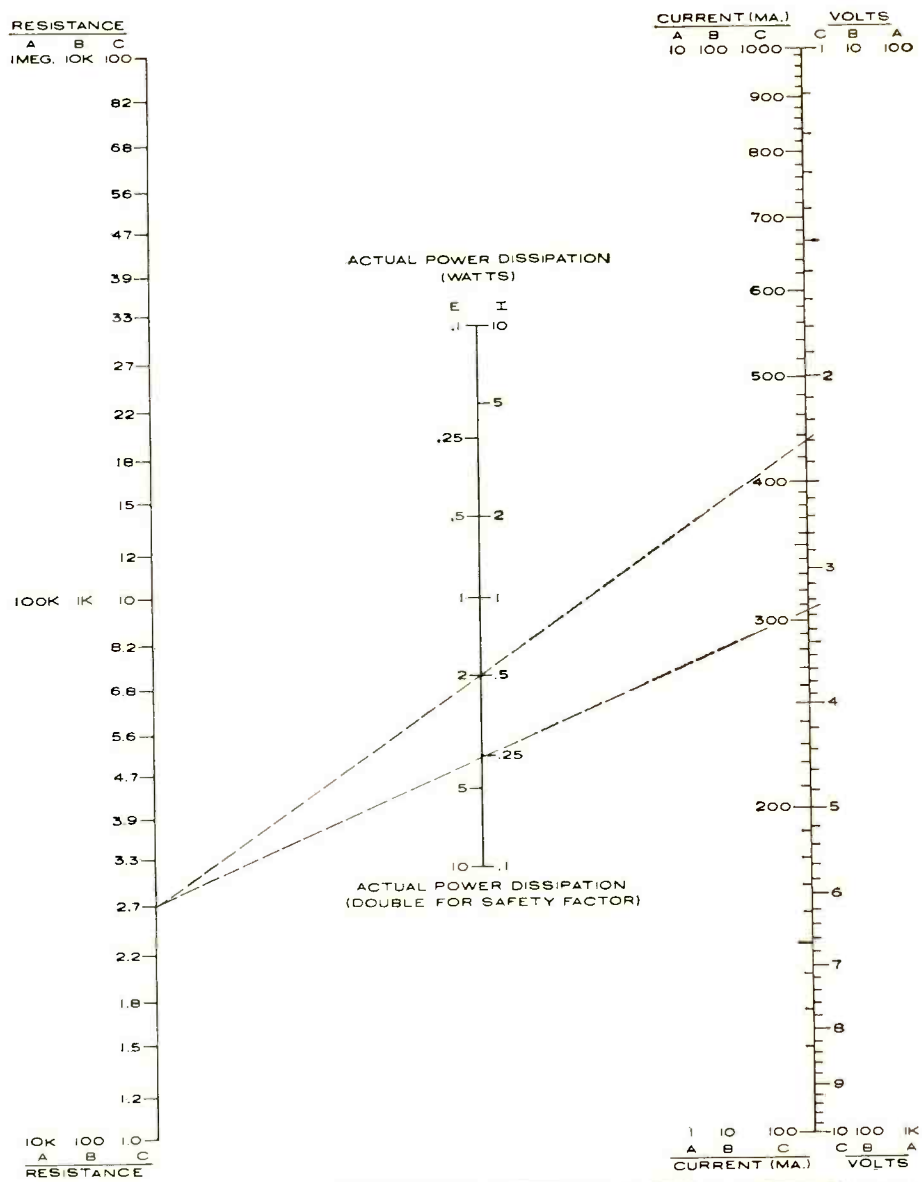
By JIM KYLE

The use of this chart simplifies power calculations, especially when using low currents and high resistance.

HERE is a nomogram which can be used to determine the resistor power rating required when only the voltage drop across the resistor or the current flow through it is known. While the power rating required can be worked out by using the formulas $P = E^2/R$ and $P = I^2R$, the values tend to become confusing to even the experienced technician when dealing with milliamperes and megohms.

But if the value of the resistor and the voltage across it are known, the power rating required can be determined quite simply by laying a straightedge across the chart. Similarly, if the resistance and power rating are known, the maximum safe voltage (or current) can be readily determined in the same manner.

Three scales are provided to cover the current range from 1 milliampere to 1 ampere and the voltage range from 1 to 1000 volts. Resistance values range from 1 ohm to 1 megohm. Only Scale C includes all intermediate values; Scales A and B are read by taking the intermediate values from Scale C and multiplying by the appropriate factor.



Example of Use

For the example worked out on the nomogram, a 27,000-ohm, ½-watt resistor is to be installed in a circuit and we want to know how much current can safely be allowed to pass through it. Since 27,000 ohms is between 10k and 100k, we use the lower half of Scale C and locate the 2.7 point. Then a straightedge is aligned with 2.7 on resistance Scale C (or 27k on resistance Scale A) and 0.5 watt on power scale I (since we are interested in current). The straightedge crosses the current scale at 430 on Scale C, which is the same as 4.3 ma. on current Scale A. Since the resistance was on Scale A, the current will also be on Scale A, and the answer is 4.3 ma.

Note that 4.3 ma. through 27,000 ohms represents an *actual* power dissipation of ½ watt in the resistor; good engineering practice requires a 100-percent safety factor in resistor power ratings, so that we should run the calculations for a ¼-watt resistor. We would then come up with 3.04 ma. as the maximum safe current.

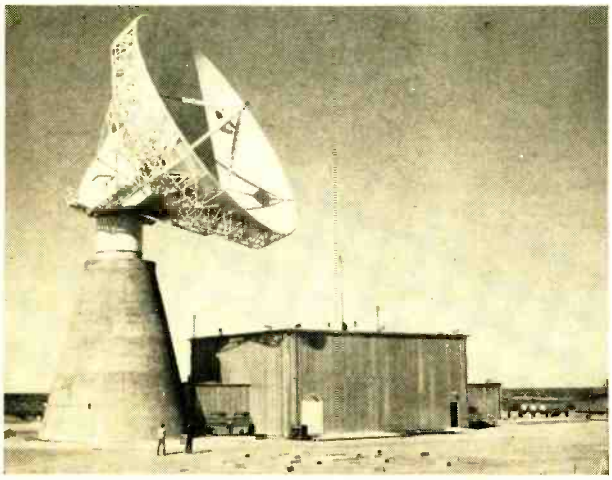
The same example line can be used to illustrate the reading of power rating by assuming that we have a 270-ohm cathode resistor which is required to drop 23 volts. What power rating is required?

Intersection of the straightedge with the E scale of the power scale is at the 2-watt point. This tells us that the resistor will actually be dissipating 2 watts in operation. For safety we would want to use a 4-watt unit but, in practice, a 5-watt unit would usually be chosen. ▲

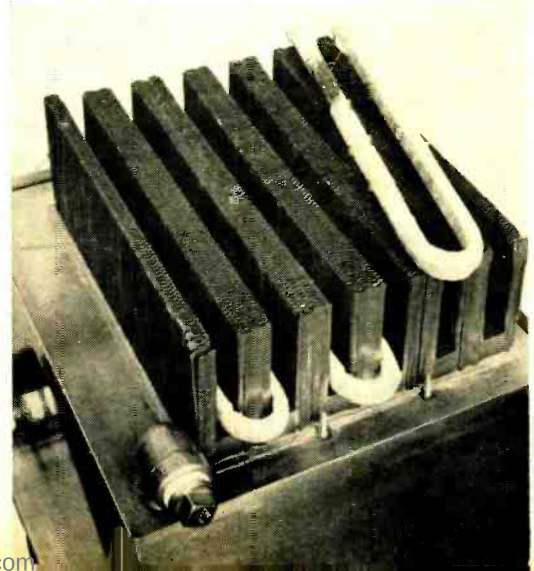
RECENT DEVELOPMENTS in ELECTRONICS

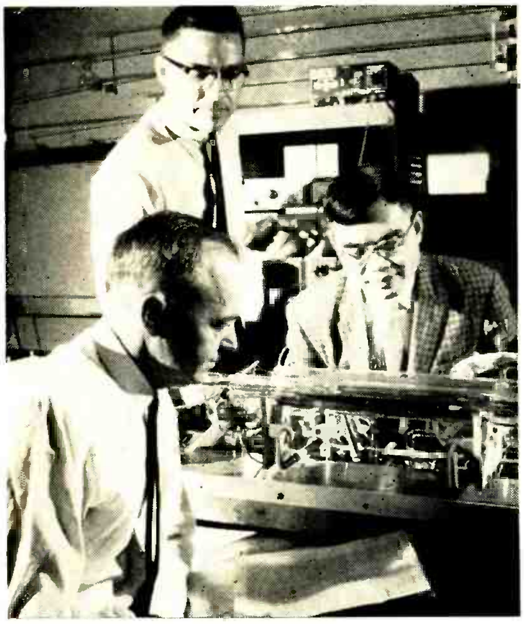
Automated Design Engineering. (Below) Guided by computer-produced design instructions, the operator is winding the coil for a transformer at the I-T-E Circuit Breaker Co. In winding wire on the 14-in. cylinder, the operator must follow precise design instructions, which are based on specific customer requirements. An IBM computer generates a listing of all values, such as wire size, number of turns, spacing, and strands. These values are keyed to a standard drawing, which is shown in the photo below taped to the computer instructions.

Infrared TV Link. (Above) A television picture is transmitted over an invisible infrared light beam, demonstrating a new data-link system developed by G-E. The actual system consists of a compact transmitter shown at the far left and a receiver atop the TV monitor. The system may soon be used to carry valuable data to astronauts, to transmit other data from one location at a missile launch center to another, or to carry commercial TV signals from a studio to a transmitter. A gallium arsenide diode, used as the light source, produces light that varies directly with the amount of current passed through it.... **New Ultrasonic Transducer.** (Below) A new ultrasonic cleaning transducer, said to double the efficiency of magnetostrictive transducers, has been developed by Westinghouse. Preformed, interchangeable coils are used with critically spaced (rather than tightly stacked) laminations. Each lamination acts as a driving element in unison with the others to contribute to the whole piston-like vibration of the tank plate used.

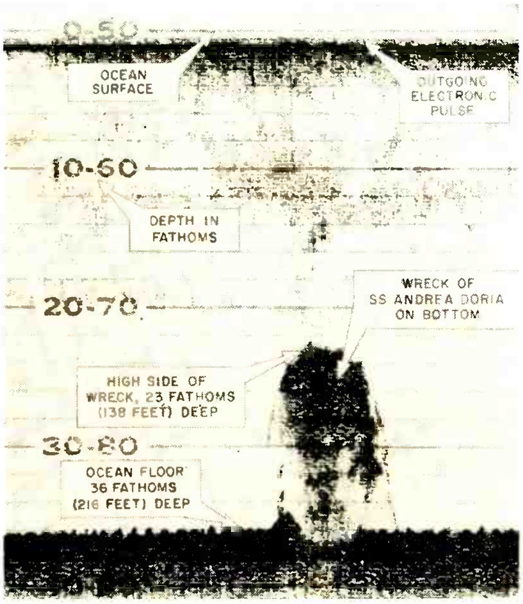


Measurements Radar Checks Missiles. (Above) This 60-foot antenna, installed at White Sands Missile Range, emits a pencil beam used to trace the paths of payloads plummeting through test areas at reentry speeds. The Raytheon-built tracker is designed to obtain precise cross-section and Doppler reentry measurements. A 10-megawatt peak power klystron transmitter and other circuitry are located in the 70 by 230 foot building next to antenna.

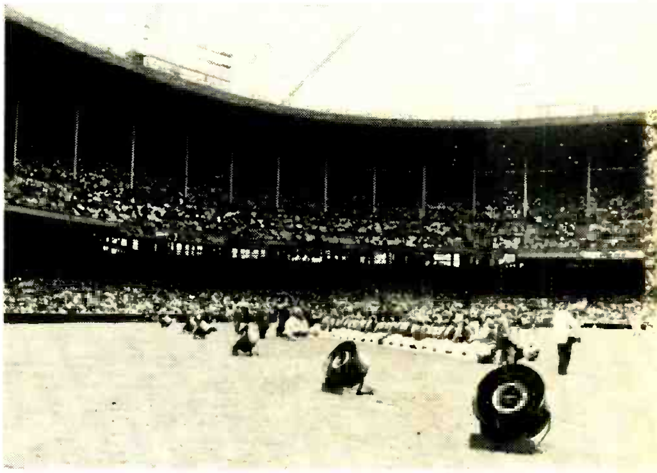




Triode Laser Invented. (Above) A new type of gas laser, which, like a triode, can be modulated by varying the voltage on the grid in the tube, has been invented at Bell Telephone Laboratories. Excited by a beam of electrons of nearly identical energies emitted from a hot oxide cathode, the triode laser oscillates without the usual glow discharge present in ordinary gas lasers.... **Depth Sounder Sights Shipwreck.** (Below) A depth sounder aboard a salvage vessel graphed this view of sunken liner SS Andrea Doria, lying on her side in 216 feet of water off Nantucket, Mass. The electronic view of the wreck was made with a Raytheon depth sounder that sends out ultrasonic impulses and records echoes bouncing off the bottom, obstructions, and passing fish. Various teams of would-be salvagers have been attracted to the site since the liner went to the bottom in 1956.

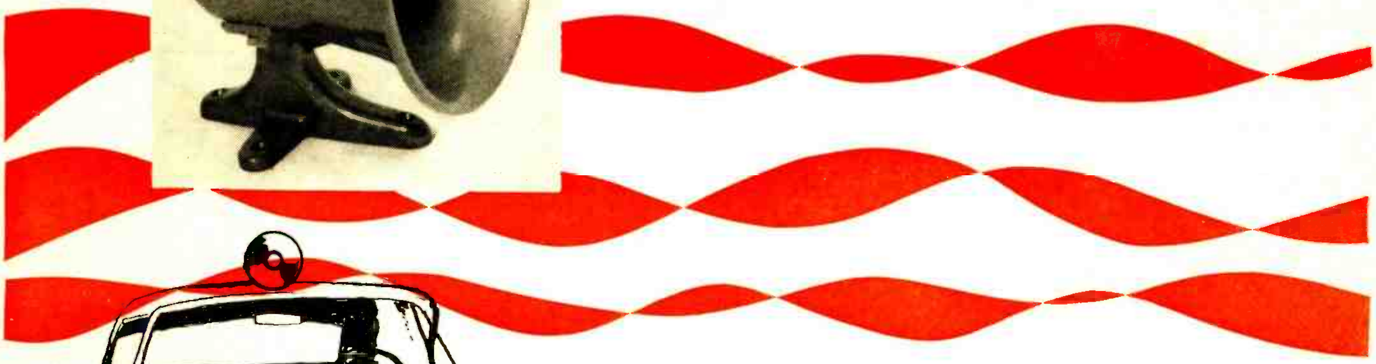


Football-Field P.A. (Below) A unique new speaker installation has been made in the Municipal Stadium in Cleveland, Ohio, home of the Cleveland Browns. The system is used to allow the local announcer to make a running commentary on the game to all the spectators in the huge stadium. Previous systems have not been able to compete with the fans' portable radios. A total of 24 University loudspeakers are used, mounted on special brackets. The system is owned by the team and it can be taken with them to whatever football stadium they are playing in.



Underwater Communications. (Above) The two divers are conversing under water using a new undersea communications device, with almost as much freedom as they would above the surface. The stainless steel cylinders attached to their air tanks each contain battery-operated amplifiers and transducers which send their voices through the water to all other divers within 100 yards. No special receiving equipment is necessary—only the human ear. A special mouth mask to which the air hose attaches enables the divers to enunciate their words, and a throat microphone conveys the sounds to the transducer. The Bendix unit costs about $250.

ELECTRONIC SIRENS



Operation and circuit description of mobile p.a. and siren systems coming into wide use on public-safety vehicles of all types.

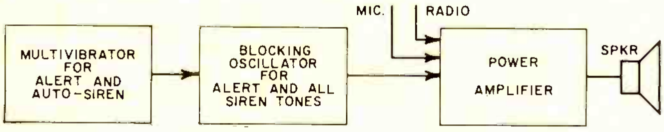
By JIM KYLE

ELECTRONIC sirens are gaining wide popularity with public-safety officials across the nation. What is the electronic siren and what does it do? Basically, it is a mobile public-address system with heavy-duty speaker, together with some special oscillator circuitry that produces the familiar siren tone. A dog-like yelp is also available on most models for use either as a civil-defense warning or as a special attention-getter. Since the basic component of the electronic siren is a mobile p.a. system, all models include the option of public-address use.

The public-address feature is the chief attraction of the electronic siren as far as public-safety officials are concerned. In this unit, for approximately the same cost as a conventional air siren of comparable loudness, both a siren and a p.a. system can be obtained. One Colorado deputy sheriff credits the p.a. feature with saving two lives recently. The deputy was driving near a railroad crossing when he saw a woman driver accompanied by a child making a turn onto the crossing directly into the path of an oncoming train. Punching his siren to the p.a. mode, he yelled a warning and the woman stopped inches short of disaster. "Nothing else could have stopped her in time," declared the deputy.

The key to the siren's feasibility is, of course, the transistor. The amplifier, typically rated at from 30 to 50 watts audio output, employs three to five transistors to achieve this power level. The siren-oscillator circuits usually use three more transistors, raising the total semiconductor complement to six to eight for the complete mobile p.a.-siren system.

Fig. 1. Block diagram of a representative mobile siren-p.a. system.



Does the electronic siren involve any special problems? Like any other electronic device, the answer is yes. The speakers used with the siren must take punishment far in excess of that normally applied to p.a. speakers; although specially developed speakers are employed, the chances of voice-coil failure are still higher than in more conventional service. Prevention of electrical noise is also a problem at times, although one easily solved in practice.

Typical Circuitry

Although many firms, including *Federal Sign & Signal Corp.*, *Dominator Corp.*, *Fyre-Fyter Electronic & Alarm Corp.*, *Sirecor Signal Mfg. Co.*, *General Electric Company*, *Motorola*, and *University Loudspeakers* make electronic sirens and firms such as *Atlas Sound* make the speaker units, we have selected the *University* "Vanguard I" as fairly typical. Although details may vary, the principles of operation for all of the units are very similar.

The "Vanguard" provides the user a choice of five modes of operation (the *Motorola* unit does the same). These modes are automatic siren, manual siren, "alert" (the yelp), public address, and radio page.

In the automatic-siren mode, the unit emits the characteristic wailing tone with no effort on the part of the operator. In the manual mode, control of the sound is achieved by pressing a switch (this mode corresponds almost exactly to normal air-siren usage). In "alert" the operation is also automatic but the output sound is a 450-cps tone, frequency-modulated $\pm$ 2% at an 8-cps rate. This is the standard CD alert tone. The public-address mode is self-explanatory. In the radio-page mode, the output of the vehicle's two-way radio is connected to the siren amplifier input so that the officer may hear radio calls when far from the vehicle, as for example at the scene of a fire.

Electronically, the unit consists of a high-gain power amplifier rated at 50 watts output (siren) and 30 watts output with speech; a blocking oscillator; a multivibrator; and control switches. (See Fig. 1.)

The power amplifier, shown schematically in Fig. 2, is fully conventional. Input voltage amplifier Q4 (the designations are those employed by the manufacturer in the service manual) is transformer-coupled to driver amplifier Q5, which in turn is transformer-coupled to the push-pull output stage. Transistors Q6 and Q7 are coupled to the speaker *via* autotransformer T4. Thermistor TH1, rated at 2½ ohms, stabilizes the output stage with regard to temperature; Q4 and Q5 use emitter resistors for this purpose.

With the exception of Q5, a specially picked unit, all transistors employed are EIA types. The power transistors are type 2N1544, while Q1 through Q4 are type 2N1372.

The blocking oscillator, shown in Fig. 3, produces both the siren and the alert tones. Transistor Q3 produces pulses which are clipped to an approximately rectangular shape by saturation of the transistor. When capacitor C3 is charged by the multivibrator output, Q3 is base-biased to a point which results in a pulse rate from the blocking oscillator of approximately 1000 cps. As C3 discharges through R8 and R10, the change in base bias on Q3 reduces the pulse rate. This produces the characteristic siren wail.

To prevent the siren from starting at a low tone should the multivibrator happen to be near the end of its cycle when "automatic siren" mode is chosen, a momentary contact on the "auto" switch (see Fig. 4) charges C3. This assures that the sound will start at a high pitch irrespective of the portion of the cycle during which operation begins.

In the "manual" mode of operation, the base bias of Q3 remains steady, holding the pulse rate at 1000 cps. When the control switch is opened, C3 discharges as before, so that the "rundown" tone of an air siren is reproduced.

Output of the blocking oscillator is fed to the power amplifier through resistor R24 in the base circuit of Q4 (see Fig. 2); this resistor is in the circuit at all times regardless of the positions of the mode switches, so that siren output is always available from the external control switch if the unit is not turned off.

The multivibrator, shown in Fig. 4, handles timing of both the automatic-siren and the alert modes. It is a conventional cross-coupled free-running circuit made up of transistors Q1 and Q2. In such a circuit, the pulse rate of the multivibrator is determined by the supply voltages, by the values of the coupling capacitors, and by the values of the base return resistors. This circuit switches in lower valued base-return resistors at all times except when in the auto-siren mode, so that the normal pulse rate of the multivibrator is 8 cps.

In the auto-siren mode, however, the switches are opened and the base resistances rise appreciably. This lengthens the pulse rate out to 8 seconds per cycle.

Output of the multivibrator is taken through diode D1, which removes positive-going pulses, to capacitor C3 in the blocking-oscillator circuit. There it times the blocking-oscillator action.

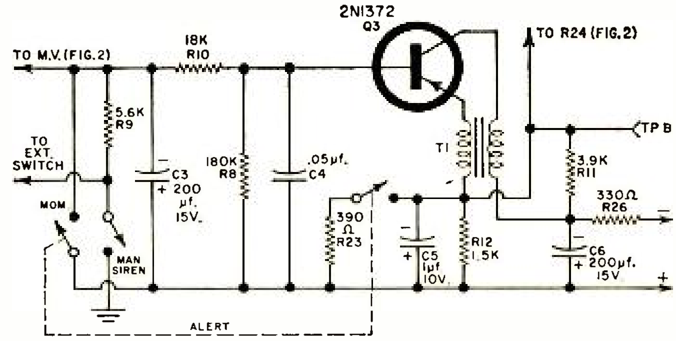


Fig. 3. The blocking oscillator generates the siren tones.

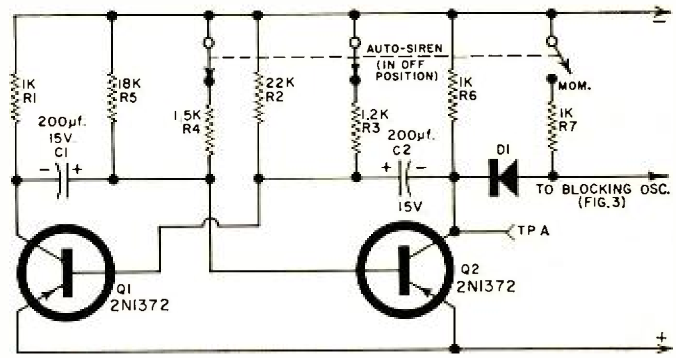


Fig. 4. The multivibrator controls the blocking oscillator.

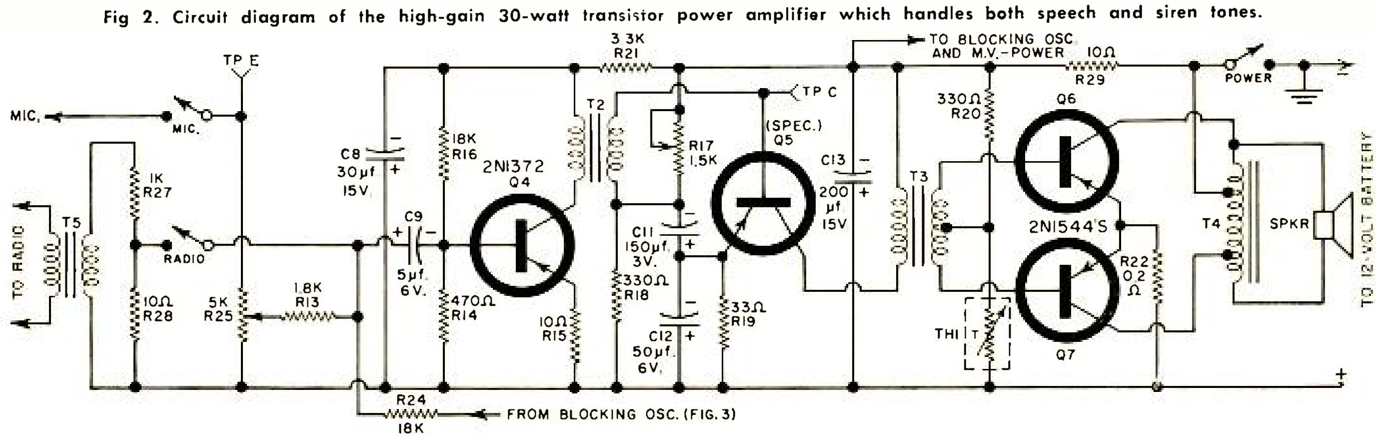
Control circuitry is included on each partial schematic. In the auto-siren mode, the switches associated with R3 and R4 (Fig. 4) are opened and the momentary-contact switch in series with R7 (Fig. 4) is closed briefly. In the manual mode, the switch in series with R9 (Fig.3) is closed. In this mode, the siren produces sound as long as the button is held in; the remote switch simply parallels the button.

In the alert mode, a momentary-contact switch discharges C3 while an additional resistor is connected in the bias circuit of Q3 to accommodate a change in signal input level; both switches appear in Fig. 3.

In the public-address mode, the microphone is connected to the input of the amplifier, while in the radio mode, the radio output (having passed through transformer T5 to avoid any possibility of shorting out the siren by cross-polarity and through an attenuator composed of R27 and R28 to allow normal settings of the two-way radio volume control), is connected to the amplifier input. Both sets of switches appear in Fig. 2.

The "off" button breaks the main power connection; all six buttons are interlocked mechanically so that pressing one will release all the others. ▲

Fig 2. Circuit diagram of the high-gain 30-watt transistor power amplifier which handles both speech and siren tones.



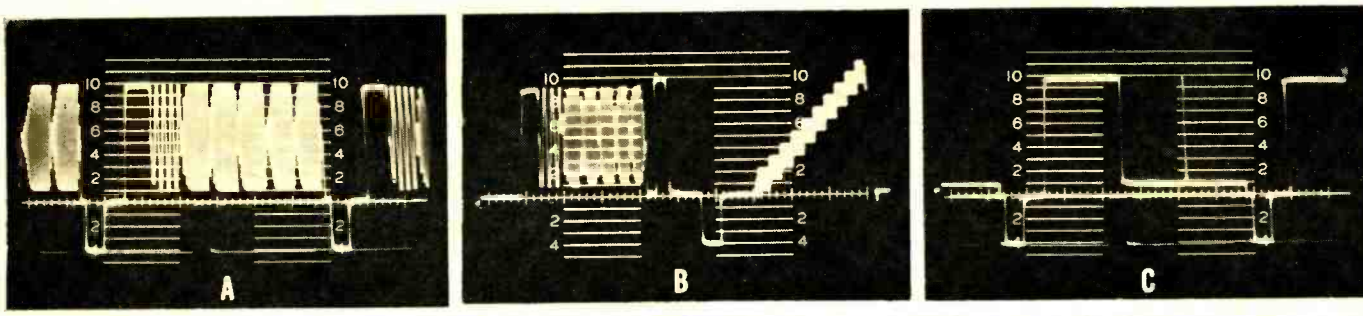


Fig. 1. (A) Multiburst consists of peak white segment followed by six bursts of test frequencies. (B) CBS arrangement of multiburst and with stairstep modulated by 3.6-mc. sine waves. (C) The window and sin^2 signal as seen on test scope.

HIDDEN TV TEST SIGNALS

By LESLIE SOLOMON / Associate Editor

Networks are using portions of the 21 lines not used during vertical retrace to transmit a series of test signals equivalent to a conventional TV test pattern.

TO most TV viewers, the television video signal is the picture that appears on the screen of the CRT. To the more technically minded viewer, a monochrome TV signal consists of horizontal, vertical, and equalizing pulses with the actual picture information occurring between the horizontal pulses. Color signals contain other components and, of course, are more complex. This is about the extent of most viewers' knowledge of the TV signal.

There is another area of TV signals that does not concern the viewer but is of great interest to the broadcaster, especially network stations. These test signals are used to check the various electronic characteristics of the TV network over the many thousands of miles of coaxial cable and microwave repeater stations stretched from one coast to the other. These tests must be conducted on a regular basis, yet be out of sight of the viewer so as not to cause interference to the picture being watched.

The place to hide such test signals would be during the vertical retrace interval while the electron beam of the CRT is getting ready to display the top of the picture. This relatively lengthy interval contains no video information and consists of the various pulses that make up the vertical sync pulse and pulses to keep the set's horizontal oscillator in step during the retrace time. There is the equivalent of 21 unused horizontal lines between the beginning and end of the vertical retrace interval for each field.

The first 12 or so of these lines cannot be used as they occur while the electron beam is passing through the exposed portion of the CRT screen and any disturbance here would show up on the screen and possibly disturb the viewer. Lines 14 through 21 occur at the top of the picture and are hidden by the receiver mask. This is because most TV screens are overscanned so that picture edges are not visible.

FCC transmission standards specify that the interval beginning with the last 12 microseconds of line 17 and continuing through line 20 of the vertical blanking interval of each field can be used for the transmission of test signals. These signals may include signals used to supply reference modulation levels, signals designed to test the performance of the over-all transmission system or its individual components, and cue and control signals related to the operation of a TV broadcasting station.

These one- to two-line test signals are gated out by the various network stations and displayed on calibrated oscilloscopes for system analysis. They are usually photographed.

Although these signals are for use by the broadcaster, interested viewers can use them for a gross check of the operation of their TV sets from antenna to CRT screen.

The signals can be observed on a home TV set by adjusting the vertical hold control until the wide black vertical retrace bar appears in the picture area. If the station is using test signals, they will appear four to six interlaced lines above the lower picture and will look like one or two lines displaying various shapes of white dots and bars.

There are three basic types of test signals currently being transmitted, with a few variations introduced by some stations (and at least one network), for special internal camera level alignment and other test purposes.

Multiburst

The multiburst signal is used by network stations as a quick means of checking amplitude-frequency response at several selected frequencies, as a check for black-or-white compression, and for compression which may be selective with frequency (called axis shift).

A typical multiburst signal occupies one horizontal line interval and is shown in Fig. 1A. It usually consists of a segment of peak white (called the white flag that is used to establish white reference), followed by six bursts of sine-wave frequencies of .5, 1.5, 2.0, 2.9, 3.6, and 4.0 mc.

On home receivers, the multiburst appears as shown in Fig. 2A with the *CBS* version shown in Fig. 2B. The .5-mc. burst will consist of 3 cycles when the signal originates on the West Coast, 4 cycles when it originates on the East Coast, and 5 cycles when it is originated by the telephone company.

Note that in Fig. 2B, a small white bar follows the multiburst signal. This is used only by *CBS* and is the result of an internal (studio) signal white reference so that all cameras can be set to the same white level. It is not removed when the signal goes out to the network.

Another recent *CBS*-only arrangement is shown in Fig. 1B. Here, they transmit the white flag and bursts at 90% amplitude and follow this by a 100% peak white signal. Then they transmit a 3.6-mc. modulated stairstep signal on the next line. Other networks transmit each signal alone for a short period of time, then switch to one of the other signals.

Because the sine-wave bursts extend from black-to-white, the tip of each cycle will appear as a white dot on a black line. The extent to which these dots can be resolved can be used as a gross check of over-all receiver response. The dots will merge near the point where the over-all response starts to fall just as in the vertically positioned resolution wedges of a conventional test pattern. In essence, what is transmitted in the multiburst are selected portions of the conventional test pattern resolution wedge and they can be used in the same fashion to determine over-all resolution.

Stairstep

This signal is used by the broadcasters for measuring the differential phase (phase at different levels) and differential gain (gain at different levels) within the network system. It involves the transmission of a 10-step stairstep signal extending from black to white.

There are two ways of transmitting these signals. In one case, sine waves of 3.6 mc. (actually, 3.57+ mc., the color-TV burst frequency) are superimposed on each step as shown in the stairstep portion of Fig. 1B and, at the stations, a high-pass filter is used to remove the stairstep portion but retain the 3.6-mc. signals. The bursts are compared in amplitude and any difference is due to differential gain within the system. By means of a color analyzer, differential phase can be measured. In the second case, the stairstep signal is transmitted without the 3.6-mc. burst added to the steps.

As each step has equal time duration, horizontal linearity can be checked by noting the difference between section lengths measured horizontally along the CRT screen. Also, as each step has equal amplitude going from black to white, the degree to which the home receiver responds from black to white may also be checked. These steps can be used in the same fashion as the contrast bars found on a conventional test pattern. A perfect receiver would show all 10 gradations. Fig. 2C shows the response on a typical receiver.

Window and $\sin^2$

This signal actually consists of a pair of separate signals, one (called "window") looks like a square wave going to white, while the other (called the "$\sin^2$" pulse) looks like a sharp pulse also going to white. These are shown in Fig. 1C.

Because the window signal rapidly passes from black to white and then back to black again, it can be used to detect streaking (that is, how fast it takes the system to switch from black to white or from white to black). The sharper the transition (the less fuzziness at the transition points), the better the response.

The stations use the window to check white level, to measure sync compression or expansion, and to check for signal streaking.

The $\sin^2$ technique involves the transmission of a pulse with a half-amplitude width equal to the time of one picture element. When the camera pickup scanning beam passes across a black-to-white bar, it will produce one cycle of the frequency representing the fineness of transition. One cycle occurs in a time equal to the reciprocal of its frequency so that one cycle at 4 mc. equals .250 microsecond. Because the black was one picture element and the white another, a picture element for a 4-mc. system is equal to .125 microsecond, therefore a single .125-microsecond pulse can be used to check the high-frequency characteristics of a 4-mc. system.

At this writing, *CBS* and *NBC* transmit the window followed by the $\sin^2$, while *ABC* transmits the $\sin^2$ first followed by the window signal.

Fig. 2D shows a typical received window-$\sin^2$ signal. The window can be used to check streaking in the same fashion as the streaking bars on a conventional test pattern. The relative brightness of the $\sin^2$ pulse can be used to approximate receiver response at 4 mc. If the response is down, the brightness of the tip of the $\sin^2$ pulse will be towards the gray. Reference white can be determined by comparison with the level of the window signal. (The mechanics of printing makes reproduction of the $\sin^2$ pulse difficult.) Fig. 2E shows positioning of the *CBS* internal white reference.

Other Signals

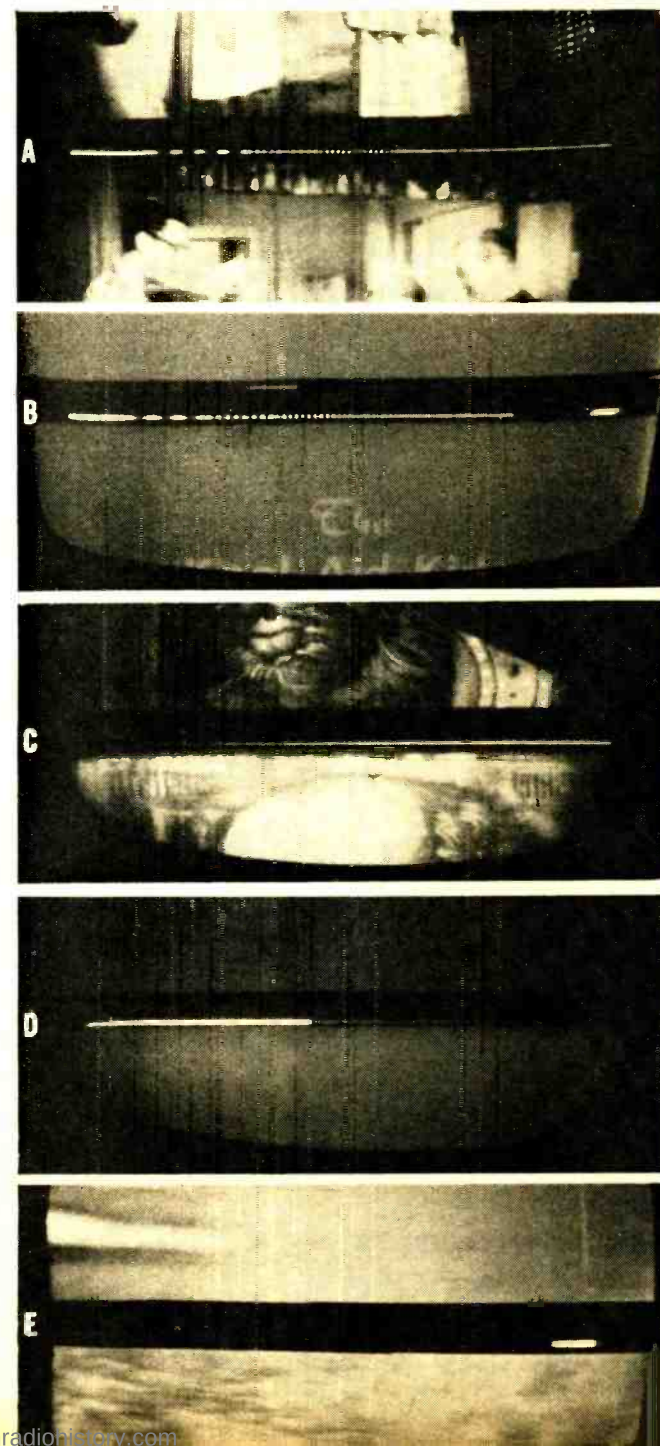
Although the signals covered in this article are being used by all three networks and some independent stations, they are not official. The industry has proposed that a standard set of signals be adopted, with the formation proposed as: multiburst on line 18 followed by the window and $\sin^2$ on line 19 for field 1; then the multiburst on line 18 followed by the stairstep on line 19 for field 2.

This means that the three test signals will be transmitted during each frame as opposed to the present approach where the signals are alternately transmitted for a period of several minutes for each signal.

It has also been recommended that the color burst and a color bar signal be transmitted so as to make the system equally useful for color transmissions. ▲

Fig. 2. (A) Full-line multiburst. (B) CBS multiburst with peak white reference. (C) Stairstep signal. (D) Window and $\sin^2$ signal. (E) CBS internal peak white reference signal.

A B C D E



ENGINE TEMPERATURE INDICATOR

By WILLIE T. DAVIS
Naval Research Laboratory

Construction of monitor for auto engines that measures temperatures from about 72 to 200 degrees F.

WITH the ever decreasing number of accurate meters left to the motorist these days, many will welcome the addition of a means for determining engine temperature accurately and for any part of the engine that is accessible, such as cylinder head or manifold. This will also prove to be a neat accessory for many compact cars with no temperature indicators at all. Most autos which still have pointers simply use "C"-"H" (cold-hot) nomenclature which tells one absolutely nothing in terms of degrees F. The circuit described here will reliably measure temperature up to several hundred degrees Fahrenheit.

Circuit Description

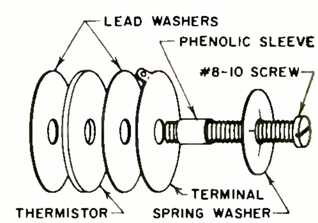
The circuit (Fig. 2) makes use of a Wheatstone bridge with a thermistor completing one leg of the bridge. The circuit shown here was built for a car with a 6-volt system; however, by adjusting *R5* the circuit may be used equally well on 12-volt systems. It was decided to let this unit measure temperatures between 72 and 200 degrees F. The resistance of the particular thermistor used is 360 ohms at 72 degrees F. Resistors *R1*, *R2*, and *R3* are made 360 ohms so that the bridge is balanced at 72 degrees, but the meter will read for all temperatures above 72 degrees. Diode *D1* prevents reverse reading of the meter at temperatures below 72 degrees.

Setting of *R5* can best be done with the help of the thermistor curves. First decide what is the highest temperature you wish to measure. In this instance, that was 200 degrees F. Now refer to the curve (Fig. 3) and see what the thermistor resistance is at 200 degrees. It should be quite low and for the thermistor used here it turned out to be 28 ohms. Now substitute a resistor of 28 ohms in place of the thermistor and, with S1 on, adjust *R5* for full-scale or near full-scale deflection on *M1*. *R5* will not need further adjustment.

Now the unit must be calibrated so that one can tell temperature from the milliampere meter reading. One way of doing this is to replace the thermistor temporarily with a 500-ohm rheostat. A 20-ohm resistor should be placed in series with the rheostat to prevent meter damage. With *S1* on, adjust the rheostat for a reading of about 1 ma. on *M1*. With an ohmmeter measure the resistance of the rheostat plus the series resistor. Disconnect one side of this resistance from the circuit while making this measurement. Now refer to the curve and note what (*Continued on page* 60)

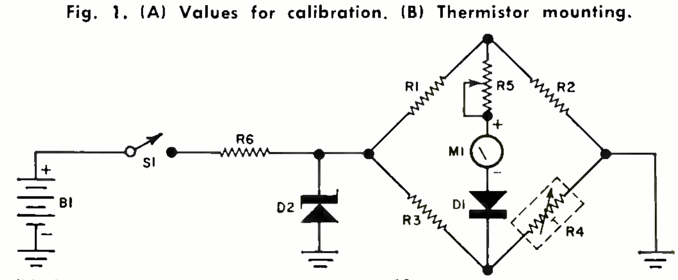
RESISTANCE MEASURED (OHMS)	THERMISTOR TEMPERATURE (°F)	METER READING (MA.)
360	72	0
200	97	1.0
111	124	2.0
87	135	3.0
54	155	4.0
28	200	5.0

(A)



(B)

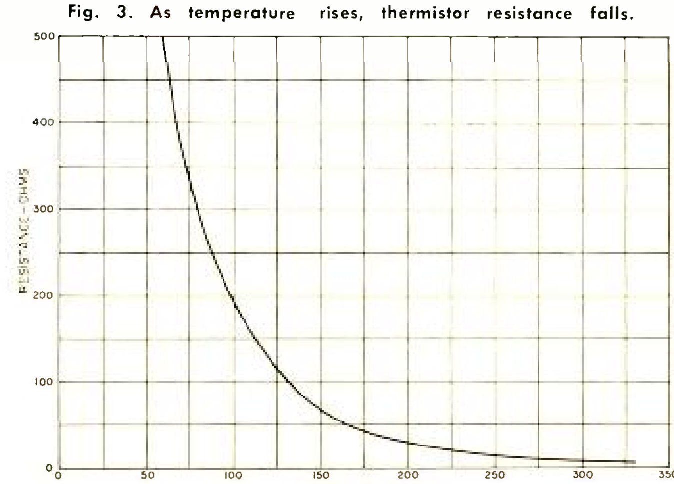
Fig. 1. (A) Values for calibration. (B) Thermistor mounting.

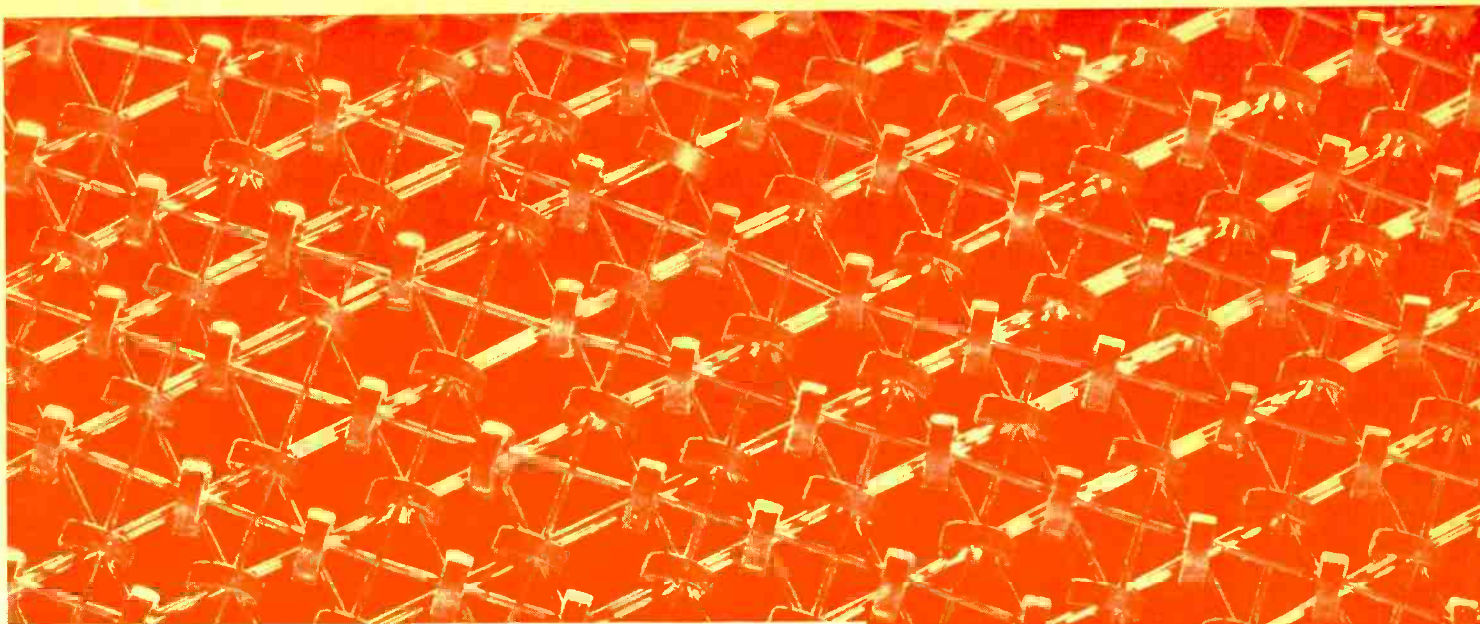


R1, R2, R3—360 ohm, ½ w. res.
R4—Thermistor (Fenwal Type WA23W1, available from Allied Radio, stock No. 8E686)
R5—500 ohm pot (1000 ohms for 12-v. systems)
R6—33 ohm, ½ w. res. (67 ohms, 12-v.)
S1—Auto ignition switch
M1—0-5 ma. d.c. meter
B1—6- or 12-volt auto battery
D1—1N100 diode or equiv.
D2—1N1519 zener diode (4.7 v., 1 w., see text)

Fig. 2. Thermistor is used as one arm of Wheatstone bridge.

Fig. 3. As temperature rises, thermistor resistance falls.





magnetic Core memories

By RICHARD B. RUSCH

One of the most common types of digital computer memory systems uses a large number of tiny rings of ferromagnetic material. The rings can be made to store digital data in their magnetic state.

IMAGINE a computer memory that permits electronic reading and writing at the rate of over 11-million alphabetic characters a second—in effect, the equivalent of 22 conventional full-length books.

This is exactly what's happening in magnetic core storage development. And, as further advances are made in this area of computer technology, it is reasonable to expect even more startling achievements.

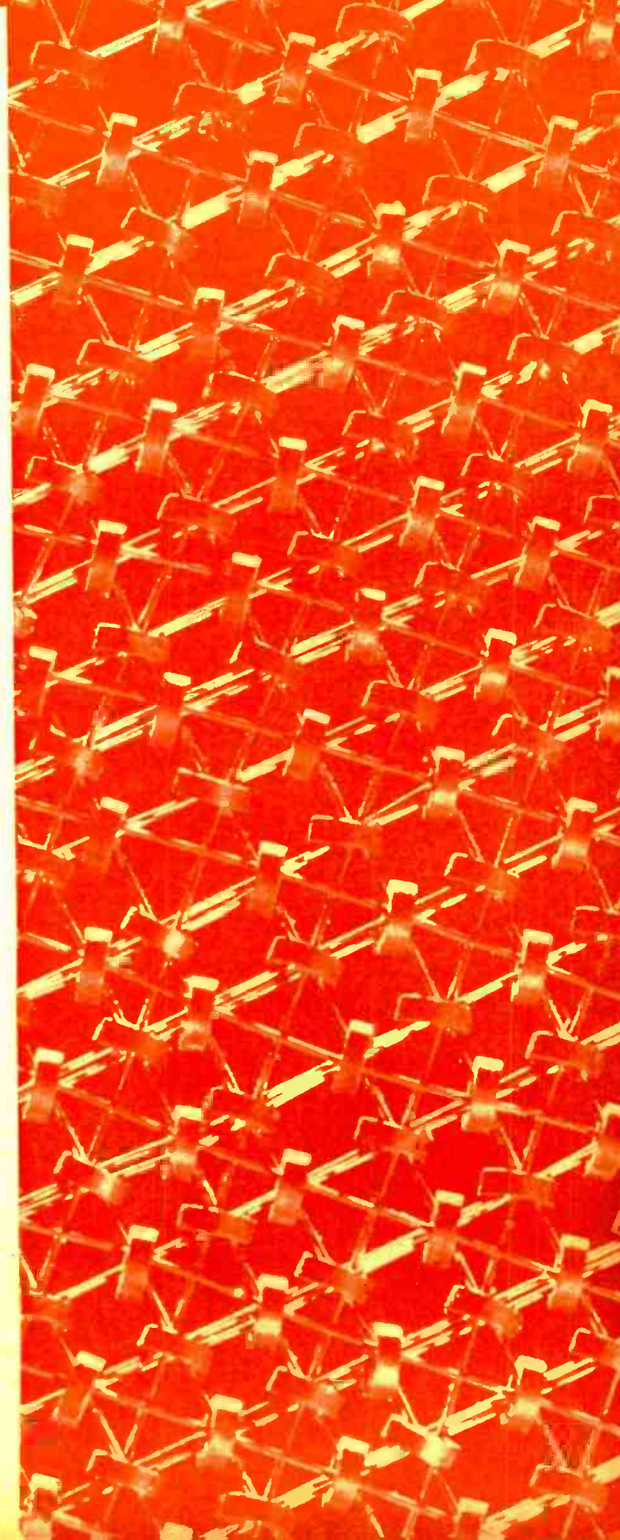
While the abilities of computer memories can most aptly be dramatized in terms of speed, this characteristic can, however, become highly confusing unless it is precisely understood what is meant by one figure or another, and exactly what is involved in the use of magnetic core storage systems.

Storage

Storage can best be defined by saying it is somewhat like a filing cabinet, completely indexed and allowing almost instantaneous selection of data. In electronic filing, this can be accomplished either in auxiliary storage or main storage.

In auxiliary storage are found magnetic tapes, disc files, and the familiar punched card. This storage is necessary when the capacity of the main storage unit must be augmented.

Data from auxiliary storage units, however, is not directly accessible to the central processing unit, or input or output devices. This data must be routed through the main storage unit before it can be acted upon.



The magnetic core memory storage console, shown above, is an integral part of a modern, high-speed, data processing system.

Main storage, which is located within the central processing unit, can accept data directly from an input unit—such as auxiliary storage—supply instructions to the central processing unit, and furnish data to an output unit such as a printer. To date, main storage memories consist of magnetic drums, magnetic thin films (very few as yet), and magnetic cores, by far the most dominant.

Since all data to be processed by any system must pass through main storage, this memory unit must have the capacity to retain a usable amount of data plus the necessary instructions for processing it. Additionally, because so many references must be made to this unit, the speed of access to its information content has a direct bearing on the efficiency of the entire data processing system.

These cores could store all the words in an adult's vocabulary.

Although most computers use high-speed ferrite magnetic core storage, the magnetic drum is still used because of the economy it affords. The magnetic drum "stores" information on an oxide layer surrounding a rotating drum in the same manner as a conventional audio tape recorder impresses its information on a moving strip of magnetic tape.

As computers come into greater use, and more use is made of them, memory systems will have to be greatly enlarged. In the not-too-distant future, computers with multi-million word random-access memories will be called upon to perform the necessary storage required of such systems.

Speed

Normally when the speed of a magnetic core memory is mentioned, it usually relates to either access or cycle time.

In core memories, storage is arranged somewhat like a group of stacked, numbered boxes, with each box holding a specific unit of data. This may be a character, a digit, a complete record, or a word. To insert or remove a specific piece of data, the correct box (referred to as *address*) is selected.

When new information is placed in an address, it replaces the previous contents of that address. However, when information is taken *from* the address, the contents remain unaltered. Thus, once located in storage, the same data can be used repeatedly.

Basically, it is the *time* the system requires to locate and transfer this data to or from storage that determines the speed of the memory unit.

When the term "cycle-time" is used, it refers to the time it takes to select a bit (one storage location), remove the data, and be ready to select it again. In practice, the system might move on to another storage location before the contents of the previous location were returned to their original position. This would be "access-time"—the time it takes to select a bit.

Of the two figures, "cycle-time" probably is the more apropos, especially when describing today's most advanced core memories with access times of 0.5 to 0.6 microsecond and cycle times of 0.7 microsecond.

Magnetic Core Storage

While it is beyond the scope of this article to fully explain magnetic core storage, some basic information can be given which will be of considerable help in understanding the operation of all data processing systems using cores.

A magnetic core is a tiny ring of ferromagnetic material the smallest of which, developed to date, being 21/1000th of an inch in diameter. Each core is pressed from a mixture of ferric-oxide powder and other materials and then baked in an oven.

Another important advantage of the core, aside from its compact size, is its ability to achieve a state of total magnetism within a few microseconds or less. And, unless deliberately altered, it retains this magnetism indefinitely.

In use, the core—actually a number of cores—are strung on a wire, and a strong electrical current is sent through the wire. The direction in which the current flows determines the polarity or magnetic state of the core, as shown in Fig. 1.

This means that a core can represent either of two states or conditions: "0" or "1," "yes" or "no," "plus" or "minus," or "on" or "off." This difference in condition between cores is the basis for storing most information.

In almost all large-scale computer systems today, more than one million cores are used. For other smaller computers, only 16,000 cores (or less) may be required. In these smaller systems, the storage capacity is normally increased through the addition of auxiliary memory units.

Since any specified location of storage must be instantly accessible, these cores—strung on a wire—are further arranged so that any combination of ones and zeros representing a character—such as the letter "A"—can be written magnetically and "read" back when needed. To accomplish this selection, another wire is strung through each core, crossing at a right angle to the original wire. See Fig. 2. By sending half the current required to magnetize a core through each wire, only the core circling the intersection of the wires is magnetized; no other core in the string is affected.

With this principle, numerous cores can be strung on a screen of wires, yet any given core can be selected (either for storage or read-out) without affecting any other. Such an array of wires and cores is called a plane and is shown in Fig. 3.

Actually, it takes more than one core to represent an alphabetical character. To illustrate this, assume the letter "A" is to be placed in storage. Using the binary coding decimal (BCD) system—the system used most frequently in the majority of computer systems—seven planes such as shown in Fig. 4 will be required. One core in each of these planes is magnetized positively or negatively, the seven cores thus representing the configuration of the letter. In this case, the letter "A" will be represented by the numbers 1110001.

Note that the planes in the memory unit are stacked one on top of the other, with all cores representing "A" appearing at the intersection of the same two wires (*i.e.*, position on the plane). If an imaginary line is drawn vertically through these cores, it would show the physical location of one character position of storage.

Once this information is placed in core storage, some means must be devised to make it accessible; that is, to recall it when needed. While it was shown previously that a definite magnetic polarity could be achieved in a core by passing a current through its center, in actuality this flow of current is not constant. It appears as an electrical impulse.

This pulse causes the core to "flip"; *i.e.*, change the state of the core from a positive to a negative polarity, or *vice versa*, depending on the direction of the pulse. When this change in magnetic state occurs, a current pulse is induced which is picked up by a third wire also running through the center of the core (Fig. 5A). This signal determines, by its presence, that the core contained a "1." If no pulse was produced, the core contained a "0." Unlike the other wires in the plane, only one sense wire is required for the entire plane since only one core at a time is tested for its magnetic state. In other words, read-out is destructive. To retain the originally stored data, then, the computer must replace a "1" in those cores that previously contained a "1" while, at the same time, allowing those cores that contained "0" to remain as "0."

To achieve this, the computer, in effect, writes "1" in all the cores which previously were "1" while suppressing the writing in cores, through the use of an inhibit pulse, in those which previously contained "0." This inhibit pulse flows through a fourth wire and, like the sense wire, runs through every core in the plane (Fig. 5C).

This, generally, is how a memory unit of a magnetic core computer operates. During the last year, however, several key technological changes have been perfected which allow the production of the sub-microsecond type core memory computers previously mentioned.

The means of locating information has been simplified. In conventional core storage the selection of a character is made by a coordinate selection system in which two choices must be made. In the new memories only one choice is made, and only the cores selected receive the switching current. This has resulted in the ability to achieve, for the first time, submicrosecond access and cycle-time speed in the interrogation of cores.

Partial core-switching is being used. In the typical computer memory, the magnetic cores are completely switched. In the new memory circuits, the cores are only partially switched. That is, they never change magnetic polarity, only the intensity of magnetization. This change in intensity is only a fraction of the change that occurs in the typical system mentioned previously. As a result, switching time and power requirements are greatly reduced. ▲

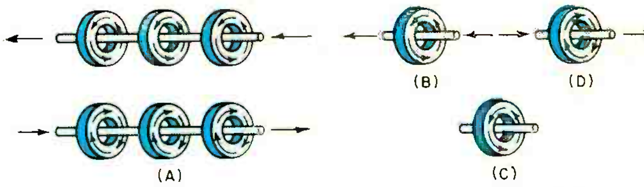


Fig. 1. (A) The direction of current flow determines the magnetic state of the core. (B) Magnetic field when current is applied. (C) When current is removed core remains magnetized. (D) When current is reversed, core reverses magnetic state.

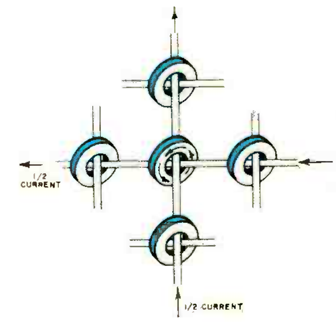


Fig. 2. Each wire carries one-half the current needed to magnetize a core and only the core at the intersection gets enough current to fully magnetize it.

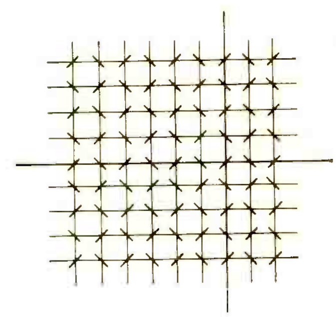


Fig. 3. An array of wires and cores is called a plane. Any core can be selected by passing current down a pair of wires.

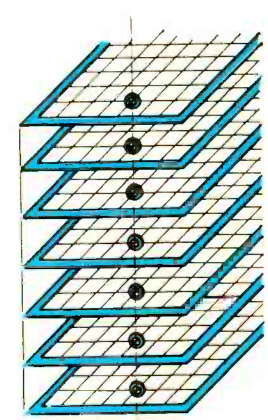
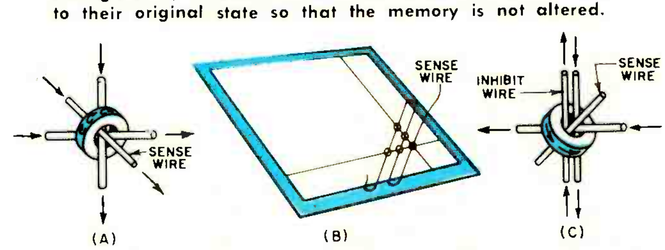
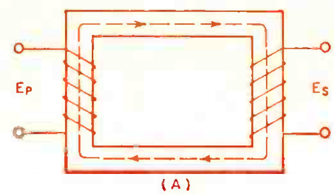


Fig. 4. In this seven-plane core memory, all cores representing a particular alphanumeric character are stacked one above the other and are magnetized to represent only that particular character.

Fig. 5. (A) When a core is made to change state, a pulse is picked up by the sense wire. (B) This sense wire is threaded through each core in the plane. (C) The inhibit wire passes through every core in the plane and is used to reset cores to their original state so that the memory is not altered.





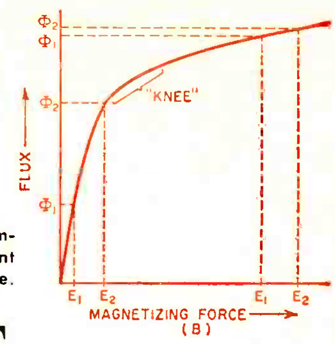


Fig. 1. (A) The magnetic circuit of a conventional transformer. (B) Magnetization curve shows how relatively constant voltage can be obtained by operating above the curve knee.

CONSTANT-VOLTAGE TRANSFORMER OPERATION

By TOM JASKI

By altering the magnetic circuit of a conventional transformer and adding an extra winding and a capacitor, a transformer is produced that maintains its output voltage relatively constant despite variations in line voltage.

MANY instruments and control devices used in industry require a substantially stable voltage supply. Unfortunately, most industrial power systems are not very stable, but are subject to voltage fluctuations that can produce false indications on instruments or ragged control of manufacturing processes.

There are a number of causes of voltage variations, and these may be all types, from very brief, violent, voltage drops to slow, periodic changes. The short and violent variations can usually be blamed on high-starting-current motors being placed in operation. Such motors may have a starting current as much as ten times normal full-load current. The voltage variations caused by them are not always visible on a meter, for meter movements have inertia and are relatively slow devices. Although the meter may show a brief dip, the extent of the change in meter reading will be but a fraction of the actual voltage drop. An oscilloscope might reveal such a fluctuation. Yet, any dip caused by such a motor may cause an electronic counter to lose as much as thousands of counts.

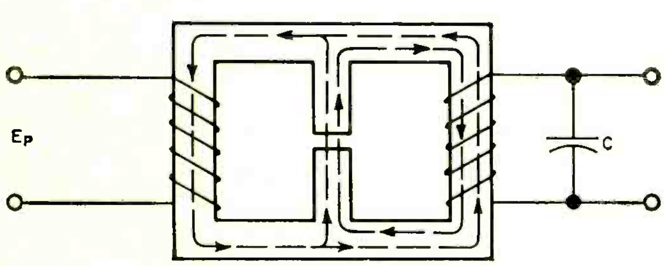


Fig. 2. Magnetic circuit of a constant-voltage transformer showing flux flow when using a magnetic shunt with air gap.

The long and slow variations can be handled by electronically regulated supplies, often built directly into the instruments. These supplies react relatively slowly because their time-constant is large, due to the capacitance in the circuits following them.

The fast current dips lasting only a cycle or two cannot readily be counteracted by electronically regulated supplies, even though there may be a momentary 10 to 50% drop in voltage.

To deal with such voltage drops, constant-voltage transformers (static-magnetic regulators) are used. These will adjust a.c. voltages supplied to instruments, control equipment, or computers within one cycle, fast enough so that the storage capacity of the rectifier-filter system is not taxed by an extremely rapid change in voltage.

Operation

To understand how a constant-voltage transformer operates, we must first consider why an ordinary transformer fails to regulate. Fig. 1A shows the magnetic circuit of a simple transformer. The flux created by the current in the primary induces a voltage in the secondary. With a purely resistive load connected to the secondary, the current flowing in it will set up a counter-flux in the core, which tends to cancel the flux created by the primary. The primary then must supply additional magnetizing force, and the current in it increases until a certain "net" magnetizing force is reached. The energy dissipated in the secondary load circuit plus the energy needed to magnetize the core must now be supplied by the primary winding. This situation is illustrated in Fig. 1B. When the transformer is operated in the region to the left of the "knee" in the characteristic curve, the magnetizing force and the resultant flux are related almost linearly. At the knee, the curve becomes less linear while to the right of it, it becomes relatively flat.

A smaller increment of flux results from a larger increase in magnetizing force if a transformer is operated in the flat portion of the curve. Transformers so operated have their core very nearly saturated, and are called saturated transformers.

A saturated transformer would be a constant-voltage transformer for changes in flux would no longer have a great effect on output voltage. However, such transformers are impractical because of their very-low primary impedance. When a transformer or reactor core is saturated, all core losses have been overcome, and the primary of the transformer no longer needs to supply energy to make up for core losses. The only thing that limits primary current at this point is copper (winding) resistance. During each cycle, the core will be saturated long before the maximum primary voltage has been reached, and since no additional magnetizing force is needed, the current will rise sharply at the point of core saturation. The low primary impedance necessitates adding some means of controlling primary current. This can be done with a series reactor, but then both efficiency and regulation are lost.

Conventional transformers are operated in the steep portion of the curve and poor regulation results. A small change in magnetizing force (or primary voltage) results in a large change in flux and secondary voltage. An ideal transformer would be one with the primary operated in the steep portion of the curve and the secondary responding as if operated in the "flat" portion of the curve. The basic magnetic circuit of such a transformer is shown in Fig. 2.

As shown in Fig. 2, the core contains an additional magnetic shunt with an air gap. By controlling the dimensions of the shunt and the width of the air gap, the amount of flux shunted through this leg can be closely regulated. The magnetic shunt in effect "loosens" the coupling between the primary and secondary. Some of the primary flux is passed back to the primary winding through the leg, and this portion does not affect the secondary winding. Similarly, some of the secondary flux does not oppose the primary flux.

Suppose a capacitor is connected across the secondary. With a resistive load, the counter-flux created by the secondary is opposed to the primary and cancels part of it. With a capacitive load this is no longer true. The phase of the secondary current and therefore the flux has now shifted (by 180 degrees) so that the flux in the shunt leg consists of the primary flux and is brought beyond the knee of the characteristic curve. Notice from the arrows in Fig. 2 that the portion of the secondary flux which passes through the rest of the core opposes the primary. Since the leg (as part of the secondary core) is now operated in the flat portion of the curve, a relatively large change in primary voltage will not have as much effect on the secondary voltage, but, because the total flux increases, the secondary voltage will increase slightly. The increase of the secondary voltage could be higher than would be expected from the turns ratio, as the secondary and capacitor form a resonant circuit. Additional reduction of secondary voltage variations can be obtained with a compensating winding wound directly over the primary (see Fig. 3).

The voltage from this winding will vary with the primary voltage. It is connected in opposition to the secondary and the actual amount of voltage variation in the compensating winding is determined by its ratio to the primary. As the primary voltage increases slightly, the secondary voltage increases very slightly, and the compensating winding voltage also increases slightly. This last voltage increase opposes the secondary voltage increase, and the net result is very little change in secondary voltage. Therefore, by choosing the proper compensating voltage, there will be a point at which there is the least output voltage variation.

Since the capacitor-transformer circuit is a resonant one,

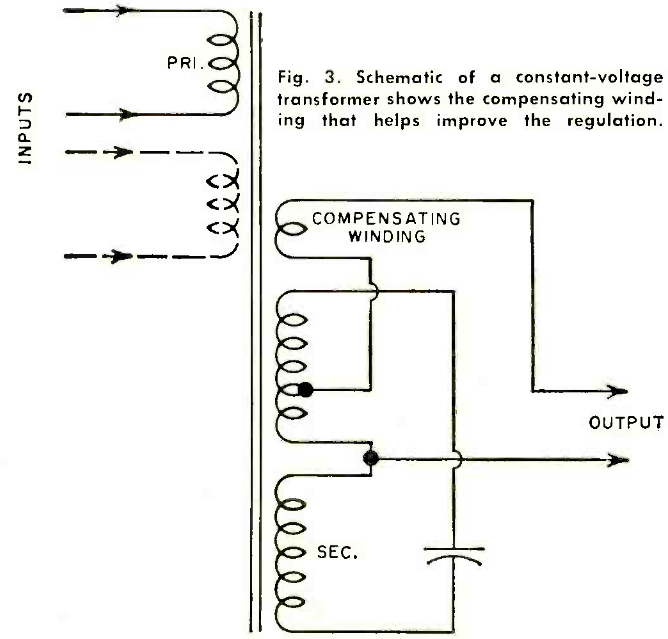


Fig. 3. Schematic of a constant-voltage transformer shows the compensating winding that helps improve the regulation.

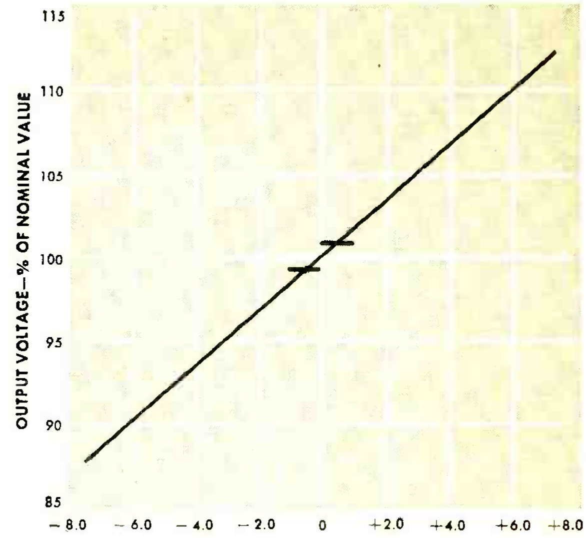
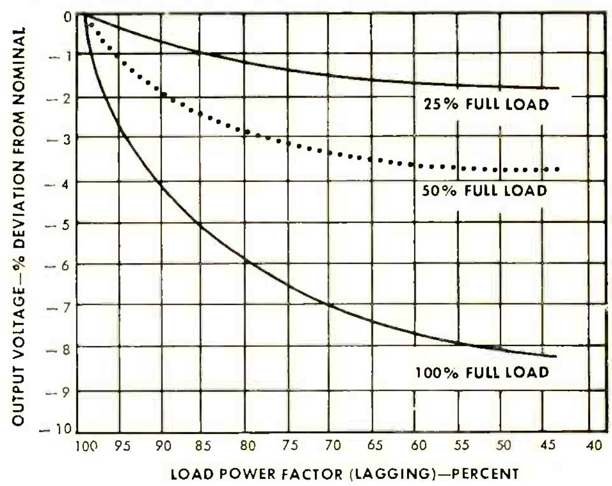


Fig. 4. Variation in output of a frequency-sensitive, constant-voltage transformer with variations in power-line frequency.

Fig. 5. Variation in output of a constant-voltage transformer is a function of both load power factor and amount of load.



the constant-voltage transformers, as described here, are frequency-sensitive. Any variation in frequency results in an output voltage variation. However, as public utilities are usually required to keep frequency variations within an average of .25 cycle, this is not a drastic defect. Fig. 4 shows the variation with frequency.

Load changes will also affect the output, because they result in rather large changes in secondary flux. Fig. 5 shows this relationship. However, there are other means to protect circuitry against such load-derived voltage variations. For example; zener diodes or VR tubes are often used because they handle such changes very readily.

Dynamic Regulation

So far, only static operation of the constant-voltage transformer has been discussed. The process of dynamic regulation, in which the transformer catches up with changes that are going on, is so theoretically complex that even the transformer's designers have not completely worked it out. Experimentally, it has been shown that the transformers will correct in less than one cycle. If the changes occur faster than the time-constant of the transformer, the transformer will follow as rapidly as its time-constant will allow and will adjust to the last increment of change. It will keep on adjusting until the variations cease. It is the changes lasting several cycles which are most profitably dealt with by the transformers. ▲

transistors for HI-FI:

PROMISE OF PROGRESS

By MARSHALL R. MYERS, JR. & MORLEY D. KAHN
Acoustic Technology Laboratories, Inc.

The viewpoint of a manufacturer who strongly believes that the use of solid-state circuitry results in a definite and audible improvement in sound reproduction.

Editor's Note: Is there a difference in "transistor sound?" Is the difference real or imaginary? And is it worth the higher price that the user must pay for a well-designed transistor amplifier? This manufacturer insists that the difference is real and worth the added cost. Although some of the points made in rebuttal to previous articles we have run on this same subject are debatable, this viewpoint is certainly worth presenting.

TODAY the audio industry stands at a new crossroads. The era of solid-state awaits. Is this to be another step forward like the changeover from the acoustic to electrical system of recording and playing back, the 78 rpm to the long-playing record, and mono to stereo? Does the use of solid-state circuitry result in an audible improvement in sound reproduction? Only if these answers are in the affirmative can this change be recognized as progress.

We believe in the advantages of solid-state circuitry. Our company was established because of this belief. However, if the industry is to move into the solid-state era, still more affirmative voices are required.

To us, the most exciting aspect of the article "Transistors for Hi-Fi: Panacea or Pandemonium?" in the September 1963 issue was the affirmative stand taken by D. R. von Recklinghausen, Chief Engineer of *H. H. Scott, Inc.*, and his associates. To us, however, his explanations for the improved sound quality obtained from a properly designed transistor amplifier are debatable. Yet, differences of opinion are what make audio the fascinating subject it is. Much of this article is a rebuttal to some of the previous statements on why transistor amplifiers can sound better.

In his ELECTRONICS WORLD article, Mr. von Recklinghausen makes the point that superior transient response, as represented by good reproduction of square waves, is not a factor in transistor sound. He stated: "Any change in the appearance of a square wave used for testing an amplifier does not indicate any change in listening characteristics of the amplifier. Hence any square-wave test of audio equipment is meaningless and superior square-wave response of an amplifier has very little bearing on the actual listening quality of the audio equipment."

If this premise is accepted, then: (1) Extending the frequency response of an amplifier beyond the audible 20 to 20,000-cps range is not only unnecessary, but is actually harmful. It permits undesirable disturbances from associated equipment, such as subsonic turntable rumble and ultrasonic cartridge resonances, to be reproduced by the amplifier and seriously detract from performance and power. Therefore, it is desirable to cut off response above 20 kc. and below 20 cps despite the serious effect this has on square-wave response.

(2) It is perfectly all right to use driver and output transformers in the audio circuits of an amplifier even though these also have a serious effect on square-wave response.

(3) It is pointless to use silicon power transistors whose response can extend up to and beyond 1 megacycle. The much less expensive germanium transistors will work quite as satisfactorily if you are only interested in a limited frequency response from your audio equipment.

Importance of Transient Response

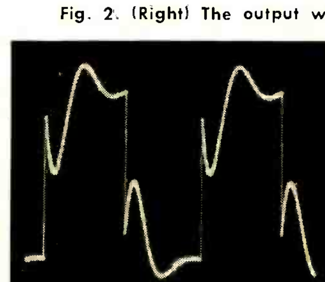
Just how important is transient response? We think it is extremely important and we are hardly alone in this opinion. Decades ago, Helmholz demonstrated that almost all musical sounds consist of a series of tiny transients that blend together in our ear. Some instruments produce more transients than others. For example, instruments like the piano produce highly transient sounds. Brasses are also significant producers of transients.

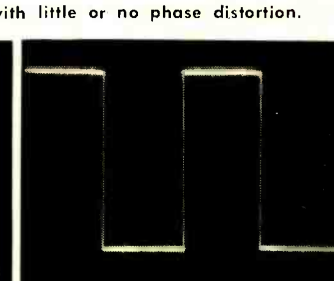
Amplifiers used in the home are designed to reproduce music. If music is a blend of transients, then an amplifier, if it is to do its job well, must be able to reproduce transients. A square wave *should* be used in testing amplifiers because it represents a musical transient more accurately than almost any other controlled signal available to the designer. Music patterns, while they are important in listening tests, are impossible to use when analytic measurements are necessary.

This is hardly a new theory. The 1953 edition of the "Ra-

Fig. 1. (Left) Appearance of square wave with changed phase relationship of harmonics with respect to the fundamental.

Fig. 2. (Right) The output with little or no phase distortion.





diotron Designer's Handbook" reports on an experiment by Richardson which concluded that "It is the attack and decay times of sounds that largely determine their tonal quality, rather than their harmonic content." This experiment took place almost twenty years ago. The Handbook goes on: "An amplifier which gives fairly good reproduction of steady (*i.e.*, sine wave) tones may give serious distortion with transients. The distortionless reproduction of a short pulse requires (1) very wide frequency response—possibly higher than the limit of audibility; (2) no phase distortion; (3) no hangover. . . . Hangover effects are caused by insufficiently damped *LC* circuits such as *may occur with audio-frequency transformers, tone-correction circuits, and filters*." (Emphasis ours)

The previous authors, in decrying the importance of the square wave concentrated their fire only on the importance of low phase distortion. They referred to a "classic experiment . . . whereby the fundamental frequency of the square wave was shifted by 180 degrees, by 90 degrees, and also by some intermediate values. . . . The audible sound did not change at all. Later concurring experiments showed the ear to be totally insensitive to phase in a steady signal."

Referring back to the "Radiotron Designer's Handbook," we find the following statements on phase distortion: "A fixed phase shift of 180 degrees (or any multiple of 180 degrees) does not constitute phase distortion. A phase shift which is proportional to the frequency also does not cause a phase distortion (but) . . . large changes in aural perception can occur through changes in phase only. . . . These effects vary from a raucous to a smooth sounding quality, depending on the relative phases. . . . In the light of known effects, and with insufficient data to determine what degree of phase shift is permissible for high-fidelity reproduction, it is wise to reduce the phase shift in amplifiers to the lowest practical value."

Audible Effects

Not being satisfied with accepting the Handbook's statements without question, we performed a simple test in our own laboratories. We fed into our audio system square waves varying in frequency from 20 to 20,000 cps. In every case, whenever a significant change in pattern could be seen on the scope by changing phase of harmonics (Fig. 1), differences in sound were clearly audible as compared to when little or no phase shift occurred (Fig. 2). These changes were not at all subtle but were quite evident to all listeners, emphasizing the importance of designing for low phase distortion.

However, there is a good deal more to good transient response than just low phase distortion. In fact, other factors may be of greater importance. Referring to Fig. 3, observe what happens to a square wave when fed through a poorly designed amplifier. Notice the slow rise time, the overshoot and ringing, as well as the phase shift. Some of these problems arise from using filters to attenuate response *outside* the audio range. Overshoot and ringing may result from poorly designed transformers. Slow rise time is a result of insufficient high-frequency response.

Transistor amplifiers permit the designer to avoid almost all of these problems. By eliminating audio transformers and by using silicon transistors with their much wider frequency range, and by permitting the frequency range to go from below several cycles to well over a quarter megacycle, the square-wave output looks as it does in Fig. 2. To critical listeners, music played through such an amplifier sounds significantly better than that played through an amplifier producing patterns such as shown in Fig. 3.

Extended Frequency Response

The concept of extended frequency response beyond the audio range is one that some people find hard to justify. After all, they claim, most people cannot hear sounds above about 20,000 cps or below about 20 cps, so why bother designing amplifiers than can reproduce these frequencies. We agree completely. Our point is why use a sine wave to represent these frequencies? A sine wave does not really look like music, but square waves do more faithfully represent the effect of music. Let us design an amplifier that will reproduce square waves in the range from 20 to 20,000 cps.

An amplifier that will reproduce square waves properly in the audio range is capable of reproducing sine waves down to below several cycles and well above a quarter megacycle. This is a side effect of the basic design.

What about the sub- and ultrasonic disturbances that we have heard so much about? Do you limit the performance of an amplifier because the associated equipment may have deficiencies or do you try to design each component for best performance? A good amplifier will enhance the sound quality of inferior associated equipment. There is nothing wrong in incorporating *optional* low-frequency roll-off filters for people who have turntables with excessive rumble in the subsonic range. However, there are good turntables and cartridges which do not have such problems.

Even if subsonic and ultrasonic disturbances exist, do they really waste much of the usable power of a properly designed amplifier? Using a wide variety of turntables, record changers, and cartridges, we were unable to detect any adverse effects on the ability of a properly designed amplifier to provide all

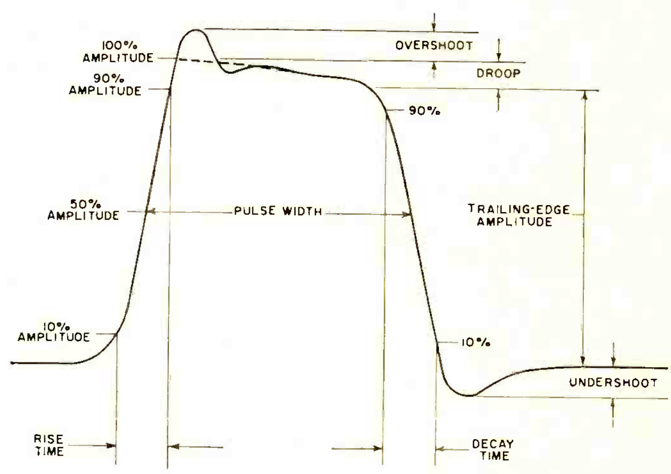


Fig. 3. Standard characteristics of a square-wave pulse.

the clean power, free from clipping, that a listener could use. This should not be too surprising because of the high ratio of the desired music signal to the undesired noises outside the audio range in a quality music system.

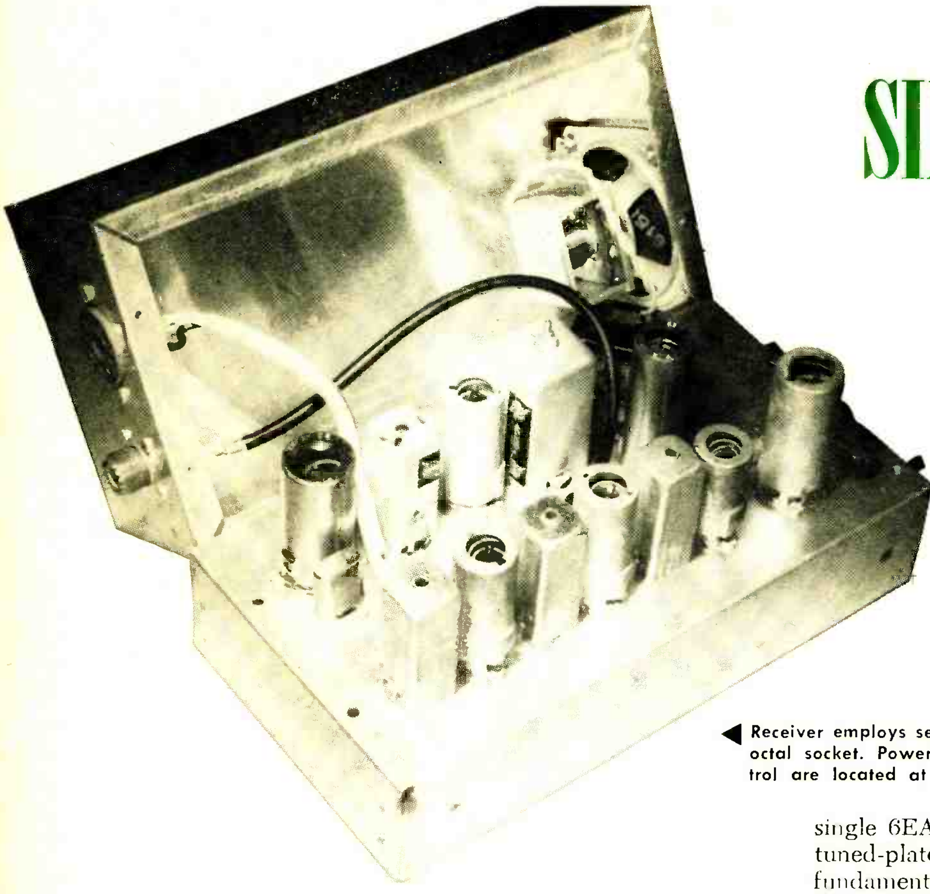
It is much easier to design an amplifier that will work properly in a narrow range than it is to design a fully stable amplifier with extended response and with low distortion. The only justification for the time, trouble, and expense involved in designing a wide-band amplifier is the definite audible improvement in the sound.

Higher Reserve Power

The writers of the article "Transistors for Hi-Fi: Panacea or Pandemonium?" state that "transistor sound" is a result of the substantially greater power capabilities of a transistor amplifier when reproducing music. That transistor amplifiers convey a feeling of greater power is a common reaction of listeners and reviewers.

Our experience and considerable experimentation dictates different lines of reasoning than set forth by the previous authors to explain the greater power capabilities of a solid-state amplifier when reproducing music.

When music is monitored on a calibrated oscilloscope, it can be observed that a vacuum-tube amplifier with output transformers maintains a constant clipping *power* (E^2/Z) regardless of the speaker's impedance. This instantaneous clipping power is usually (*Continued on page 76*)



SINGLE-FREQUENCY RECEIVER

By WILLIAM B. KINCAID
Aladdin Electronics

Construction and design of spot - frequency receiver with squelch for MARS, CAP, WWV, or amateur radio use.

◀ Receiver employs separate power supply which is plugged into octal socket. Power switch, squelch control, and volume control are located at the far end of the chassis in this photo.

THE receiver to be described is a seven-tube, crystal-controlled, single-frequency receiver designed around readily available parts. It is easily duplicated and provides superior performance when used either as a spot-frequency receiver for WWV, MARS, CAP, or net operation or as a "tail end" for a tuner or converter. Mobile operation on either 6 or 12 volts or 117-volt a.c. operation is possible by use of separate plug-in power supplies.

The Circuit

The input circuit consists of a 6BZ6 r.f. amplifier (*V*1) whose input transformer is a double-tuned i.f. unit to which an input link has been added. The output of this stage is coupled through another similar i.f. transformer to the grid of the mixer section of the 6EA8 mixer-oscillator (*V*6). The input frequency to the receiver can be anything from 1 mc. to over 30 mc. by selecting the proper transformers for the antenna and r.f. stage and picking a crystal for the local oscillator that converts the input frequency to the i.f. frequency.

The transformers can be regular 1.5-mc., 4.5-mc., 10.7-mc., 27-mc., or 26-mc. i.f. transformers or these transformers can be modified by changing the resonating capacitors to make the transformer operate at any nearby frequency desired. A grid-dip meter can be used to determine resonance when changing capacitors in the i.f. transformers. Select i.f. transformers that are stud-core tuned as these are the easiest to modify. The cup- or shell-core tuned i.f.'s are almost impossible to alter. The types given in the parts list can be easily modified. Most standard i.f. transformers have at least a 10% tuning range and, if the frequency picked falls within 10% of the input frequency selected, no modification will be necessary.

The use of two double-tuned transformers preceding the mixer grid, instead of the usual two tuned circuits, results in a tremendous increase in r.f. amplifier gain, selectivity, and image rejection. This improves the mixer signal-to-noise ratio by providing the mixer grid with a signal of increased amplitude to convert to the i.f. frequency.

The mixer/local oscillator functions are combined in the single 6EA8 triode-pentode. The triode (*V*6*B*) is used as a tuned-plate crystal oscillator, making it suitable either as a fundamental-output oscillator in the 3-mc. to 10-mc. range or as a third-overtone output oscillator for use with third-overtone crystals in the 10-mc. to 50-mc. range. No external coupling between the oscillator and the mixer was found necessary; the stray capacitance in the tube provides sufficient coupling with a crystal of normal activity. The 47,000-ohm value for resistor *R*30 feeding the "B+" to the plate of the oscillator can be adjusted downward to provide more oscillator injection on low-activity crystals.

The mixer or pentode section of the tube (*V*6*A*) is utilized in a quite conventional circuit except for the manner in which "B+" is fed to the plate. Referring to Fig. 1, note that "B+" is fed to the plate through a 47,000-ohm resistor (*R*6) and that coupling to the first i.f. stage is accomplished through a 27-pf. capacitor (*C*6). This arrangement operates the mixer into a relatively low plate load (47,000 ohms) instead of the high (500,000 ohm) impedance of the i.f. transformer. This, plus the use of only 125 volts "B+" on the entire receiver, reduces the over-all noise figure of the receiver significantly. Also, use of a small coupling capacitor to feed the signal to the first i.f. transformer reduces the mixer loading effect on the i.f. transformer which, in turn, improves the bandwidth characteristics of that transformer.

Two i.f. amplifier stages are utilized. The i.f. frequency can be either 455 kc. or 262 kc. The 262-kc. i.f.'s will usually provide a narrower over-all bandwidth in the receiver and are to be preferred for that reason. Transformers salvaged from old table or car radios can be used if available. The oscillator crystal frequency should be determined by adding the i.f. frequency, either 262 kc. or 455 kc., to the input frequency to be received. For example, to receive 10.7 mc. with 262-kc. i.f.'s:

10.7 mc. + .262 mc. = 10.962 mc. = Xtal. Freq.

Both i.f. stages use 6BA6 remote-cut-off pentodes (*V*2, *V*3) as amplifiers. Due to the high over-all gain of the "front end" only a little gain is needed in the i.f. amplifiers. To reduce i.f. gain and avoid overloading the detector stage, the screen resistors were raised from the normal 33,000 ohms to 150,000 ohms (*R*9, *R*27). This also improves the control of gain by the a.v.c. circuit.

The i.f. stages are followed by a 6AL5 (*V*4) detector and noise limiter. The 12AU7 (*V*7) is used as first audio and squelch. The squelch control grid is fed a.v.c. voltage from the detector through a 4.7-megohm resistor (*R*21), bypassed by a .05-μf. capacitor (*C*17). This *RC* combination provides a time delay of a fraction of a second in the squelch opening and closing so that a static pulse will not cause the squelch to open or a sudden fade in the received signal to cause it to close. The .05-μf. capacitor can be changed to anything between .001μf. and .5 μf. to make the delay shorter or longer to meet individual requirements.

A 6AQ5 (*V*5) is used as an audio output amplifier. Note that the volume control (*R*13) is in the grid circuit of this tube rather than in the grid of the first audio amplifier. This eliminates the need for using shielded hookup wire to prevent hum and noise pickup and also allows more of the wiring of the receiver to be done on the circuit terminal boards which greatly simplifies the wiring procedure.

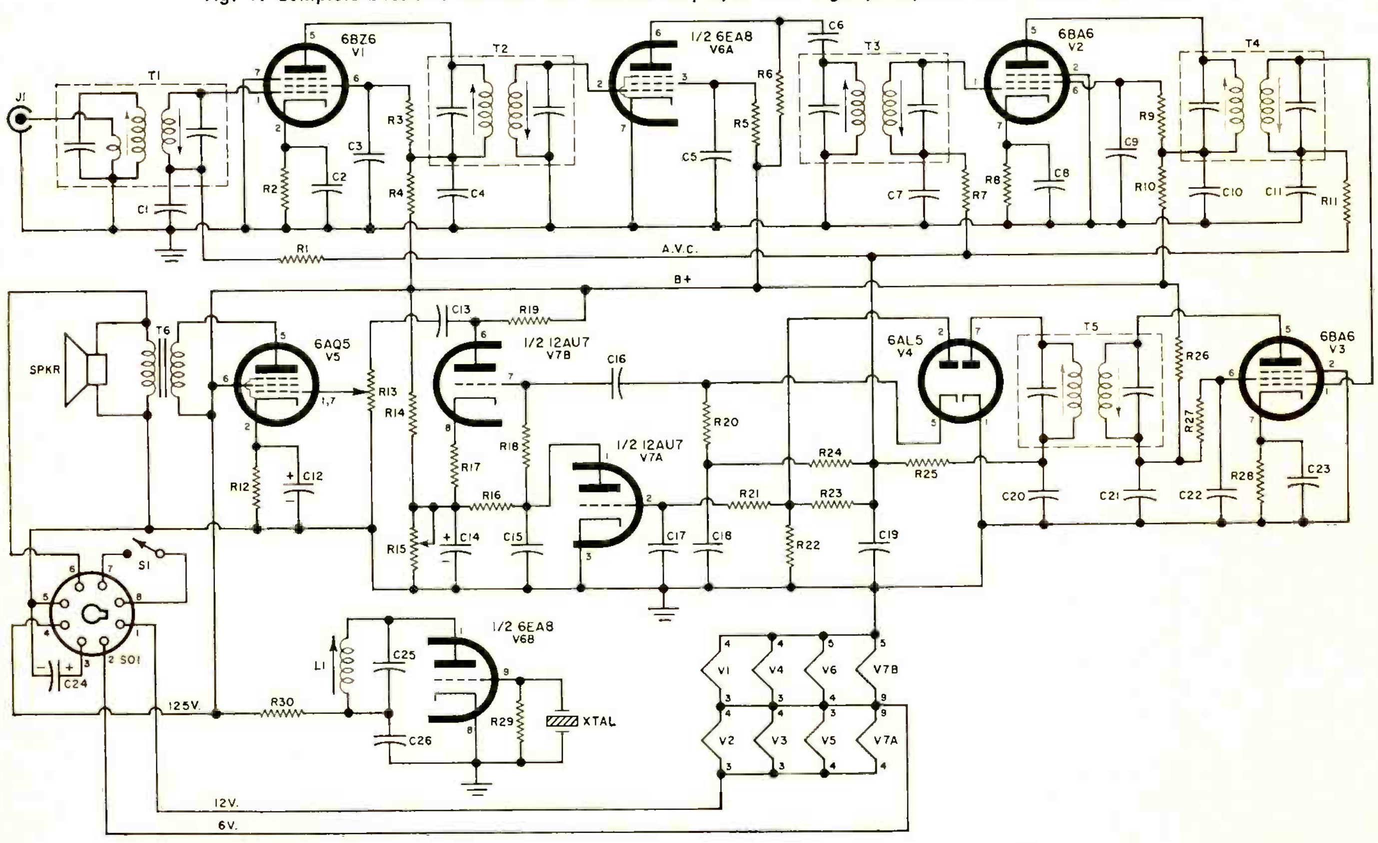
The heaters are so connected that by suitable wiring of the power plug from the power supply, either 6- or 12-volt operation is possible. Power requirements are 105 to 125 volts at about 25 ma. and either 6- or 12-volts a.c. or d.c. at 2.4 amps or 1.2 amps respectively. For mobile operation, an ARC-5 24-volt receiver dynamotor, operating on 12 volts, will provide more than adequate power. If you don't have one (and practically everyone with a good junk box does), they are available for about $1.95 at many surplus houses.

The actual construction of the set was somewhat unique in that 90% of the wiring was done on two staked phenolic boards, each measuring 8⅜" x 1⅞" x 1/16" thick. Holes, as required, were drilled with a #33 drill and terminals (*Cambrion* 1724-B) inserted in the holes. A blunt-nosed center punch was used to flare out the terminals and secure them to the board. A 5/32" hole drilled in a piece of metal makes a good socket to hold the heads of the terminals while flaring.

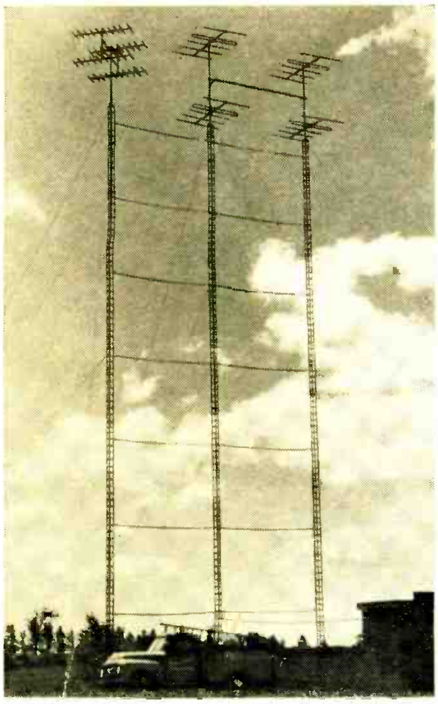
A three-inch deep chassis is used as a cover for the set and has a 3"-square speaker mounted behind the front with a piece of fine mesh wire cloth as a speaker grille. A standard 3" speaker is about 3/16" too big to fit inside the top cover unless that amount is trimmed from the speaker frame. The antenna connector and power plug are located in the back of the cover. There is room for these connectors on the rear of the chassis but it was found that too much noise got into the adjacent circuitry when they were located there. To prevent this, the antenna and power connectors were moved to the top cover and the leads brought out through a rubber grommet directly above the "on-off" switch.

To modify the antenna transformer, remove the can then remove the coil and capacitor lead wires from the plate terminal. Leave the coil and capacitor lead wires soldered together and position them so that they will not short out to the can when it is replaced. Take a piece of #20 to #24 enameled wire and wind (*Continued on page 82*)

Fig. 1. Complete circuit of unit that can also be employed as a high-quality i.f.-a.f. strip for converter.



R1, R7, R11, R16, R18, R20, R24—1 megohm, ½ w. res.
R2, R8, R28—68 ohm, ½ w. res.
R3—33,000 ohm, ½ w. res.
R4, R10, R26—2200 ohm, ½ w. res.
R5—180,000 ohm, ½ w. res.
R6, R14, R25, R30—47,000 ohm, ½ w. res.
R9, R27, R29—150,000 ohm, ½ w. res.
R12—330 ohm, 1 w. res.
R13—500,000 ohm audio taper volume control
R15—50,000 ohm audio taper squelch control
R17—1000 ohm, ½ w. res.
R19, R22, R23,—270,000 ohm, ½ w. res.
R21—4.7 megohm, ½ w. res.
C1, C2, C3, C4, C5, C7, C8, C9, C10, C11, C15, C18, C21, C22, C23—.01 μf. disc ceramic capacitor
C6—27 pf. mica or ceramic capacitor
C12—25 μf., 25 v. elec. capacitor
C13, C16, C26—.001 μf. disc ceramic capacitor
C14, C24—8 μf., 150 v. elec. capacitor
C17—.05 μf. disc ceramic capacitor
C19, C20—50 pf. mica or ceramic capacitor
C25—100 pf. mica capacitor
L1—Adj. coil to tune to crystal freq. with 100 pf. Select coil required (J. W. Miller Series 4500)
J1—Coax connector
Spkr.—3" square speaker, 3.2 ohms (Quam SP3A)
Xtal—Crystal (see text for freq.; International Crystal FA-5)
S1—S.p.s.t. toggle switch
SO1—Octal socket
T1, T2—I.f. input or interstage trans. (see text; J. W. Miller 12W1 for 1500 kc.; 1466 for 4.5 mc.; 6190 for 21 mc.)
T3, T4, T5—I.f. output trans. (J. W. Miller 13PH2 for 262 kc.; 13PC9 for 455 kc.)
T6—Output trans. plate-to-v.c. 5000:4 ohms; 5 w. (Stancor A-3877)
V1—6BZ6 tube
V2, V3—6BA6 tube
V4—6AL5 tube
V5—6AQ5 tube
V6—6EA8 tube
V7—12AU7 tube
1—9½" x 5" x 2" chassis (Bud AC-403)
1—9½" x 5" x 3" chassis (Bud AC-421)



This community antenna TV system uses the interference reduction arrangement discussed in this article. All wiring is double-shielded coaxial for reduction of downlead effects.

HARNESSING the ANTENNA

By ROBERT JONES

Besides producing gain in the desired direction, it is also possible to stack antennas to get as much as 40 db rejection of any unwanted signals in other directions.

USING stacking between antennas (both horizontally and vertically polarized), forward gain can be improved by a power gain of 3 db each time the number of antennas is doubled. In addition to this effect, there is also a change in the over-all pickup pattern of the system. This change is in the form of very high signal rejection in certain directions, often on the order of more than 40 db power loss or 1/10,000 of the power in the desired direction.

The dipole has a basic electrical pattern similar to a figure-8. If a second dipole is placed beside the first with a center-to-center spacing of one wavelength, the resulting over-all pickup pattern is as shown in Fig. 1. The feature with which we are primarily concerned is the four null indentations of the curve marked *N*. The reason for these indentations can be found by considering both dipoles as point-source radiators which are fed by equal-amplitude identical frequency and phase signals. The resulting interference pattern produces cancellation along a line which has one-half wavelength longer path length from one antenna to the other.

Another way of visualizing the interference pattern produced in Fig. 1 is to drop two stones, spaced about the distance of two ripple wave crests apart, into a quiet pond. The resulting systems of circular rings will intersect to cause constructive and destructive interference of each ring pattern. If a line is drawn through the place where the two stones struck the water and we considered this line to run east and west, then the line running north and south through the middle of the two drop points is on a line of constructive interference (both wave amplitudes adding). At an angle of about 30 degrees from this north-south line will be found a line along which destructive interference occurs (both wave amplitudes cancel). It is this line that represents the notch in Fig. 1.

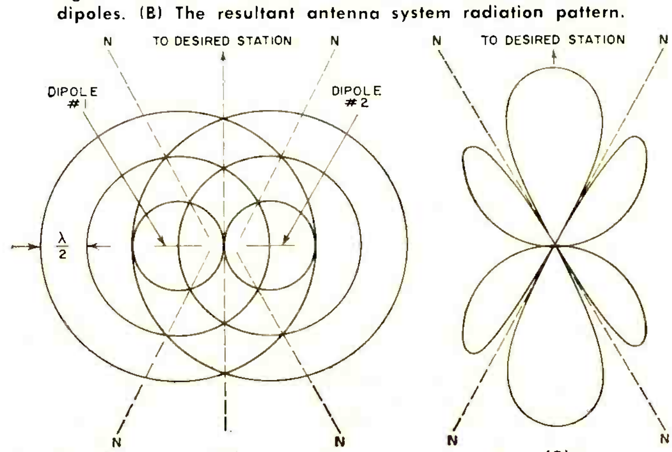
The direction that the destructive interference notch faces is determined by the spacing between the two sources of interference. Thus, we can control the direction that the notch in Fig. 1 faces by varying the dipole spacing. Direction in degrees *versus* spacing in wavelengths is shown in Fig. 2. Here, *R* means maximum rejection, *P* means maximum pickup while S1, S2, and S3 are explained by Fig. 3. In applying the chart to an antenna system, it should be realized that the spacing and angles can be applied equally well to both vertical as well as horizontal antenna spacing. This same principle can be applied to an antenna system comprising many dipoles placed end-to-end and spaced horizontally to give a rejection angle in the horizontal plane of the radiation pattern. At the same time, other dipoles can be added vertically to give a different angle of vertical rejection. These vertical and horizontal directions refer to the radiation pattern of the antenna system and not to wave polarization.

Up to now this discussion has been concerned with horizontally polarized waves, that is, waves produced on dipoles whose length is in the horizontal plane. Vertically polarized waves (dipole length runs up and down) are handled the same way, and Fig. 2 applies to both planes of wave polarization. Dipoles are not the only antennas that can be used with this rejection notch method. In fact, folded dipoles, multifolded dipoles, yagis, corner reflectors, and sheet-reflector antennas have been used successfully in this application.

Using more than one antenna to make up a system of antennas has the advantage of providing greater signal gain in the desired direction of transmission. Starting with the single dipole as a reference, two dipoles provides 3-db gain or 2 times the effective radiating power of one dipole. Four dipoles will provide 6-db gain or 4 times the effective radiating power, eight dipoles provide 9-db gain or 8 times the radiating power of one dipole, and sixteen dipoles will give 12 db or 16 times the radiated power. In other words, doubling the number of radiating units increases the effective radiating power by 2 times or 3 db of power. By this means, and starting with a yagi of say 12-db gain, it is possible by vertical and horizontal stacking of 8 yagis to obtain a power gain over a dipole of 21 db, representing a power gain in the forward direction of 126 times greater than that of a single dipole.

The number of rejection and pickup directions appearing in the final antenna system pattern depends on several fac-

Fig. 1. (A) Constructive and destructive interference by two dipoles. (B) The resultant antenna system radiation pattern.



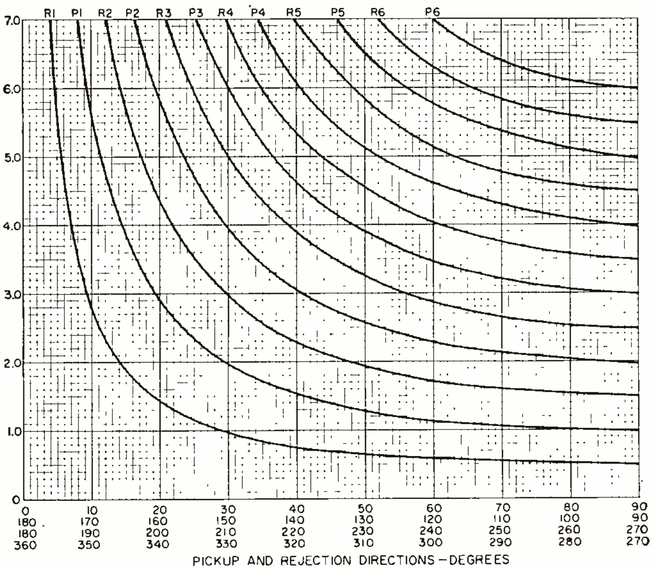


Fig. 2. Pickup and rejection directions in azimuth degrees as a function of the antenna-to-antenna spacings of Fig. 3.

tors, which include the pickup pattern of the individual antenna making up the system, the spacing between antennas (both vertical and horizontal), and the spacing between banks of antennas (both vertical and horizontal). The chart of Fig. 2 indicates the resulting maximum pickup directions marked *P1* through *P6*, as well as the directions of maximum rejection, marked *R1* through *R6*, as a function of element spacing identified as S1, S2, and S3 in Fig. 3. In this manner, a very large number of rejection directions is available. For example, if 1.5 wavelengths were used for S2, and 4 wavelengths are used for S3, there would be a rejection at 20, 90, 160, 200, 270, and 340 degrees due to S2 and 7, 22, 39, 61, 119, 141, 158, 173, 187, 202, 219, 241, 299, 321, 338, and 353 degrees due to S3. In addition, if the vertical spacing of S1 were made ½ wavelength, it would reduce electrical interference produced in the supporting structure.

Antenna Interconnection

Interconnection and matching of many antennas to provide a workable antenna system becomes a considerable theoretical problem since the impedance of the individual antenna depends on its height above ground, vertical antenna spacing, horizontal antenna spacing, as well as the antenna's supporting structure. In practice, another approach works very well and considerably reduces the work involved in harnessing several antennas.

Consider each antenna as operating in free space having the impedance commonly listed in the catalogues, for example, a dipole at 72 ohms, folded dipole at 300 ohms, and the common TV yagi at 300 ohms. Applying this approach to the four-antenna array of Fig. 4, antenna 1 and antenna 2 are each considered to have 300-ohm terminal impedance, therefore 300-ohm transmission line can be used to join them. The length of this line is not critical but should be kept as short as convenient. Antennas 3 and 4 are considered exactly the same as antennas 1 and 2. The center of the line joining antennas 1 and 2 looks into a 300-ohm antenna at both ends, therefore this produces a resulting impedance of 150 ohms. A 150-ohm line can be connected between the center of the 300-ohm line connecting the antennas 1 and 2 and the center of the lead between antennas 3 and 4. The 150-ohm line is not critical in length but it should be kept as short as conveniently possible.

The midpoint of the 150-ohm lead can be considered as being two 150-ohm loads connected in parallel with a resulting impedance of 75 ohms. A quarter-wave transformer is used to match this 75-ohm connection to the downlead impedance. If the required impedance is 300 ohms, a quarter-wavelength of 150-ohm line will serve in accordance with the quarter-wave impedance matching transformer equation $Z=\sqrt{Z1Z2}$, where Z is the transformer impedance and Z1 and Z2 are the two impedances to be matched.

A matching section is frequency sensitive and should be a quarter-wavelength long at the center of the frequency band to be received. While the lines joining the antennas are not critical in length, the important thing is that the mid points must be accurate or the phasing of the signals to or from each antenna will vary and the end result will be to seriously reduce signal gain as well as the depth of the directional attenuation in the over-all radiation pattern.

Spacings which produce the best impedance match to the feeder line are .7 wavelength for S1 of Fig. 3 and .95 wavelength for S2. This same spacing also provides the greatest signal gain. For spacings of S1 and S2 larger than two wavelengths, the impedance changes due to proximity effect is very small and in practice the maximum v.s.w.r. presented to the downlead, is on the order of 1.2:1 or a reflection coefficient of 0.09. The spacings referred to for S1, S2, and S3 are the wavelength of the interfering frequency in air. Formula for wavelength in air is 300/*mc.=meters*, 984.3/*mc.=feet*, or 11,811/*mc.=inches*.

Applications

These antenna techniques have been applied to TV interference reduction in co-channel reception (venetian-blind pattern), TV adjacent-channel interference, short-wave AM interference, auto-ignition noise, tower noise reduction, and reduction of TV ghosting (if the direction of the reflected signal can be found). In FM reception, short-wave interference, auto-ignition interference, preamplifier overloading by a strong local station, and tower noises can also be reduced.

This method of interference reduction has also been used by several CATV systems. ▲

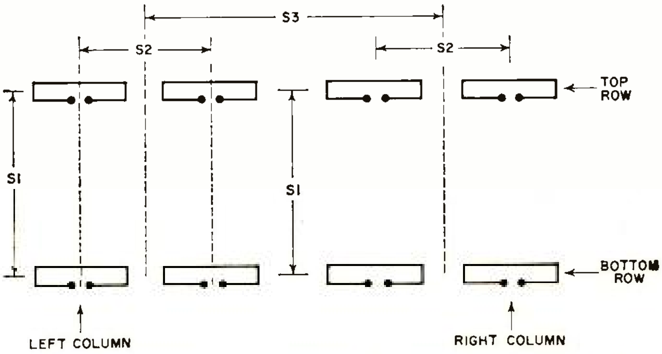
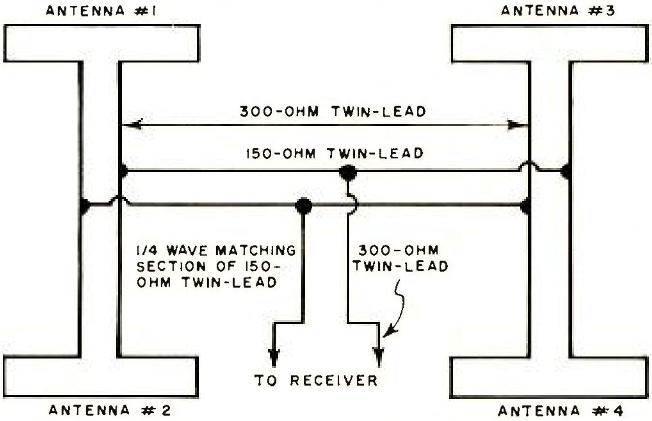
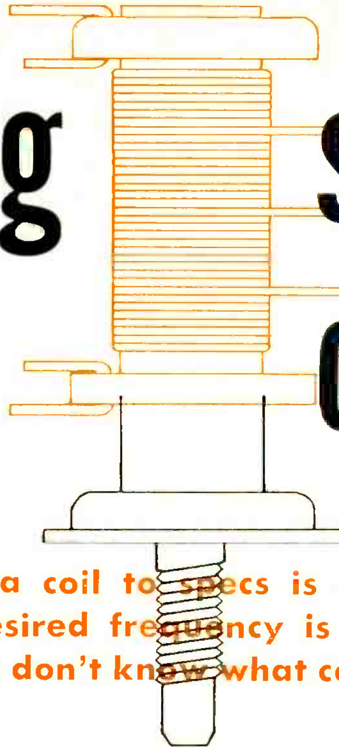


Fig. 3. Mechanical arrangement of eight folded dipoles in a system. Pickup and rejection angles are shown in Fig. 2.

Fig. 4. Impedance matching a system of four folded dipoles.





Using slug-tuned coils

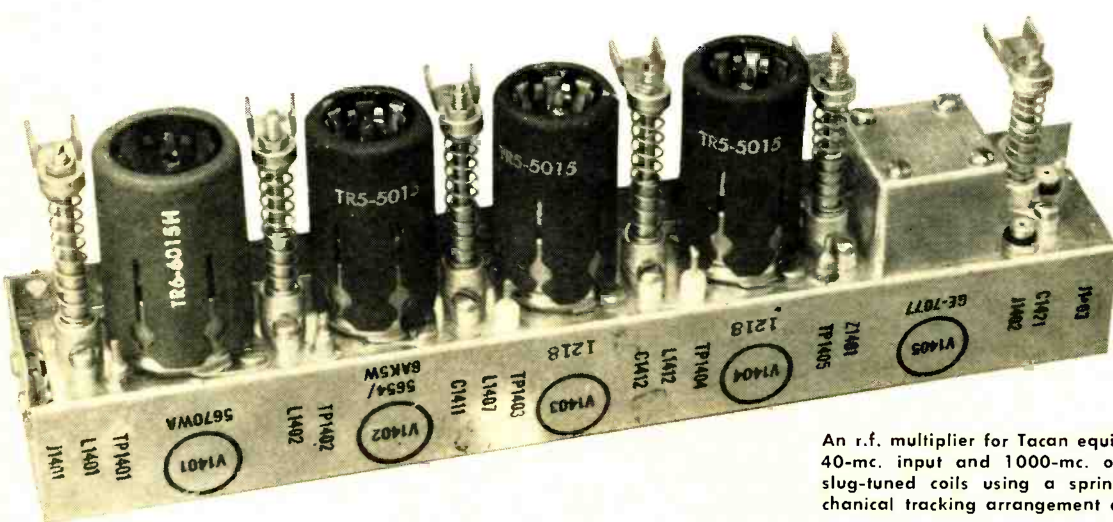
Winding a coil to specs is easy. Making it resonate at the desired frequency is another story, especially when you don't know what core material is being used.

By JOSEPH TARTAS/ITT Laboratories

AFTER building an electronic gadget from a construction article, it is very frustrating to have to drastically prune coils or change trimmer capacitor values in order to make the tuned circuits hit the correct frequency. Why does this have to happen? The explanation often lies in the words of the article; "... the coil was wound on a surplus ½-inch diameter, slug-tuned form," or "... the coil was wound on a ⅜-inch form with an adjustable core." No mention is made of the type of core material used.

A look through several parts catalogues reveals some very interesting facts about coil forms and associated cores (often called slugs). Some catalogues list only pre-wound coils with no choice of core type, some stock forms only but give no choice of core material, while others list a variety of coil forms and core material but only by the manufacturer's part number. Most catalogues usually give no information as to the differences among core materials and means of identifying them.

To properly understand the differences among cores, the core material must be judged by its effect on the coil. The two terms commonly associated with coils and tuned circuits are "Q" and "μ." "Q" is the figure of merit of the coil or tuned circuit and is the ratio of energy stored to the energy dissipated per r.f. cycle. "Q" can be made to vary by introducing a core within the coil, as the amount of losses will increase with the introduction of a core into a coil that formerly had air as the dielectric. The greater the loss, the lower the "Q" of the core, hence the lower the resulting "Q" of the coil and tuned circuit. Permeability (μ) defines how the inductance of the coil is affected by the introduction of the core and therefore the amount of frequency change that results. As a general rule of thumb, permeability is inversely proportional to "Q" at any one frequency. The highest permeability core has the lowest "Q" at the highest frequency, and the lowest permeability core has the highest "Q" at the higher frequencies. Therefore, it is necessary to make the proper selection of core material to produce the most desirable results possible.



An r.f. multiplier for Tacan equipment having 40-mc. input and 1000-mc. output. Special slug-tuned coils using a spring-loaded mechanical tracking arrangement are employed.

All standard tuning slugs or cores are made in accordance with specifications established by the Metal Powders Association. Although each coil manufacturer has his own catalogue designation for the type and size of core, the basic material is always identified by a "basic material" designation and color code.

The mixes and color codes are shown in Table 1, as well as the frequency ranges recommended by some manufacturers. Note that there are a few inconsistencies in the table which may account for some confusion in core selection.

The mixes are composed of various types of powdered-iron compositions using a plastic binder and compressed into the desired core dimensions. The characteristics of the core depend on the type of iron and percentage of iron to binder in the mix, as well as the size of the iron particles.

Because these ratios are closely controlled, there is excellent conformity between cores of the same type and similar cores from different manufacturers. The greatest variations are among core types.

This relationship is best shown by the graphs (at right), based on actual measurements. In the graphs, C_T is the tuning capacitor of the tuned circuit being checked. The curves shown are only representative and will vary to some extent with:

(1) Length of winding relative to form and core length, and length-to-diameter ratio of coil and core.

(2) Type of winding: *i.e.*, solenoid, multi-layer, space-wound, close-wound, or bi-filar.

(3) Size of wire. This affects winding length, "Q," and coil capacitance.

(4) Presence of taps or secondary windings. There are multiple effects of mutual inductance, lead inductance, and capacitance from one winding to the other.

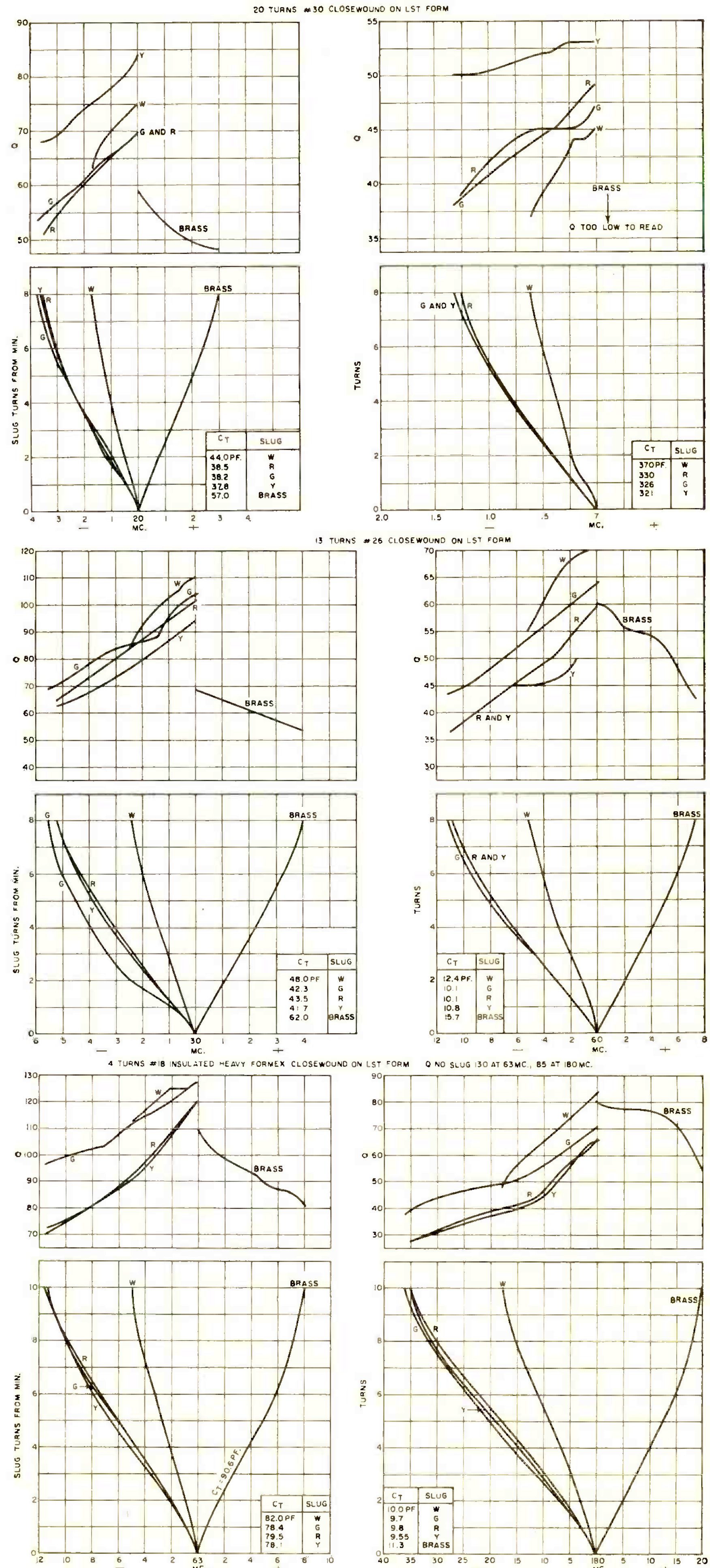
(5) Types of terminals used on the coil form. Some types can reduce coil "Q" by more than 30%.

(6) Position of the winding on the form relative to the starting position of the core and the ratio of the core diameter to the coil diameter.

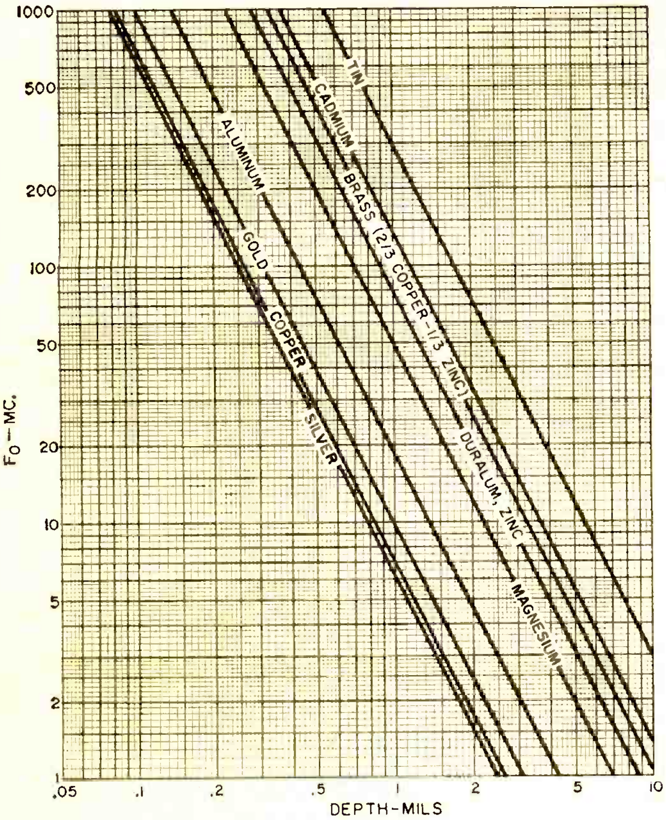
(7) The size and material of the core adjusting screw. A brass screw reduces "Q" and inductance a small amount, while an iron screw lowers "Q" considerably, but increases inductance by a small amount.

Non-Ferrous Cores

In addition to powdered iron cores, brass, copper, and silver are often used



The effect of various types of slugs on the frequency and "Q" of tuned circuit. ►



Skin penetration of various conductors changes with frequency.

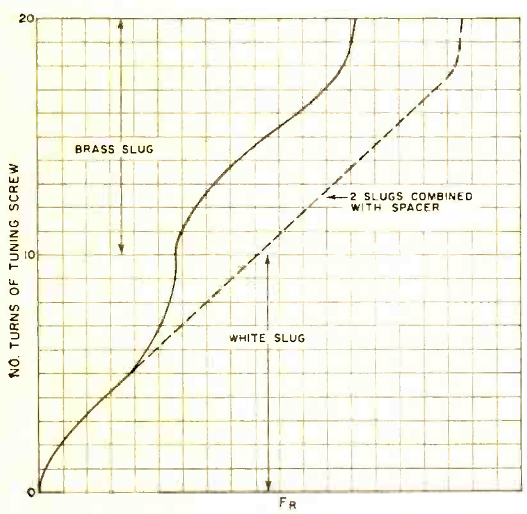


Fig. 1. The dashed curve shows the tuning range of a coil when a brass slug is combined with a white color-coded one (IRN-9), with the two separated by an insulating spacer.

at the higher frequencies (50 mc. and above). Because of skin effect, r.f. currents tend to travel more on the surface at the higher frequencies, therefore a thin metal sleeve will do the same job as a solid core. For this reason, non-ferrous cores may be found in a variety of combinations. Copper, silver-plated brass, or a silver sleeve with a plastic core, will provide similar tuning effects, although the latter type would have less of a capacitance shunting effect.

As brass, silver-plated brass, and solid silver produced the same results in the measured tests, only one is shown in the graphs.

Non-ferrous cores produce the opposite effect on a coil than does a powdered-iron core. An iron core increases the magnetic lines of force within the coil, and since inductance is dependent on the strength of the magnetic field, it is therefore increased.

Brass or silver cores act like a shorted turn thus reducing the effective coil inductance. Losses due to this type of core will depend on the effective r.f. resistance of the metal. If the coil and core are considered as a transformer, and the secondary winding core has a low resistance, the power dissipated in the secondary due to the high secondary current, will then be reflected as a relatively low impedance across the primary. If the secondary has a low r.f. loss, it will appear as a minimum reflected load on the primary. In this case, little power is dissipated and the "Q" will be high because "Q" is the ratio of power stored to power dissipated per cycle. It can be seen that the highest "Q" results when the least power is dissipated in the core.

Since the current flows mainly near the surface at the higher frequencies, a thin silver plating can be used to provide a low-loss path for these currents. The non-ferrous core is, as a result, only efficient above approximately 50 mc. where the "Q" is as high, or higher than, the best powdered-iron core. As the effective non-ferrous core "Q" goes up with frequency, the powdered-iron "Q" decays rapidly. Variation in inductance is smaller with the brass or copper core but is more desirable at these frequencies.

Composite Cores

The tuning range of a coil may be greatly extended by combining two types of cores separated by an insulating spacer on the same tuning screw. Fig. 1 shows the typical tuning curves of the same coil using a powdered-iron (white color-coded) and a brass core, together with the resultant range when the two cores are properly combined.

Some manufacturers of coil forms attempt a crude approach to this composite curve by combining an iron core with a brass core on the tuning screw. This combination defeats its own purpose by putting the brass and iron in too close proximity and not providing a spacer between them to make the change more linear. This also reduces the amount of available travel for the composite core. To be more effective, the composite core must start at the minimum inductance position and be able to travel far enough to reach the maximum inductance position.

Table 1. Characteristics of various types of commonly used core materials.

Color Code	Approx. μ	Basic Material	Recommended Frequency Range in Mc. Radio Cores Inc.	H. L. Crowley & Co.	Delevan Electronics Corp.	Cambridge Thermionics Corp. (CTC)
Yellow	30	Carbonyl-C	.1-1.5	.01-1.5	.3-1.0	.2-1.5
Red	12	Carbonyl-E	.5-10	.5-5.0	.5-20	1-20
Purple	10	Carbonyl-TH	10-30	2-20	no equiv.	2-40
Blue	5	Carbonyl-SF	30-50	10-30	.2-100*	4-300
Green	10	Carbonyl-J	40-140	30 and up	20-150	20-50
White	3	IRN-9	50-200	50 and up	not given	30 and up

*Designated by Delevan as ferrite instead of Carbonyl-TH.

Conclusion

Proper selection of both coil form and tuning slug will usually yield the desired results. Once the correct coil and core configuration has been arrived at, the coils and their tuning ranges can be duplicated in almost unlimited quantities, with excellent duplication of characteristics, with a minimum of difficulty.

If an existing coil does not perform adequately, the tuning range may be extended, reduced, or shifted by replacing the present core with a different type of material, permeability, or "Q." ▲

This G-E transistorized mobile communications equipment is furnished with a rugged controlled-reluctance microphone.

MICROPHONES FOR COMMUNICATIONS

Types, characteristics, sensitivity ratings, and special features for two-way radio, CB, and amateur applications.

By R.L. CONHAIM

EVER since Alexander Graham Bell's cry, "Mr. Watson, come here, I want you!" heralded the first successful telephone in 1876, what we now call the microphone has been an indispensable part of voice transmission. It is the common denominator of all voice-modulated communications equipment.

Microphones for communications equipment are not vastly different from those used in broadcast work, but they have been developed to meet the special requirements found in mobile and fixed-station communications equipment. Especially in mobile work, communications microphones must meet the stringent requirements of extremes in temperature, humidity, and barometric pressure. And, they must be designed to operate under high ambient noise conditions. Unlike broadcast and recording microphones, where wide frequency response is a "must," most communications microphones are designed to have their greatest response in the 250-3500 cps voice-frequency range in order to provide maximum "talk-power."

Communications microphones can be classified in many ways—by type of element, method of operation, intended use, directional characteristics, or even by cost. The most common method of broad classification is by type of element—carbon, crystal or ceramic, and magnetic. All are used in communications, the particular type depending upon the associated equipment and its intended use.

Microphones are further classified by their mode of operation. Pressure microphones, those most widely used, have their diaphragms exposed to sound from one side only and displacement of the diaphragm is proportional to the instantaneous pressure developed by the sound waves.

A velocity-operated microphone is one in which the electrical response corresponds to the particle velocity which results from the propagation of a sound wave through the air. These microphones are sometimes called pressure-gradient types and are represented in communications work by certain kinds of noise-canceling and cardioid microphones which will be discussed later in this article.

Types of Microphones

Carbon Microphone. One of the oldest types of microphones is the carbon. At one time, it was popular in broadcast use. Now, it is widely used in mobile communications. The carbon microphone operates on the principle of the change in resistance in carbon granules, caused by sound pressure striking a diaphragm which is physically connected to the granule-containing cup or carbon "button." This alternate pressing and releasing of the carbon granules results in an increase and decrease of electrical resistance. Direct current, which flows through the granules, is thus altered at an audio rate corresponding to the original sound waves. Unlike other basic types, the carbon mike requires a source of d.c.

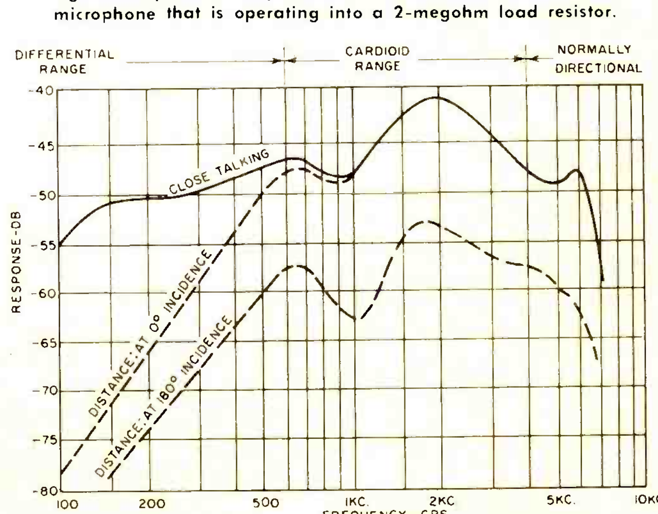
Because of its exceptional ruggedness and satisfactory voice-frequency response, the carbon microphone has been deservedly popular in mobile communications work. Its high output makes it the microphone of choice where a saving in audio circuit components is desirable. Carbon microphones are relatively immune to changes in temperature, humidity, and barometric pressure.

The carbon microphone does, however, have a number of disadvantages. Occasional packing of the carbon granules, due to excess current and switching transients, results in reduced output. This can generally be relieved by light tapping. Background hiss is also common in carbon microphones and is caused by random movement of the carbon granules. This generally increases with age, resulting in higher noise levels.

Because of these disadvantages and with the development of tiny transistor amplifiers, the carbon microphone is being replaced in some communications work by the transistor-amplified dynamic or controlled-reluctance type.

Current for carbon microphone operation may be taken from the cathode circuit of an audio stage, usually the output stage, because of the larger current available at that

Fig. 1. Response of Euphonics C47D ceramic noise-canceling microphone that is operating into a 2-megohm load resistor.



Shure 545 cardioid dynamic. Sonotone CMC-10A ceramic. American D11 dynamic. E-V 729 ceramic. Astatic G10-C ceramic. Turner 500 dynamic.

Some examples of typical base-station communications microphones.

point. The carbon mike is usually connected to the first audio stage *via* a transformer since it has low-impedance.

Crystal Microphone. Operating on the principle of piezo-electricity, the crystal microphone employs a diaphragm connected to a crystal element made of Rochelle salts. Sound pressure causes a twisting or bending of the crystal element, resulting in the generation of potentials of approximately the same pattern as the sound waves causing them. The output of the crystal mike can be connected directly to the grid of the first audio amplifier, without an input transformer or d.c. source, since it is basically a high-impedance device.

Because Rochelle salt crystals can be permanently damaged at temperatures in excess of 130°F, the crystal mike is not commonly used in mobile communications. Temperatures in vehicles parked in the sun can easily exceed the safe point for crystal microphones, so their use for such purposes may be hazardous unless the element is specially protected. They are, however, popular in base stations because of their relatively high output, high impedance, and low cost.

Ceramic Microphone. A microphone quite similar to the crystal, but employing a barium titanate wafer, is the ceramic type. This microphone is much better able to withstand extremes of temperature and humidity and the latest versions have a high output, comparable to crystal microphones. The ceramic mike finds widespread use with low-cost transmitters such as Citizens Band units. Like the crystal mike, it can be connected directly to the first audio amplifier grid because of its fairly high output and high impedance.

Dynamic Microphone. Like a PM speaker, this basic form of microphone consists of a light coil form on which are wound a few turns of wire. The moving coil, connected to a diaphragm, is fitted into an annular magnet. As the diaphragm moves in response to sound energy, current is generated in the voice coil, which is proportional to the magnitude of the original sound waves. Latest versions employ diaphragms made of plastic materials which are fairly immune to temperature and humidity effects.

Dynamic microphones are made in a wide variety of types and their directional characteristics can be altered by varying the design configurations. While basically a low-impedance device, the dynamic microphone often includes a built-in transformer permitting either low- or high-impedance operation. A low impedance of as little as 20 ohms is found in some types and as high as 100,000 ohms in others. Because it is basically similar to a loudspeaker in construction, dual-purpose speaker-microphones operating on the dynamic principle can be found in some CB transceivers and portable units. Here, the dynamic unit serves as a microphone during transmission and as a speaker during reception.

Controlled-Reluctance Microphone. The controlled-reluctance or balanced-armature microphone is related to the dynamic type, but its method of operation is different. In this type, a light armature is connected by a drive pin to the diaphragm. This armature is set within a fixed coil, consisting of many turns of fine wire. The free end of the armature, placed within a magnetic gap, sets up a varying magnetic field as it vibrates in response to sound pressure. Audio-frequency currents are thus induced in the fixed coil. As with dynamic types, the controlled-reluctance microphone is available in both medium- and high-impedance versions. This type of microphone is also available with built-in transistor amplifier so that it is directly interchangeable with high-output carbon microphones.

Special Features

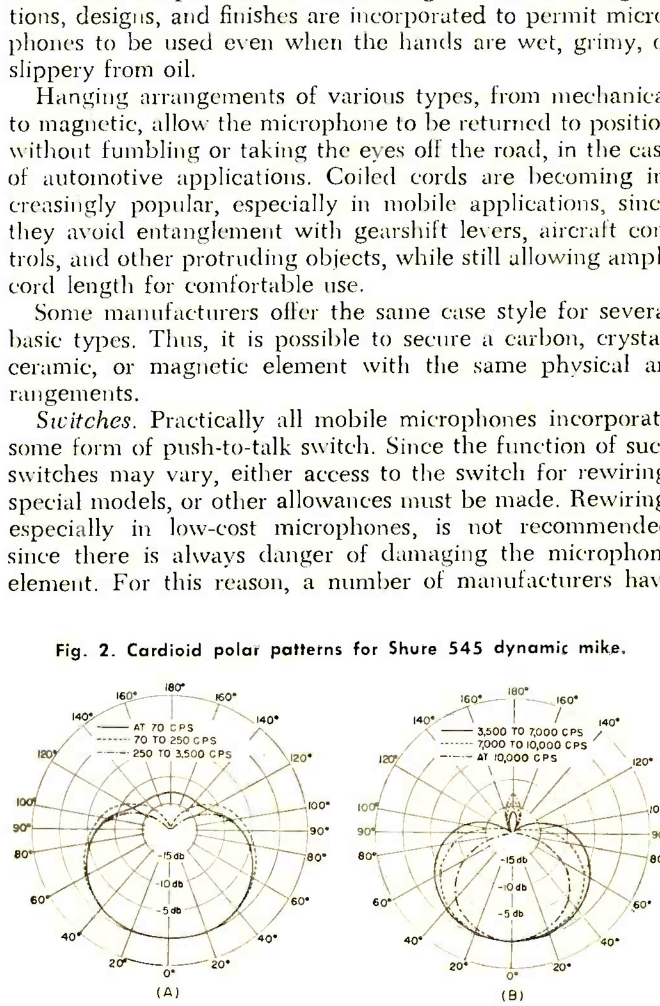
Case Designs. Especially in mobile microphones, compact, hand-fitting, close-talking designs are essential. Both plastic and metal cases are in wide usage. Plastics offer light weight and ease of handling, especially in extreme temperatures and modern plastics are exceptionally rugged. Lightweight aluminum cases are preferred in some designs. Various configurations, designs, and finishes are incorporated to permit microphones to be used even when the hands are wet, grimy, or slippery from oil.

Hanging arrangements of various types, from mechanical to magnetic, allow the microphone to be returned to position without fumbling or taking the eyes off the road, in the case of automotive applications. Coiled cords are becoming increasingly popular, especially in mobile applications, since they avoid entanglement with gearshift levers, aircraft controls, and other protruding objects, while still allowing ample cord length for comfortable use.

Some manufacturers offer the same case style for several basic types. Thus, it is possible to secure a carbon, crystal, ceramic, or magnetic element with the same physical arrangements.

Switches. Practically all mobile microphones incorporate some form of push-to-talk switch. Since the function of such switches may vary, either access to the switch for rewiring, special models, or other allowances must be made. Rewiring, especially in low-cost microphones, is not recommended since there is always danger of damaging the microphone element. For this reason, a number of manufacturers have

Fig. 2. Cardioid polar patterns for Shure 545 dynamic mike.



made the same basic microphone available with different wiring schemes and different connectors, as exact replacements for various transceivers.

A wide variety of switching techniques have been incorporated for base-station use. Some microphones feature lift-to-talk, touch-to-talk, grasp-to-talk, push-to-talk, or locking switches. And, some even include combinations of these features. In other cases, switching devices are included in base-station consoles so that the microphone itself need not have a switch.

Designs for Base Stations. Since the type of usage varies so widely in base-station applications, a great number of designs and accessories are available. Special stands and holders, flexible gooseneck designs, combination headphones and miniature microphones, or telephone handset styles are offered to fit a particular application. Where the base-station operator needs his hands free, perhaps for typing, foot switches or voice-actuated (vox) devices have been used.

Differential or Noise-Canceling Microphones. Because many communications applications involve areas of high ambient noise, such as in light aircraft and automobiles, special noise-canceling microphones, called differential types, have been developed. These techniques were first used with carbon microphones, but are now available in ceramic, dynamic, and controlled-reluctance types as well. The differential principle incorporates two apertures leading to the microphone. When the microphone is close-talked, as it must be in this application, the desired sound enters only one aperture before striking the diaphragm. Sound arriving from a distance of more than several inches enters both apertures. Since the effect of this unwanted sound on the diaphragm is equal and opposite, there is a cancelation effect of the unwanted noise. Some noise-canceling microphones exhibit a differential effect over a confined frequency band while others are noise canceling over a considerable range of frequencies. (See Fig. 1.) Some types are able to cancel out noise effects so well that the speech of operators comes through crisp and clear, even when ambient noise is so high the operator cannot hear his own voice. These microphones have been used successfully by radio stations when broadcasting from light aircraft and helicopters. Such microphones may incorporate a rubber lip guard to insure that the microphone is kept the proper distance from the mouth. This distance is quite critical in such designs if maximum noise canceling is to be obtained.

Unidirectional Microphones. In base-station use, where high noise is present in some directions, unidirectional or so-called cardioid microphones are often used. This microphone design derives its name from the shape of its response polar pattern, which resembles a heart. (See Fig. 2.) Such a design has high sensitivity from a single direction with very little pickup from the back or sides of the microphone. In the better designs, this characteristic is maintained over the entire frequency range of the mike.

One method of accomplishing cardioid response patterns is by the use of ports which provide a controlled combination of pressure and phase shift to cancel sounds from unwanted directions. Where surrounding area noise is not present, the directional pattern is not a factor. However, many base stations cannot afford the luxury of a recording-studio type of location and as there is usually the clatter and noise of office machinery, people talking in the background, reverb, or the conversations of other operators, directional characteristics must be considered.

Shaped Responses. Physical configurations are often employed in communications mikes to alter the natural response of the basic element. In this way, natural resonance peaks can be damped. A crystal microphone, for example, may have a natural resonance peak at about 3000 cycles. Such a peak may be as much as 20 db higher than the response at 1000 cps. Since this is the area where sibilance, the hissing "s" sounds occur, special mechanical damping can be used to alter the response curve. This is especially desirable where a microphone is used for single-sideband transmitters. (See Fig. 3.)

Frequency Adjustments. The physical, rather than the electrical, construction of certain microphones permits the adjustment of frequency response. Low-frequency response in one type, for example, may be changed by sealing off two of the three color-coded parts and leaving the third open. In this way, a low-frequency cut-off of 40, 80, or 160 cps may be selected. High-frequency cut-off can be adjusted for 20 kc. or 10 kc. by turning a screw concealed beneath the center grille cap. (See Fig. 4.)

By other mechanical construction techniques, output can be limited or the response curve altered from the natural response of the element to make the microphone more suitable for communications applications.

Microphone Sensitivity Ratings

To many technicians, the most confusing microphone specification is sensitivity. It is confusing because there are a number of ways to rate a microphone and, unfortunately, there is little consistency among manufacturers. Ratings are usually made at a frequency of 1000 cps. All ratings are normally given in db, the figure invariably being a minus quantity. Thus the microphone with the smallest numerical minus db rating is the one with the greatest output, specified conditions being equal. A microphone with a rating −30 db is thus more sensitive than one with a −55 db rating. But the catch is that a decibel rating is nothing but a comparative ratio and has no fixed value unless the rating conditions are specified.

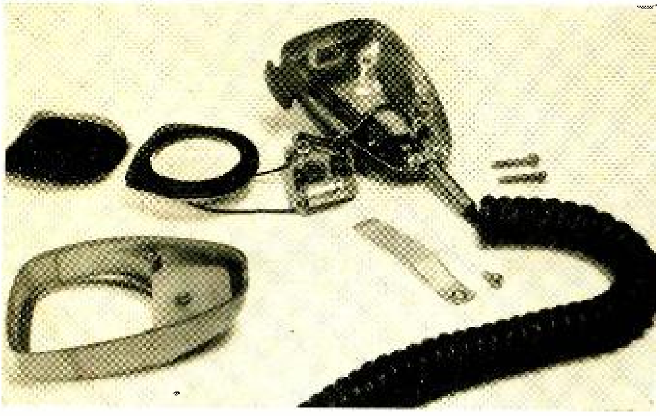
The EIA has established a standard rating technique but not all manufacturers use it. The EIA microphone rating (G_M) is defined as the ratio in db relative to 0.001 watt and 0.0002 dyne per square centimeter of the electrical power available from the microphone to the square of the undisturbed sound field pressure in a plane progressive wave at the microphone position. The formula is:

$$G_M = (20 \log_{10} \frac{E}{p} - 10 \log_{10} R_{MR}) - 50 \text{ db}$$

where E is the open-circuit volts generated by the micro-

Some examples of typical microphones designed for use in mobile communications.

Electro-Voice noise canceling 717 ceramic. Astatic 332 crystal. Euphonics C47D noise-canceling ceramic. American B2135 ceramic type. Shure 488 noise-canceling controlled-reluctance. Turner 355C ceramic.



Motorola dynamic mike with built-in transistor amplifier.

phone, p is the undisturbed sound field pressure in a plane progressive wave at the microphone position in dynes/cm.²

$$20\, log_{10} \frac{E}{p} \text{ is the normal field response}$$

R_{MR} is the categorical rating impedance considered as a pure resistance and taken from a table in EIA specification SE-105. This is usually not the actual impedance of the microphone.

EIA ratings are characteristically lower than those usually employed. A typical rating might be −145 db for a fairly sensitive microphone.

Other ratings in common use are: (1) Open-circuit voltage for a sound pressure of 1 dyne/cm.² in which 0 db is 1 volt. (2) Open-circuit voltage for a sound pressure of 10 dynes/cm.² in which 0 db is 1 volt. (3) Output power for a sound pressure of 1 dyne/cm.² in which 0 db is 1 milliwatt. (4) Output power for a sound pressure of 10 dynes/cm.² in which 0 db is 1 milliwatt.

However, these are by no means all the rating systems used. In some cases, especially for close-working microphones, the output for a 100-microbar sound pressure might be used in preference to some other rating system.

Meaning of Rating Terms

The dyne-per-square centimeter is most often used as a measurement of sound pressure. The dyne is a unit of force and is defined as the force that produces an acceleration of one centimeter per second on a one-gram mass. The unit "microbar" is also widely used in microphone rating systems, but it need not cause confusion if you remember that a microbar is equal to one dyne per square centimeter.

A pressure of 0.0002 dyne/cm.², as used in the EIA rating system, is the lower limit of audibility, the threshold of hearing. A man, speaking in a normal tone of voice at a distance of one foot from the microphone, will produce a sound pressure of about 10 dynes/cm.² When speaking with his mouth very close to the microphone, as is common in mobile work, the peak sound pressure is about 100 dynes/cm.²

While it is possible to convert one rating system to another, this is not always advisable and can be misleading. Crystal and ceramic microphones are usually rated in terms of voltage because their internal resistance is small compared with the load resistance. Their output voltage at middle and high frequencies is approximately constant for widely different values of load resistance.

A crystal or ceramic microphone cannot be rated in terms of power and other types can only be compared with crystal and ceramic mikes on the basis of the voltage on the unloaded grid circuit. If a voltage rating is used for a low-impedance microphone, the impedance across which the voltage occurs must be stated or the rating is meaningless.

Other things being equal, converting from 1 dyne/cm.² to 10 dynes/cm.² involves a change of 20 db, while converting to 100 dynes/cm.² involves a change of 40 db.

Because of these widely varying rating techniques, most of which are not clearly understood by the uninformed user, the manufacturers of microphones are often reluctant to use a common rating technique. For example, we could take one microphone with an EIA system rating of −151 db and compare it with another microphone with a rating of −57 db referenced to 1 volt/10 dynes/cm.² Casual comparison would indicate that the −57 db rated microphone is much more sensitive. But when it is remembered that the EIA rating is referenced to a sound pressure of only 0.0002 dyne/cm.², a little calculation will show that these microphones have exactly the same sensitivity, assuming they both have the same impedance, for the difference between 0.0002 dyne/cm.² and 10 dynes/cm.² is approximately +94 db. Adding this +94 db algebraically to the EIA rating of −151 db, we come up with −57 db.

For these reasons, some microphone manufacturers rate their units in a number of different ways so that comparisons can be made although, as mentioned before, comparisons can be dangerous. You obviously would not want the same sensitivity in a microphone designed for close-talk use as for one designed to be used a foot away. Unfortunately, some manufacturers will give a db rating without any indication of the reference level and this is meaningless. Usually, such ratings are based on the high-impedance equivalent to 1 dyne/cm.², in which 0 db = 1 volt, but unless these conditions are stated, the user simply cannot be sure of the sensitivity.

Care of Microphones

Microphones, at best, are sensitive precision devices which should not be subjected to unnecessary jarring or dropping. The microphones provided with communications equipment have been selected by their manufacturers for optimum operation with the transmitter in question. Replacement by other types should be avoided unless special applications require the use of a different mike. Even in this case, the user or service technician should check the new mike with the transmitter to be sure it will produce the desired modulation.

Crystal or ceramic microphones should never be connected to points where appreciable voltage is present or severe damage may result. Given reasonable care, a communications microphone should last for years. ▲

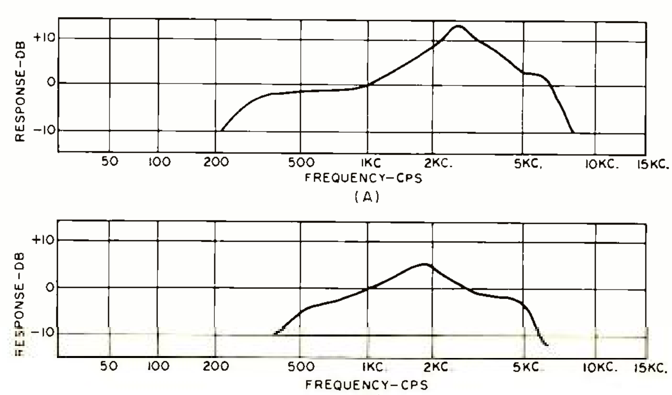
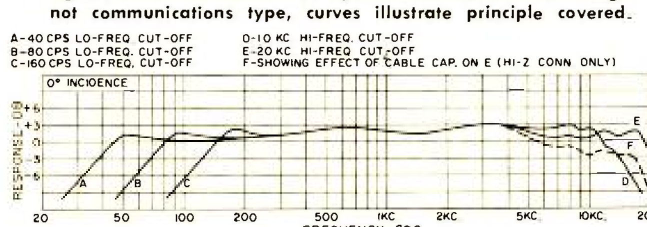


Fig. 3. (A) Normal peaking at 3 kc. for Astatic 10C crystal mike. (B) Reduced peak in 10D dynamic designed for SSB use.

Fig. 4. Curves for Turner 401 dynamic broadcast mike. Though not communications type, curves illustrate principle covered.



JOHN FRYE

Modern non-electrolytic fixed capacitors are offered in various forms and must be "hand-picked" for specific job.

CAPACITORS—an INFINITE VARIETY

BARNEY was already at work when Mac, his employer, marched in and thumped an armload of papers and booklets down on the bench.

"There is some homework for you," he said to the youth.

"What the heck is it?" Barney asked, eyeing the pile suspiciously.

"Dope on non-electrolytic fixed capacitors," Mac explained. "The article 'Modern Capacitors' by John R. Collins in the May, 1963 issue of ELECTRONICS WORLD painfully reminded me of how dated was my knowledge of the new bypass and coupling units we are encountering in our work. I wrote every capacitor manufacturer whose products are listed in our big electronics wholesale catalogue and asked for all available material on their non-electrolytic capacitors. That seven-pound stack of paper is the result. I've been plowing through it at home nights and now I feel somewhat like the little girl who began her essay on frogs by admitting that in preparing it she had learned more about frogs than she really cared to know. You'd never think a simple device like a capacitor, which consists essentially of two conducting plates separated by a dielectric, could take so many different forms."

"Why don't you sort of brief me on what you've learned?" Barney suggested hopefully. "That way I won't have to read so much."

"Okay, but don't flatter yourself you've conned me. I know you're more interested in getting out of work than in learning about capacitors. However, I also know the best way to 'set' new information in the mind is to try to explain it to someone; so here goes: I have material here from *Aerovox, Arco-Elmenco, Centralab, CDE, Mallory, Sangamo, Sprague,* and *Vitramon*. All the major companies manufacture equivalent types of the most popular capacitors, but there are subtle differences among them that can be learned only by comparing specifications and test data each company will be glad to supply. In addition, practically every company has one or more specialties of which it is particularly proud."

"What's the best capacitor?" Barney wanted to know.

"There's no such animal," Mac answered promptly. "Every type has some advantages and some drawbacks. You have to ask which is the best capacitor for a specific application and supply answers to questions like these: Will a.c., d.c., or a combination of both be applied to the capacitor? How much voltage will be applied? In what temperature range must the capacitor work? What frequency will be applied to it? How much d.c. leakage can be tolerated? Is weight important? Is size? Will the capacitor be exposed to radiation? Must it work at high altitudes? Will there be vibration? How about humidity? Is the capacitor to be used in a wired or a printed circuit? Will it be installed by hand or by automatic machinery? Does an urgent need for long-term stability or reliability warrant the extra cost of premium high-reliability types?

"When I first started working on radios back in the twenties, only two types of capacitors—we called them condensers—were in use: the foil-and-paper unit used in B-eliminators for filtering and the mica capacitors used sparingly in the battery-type receivers. Oddly enough both types of capacitors are still popular, but they've certainly been improved. The first cartridge capacitor consisted simply of alternate layers of paper and metal foil rolled into a cylinder and shoved into a cardboard tube. Sealing wax poured into the ends of the tube afforded protection against moisture and gave support to the axial leads. Later the whole capacitor was dipped in soft wax to give further moisture protection. These units were not very satisfactory. The wax coating softened with heat and dripped onto the bottom of the cabinet. The sealing hardened and shrank, allowing moisture to enter and leaving the leads without support."

Mac pulled a little notebook from his shirt pocket and explained. "As I read, I tried to make notes on the comparative virtues of modern capacitors. While these are probably somewhat over-simplified, they serve as a rough guide as to why each version has been developed and where each type can best serve.

"Modern paper capacitors are hermetically sealed in cases of molded plastic, glass, or metal; or are sheathed by being dipped in a phenolic resin. In many cases the capacitor is vacuum impregnated with wax or mineral oil, according to the voltage rating. Leads will withstand a pull of several pounds and can be bent back and forth without danger of breaking or coming loose from the foil.

"Substituting a Mylar film for the paper adds about 30% to the cost and subtracts the same amount from the size. Mylar more than doubles the insulation resistance and permits operation at a higher temperature, but there is more change in capacitance with a change in temperature. Combining Mylar and paper dielectrics produces a capacitor of very superior reliability. It costs more than twice as much as our paper type, but the temperature coefficient is almost as good as that of the paper type, and the increased reliability in critical applications is worth the extra cost.

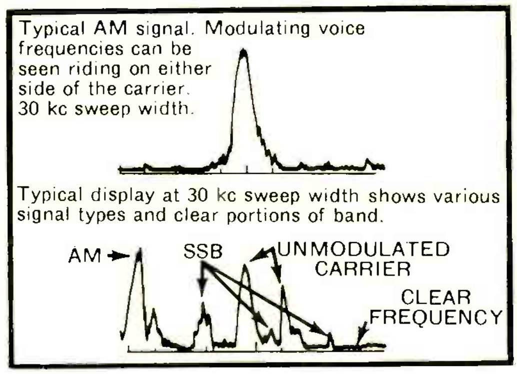
"More than 40% reduction in size can be made in our basic paper capacitors by getting rid of the metal foil and substituting a metallic film deposited right on the paper. The cost is only 20% greater and a voltage puncture of the paper will often burn away the film in the punctured area and automatically cure the short circuit. Insulation resistance, though, is only about 1/10 that of paper-and-foil. Metallized Mylar costs about twice as much as paper but is only half the size. Otherwise, its virtues and shortcomings are about the same as Mylar-foil types.

"Employing a polystyrene film produces a capacitor about twice the size of our paper unit, but it has an almost-perfect temperature coefficient and about five times the insulation resistance. It lacks, however, the temperature range of the paper unit. When the dielectric film is Teflon, you retain the high insulation resistance and the capacitor will operate up to 200°C, but you have to pay ten times as much as for paper and the Teflon capacitor is adversely affected by radiation."

"I begin to see why you say there's no universal best ca-

WATCH IT, HAMS & CBers

MODEL
HO-13



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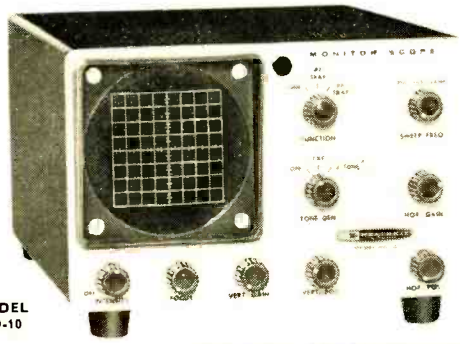
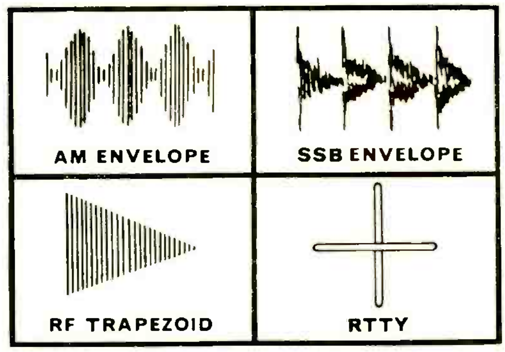


MODEL
HO-10



...AND THE HEATHKIT® SIGNAL MONITOR

Add "sight" to "sound" in amateur & CB radio operations. With the new Heathkit HO-13 "Ham-Scan" Spectrum Monitor and HO-10 Signal Monitor you add the extra convenience and versatility of "sight" to ham & CB communications. You can visually observe if your signal is clean and undistorted while monitoring band conditions . . . you have the advantage of "seeing" what's happening during transmission and reception! And best of all you can add both of these superb units to your station facilities at savings you never before thought possible. Check the features below and see what an outstanding value they represent!

New Heathkit "Ham-Scan" Spectrum Monitor . . . HO-13 Another Heathkit First! The Heathkit "Ham-Scan" is the first Spectrum Monitor in easy-to-build kit form! Operates with virtually all receivers & transceivers in amateur & CB service today.

Continuously samples up to 100 KC of band! You can visually observe all signals appearing up to 50 kc on either side of the station to which you are tuned . . . even identify signals as to SSB, AM or CW type. Clear portions of the band, DX stations, and VHF "band-opening" signals are easily spotted above or below your receiving frequency. It will also prove useful in checking carrier and sideband suppression of SSB transmitters and aid in identifying "splattering" received signals. As you tune your receiver the display moves horizontally across the baseline with your receiver frequency always appearing in the center of the screen.

Order Now! Be one of the first to enjoy the many advantages this *most-requested* "Ham" accessory has to offer . . . use the handy coupon at right!

Kit HO-13 . . . 11 lbs. $79.00

SPECIFICATIONS—Receiver IF: 455, 1600, 1650, 1681, 2075, 2215, 2445, 3000, 3055, 3395 kc. **RF Amplifier—Response:** ±0.5 db at ±50 kc from receiver IF. **IF—**350 kc. **Sensitivity:** Approx. 100 uv input for 1" vertical deflection at full gain setting. **Horizontal Deflection—Sweep generator:** Linear sawtooth, recurrent-type (internal). **Frequency:** 10 to 50 cps, variable. **Sweep width:** 30 kc or less, to 100 kc ±20%. Continuously variable. (Approx. 15 kc to 100 kc for 455 kc IF). **Resolution:** 1.5 kc (frequency difference between two 1" pips whose adjacent 3 db points coincide. Measured at slowest sweep speed and at 30 kc sweep width). **Power supply:** Transformer operated, fused at ½ ampere. **Low voltage:** Full wave voltage-doubler circuit provides 250 volts @ 20 ma, & 580 volts @ 6 ma. **High voltage:** Half wave circuit provides -1600 volts @ 1 ma for CRT. **Power requirements:** 120 volts AC, 50/60 cps, 40 watts. **Tube complement:** 3RP1 CRT (medium persistence green trace), 1V2 HV rectifier, 6AT6 detector, 6EW6 RF amplifier, 6C10 sweep generator/horizontal amplifier, (2) 6EW6 IF amplifier, 6EA8 oscillator/mixer, (4) 500 ma silicon diode low voltage rectifiers, crystal diode, IN954 voltage-variable capacitor. **Controls:** On-Off/Intensity, focus, horizontal gain, sweep width, pip center, horizontal position, pip gain, vertical position, sweep frequency/AGC, astigmatism. **Dimensions:** 5¼" H x 7⅜" W x 11" D.

Heathkit Signal Monitor . . . HO-10 Specially designed for Amateur & CB radio use. The Heathkit Signal Monitor provides the perfect answer for visual observation of both transmitted and received amateur & CB signals. Standard coaxial connectors on the rear panel allow simple connection to the antenna system feed line (50-75 ohm). Phono jacks accept all other connections. Complete instructions included.

Displays Envelope, AF & RF Trapezoid patterns. Automatic switching is featured between transmitted & received envelope patterns. On RF trapezoid patterns a clamping circuit is employed to pull the spot "off-screen" during "receive" to prevent burning of CR tube phosphor. The RF trapezoid pattern is especially useful in checking for "flattopping" and non-linearity in SSB linear amplifiers.

Independent of frequency. The HO-10 requires no additional tuning when used with transmitters operating 160 through 6 meters. Handles from 5 watts to 1 kilowatt. Operates with all tube-type receivers having I.F. frequency up to 500 kc. Instructions included for low-power CB use.

Built-in two-tone test oscillator. Simplifies transmitter adjustments and testing. A 4-position RF level attenuator permits easy match to transmitter output power.

Enjoy it now! Add this convenient accessory now . . . enjoy the pride it brings in knowing that your transmitted signal is of the best quality at all times for outstanding communications!

Kit HO-10 . . . 11 lbs. $59.95

SPECIFICATIONS—Vertical response: ±3 db from 10 cps to 500 kc. **Sensitivity:** 500 mv per inch deflection. **Input resistance:** 50 k ohm. **Horizontal response:** ±3 db from 3 cps to 30 kc. **Sensitivity:** 800 mv per inch deflection. **Input resistance:** 1 megohm. **Sweep generator: Recurrent type:** 15 to 200 cps (variable). **Tone oscillators:** Approximately 1000 cps and 1700 cps. **Output voltage:** 15 mv (nominal). **GENERAL: Frequency coverage:** 160 through 6 meters (50-75 ohm coaxial input). **Power limits:** 5 watts to 1 kilowatt output. **Front panel controls:** Function Selector, Sweep Frequency, Tone Generator, Horizontal Gain, Horizontal Position, Vertical Position, Vertical Gain, Focus, Intensity/Off. **Rear control:** Xmtr. Atten. Attenuates 0 to 24 db at approximately 6 db per step. **Power supply:** Transformer operated, fused ½ amp. **Power requirements:** 105-125 VAC, 50/60 cps, 35 watts. **Dimensions:** 5¼" H x 7⅜" W x 10½" D.

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pacitor," Barney offered in agreement.

"There *is* one near-perfect dielectric: mica," Mac admitted. "The *Sangamo* literature says ancient Hindu writings reveal mica was thought to be produced in the earth by lighting and had religious significance. Actually, it was formed in the early stages of the earth's cooling by heat and pressure in the presence of water vapor and magnetic fields. *Arco-Elmenco* says mica is probably the best dielectric presently available when measured in terms of stability, resistance, dielectric strength, Q, dielectric constant, longevity, reliability, chemical inertness, ruggedness, and resistance to puncture and moisture. India Ruby Muscovite mica, of which most capacitors are made, has a dielectric constant of 6.5-7.8 and a dielectric strength of 3000-6000 volts per mil.

"A mica-and-foil capacitor is exceptionally good for carrying heavy r.f. currents because of its low dissipation factor. The mica heats very little even when the capacitor is carrying many amperes of high-frequency current. This is important because the life expectancy of a capacitor is reduced by a factor of approximately ½ by each 10°C rise in the temperature of the dielectric. Where stability is important, as in tuned circuits, the mica capacitor can be improved by firing metallic silver directly on the mica sheets in place of foil. These 'silver-mica' capacitors in molded cases or dipped in phenolic resin are ultra-stable and dependable.

"The *Vitramon* people build a highly reliable capacitor with porcelain as the dielectric. A mosaic of layers of semi-fluid porcelain and silk-screened silver dispersion is built up and then individual capacitors are cut from this mosaic like cookies from a sheet of dough. These highly uniform capacitors are baked for ten hours; leads are attached to the silvered layers; and then the capacitors are fired for fifteen hours at 1200° F to convert them into monolithic blocks of dense porcelain and fine silver requiring no case or hermetic seal. Porcelain capacitors have a very low noise level and are unaffected by a neutron flux of 10^{14} neutrons per $cm.^2$ They are especially effective in handling high-power high frequencies or in tuned circuits.

"But when it comes to packing the most capacity in the smallest space, rutile ceramic dielectric takes the cake with dielectric constants up into the hundreds. Tubular and disc ceramics with their small size and closely spaced leads are ideal for bypassing r.f. and u.h.f. currents right at the tube sockets. Unfortunately—and fortunately—ceramic material displays a considerable change in dielectric constant with temperature. That's why ordinary ceramics should not be used in critical tuned circuits. On the other hand, carefully controlled ceramic material is used in temperature-compensating capacitors. *Centralab*, for example, produces a line of T-C capacitors that vary all the way from positive 100 ppm per °C to negative 5250 ppm per °C. While the usual ceramic capacitor does not come in very large capacity values, *Aerovox* makes a 'rolled ceramic' line that goes up to 2 μf.

"These companies make capacitors for every possible need. Single-ended cartridge types and ceramics with kinked leads are made for installation in printed circuits. Wax-free capacitors are supplied for machine installation so the wax will not foul the machinery. Uncased units are available to save space and for potting. Ultra-stable precise standard capacitors for laboratory measurements are available. Capacitors are built with glass cases to prevent corona at high altitudes. *Sprague*, as well as other companies, manufactures lightweight, large-capacity, high-voltage energy storage capacitors for use with lasers, satellites, and missiles. *Mallory* keeps ahead of demand by producing high-voltage ceramic capacitors for use in TV sets with working voltages up to 30,000 volts. But I can't begin to remember all the types of capacitors produced by these companies. Each basic kind of capacitor has variations in cases, impregnants, terminals, voltage rating, shape, etc. The smart thing for an engineer with a problem to do is to get in touch with his favorite capacitor manufacturer and explain his needs. In many cases, a stock item can be supplied that will solve the problem. If not, most of these companies are willing to produce a custom capacitor that will do the job.

"When you get into that literature," Mac concluded, putting his notebook back into his pocket, "be sure and study the 'Application and Selection Wall Charts' put out by *Cornell-Dubilier Electric*. They show you at a glance how various types of capacitors compare with each other over a wide range of parameters and practically lead you by the hand to the selection of the best capacitor for your needs. A red-blooded, rising young technician like you should find that material more interesting to read than Elizabeth Taylor's diary!"

"About the only faint resemblance I can see," Barney said glumly, fingering the papers, "is that capacitors, like Cleopatra, seem to have 'infinite variety.' "▲

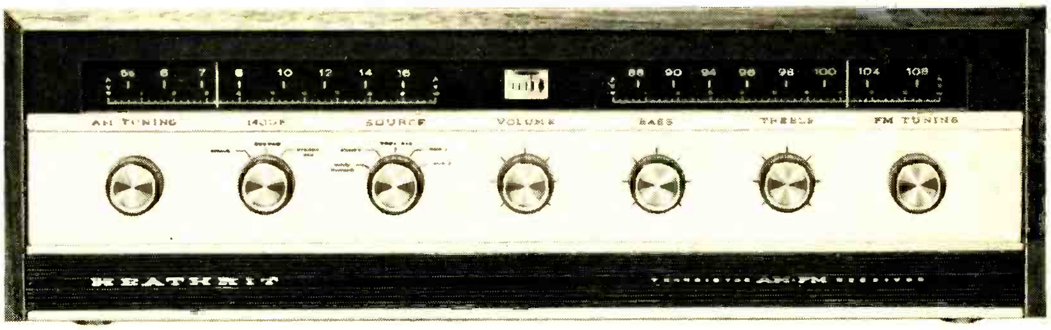
ELECTRONICS EMPLOYMENT

THE Bureau of Labor Statistics, U.S. Department of Labor, has just issued a new edition of its book "Employment Outlook and Changing Occupational Structure in Electronics Manufacturing," a valuable compilation of job opportunities and trends in the field. Projections to 1970 are included.

Copies are 40 cents each from Supt. of Documents, Govt. Printing Office, Washington, D.C. 20402. ▲

what's new at Heathkit?

me!



Thirteen years ago we introduced the "Williamson Type Amplifier Kit". It represented a breakthrough in "do-it-yourself" high fidelity. For the first time a truly high fidelity amplifier was made available in kit form at an "easy-to-afford" price. The old WA-1 and its successors including the famous W-5 provided high fidelity listening pleasure to hundreds of thousands of music lovers across the nation. Ever since, Heath's history has been one of major advances in the hi-fi/stereo field. And now today, another first from Heathkit! Heath's newest . . . an all-transistor Stereo Receiver Kit, incorporating the latest in solid-state circuitry, at a price far below similar units . . . only $195.00!

Now in one compact unit! . . . two 20-watt power amplifiers, two separate preamplifiers, plus wide-band AM, FM, FM stereo . . . all superbly engineered to give you the clean, uncompromising realism of "transistor sound". All with transistor circuitry . . . a total of 43 transistors and 18 diodes . . . to give you the coolest, fastest, most-reliable operation possible! All handsomely housed in a single, smart-looking walnut cabinet with a striking extruded gold-anodized aluminum front panel . . . fashioned in Heathkit's modern low-silhouette styling! This is the beautiful new AR-13. This is the first all-transistor, all-mode stereo receiver in kit form! Compact in size, compact in price!

Many advanced features have been incorporated to make possible the advanced performance of the AR-13. You'll like the way this unit *automatically* switches to stereo, and the stereo indicator light silently verifies that stereo is being received. For all-around versatility there are three stereo inputs (mag. phono and two auxiliary) plus two filtered tape recorder outputs for direct "off-the-air" beat-free recordings. Dual-tandem controls provide the convenience of simultaneous adjustment of volume, bass, and treble of both channels. Balancing of both channels is accomplished by a separate control. The AM tuner features a high-gain RF stage.

Other quality features include an FM local-distance switch to prevent overloading in strong signal areas; a squelch control to eliminate between-station noise; AFC for drift-free reception; heavy die-cast flywheel for accurate, effortless tuning; pin-point tuning meter; and external antenna terminals for long-distance reception. For added convenience the secondary controls are "out-of-the-way" under the hinged lower front panel to prevent accidental system changes. The slide-rule AM and FM dial is fully lighted.

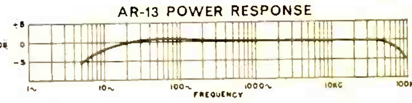
An exciting challenge for the more experienced kit-builder. Takes approximately 35 hours to assemble. The "front-end" and AM-FM I.F. strip are already preassembled and prealigned to aid construction.

Compare the new AR-13 Stereo Receiver with similar units. You'll agree that for advanced features, advanced solid-state engineering, advanced styling, and money-saving *price*, no unit matches the AR-13. Start enjoying the "transistor sound" of tomorrow, *today*, by ordering the AR-13 now!

Kit AR-13 . . . 30 lbs. $195.00

SPECIFICATIONS — Amplifier: Power output per channel (Heath Rating): 20 watts /8 ohm load, 13.5 watts /16 ohm load, 9 watts /4 ohm load. (IHFM Music Power Rating): 33 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 cps to 30 KC @ rated output; ± 3 db from 10 cps to 60 KC @ rated output. **Harmonic distortion** (at rated output): Less than 1% @ 20 cps; less than 0.3% @ 1 KC; less than 1% @ 20 KC. **Intermodulation distortion** (at rated output): Less than 1%, 60 & 6,000 cps signal mixed 4:1. **Hum & noise:** Mag. phono, 50 db below rated output; Aux. inputs, 65 db below rated output. **Channel separation:** 40 db @ 20 KC, 60 db @ 1 KC, 40 db @ 20 cps. **Input sensitivity** (for 20 watts output per channel, 8 ohm load): Mag. phono, 6 MV; Aux. 1, .25 v; Aux. 2, .25 v. **Input impedance:** Mag. phono, 35 K ohm; Aux. 1, 100 K ohm; Aux. 2, 100 K ohm. **Outputs:** 4, 8, & 16 ohm and low impedance tape recorder outputs. **Controls:** 5-position Selector; 3-position Mode; Dual Tandem Volume; Bass & Treble Controls; Balance Control; Phase Switch; Input Level Controls (all inputs except Aux. 2); Push-Pull ON/OFF Switch. **FM: Tuning range:** 88 mc to 108 mc. **IF Frequency:** 10.7 mc. **Antenna:** 300 ohm balanced (internal for local reception.) **Quieting sensitivity:** 2½ uv for 20 db of quieting, 3½ uv for 30 db of quieting. **Bandwidth:** 250 KC @ 6 db down (full quieting.) **Image rejection:** 30 db. **IF Rejection:** 70 db. **AM Suppression:** 33 db. **Harmonic distortion:** Less than 1%. **Multiplex: Bandpass:** ± ¼ db, 50 to 53,000 cps. **Channel separation:** 30 db, 50 to 2,000 cps; 25 db @ 10 KC. **19 KC Suppression:** 50 db down, from output @ 1 KC. **38 KC Suppression:** 45 db down, from output @ 1 KC. **SCA Rejection:** 30 db. **AM: Tuning range:** 535 to 1620 KC. **IF Frequency:** 455 kc. **Sensitivity:** 1400 KC, 3.5 uv; 1000 KC, 5 uv; 600 KC, 10 uv—standard IRE dummy antenna. **Bandwidth:** 8 KC @ 6 db down. **Image rejection:** 30 db @ 600 KC. **IF Rejection:** 45 db @ 600 KC. **Harmonic distortion:** Less than 1%. **Overall dimensions:** 17" L x 5⅜" H x 14¾" D.

AR-13 POWER RESPONSE



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HF-155

Engine-Temperature Indicator

(*Continued from page* 36)

temperature the thermistor must be in order to exhibit this resistance. Record these values and adjust the rheostat for another increment of 1 ma. so that the meter reads about 2 ma. Take the same information again and record all values. Take several more readings throughout the meter range and you will then have a table of values, as shown in Fig. 1A. The meter face may now be marked in degrees F instead of milliamperes.

The calibration method may also be reversed to select round-number temperature figures from the curve, such as 75, 100, 125, etc. Then note the corresponding value of resistance and set the total resistance of rheostat and series resistor to this value. Connect this value of resistance into the circuit and one gets the corresponding meter indication for round figures of temperature. Once calibration is finished, connect the thermistor back into the circuit.

A circuit refinement is to add a series resistor (*R6*) and a zener diode (*D2*) to stabilize the voltage across the bridge as battery load varies. For 6-volt systems, a 4- to 5-volt zener diode is recommended. For 12-volt systems, a 10- to 11-volt zener diode should be employed in the circuit.

The thermistor that was ordered for this circuit came without a curve; however, the author obtained sufficient data from the manufacturer to plot the curve in Fig. 3.

Construction is straightforward and no special layout is needed. The circuit shown here was wired on a 2″ x 3″ piece of circuit board. The thermistor used is a washer type which mounts easily to the engine with one center screw. Note that one side of the thermistor is grounded, therefore it may be mounted to the engine, allowing one side to make electrical contact. See Fig. 1B. *R2* may be grounded to the auto frame at any convenient point.

Note that when the thermistor is mounted, care should be taken that it is not short-circuited by the mounting bolt. If the terminal washer shown in Fig. 1B is made entirely of metal, then the metal spring washer must be insulated from it by using an insulating washer. On the other hand, if the terminal washer is non-conducting, then a lug terminal should be inserted between it and the lead washer in order to make contact with the thermistor. In any event, the thermistor must not be short-circuited.

The unit described has been installed in a 1961 *Volkswagen* with the thermistor mounted to the engine block. It has been in use for several months and performs excellently through all temperature conditions. ▲

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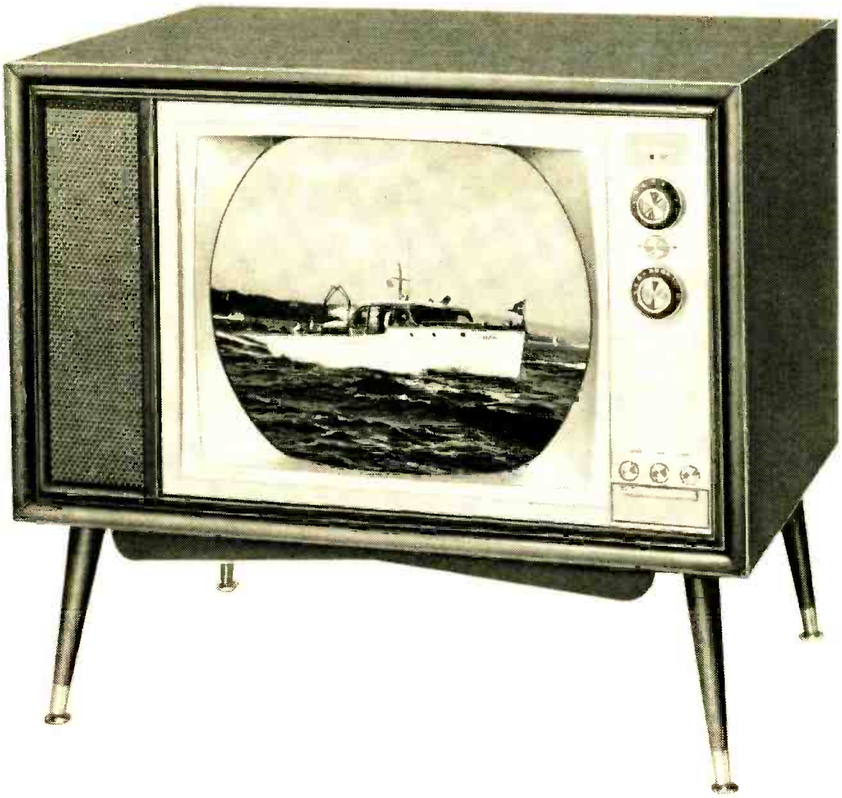

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CL-174

UNIJUNCTION C.W. MONITOR

By JOHN F. CLEARY / Semiconductor Products Dept., General Electric Co.

How to construct an r.f.-powered c.w. monitor using a unijunction transistor. It can also be used to mute the receiver during key-down conditions.

ALTHOUGH it is not generally known, the unijunction transistor will perform at quite low supply voltages. The great majority of circuits using unijunctions are usually operated within a 10- to 25-volt range while recent types, such as the 2N2840, will operate with voltages as low as 1.5 volts. The lower priced 2N2646 will also perform at low voltages and is especially suited for use in the r.f.-powered unijunction c.w. monitor to be described.

Fig. 1 shows this unusually simple monitor. Radio-frequency power taken from the transmitter is rectified by the 1N4009 diode and is used to supply the d.c. operating power to the unijunction relaxation oscillator. No batteries are used since operating power is needed only during "key-down" conditions and, then, depending on tone and tone loudness, only about 400 microwatts to 10 milliwatts will be consumed by the monitor. The simplicity of the monitor can be better appreciated when the unijunction transistor portion of the circuit is more clearly understood. For those not familiar with the unijunction, a brief explanation of how it works will, undoubtedly, help. Further and more detailed information will be found in the list of references at the end of the article.

A voltage applied from point "A" to ground of Fig. 1 will cause two simultaneous actions to take place. *C*3 will slowly charge up through *R*1, the rate of charge being dependent on the applied voltage and the value of *R*1. At the same time, an electric field will be established from base 2 (*B*2) to base 1 (*B*1) of the unijunction, as shown in Fig. 2A.

The *B*2-*B*1 element consists of a *n*-type silicon bar containing electrons as the majority carriers. Since the total resistance of the bar from base to base will range from 4700 to 9100 ohms for the 2N2646, a voltage gradient, as shown in Fig. 2B exists from the base 2 end of the bar to the base 1 end. The emitter, which is connected to the bar at a point approximately midway between *B*1 and *B*2, but somewhat closer to *B*2, will increase in voltage toward point "A" as capacitor *C*3 charges.

Since the emitter element of the unijunction transistor consists of an aluminum wire, a *p-n* junction is thus formed between this aluminum emitter wire and the silicon bar.

As the emitter voltage continues to increase with the charging of *C*3, the "emitter peak point" will be reached, a point at which the unijunction will fire and cause conduction to occur between the emitter and base 1. Conduction is established by positive "holes" being injected from the *p*-type emitter into the *n*-type silicon bar and coming under the influence of the electric field that exists between base 2 and base 1.

As the emitter current increases, the emitter-to-base 1 voltage decreases and a negative-resistance characteristic is observed between the emitter and base 1. Placing a resistor in the base-1 lead to ground, as shown in Fig. 1, results in a positive-going voltage pulse appearing at base 1. The pulse frequency depends on the *R*1-*C*3 time constant, the supply voltage, and the characteristics of the unijunction. By selecting the proper *RC* time constant and replacing *R*2 by a loudspeaker, the current pulses will be sufficient to drive the speaker and produce a harmonically rich audio tone.

Sufficient r.f. power must be coupled from the transmitter to supply at least 1.5 volts to point "A" and possibly slightly

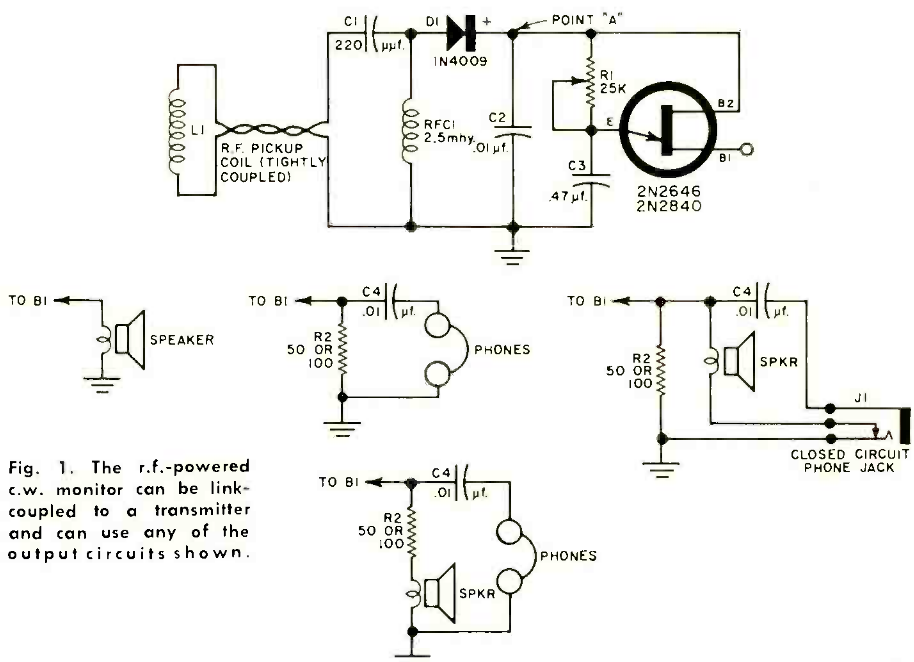
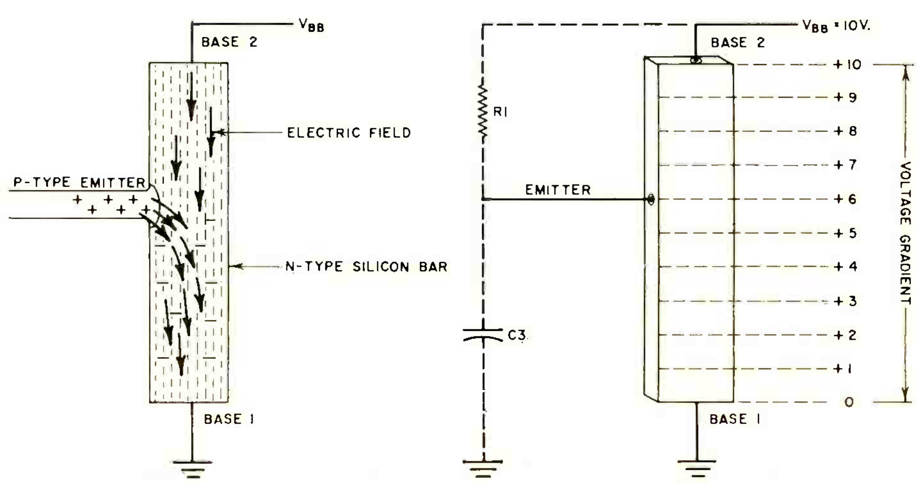


Fig. 1. The r.f.-powered c.w. monitor can be link-coupled to a transmitter and can use any of the output circuits shown.

Fig. 2. During operation, an electric field is set up along the silicon bar (A) and a voltage gradient exists between B2 and B1 (B). When emitter peak voltage point is reached, conduction occurs between emitter and B1.



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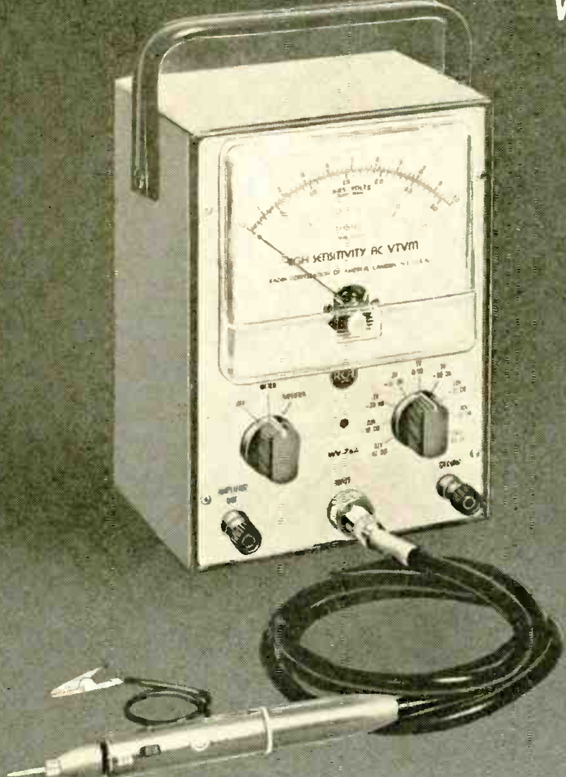

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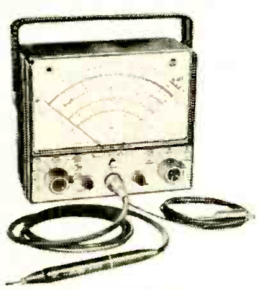

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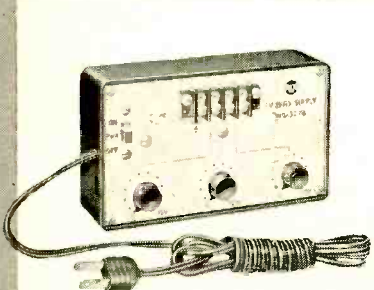

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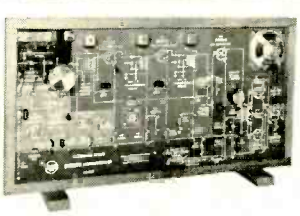

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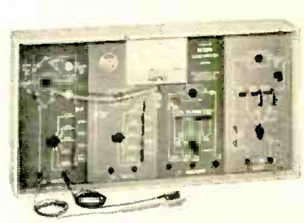

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***User price (optional)**

RCA® The Most Trusted Name in Electronics more depending on the characteristics of the particular unijunction used. Audio output from either a loudspeaker, headphones, or a combination of both, may be used as shown in Fig. 1. Output will be adequate for most c.w. operation and, in most cases, too loud. Initial adjustment is made by placing a two- or three-turn pickup coil, 1″ to 2″ in diameter, close to the transmitter tank. A tone will be heard from the speaker. If no tone is produced, adjust *R*1 to be sure that the emitter is not shorted to *B*2 which will occur when the potentiometer rotor is adjusted to the extreme *B*2 end. Because of the low voltages and currents involved, a limiting resistor is not used

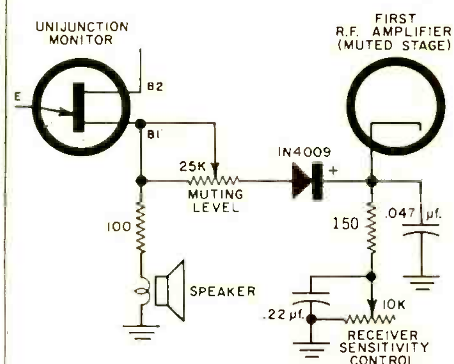

Fig. 3. Rectified positive-going pulses can be used to mute the receiver's r.f. stage during transmitter key-down time.

but can be installed if desired. If still no tone is produced, tighter r.f. coupling is required.

An alternative coupling method which gives good results eliminates the pickup link coil and connects capacitor *C*1 directly to the transmitter tank. Capacitor voltage rating should be great enough to prevent breakdown. In either case, the monitor can be permanently installed to operate on all bands from 160 meters to 6 meters with no battery changes or other circuit changes being required.

Once a particular tone has been decided on, and the monitor will not be moved with respect to the transmitter, *R*1 can then be replaced with a fixed resistor.

A less obvious feature of this simple c.w. monitor is shown in Fig. 3. By feeding the rectified positive pulses that appear at *B*1 during "key-down" conditions to the cathode of the receiver's r.f. stage, receiver muting can be accomplished. Muting level is set by adjustment of the potentiometer during key-down conditions. ▲

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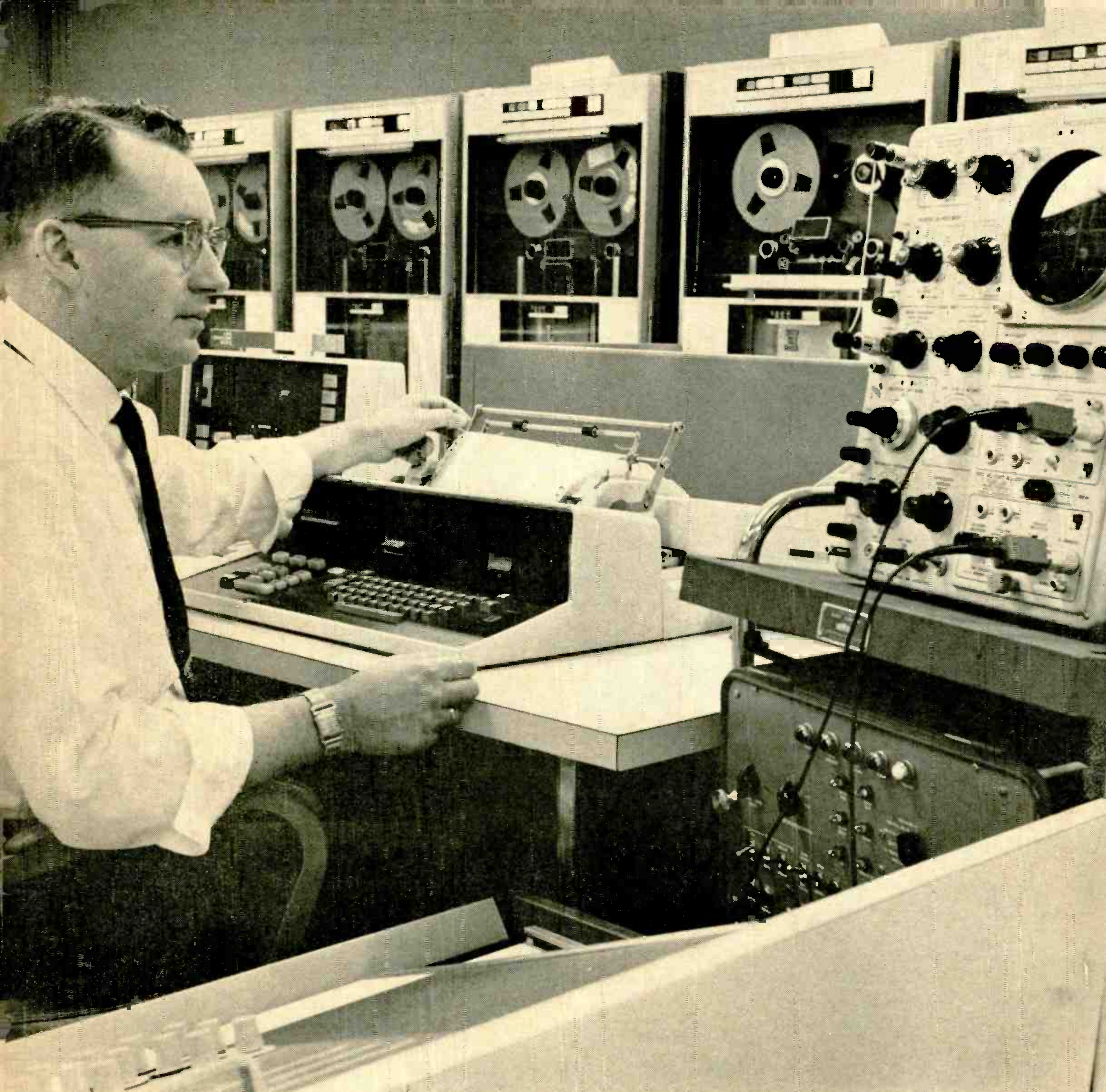

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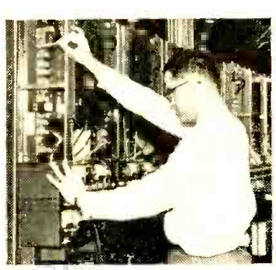

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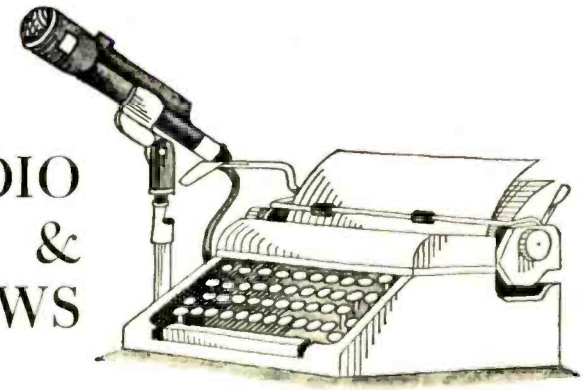
RADIO & TV NEWS



WITH the great increase in imported small-screen, all-transistor TV sets, a number of people have been wondering about the appearance of an all-transistor, large-screen American TV set. At present, either germanium or silicon transistors are capable of producing a TV set competitive with the tube version in terms of sensitivity. However, the relative price between transistors and tubes is holding back the introduction of such large-screen TV sets.

Another problem the industry faces is what type of semiconductors to use. Will they be silicon, germanium, a combination of both, and which device can best be used in a particular circuit? These are among the decisions the electronics industry must make if the large-screen TV set is to come.

Although silicon transistors are slightly more expensive than germanium, it is hoped that new manufacturing techniques will make them competitive. The price differential is a function of manufacturing techniques. Whereas germanium mesas are basically made by a three-step process, silicon requires between 10 and 20 steps.

Germanium is a better performer and has less noise at the higher frequencies, silicon devices can withstand higher temperatures with less noise, have higher dissipation, and have less leakage current and better current gain. Silicon devices also pack more power into the same size package.

Many 1964 TV sets are using germanium transistors as the local oscillator in the u.h.f. tuner. Tests have shown that presently available silicon planar transistors are rapidly approaching the power gain and noise figure obtainable with germanium.

Once transistor types are established and semiconductor manufacturers are geared to the demand, then we shall see the introduction of the mass-produced, large-screen, all-transistor TV set.

Infrared Troubleshooting

Air Force electronics researchers have added a new tool to the industry with the development of an infrared technique for detecting faulty components.

Laboratory studies have shown that components about to fail undergo minute heat changes and that changes greater than the .5°C that were predicted, were also detectable.

However, a general search for hot spots is not sufficient for maximum fault isolation. Temperature difference (component temperature minus ambient temperature) is the important factor.

The report suggests that infrared pattern recognition techniques look promising for failure prediction as a supplement to other, more conventional, checkout procedures.

Macro Amplifiers

During the past several years, the trend in electronic circuits has been toward the ever-smaller device and we have been able to shrink just about every electronic device to almost a fraction of its previous size.

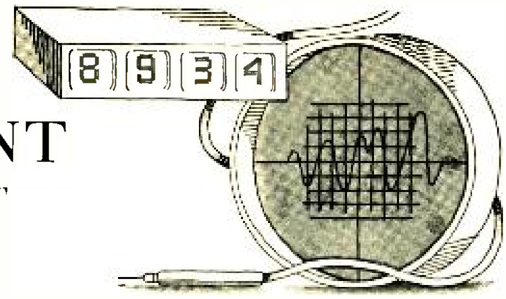
However, in at least one case, the shrinking process has been reversed and the proposed amplification system has grown not only out of the laboratory, but literally out of this world, in fact, out of the solar system.

In a recent report to the American Physical Society, Dr. Fred. Johnson, a physicist with *Electro-Optical Systems, Inc.*, has proposed a method of using laser technology to seek out possible signals transmitted by intelligent beings on other star systems. He has found that many nebulae (about 400 so far) exhibit the necessary conditions for laser-type amplification. Dr. Johnson proposes that we listen on 4686 angstroms (the helium wavelength) as helium and hydrogen are the most abundant elements in the universe.

As an example of this communication system, beings on a planet 3000 light years away could send their modulated signals to a nearby nebula for amplification. Present computation shows a maximum nebula amplification gain of 50 db and a minimum gain of minus one decibel.

This would have to be a long-term project as it would take 6000 years for a round-trip message. It is quite possible that either or both technological societies could cease to exist while the message is in transit. ▲

TEST EQUIPMENT
PRODUCT REPORT



B & K Model 445 CRT Tester-Rejuvenator

For copy of manufacturer's brochure, circle No. 45 on coupon (page 15).

THE most expensive component in a TV receiver is its picture tube. So it seems natural that the first question asked of the TV service technician is, "Is my picture tube okay?" The *B&K* Model 445 CRT tester-rejuvenator is designed not only to answer this question but also to restore life to many failing picture tubes. This rejuvenation process is not 100 percent sure and there is some risk involved, but in most cases, if this is explained to the set owner, he is willing to have the technician make the attempt rather than buy a new tube.

Three basic tests are employed to check the quality of a picture tube. First, inter-element leakage and element continuity are checked using an unusual triple neon-lamp display. These lamps are in the grid 1, grid 2, and heater circuits of the tube being tested. Second, the picture-tube emission is checked with d.c. voltages applied to the above grids. Indication of emission is on a meter which has both "good-bad" and microampere calibrations. The third test evaluates the cut-off characteristics of the gun.

The rejuvenate function of the Model 445 has three steps. In each of these a high d.c. potential is applied between grid 1 and cathode of the tube under test in an effort to strip surface impurities from the cathode and restore its emission. In the last two steps of the rejuvenate function, somewhat elevated heater voltages are used in an attempt to restore emission. There is no precise way of knowing which of the three steps to use or how long the restored tube will retain its increased emission. It is wise to start in the "Low" position, then check for increased emission. If no effect is noted, the "Med" and "Hi" rejuvenate steps can be tried.

A second facility for repairing a picture tube is the ability of the instrument to remove grid-to-cathode shorts. This is done by application of a high d.c. potential between the shorted or leaky elements. The material causing the short or leakage is frequently burned away when this is done. The heater circuit is opened during this particular testing procedure.

The model 445 tests and rejuvenates just about all currently used picture tubes at their correct heater voltage, from 1 to 12 volts. This includes tubes with high grid-2 voltage and those with grid-2 voltages as low as 30 volts. The 110-degree tubes and the new 19-inch and 23-inch tubes can also be checked. Color picture tubes, including the 23-inch, 90-degree 23BG22, are checked by applying test voltages to each of the three guns separately.

Test sockets are included for all standard and 110-degree tubes and there are two sockets for color tubes.

The instrument is readily portable so that tubes can be checked in the set owner's home. The leatherette-covered carrying case measures 14" by 8" by 4¾", and space is provided for the test cables and extra adapter sockets. Price of the unit is $74.95. ▲

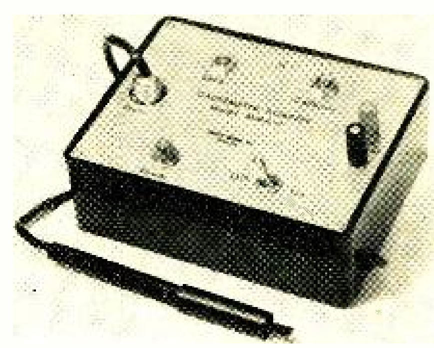
Scientific Columbus MMA-1 Gaussmeter Adapter

For copy of manufacturer's brochure, circle No. 46 on coupon (page 15).

AN adapter unit that converts any d.c. v.t.v.m. to a gaussmeter is available from *Scientific Columbus, Inc.* The Model MMA-1 gaussmeter adapter measures magnetic induction and furnishes a d.c. output voltage proportional to the magnetic field. The d.c. output from the adapter can be measured with a high-impedance v.t.v.m. capable of measuring in the millivolt range.

The gaussmeter adapter utilizes a Hall generator to sense the magnetic field. When a control current is flowing through the Hall generator and a magnetic field (at right angles to the current flow) passes through the Hall generator, a voltage proportional to the product of the current and the magnetic field is generated across the device. If the control current through the device is constant, this generated voltage is then proportional to the magnitude of the magnetic field.

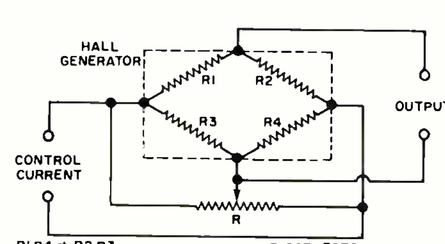
The adapter utilizes a constant-current power supply to drive the Hall generator. The constant-current supply is required because of the magnetoresistive properties of the Hall generator. This property causes an increase in the resistance of the Hall generator when subjected to magnetic fields. As the magnetic field increases, the input resistance of the Hall generator increases. Hence,



the need for a power source that supplies constant current rather than constant voltage. The power supply operates from 117 v.a.c.

A Hall generator, when not in a magnetic field, may be considered a resistance bridge. If the bridge is balanced, there is no voltage generated across the output arms of the bridge when the bridge is excited. Unbalance, however, creates a voltage. Most practical Hall generators represent an unbalanced bridge due to a physical misalignment of the Hall leads. This is corrected by connecting an external resistance network to bring the bridge into balance. The MMA-1 adapter utilizes such a technique to correct for misalignment, or as it is also called, to produce zero field voltage. (See diagram.)

The complete gaussmeter adapter, therefore, consists of a Hall-effect sensor, a constant-current source, and a zero-



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adjustment network. The output of the adapter is adjusted to yield 10 mv. per kilogauss. The Hall sensor is thin (0.014") so that the magnetic field in a narrow air gap may be measured.

The advantage of this gaussmeter adapter is that it provides a relatively inexpensive way of measuring d.c. magnetic fields. The expensive circuitry and range switching are in the v.t.v.m. rather than in the gaussmeter adapter. Price of the adapter unit is $69. ▲

Hewlett-Packard 214A Pulse Generator

For copy of manufacturer's brochure, circle No. 47 on coupon (page 15).

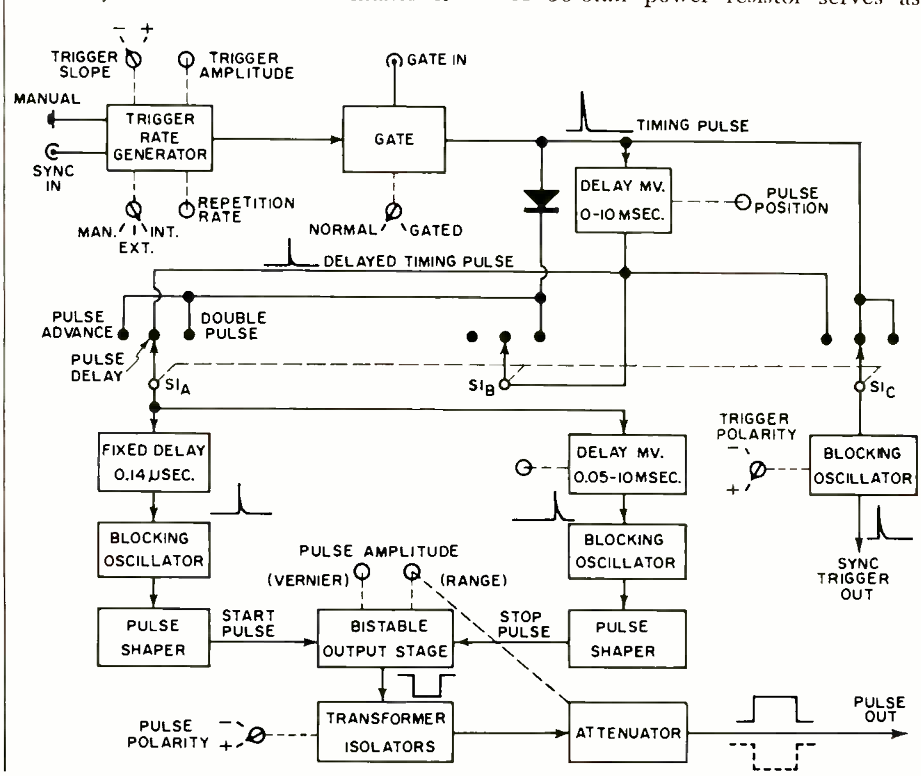
HEWLETT-*Packard's* Model 214A pulse generator is a general-purpose instrument capable of producing high-power, fast-rise pulses at pulse repetition rates up to 1 mc.

There are many uses for such an instrument. The wide range of pulse amplitudes, pulse widths, and pulse repetition rates make it valuable as a test-signal generator for a wide variety of digital circuits or other systems using pulsed signals. The generator is also useful for testing various components, the high-current capabilities being particularly applicable to testing magnetic cores, high-power semiconductor devices, or the operating time of fast relays. The high-voltage capabilities are well adapted to testing power tubes and the ionization and de-ionization time of gaseous devices, such as neon bulbs or thyratrons. The 214A is also useful for testing high-power pulse modulators and power amplifiers. At the same time, the flexibility of the instrument makes it attractive for tests requiring low-power pulses.

The output pulses are generated by a pair of parallel-connected high-perveance pentodes, originally intended for TV horizontal-deflection service. These tubes were selected because of their ability to supply considerable current at relatively low plate voltages (as much as 1 amp each with plate voltages as low as 100 volts). The power tubes are part of a bistable circuit (see block diagram) that is turned on by a fast-rising drive pulse and turned off again by a similar pulse of opposite polarity. Pulse width is therefore determined by the controllable time difference between the two trigger pulses.

Either positive- or negative-going pulses are obtained by passing the output pulse through a bifilar-wound transformer which consists of a coaxial cable wound on a large ferrite core. A reversing switch at the output connector grounds the shield of the transformer cable in one position so that the center conductor supplies negative-going pulses from the plates of the tubes to the output connector. In the other position, the switch grounds the center conductor, and the shield then supplies positive-going pulses to the output connector. The transformer inductance isolates the distributed capacitance of the output stage from the output connector so that there is no degradation of pulse shape when this is done. Of particular importance is the fact that the pulse baseline is clamped to ground for either polarity output pulse. The baseline does not shift regardless of pulse width, amplitude, or repetition rate.

A 50-ohm power resistor serves as



the plate load on all amplitude ranges from 50 volts down. This resistor acts as an internal termination to absorb any pulse reflections returning from impedance mismatches in the external cable system. This is an important feature in instruments that develop fast-rising pulses since the reflections would be reflected again if the generator did not have a matched source impedance.

In addition to the main output pulse, the instrument also supplies a trigger pulse for operating an oscilloscope. As shown in the diagram, this is either triggered directly by the timing pulses, or triggered by a delay circuit. This arrangement enables the trigger pulse to be placed in advance of or following the main pulse throughout a range of +10 to −10 millisecond.

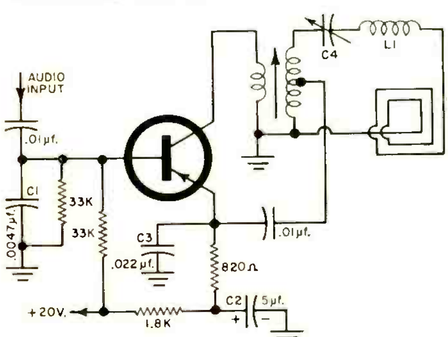
The delay circuit may be switched to trigger the main pulse circuits a second time to obtain the double-pulse mode. The double-pulse feature is useful for checking the resolution of counting circuits.

The 214A pulse generator is packaged in the company's modular enclosure. Price is $875, FOB factory. ▲

PRIVATE TV SOUND

PRIVATE TV sound that can be heard over a conventional AM radio placed at your side, with volume controlled by the AM set, is provided by the "Mobil-Sound" system used in some of the latest model Westinghouse TV sets.

Capacitor C1 acts as an r.f. bypass at the base of the transistor, L1 suppresses harmonics that could cause tweet inter-



ference, C2 drops the bass level slightly to compensate for the small loss in treble due to C1, and C3 equalizes the amount of oscillator output over the tuning range. C4 tunes the oscillator, including the loop antenna, to the desired spot in the broadcast band. ▲

Transistors for Hi-Fi

(*Continued from page* 43)

about double the r.m.s. capabilities of the amplifier. In comparison, the instantaneous clipping *voltage* varies only slightly on a solid-state amplifier like the "Acoustech I," regardless of the speaker. See Table 1. This instantaneous clipping voltage is limited only by the voltage the power supply of the amplifier is capable of delivering. Since the power supply of the "Acoustech I," although well regulated, does produce a slightly reduced voltage output when heavily loaded, the instantaneous clipping voltage falls slightly as the load impedance decreases. The better regulated a power supply, the more instantaneous power is available for playing music. Hence, we have a condition which is opposed to the IHF music power concept. The IHF music-power rating favors an amplifier with a poorly regulated power supply since the greater the difference between r.m.s. and IHF music power, the *poorer* the power-supply regulation.

Assuming that a speaker's impedance remains fairly constant at its rated value, a solid-state amplifier, rated at 40 watts r.m.s. sine wave per channel, can deliver as much power when playing music into a 4-ohm speaker as can a conventional tube amplifier rated at approximately 200 watts per channel. The ability of a transistorized amplifier to deliver instantaneous power when playing music is not necessarily directly related to its r.m.s. sine-wave power capabilities at the various impedances. For instance, the "Acoustech I" delivers 65 watts per channel r.m.s. into an 8-ohm load and 40 watts r.m.s. into a 4-ohm load.

The previous authors claim solid-state amplifiers have *poorer* power-supply regulation. Yet solid-state amplifiers usually have far *better* regulation than a tube amplifier. The transistorized amplifier can use a high value of capacitance and a low resistance in comparison to the usual tube amplifier's low capacitance and high resistance. With tube amplifiers, operating voltages are much higher; hence, very high capacitance filters at the required operating voltage would be extremely large or many paralleled units would have to be used. These amplifiers must use relatively higher resistances and lower capacitances. As a given current is drawn through a power supply, the voltage drop in the tube unit's power supply will be higher due to its higher internal resistance.

The ability of a transformerless solid-state amplifier to provide increased peak power as speaker impedance is reduced is of extreme importance. The significance of the greater instantaneous power available with transistorized units is that it is extremely difficult to drive them to clipping. Since distortion at clipping is so much higher than distortion well below clipping, would it not be better to have an amplifier with even 2% distortion that rarely, if ever, clipped than one with 0.2% distortion below clipping that clips readily.

Speaker Impedance Changes

One assumption throughout this discussion is that the actual speaker impedance is always the same as its rated impedance. It is well known, however, that speaker impedances vary with frequency. They also vary with signal strength, particularly with strong low-frequency signals. A long cone excursion that partially removes the voice coil from the magnetic field, momentarily reduces the impedance.

Speaker impedances are measured by feeding a low-voltage pure sine-wave signal to a speaker. This condition is a poor simulation of what happens when a bass drum is reproduced, or when cymbals clash, or when violins play. Hence, rated speaker impedances are not precise under all conditions.

Let us assume that a properly designed loudspeaker will normally have a minimum impedance in the audio-frequency range of only about 25% below its rated impedance. This means that a rated 8-ohm speaker can actually decrease to 6 ohms. Now if a 6-ohm speaker is connected to an 8-ohm tap of an output transformer, the power available will be $(6/8)^2$ or a little more than half of what it would be if there were no mismatch. If output transformers or an autotransformer were incorporated in the circuit of an amplifier like the "Acoustech I," the instantaneous peak available power when driving such an 8-ohm speaker would drop from 231 watts to 130 watts. Without such a transformer, peak output power remains the same or even increases somewhat.

Table 1. Instantaneous clipping voltages and powers for "Acoustech I" transistor amplifier with various speakers.

SPEAKER SYSTEM	RATED IMPEDANCE (Z)	INST. PEAK CLIPPING VOLTAGE	INST. PEAK CLIPPING POWER
KLH-4	16 ohms	45 volts	126 watts
Bozak 302A	8 ohms	43 volts	231 watts
AR-3	4 ohms	40 volts	400 watts

If the instantaneous speaker impedance of an 8-ohm speaker becomes 12 ohms, use of a transformer would reduce maximum instantaneous power to 102 watts. Without a transformer the instantaneous power in our amplifier is 169 watts. Therefore there is a substantial increase in maximum instantaneous power capabilities without an output transformer.

The why's and wherefore's of "transistor sound" are certain to be the subject of many investigations for years to come. Certainly the last word has not been said on this subject. It is only through further experimentation and airing our differences of opinion that there is chance of coming even closer to perfection. In the meantime, the listener who uses judgment and discrimination is certain to profit through improved reproduction of his favorite music. ▲

A.G.C. FOR RECEIVER AUDIO

By JAMES L. LANTERMAN, W5UJN

Simple circuit modification adds automatic control to first audio stage of a communications receiver.

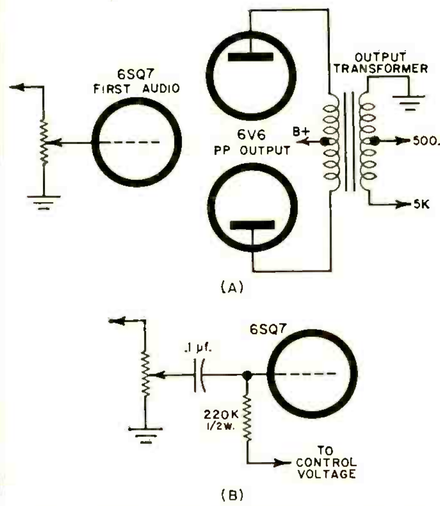


Fig. 1. (A) Partial circuit of input and output audio section of SX-25 as originally wired. (B) Changes needed to make level control adaptable to first audio stage.

Modern communications receivers have the ability to copy local and distant stations without the need for an operator to constantly ride gain on the audio. This is due primarily to the application of some sort of automatic level control built into the set whereby a control voltage is applied to the audio sections much like the a.v.c. voltage in the r.f. and i.f. sections.

Since the author's old SX-25 does not have such a circuit built in, he devised the simple circuits shown in Figs. 1 and 2 to do the job.

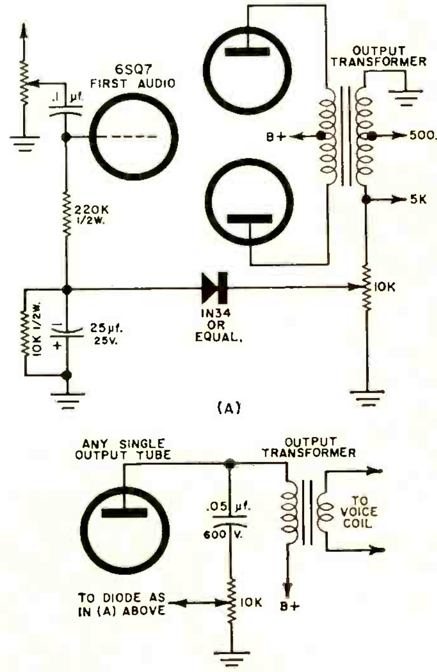
An explanation of the circuit is simply that some audio from the output circuit is rectified, filtered, and then applied back to the grid of the first audio tube. Several db of control can be had before clamping action becomes noticeable. Even then many more db of control can be obtained before the clamping action becomes objectionable.

In all cases, the 10- to 20-k pot is used to set the level at which the bias voltage starts controlling the first audio tube. Note that any a.c. voltage appearing on the output, be it voice, noise, or a.c. hum, will be changed to d.c. control voltage. So if there's some d.c. control voltage present with the volume control in the "Off" position, new power-supply filter capacitors might be in order.

In operation, set the volume control to produce slightly above-normal level with the 10,000-ohm control on zero. Then adjust the 10,000-ohm level control to bring the output back down to normal. A very strong local station will then have the noticeable effect of clamping action at the beginning of the first word of a sentence or series of words.

The circuit is especially good for net operation. Just turn the volume control up further than normal and then crank in more control. There is less chance of missing the little ones between the big ones with this circuit in use. ▲

Fig. 2. (A) Final circuit as is now being used with a.g.c. added. (B) Circuit hookup for any receiver with single output tube.



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U.H.F. RECEIVING ANTENNAS

Additional comments on a previous article dealing with u.h.f. reception and a retort by the author.

To the Editors:

Mr. Jack Beever's article "U.H.F. Reception: Practices and Equipment" in the November issue of ELECTRONICS WORLD was timely and interesting. However, he was not sufficiently precise in his discussion of the relative performance of receiving antennas at v.h.f. and u.h.f. The comparisons he drew were misleading and the casual reader would mistakenly conclude that, all other things being equal, a physically smaller u.h.f. antenna with a gain of, say, 9 db would furnish 6 db more signal power to the receiver than a physically larger v.h.f. antenna with a gain of 3 db. Mr. Beever is comparing "oranges to apples" and his oversimplified comparison is invalid.

A common misconception is that the reciprocity theorem can be indiscriminately applied to all the properties of an antenna, whether it be used for receiving or transmitting. In other words, "A half-wave dipole, 6.6 inches long, for channel 83 (890 mc.) is just as good a receiving antenna as a half-wave dipole, 98.5 inches long, is for channel 2 (54 mc.)."

Unfortunately, this is not true. One of the differences between transmission and reception appears when the operation of an antenna of given electrical length (say a half-wave dipole) is considered as a function of frequency. The radiation pattern of an antenna will be the same whether it is used for transmitting or receiving, as will be its gain and impedance. When used for reception, however, an antenna delivers to a matched load an amount of power that is proportional to the square of the wavelength. This means, for example, that at 1000 mc., the half-wave dipole delivers to its load only 1/100 of the power it would deliver at 100 mc. for the same received field intensity.

Therefore, when we speak of antenna gain, the gain is customarily expressed with respect to the gain of a half-wave dipole at the same frequency. In order to compare the relative effectiveness of receiving antennas at different frequencies (in this case, u.h.f. and v.h.f.), we must compare the signal power that each antenna makes available at the feedline terminals of the receiver or the antenna end of the transmission line; or for the TV technician, "How many microvolts are available?" In order to do this we must use a common denominator. The terms "aperture" or "effective area" are used by the antenna engineer for this purpose.

For a receiving antenna placed in the field of a linearly polarized wave, the power abstracted or the power available at the antenna terminals is equal to the effective area multiplied by the power per unit area (field intensity) carried by the wave: $W = PA$, where W is the available power at the antenna terminals, P is the power density of the wave (watts per square meter), and A is the effective area or aperture of the antenna.

The effective area of a half-wave dipole antenna is: $A = (1.64\lambda^2)/4\pi$, where λ is in meters and A is in square meters.

To relate the effective area of an antenna which has a gain with respect to a half-wave dipole, $A = (1.64\lambda^2)G/4\pi$, where G is the power gain of the antenna over a half-wave dipole at the same frequency.

It is evident that the total power available at the antenna terminals is proportional to the square of the wavelength. Let us see what happens to Mr. Beever's comparisons when the same frame of reference is used for the antennas in question.

Consider the "Twin bow-tie on a screen which will have gains up to 6 db higher than a v.h.f. indoor antenna." Although the 6-db gain he quotes is usually achieved at the highest u.h.f. frequency (channel 83), let's give him the benefit of the doubt and use the mid-point of the u.h.f. band at 700 mc. for our comparison.

For the twin bow-tie, $A = [1.64 \times (.43)^2 \times 4]/12.6$ = about 0.1 square meter.

For the indoor v.h.f. antenna (a dipole which is approximately a half wave at channel 5), $A = [1.64 \times (4.3)^2]/12.6$ = about 2.4 square meters.

From our basic equation, $W = PA$, we see that for the same received field intensity, the v.h.f. antenna delivers 24 times as much power to the receiver. Comparing the antennas on the db scale, the v.h.f. dipole has an effective power gain of 14 db over the u.h.f. twin bow-tie on a screen.

The final story is even worse for the u.h.f. picture for, as Mr. Beever points out, the transmission line losses are much higher at these frequencies, varying inversely as the square of the wavelength. So, in the final analysis, if all other things were equal, including the radiated power from the transmitting station, we would require the u.h.f. receiving antenna to be physically larger than the v.h.f. antenna in order to deliver the same signal to the TV set.

Since u.h.f. antennas of the required size and complexity would be overly expensive and difficult to maintain, the FCC has arranged the power allocations with respect to frequency accordingly. Observe that the power allocations vary inversely with the wavelength almost in the opposite degree with which the efficiency of an antenna of given electrical length. Stated in equation form: *Power Allocations* $\approx$ *1/dipole efficiency* or $1/\lambda^2$.

To sum up, there will probably be a net improvement in the reception quality at u.h.f. in that it will be possible to use antennas of higher directivity, but the advantage will not be in increased signal strength. It will evidence itself in a marked reduction in interference from unwanted signals. The ghost problem will be considerably reduced. However, as Mr. Beever points out, it will be incumbent on the TV technician to exercise care in his choice of feedlines and the manner of their installation so that the signal will not be attenuated with the attendant degradation in the signal-noise ratio.

ALBERT WEISS
Riverside, Calif.

The following comments from Author Beever are in reply to Reader Weiss' letter which is reprinted, in part, above:

I have very few objections to your treatment. It is mathematically precise and correct. I do argue with your premises somewhat.

1. Reference is made to the gain of a u.h.f. indoor antenna over an indoor v.h.f. dipole "rabbit-ears" type antenna. You treat the rabbit-ears as a tuned dipole *which delivers all its power to the load*—a TV set. Unfortunately, this is so rarely true as to be negligible. They are not matched and do not depend on efficiency to operate, witness the popular so-called "monopole" antennas. In general, the broadband dipole, a modified conical of the u.h.f. indoor type, produces much better impedance matching to the load and hence better transfer characteristics.

2. Your paragraph dealing with the u.h.f. power allocations tends to nullify your objections regarding the delivered power of a dipole which, as you point out, delivers power strictly according to an area function—not a linear one. Your calculations assume equal power densities from all transmitters, but this is not normally true. Indeed the FCC regulations on effective radiated power are made to remove the objections pointed out in your calculations.

The effective capture area of a dipole may be assumed to be one-eighth the wavelength squared ($\lambda^2/8$). Then, the capture area of a dipole cut to 69 mc. (a wavelength of approximately 4 meters) would be 2.1 square meters. The power restrictions on television stations were based on the assumption that a capture area of this size would result in an antenna of reasonable proportions able to deliver usable signals from a low-band v.h.f. station at the ranges expected.

However, a dipole for the high channels would be only ⅓ as long and would therefore exhibit only one-ninth the capture area. However, an antenna having the same physical size as the low-band dipole would have a capture area equal to the sum of the areas of three dipoles, or ⅓ the capture area of the low-band dipole. Hence, the power allocations to high v.h.f. channels were set at three times, approximately, the allocations of low-band stations, *i.e.*, 100-kw. e.r.p. (effective radiated power) low band and 316-kw. e.r.p. high band.

At u.h.f. assuming a wavelength of one-third the high v.h.f. channels, or one-ninth the low v.h.f. channels, the capture area of a dipole cut to u.h.f. is about one-eightieth of the low-band dipole. Again, however, assuming an equal physical size, the antenna would have a capture area of nine dipoles, or one-ninth that of the low-band dipole. In order to equalize this, u.h.f. stations are commonly going to very high e.r.p. The New York City u.h.f. tests, for example, were run with an e.r.p. on channel 31 of about 900 kw.

In this manner, antennas of equal physical sizes are expected to produce equal signals within normal ranges. Propagation effects, of course, reduce the effectiveness of the higher u.h.f. powers.

In actual practice, this seems to work out much better than expected. Take the real situations of v.h.f. and u.h.f. stations in operation. Up to 30 miles from transmitters, the most common antennas at v.h.f. are conical dipole and reflector combinations. The same ranges at u.h.f. find the quite similar dipole and screen reflector antennas used. Up to 60 miles at v.h.f. (where u.h.f. is at a disadvantage due to the lesser refraction over the horizon), yagi-type broadbands with gains of 8 to 10 db give satisfactory results. At the same ranges in u.h.f., 8 or 12 element billboard arrays are used, with gains (realized, not theoretical) of 8 to 12 db.

It appears to me that a much more limiting factor in u.h.f. reception is the signal-to-noise ratio obtained with comparable delivered powers. Usual noise figures in all-channel receivers came out at about 6 db, low v.h.f.; 8.5 db, high v.h.f.; and 15 to 20 db, u.h.f. We are in hopes of seeing much better u.h.f. noise figures in the near future and the article presupposes that such improvements will be made. We have transistor devices now in test that are rated at 12 to 14 db, a considerable improvement.

JACK BEEVER
Tech. Dir., Distrib. Sales Div.
Jerrold Electronics Corp. ▲

Single-Frequency Receiver

(*Continued from page 45*)

five turns, closewound, adjacent to the plate (input) coil but not between the two coils. Connect one of the wires to the lug where you removed the coil and capacitor lead and connect the other end to the "B+" terminal (grounded in this circuit) of the transformer. Do not disconnect the other wires connected to the "B+" terminal. Replace the can and mount the transformer.

Power Supply

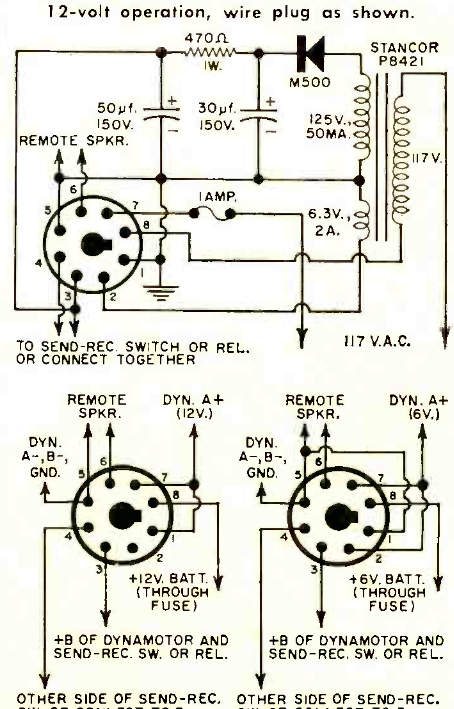
The power plug is quite versatile in that all connections for changing from 6- to 12-volt operation of the heaters; the turning on and off of either a dynamotor, vibrator pack, or a.c. power supply; the connection of an external speaker; and the disabling of the receiver during transmitting periods are provided. Consult the plug wiring diagram for the proper connections for the mode of operation you plan to use.

A 117-volt a.c. power supply (Fig. 2) can be constructed on a small chassis box and connected to the set by a short length of cable. It may be possible to rob power from the transmitter power supply or the power supply used to power the converter, if one is used. A small TV booster power transformer, with an added filament transformer, could also be used.

Alignment

Alignment of the completed receiver should be done in the usual manner. First check to make sure that the crystal

Fig. 2. Circuit of separate power supply used for 117-volt operation. For 6- or 12-volt operation, wire plug as shown.



oscillator is oscillating by using a field-strength meter or grid-dip meter or by tuning a receiver to the crystal frequency. Adjust the oscillator tuning for maximum reading and then back out the adjustment about one-half turn.

Next connect a v.t.v.m. to the a.v.c. bus or to the speaker. Connect the hot lead from a signal generator, tuned to the i.f. frequency, to the grid terminal of *T2* and adjust the top and bottom slugs of *T3*, *T4*, and *T5* for maximum reading on the v.t.v.m. Keep the signal generator output as low as possible to prevent overloading the i.f. amplifiers and to facilitate critical peaking of the i.f. transformers.

Connect the signal generator to the antenna input and tune it to the signal frequency for which the receiver was built. Tune *T1* and *T2* for maximum reading, again keeping the signal generator output as low as possible. Finally, fasten the cover on the chassis by using four sheet-metal screws run up through the top of the chassis and into the flange on the bottom of the cover.

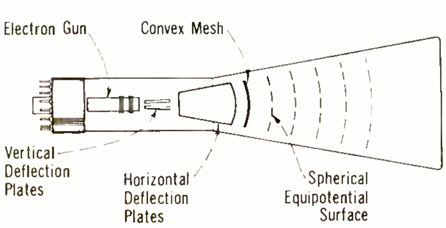
This completes the construction of the spot-frequency receiver. ▲

RADIAL-FIELD CRT

HIGH deflection sensitivity and a large, bright display are realized in a new CRT used in some late model Hewlett-Packard oscilloscopes. In contrast to conventional CRT's in which high post-acceleration potentials necessary for brightness, reduce deflection sensitivity and limit the vertical scan, the new tube achieves a sensitivity for both vertical and horizontal deflection of 12 v./cm. and a 10 cm. scan with an accelerating potential of 7.5 kv.

In a conventional tube, fringing electrostatic fields around the exit side of the deflection region tend to bend the electron beam back towards the longitudinal axis of the tube. This does not occur in the radial electrostatic field cathode-ray tube.

In the radial-field tube, a fine-grain, curved, high-transmission, metallic mesh is placed on the exit side of the deflection region. The mesh establishes a ground plane for the post-accelerating



field so that the resultant equi-potential surfaces are truly spherical, creating a radial electrostatic field.

Not only does this field prevent scan demagnification when a high post-accelerating potential is used, but it actually achieves a small degree of linear scan magnification. Deflection defocusing is also minimized. ▲

EW Lab Tested

(*Continued from page* 22)

ance section consists of a piccolo and string bass, which are to be matched in apparent level by means of tone controls.

The following portion has an excellent illustration of the effects of too high or too low recording level. In the first case, the distortion is clearly audible, and in the second case the increase in background hiss is pointed out. Similar examples illustrate microphone positions too close and too far from the subject. The sound of print-through, drop-outs, and uneven tape width are illustrated. Incidentally, the test tape itself has some print-through in other portions, as well as some wow, although neither is of serious proportions.

Following a section on typical recorded sounds, such as conversations, airplanes, and bird calls, there are several minutes of ticks at 1-second intervals. These are to be timed with a watch as a check of tape speed.

The same material is repeated at 3¾ ips on the second track. Since this uses only half the reel, the remaining 600 feet is devoted to suggestions on uses for the tape recorder, examples of editing, and descriptions of different tape materials and coatings. The tape ends with a description of the tape-manufacturing process.

The *Burgess* test tape should prove informative to the neophyte recordist for whom it was specifically designed. ▲

DOUBLE-DUTY CORD

By ART TRAUFFER

ONE of the handiest "tools" in the author's repair kit is a "double-duty" extension cord. As shown in the photo it is simply a standard extension cord with a "cheater" receptacle added to the business end.

I bought a 29-cent cheater cord, clipped off the cheater receptacle leaving about 5" of cord on it, and then wired it in parallel with the extension cord, as shown. Be sure to solder the connections and tape well with plastic tape to prevent shorts. ▲

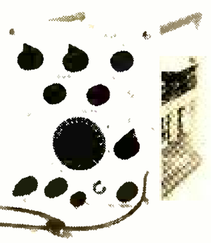
NEW PRODUCTS

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 15.

COMPONENTS • TOOLS • TEST EQUIPMENT • HI-FI • AUDIO • CB • HAM • COMMUNICATIONS

PLUG-IN SPECTRUM ANALYZERS

1 **Nelson-Ross Electronics** is now offering the second of its series of plug-in spectrum analyzers. Model 002, covering the range from 35 cps to 100 kc. The new analyzer plugs into a **Tektronix** scope accepting letter series plug-ins, converting it into a complete low-frequency spectrum analyzer.



The analyzer utilizes the internal power of the oscilloscope, has a calibrated tuning dial which provides a center-frequency range of 35 cps to 100 kc., variable dispersion of 500 cps to 30 kc., variable resolution of 35 cps to 250 cps, and an 80-db input attenuator.

The unit has a full-scan mode of operation in which the entire band is displayed as well as the normal tuning mode. Sensitivity is 500 µv. full-scale. Input impedance is 1 megohm.

PANEL-METER LINE

2 **Hoyt Electrical Instrument Works, Inc.** has developed a new series of d.c. and a.c. panel meters that can be mounted at the front or behind the panel, with or without bezel.

The bezels are of strong die-cast metal with black enamel finish. The clear plastic case is of new extra-thin design and is easy to mount with the special hardware provided. With the bezel, the meter may be mounted on the front of the panel showing the complete meter. The lower front of the case has a lined area, furnished in color if desired. All meters feature the company's jewelled movements.

CONVERGENCE DEVICE

3 **Wallin-Knight Industries** has developed a new and inexpensive time-saving device for adjusting the static convergence of color-TV receivers from the back.

Known as the "Reflect-O-scope," the device operates on the periscope principle and utilizes the shortest possible line-of-sight to the tube face.

HIGH-RELIABILITY STABISTOR

4 **Transitron Electronic Corporation** is now marketing a high-reliability stabistor with a claimed failure rate of .001 percent per 1000 hours. The device is designed for use as a low-level voltage regulator. It is rated at 400 mw., has a gated forward voltage at 1 ma. of .600-.700 volt, with a minimum-maximum of .800-.900 volt at 100 ma. Inverse current of the 1N4362 is less than 1 nanoamp at 50 volts with a peak inverse breakdown greater than 100 volts.

FOUR-CHANNEL SCOPE AMPLIFIER

5 **Hewlett-Packard Company** is now marketing the Model 1754A, a vertical amplifier which permits the direct comparison of four simultaneous signals. A plug-in unit presenting four traces, each channel having 40-mc. bandwidths and 50 mv./cm. sensitivity, it has independent position controls on each channel to make it possible to separate each trace or to superimpose any or all over the full height of the screen. A push-button for each channel will momentarily displace its trace for identification. Since the scope may be triggered from any of the four channels, timing measurements are easy and accurate.

The amplifier has been especially designed for use with the firm's Model 175A oscilloscope.

SURGE ARRESTERS

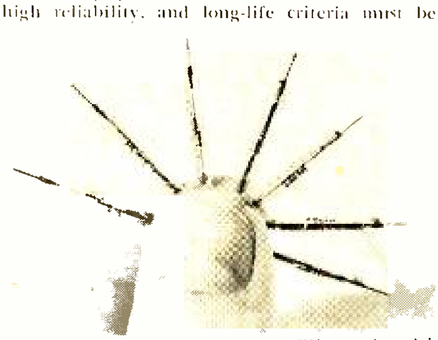
6 **Dale Electronics, Inc.** is in production on a new line of surge arresters designed to give reliable control of transient voltages of all types, including lightning, switching, breaking of inductive loads, and human error.

Among the applications suggested by the company are protection of silicon rectifiers, protection of radio equipment from transient voltages caused by lightning, protection of circuit components from dielectric breakdown, protection of diode rectifier circuits, and the protection of circuit components from transient voltages caused by switching, fuse blowing, and other causes.

Three models are available, LA-8, LA-9, and LA-10. Each uses a special spark-gap design enabling it to bypass repeated transient voltage surges without significantly changing its breakdown voltage.

HIGH-SPEED REED SWITCH

7 **IBM's Industrial Products Division** has developed a high-reliability reed switch with a mean time to first error of 125 million operations. The switch is designed for use in commercial and military equipment where low contact resistance, high reliability, and long-life criteria must be



met. It operates in less than 1 millisecond and is designed for logic switching in relays, commutators, switching matrices, limit switches, and other applications.

The switch is packaged in an inert-gas filled envelope and incorporates a two-cantilever beam construction. Contact surfaces of the beams are plated with noble metals. The switch measures 0.106" in diameter and 0.845" long.

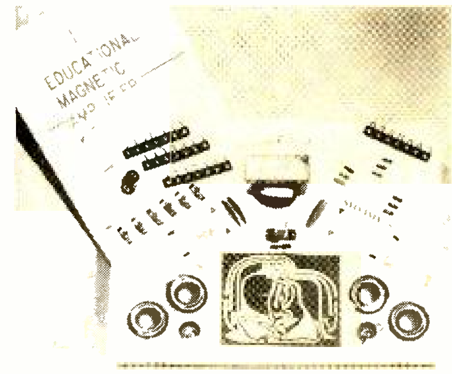
NEW PC TRANSFORMER

8 **Ferrodyne Corporation** has introduced a new transformer especially designed for use in all transistorized and printed-circuit applications and general miniaturization work.

Known as the "Ferro/Min," the new transformer measures .305"x .405" at the base. It incorporates leads of fatigue-resistant nickel-iron alloy, .020" dia. x ½" long, with rounded tips for easy printed-circuit insertion. A small base mounting pad raises the unit to permit the inspection of all solder joints.

MAGNETIC AMPLIFIER KIT

9 **Lumen Electronics** has developed a magnetic amplifier educational kit designed to give engineers, advanced students, and technicians a better understanding of magnetic amplification as used in critical circuits on guided missiles, military and commercial aircraft, air and ground servo control systems, ordnance items, and high reliability industrial controls.



Both the single-ended (5002) and the push-pull (5003) magnetic amplifier kits contain all components necessary to build amplifiers which compare favorably with military and commercial units. The materials provided can be used to perform many experiments involving scores of possible circuit connections. Easy-to-follow assembly and experiment instructions are included in the comprehensive reference manuals which accompany each kit.

TAPE CARTRIDGE FOR PROGRAMMING

10 **Amplifier Corp. of America** is now offering the "Pacatape," a continuous loop punched-tape cartridge for high-speed automatic programmed testing machines. The new unit permits the punched tape to be intermittently fed through the machine without binding or breaking. During operation, a dancer roller provides high-speed pay-off without tape stress or tape loop tightening. While the machine reads the punched tape, the dancer arm, during its delayed return motion, gently pulls the tape from the coil and readies it for the next high-speed pay-off event.

The cartridge eliminates the need for a rewind cycle and for operator attention. The unit is completely enclosed for tape protection and convenient storage.

PRODUCTION SOLDERING PENCILS

11 **Wall Manufacturing Company** has developed a soldering pencil handle with a heat rise of less than 30 degrees ambient irrespective of operating time. The new pencils are carefully balanced and weigh only an ounce and a half less cord. The handle construction was developed primarily for use in electronic production-line applications where irons and pencils are left on during extended periods of time.

OPTICAL ENLARGER

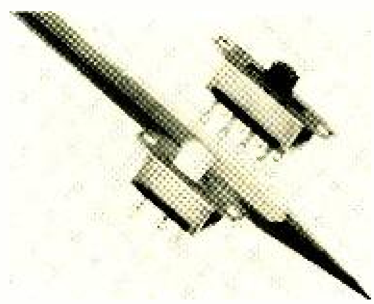
12 **Fairchild Optical Company** is offering a low-cost optical viewer designed for a wide variety

of critical operations including work on printed circuits and with miniature and subminiature electronic equipment.

The "Magna-Sighter" consists of ground and polished prismatic lenses mounted in a binocular housing equipped with an adjustable headstrap. Enlargement is over 2½ times and the unit is designed to be worn over the user's glasses. The viewer is so designed that it is not necessary to remove it when normal, non-magnified vision is required.

SUBMINIATURE SLIDE SWITCHES

13 **Continental-Wirt Electronics Corporation** has just introduced two new subminiature slide switches, the G-124 and the G-128. The G-124 is a s.p.d.t. type while the G-128 is a d.p. 3-position unit. Both are designed to be used in limited-



space applications on test and communications equipment, appliances, lamps, radio and television receivers, and similar gear.

The switches are rated at 0.5 amp a.c.-d.c. at 125 volts with a minimum life expectancy of 10,000 cycles. Mounting centers on the two-position version are .812", over-all length is 1", over-all width is .410", and distance between mounting surface and terminal tip is .300".

70-AMP SCR'S

14 **International Rectifier Corporation** has announced the availability of a new series of 70-amp silicon-controlled rectifiers designed specifically for applications where a high packing density is required in final equipment.

The 72RC-A diffused alloy SCR series spans the voltage range from 25 to 800 volts. The 72RE-epitaxial series covers the voltage range from 600 to 1300 volts as well as providing high reliability and bulk avalanche characteristics in both forward and reverse blocking directions. The 72RE-A expitaxial device is available with a specified maximum reverse avalanche voltage.

These units measure less than 1¾" above the seating plane.

PULSE TRANSFORMER LINE

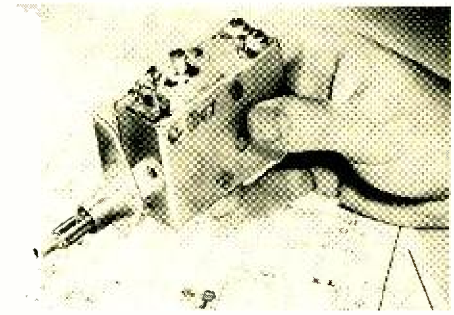
15 **Hamilton Watch Company's** Electronics Division is now marketing a wide range of precision pulse transformers which have been especially designed for easy mounting in standard printed circuits.

Included in the new line are coupling transformers, vacuum-tube blocking oscillator transformers, and miniature transistor blocking oscillator transformers. The impedance-matching coupling transformers are available from 0.25 to 80 mhy. minimum primary inductance and in numerous turns ratios. The vacuum-tube blocking oscillator units are offered in nine pulse widths ranging from 0.2 to 10 microseconds while the transistor versions are specified from 0.2 to 5 microsecond pulse widths, sharp rise times, and a wide range of output amplitudes.

TRANSISTORIZED U.H.F. TV TUNER

16 **Standard Kollsman Industries, Inc.** has announced development of a new transistorized u.h.f. television tuner, Series UT, for use in original equipment.

The new unit will fit all receivers using standard 43-mc. i.f. The noise figure averages 9 db; image rejection is 35 db minimum; i.f. rejection is 60 db minimum, balanced and unbalanced. Oscillator temperature stability is +250 kc.—500 kc. It is engineered for use with direct drive or



with planetary drives of single or dual speeds.

The tuner is approximately 1.18" wide x 3.60" long x 3" high and uses a single nut potentiometer-type threaded bushing for easy and rapid mounting into the TV chassis.

D.C. POWER AMPLIFIER

17 **McFadden Electronics Company** has developed a 100-watt d.c. power amplifier which has a frequency response better than 5 kc. Designed for use with servo amplifiers, servo valve drivers, voice-coil drivers, shaker amplifiers, or as a d.c. amplifier, the Model 130A is completely solid-state. Output impedance is less than 0.1 ohm at 5 amps, the output is protected against short-circuit, and the device provides high output current.

The unit is designed for standard relay-rack installation.

AUTOMATIC RESET TIMER

18 **Haydon Division of General Time Corp.** is now marketing a new series of automatic reset front-panel mounted timers which feature built-in relays and a choice of either interval or delay timing.

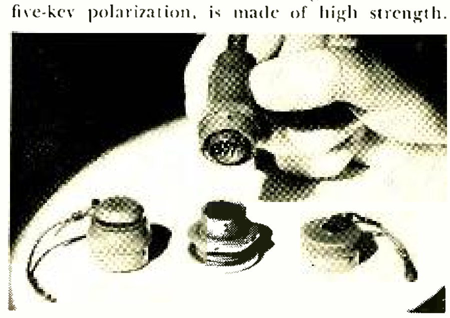
The new BN 30/40 Series are front-panel-mounted units available with or without bezels. The built-in relay eliminates the need for auxiliary relays, reduces installation time, provides isolated load switch contacts, and improves timer unit reliability.

The timers are driven by synchronous motors with integral clutch. Time ranges of 6, 15, 30, 60, and 120 seconds and 5 and 10 minutes are available as standard. Repeat accuracy is ¾% of full-scale reading.

WATER-SEALED CONNECTOR

19 **Methode Electronics, Inc.** has developed a new miniature water-sealed cylindrical connector, designed to Mil-C-26482, that provides fourteen size #20 closed entry socket and pin contacts in a size #12 shell and uses an insert that can withstand a voltage of 1500 volts at sea level.

The shell of this new 482 midget series, with five-key polarization, is made of high strength,



impact-extruded aluminum, cadmium plated with the exterior in an O.D. Iridite finish. Other shell finishes are available. Closed-entry socket solder pot contacts of copper alloy are utilized with gold over silver plating as per MS specifications.

AUTOMATIC TESTER

20 **Dimensions, Inc.** has recently introduced the Model CT-1, an automatic check-out tester for testing electronic and electromechanical equipment and components. The unit, which operates from 117-volt a.c. lines, can also be used for reliability evaluation, checking for intermittent operation, and life testing.

It initiates a process or cycle with an electrical or mechanical signal and receives a signal from equipment under test indicating satisfactory operation. The number of initiations and responses are counted separately. Operating speeds up to 50 cps are available. Life is over 100 million cycles. Double and triple redundancy is available for extra reliability.

PROXIMITY SWITCH

21 **Cutler Hammer Inc.** has developed a new transistorized proximity switch which detects ferrous materials up to ⅜" from the sensing face. The new device is applicable for counting, sorting, and selecting functions in a wide variety of materials handling and machine tool installations where contact with the material sensed is impossible or impractical.

The proximity switch may also be utilized to sort or count metallic materials from non-metallic objects. Since the device requires no physical contact with the objects being counted, it is useful in applications requiring low force or where irregular shaped objects are being tallied.

The switch is compatible with applications requiring maximum operational speeds of up to 1100 pulses per minute.

MINIATURE REED RELAYS

22 **Elec-Trol, Inc.** is now marketing a new series of reed relays that are said to have a life expectancy of 200 million operations at signal currents. The entire reed/coil assembly is encapsulated in a specially formulated, highly stable epoxy, which combines optimum electrical and physical properties that assure high dielectric strength and insulation resistance.

Specifications for the new Series 100 include contact rating of 10 watts d.c., 12 va. a.c., 0.5-amp maximum, 200 volts maximum. Contact resistance is 0.1 ohm. Coil resistances range from 50 to 2000 ohms. Contact configuration is Form A; 1, 2, 4, or 6-pole; single throw.

ELECTROLUMINESCENT DISPLAY

23 **Vogue Instrument Corporation** is now marketing a new high-reliability electroluminescent display in a compact package which includes the power supply and encoding circuits for displaying numbers and letters.

An EL character consists of several segments which, when illuminated in a particular pattern, form numbers or letters. The internal power supply generates the required excitation signals. The power supply requires only low-voltage d.c. in the 6- to 18-volt range. The display will operate from any type of input signal and accepts decimal or binary coded decimal inputs. A self-contained encoder converts these input signals and provides the control for excitation of the desired signal.

SPEED-CONTROL KIT

24 **Electro-Craft Corporation** has announced availability of the "Motomatic" speed-control kit offering an adjustable speed control range of 1000:1. The kit, made for experimental purposes, can be used to set the speed of a unique d.c. motor, capable of handling 12 in./oz. torque, by manual command or heat or light input. The motor will maintain a constant speed set anywhere between 5 and 5000 rpm, irrespective of changes in line voltage or load conditions.

The kit includes a single-transistor amplifier as well as a four-transistor wide-range circuit enabling the experimenter to determine the control requirements of any particular system.

MINIATURE POWER TRANSISTORS

25 **Delco Radio Division** has announced a new family of miniature diamond base (TO-37) power transistors with maximum continuous collector-current ratings of 5 amperes. The Types 2N3212 through 15 are medium-power "p-n-p" germanium devices. They are designed primarily for rapid switching of high-voltage, high-current loads where minimum space is available.

The drift field, non-uniform, diffused base ("Nu-Base") construction features a large element with built-in protection to current hot spots to assure freedom from secondary breakdown over the operating range. The units will dissipate 5 watts at 71°C case temperature. Operating temperatures range from −65 to 110 degrees C with a maximum storage temperature of 125 degrees C.

IN-LINE VERNIER ATTENUATOR

26 **Kay Electric Company** is now offering a new in-line vernier attenuator which provides for fine control of attenuation when used as a separate unit or in series with the firm's 1-db step attenuators.

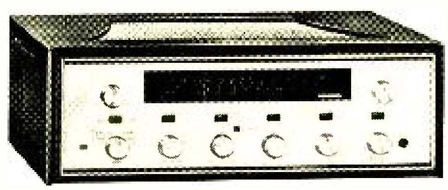
The new unit provides attenuation values in 0.1-db steps from 0.1 to 1.1 db at frequencies up to 500 mc. Typical accuracies are better than ±5% over-all at 100 mc.; ±10% at 250 mc. Maximum v.s.w.r. is 1.4 at 250 mc. The attenuators are available in 50, 70, and 90 ohms.

HI-FI — AUDIO PRODUCTS

60-WATT STEREO RECEIVER

27 **Allied Radio Corporation** has added a 60-watt stereo receiver, the KN-360, to its "Knight" line of assembled audio equipment.

Combined on one chassis is an FM-stereo tuner, a conventional FM tuner, an AM tuner, a stereo preamp, and a 60-watt stereo amplifier. The



entire unit measures 5¼" x 16" x 15" and is designed to fit on shelves or in an equipment cabinet.

The amplifier section provides 30 watts per channel and continuous sine-wave output power of 27 watts per channel. Frequency response is 20-20,000 cps ±1 db at full rated output power. Harmonic distortion is less than 0.6% at full rated output. Channel separation is 30 db or better. There are three stereo inputs and fourteen front-panel controls.

A brown metal or walnut wood cabinet is available extra.

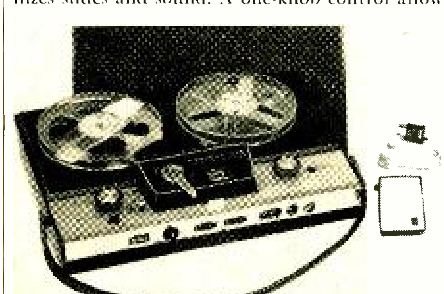
45-OHM P.A. SPEAKER

28 **Atlas Sound** has announced the introduction of its Model EC-10 paging and talk back speaker, a 45-ohm unit suitable for intercom systems which require 45 ohms for proper operation. Power input is 6 watts and frequency response is 400 to 13,000 cps.

The horn section is of precision-molded "Implex" to assure vibration-free, resonance-free output. The magnetic circuit features a new ceramic magnet and a one-piece diaphragm assembly. A steel bracket, which is adjustable, makes mounting simple and secure. The bell diameter is 7½" while the over-all depth is 6⅜".

AUTOMATED TAPE RECORDER

29 **Concord Electronics Corporation** has announced an automated, battery-operated tape recorder that will begin operation at the sound of a voice and automatically stop when the sound ceases. A built-in slide projector synchronizer automatically advances and synchronizes slides and sound. A one-knob control allows



synchronization of music and narration with any movie projector.

This lightweight recorder is self-threading on a 5" take-up reel and will record up to three hours continuously on conventional tape. The unit is powered by standard D batteries but is designed to convert to a.c. operation if desired.

STEREO/MONO TAPE DECK

30 **Eico Electronic Instrument Co. Inc.** is now offering a compact four-track stereo/mono recorder-player incorporating a three-motor tape transport with electro-dynamic braking. Available in both kit and assembled versions, the new unit provides full record and playback equalization at both 7½- and 3¾-ips tape speeds. All recording electronics are included in the deck along with a playback preamp.

Frequency response is 30-17,000 cps ±3 db at 7½ ips and 30-12,000 cps ±3 db at 3¾ ips. Wow and flutter is under 0.2% at 7½ ips. The unit measures 12¾" x 12-9/16" x 6½" and weighs approximately 22 pounds.

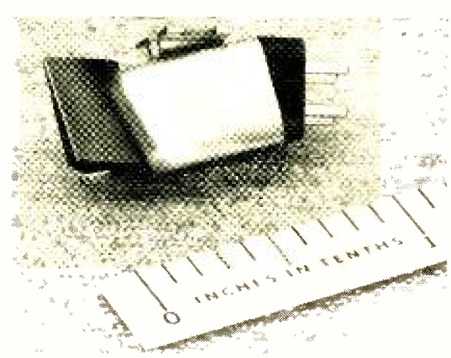
18-INCH WOOFER

31 **Hartley Products Company** is now marketing the **Hartley-Luth** 218MS speaker, an 18-inch woofer with response down to 16 cycles. The new unit has been designed to operate with the company's 10" 220MS speaker in the "Concertmaster" loudspeaker system. The two speakers are matched acoustically and, to eliminate any disassociation effect, they run together for two octaves on either side of the 550-cycle cross-over point. The woofer may also be used with other tweeter-midrange combinations.

The woofer has a 14-pound magnet, a cast aluminum frame, and a patented tri-polymer plastic cone. The firm's magnetic suspension principle is also utilized. Magnetic restoration employs a positive force for eliminating speaker hangover, resulting in improved transient response and lowered distortion.

SUBMINIATURE STEREO PICKUP

32 **Stanton Magnetics, Inc.** has developed a subminiature stereo pickup, the 500AT "Micro Fluxvalve." Thumbnail size and weighing less than 5 grams, the 500AT retains the



high output and high performance standards of the firm's "Stereo Fluxvalve." This unit is designed for the new generation of automatic turntables using low-mass tonearm systems. The unit also incorporates the recommended RIAA 15° playback angle.

SOLID-STATE TAPE RECORDER

33 **Crown International** has announced a new line of solid-state tape recorders for professional and industrial applications.

This new Series 800 has a guaranteed response of 30-30,000 cps, ±3 db at only 1⅞ ips, 30-20,000 cps ±2 db at 3¾ ips; and 50-30,000 cps ±2 db at 7½ ips. Because of this response, the 15-ips speed has been eliminated except on special order. Individual performance records are supplied with each machine showing its exact characteristics.

This performance is made possible by a design which incorporates silicon transistors (no tubes), plug-in circuit modules for each special function, plus gold-plated printed circuits on fiberglass boards. The unit has twin regulated power supplies and circuitry which will function normally over −20 to +200 degrees F.

STEREO HEADSET

34 **David Clark Company Inc.** has added the Model 100 to its line of headsets for stereo and mono applications.

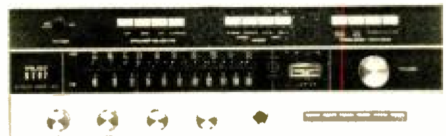
The new unit provides frequency coverage from 10 to 16,000 cps and frequency response ±3 db from 20 to 10,000 cps. Nominal impedance is 8 ohms and maximum power input is 1 watt per phone. Drivers are of the moving coil (dynamic) type. The new headset comes with an 8-foot cable and a 2-circuit stereo plug.

A special feature of these units is direct acoustical coupling which provides direct coupling between the reproduced sound and the ear with complete privacy. The ear seals are specially

molded and highly compliant. They conform to the contours of the head, even when wearing glasses.

STEREO RECEIVER

35 **Pilot Radio Corporation** has just introduced a new AM-FM, FM-stereo receiver which features a 70-watt solid-state amplifier.



Designated the Model R-707, the new unit is equipped with a center tuning meter calibrated for accurate tuning. The tuner's FM sensitivity is 3 μv. (IHF) and has a capture ratio of 4 db. The tuner also features an automatic FM-stereo indicator and three i.f. stages.

The transistorized amplifier section has a front-panel private-listening stereo headphone jack. Harmonic distortion is 1% (IHF). The unit measures 6" high x 17-15/16" deep.

40-WATT STEREO AMPLIFIER

36 **Lafayette Radio Electronics Corporation** has added a 40-watt integrated stereo amplifier to its line of audio equipment.

Complete master control facilities on the LA-260 include concentric bass, treble, and volume controls; a low cut rumble filter; selector switch for phono, tuner, tape, and auxiliary program sources; mode switch; and a panel speaker/phone switch for choice of speaker or headphone listening.

Music power output is 40 watts, 20 watts each channel. Harmonic distortion is less than 1% at rated output with frequency response 10-20,000 cps ±1 db.

The unit, housed in a case with ivory and gold front panel, measures 11¾" w. x 5⅛" h. x 11" d.

CB-HAM-COMMUNICATIONS

WIND-RESISTANT ANTENNA

37 **Jasik Laboratories, Inc.** has developed a new specially designed crossed dipole antenna which will withstand winds of up to 120 mph. Developed to resist heavy rain, snow, wind, and other severe weather conditions, the antenna consists of a strong aluminum boom mounted on a four-foot-square ground plane. The antenna elements are spaced for maximum gain on the 12½-foot aluminum tube boom which is designed as two separate sections for easy handling.

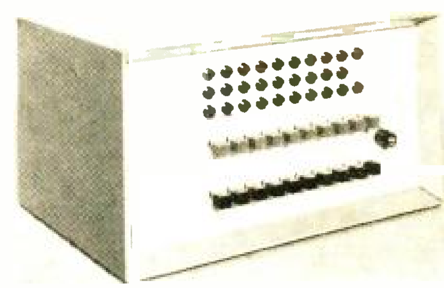
The Model 257 offers linear (vertical or horizontal) or circular (right- or left-hand) polarization with provision for externally switching signal polarization. Designed for 140 mc. with a bandwidth of 20 mc., the antenna may be scaled to other center frequencies and other bandwidths.

REMOTE BASE-STATION CONTROL

38 **Noller Control Systems, Inc.** has developed a compact, all solid-state packaged remote-control system for v.h.f. radio base-station switching which features the firm's unique two-out-of-five phase-shift modulated coding to achieve optimum performance reliability and high security.

The system provides remote-control facilities complete with check back from remote terminals for any v.h.f. radio voice communication installation of up to nine remote stations per channel frequency. The dispatcher is provided with ten individual and/or ten common controls for each remote station.

The system is compatible with open-wire pairs



and carrier-derived tone channels. Operating speed is less than 200 msec. for all functions including push-to-talk. The control panel can be supplied either as a desk-top unit or for mounting in the dispatcher's control console.

SHIP-TO-SHORE UNIT

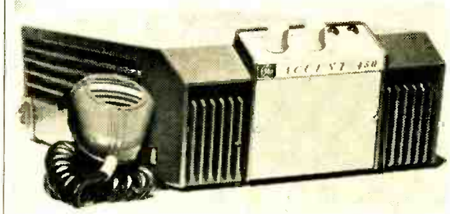
39 **Raytheon Company** has just introduced an all-transistor, ship-to-shore radiotelephone which it claims is the most powerful unit of its type ever developed. Weighing only 8 pounds and less than one-third cubic foot in size, the 45-watt unit is almost a third smaller than partially transistorized models of comparable power.

The Model RAY-1045 draws less than 1/20th the standby current required by conventional units. A full-service marine radiotelephone, it includes six channels to call the Coast Guard, other boats and ships, shore stations, and, through the shoreside marine telephone operator, anyone who has a telephone. It also has a tunable receiver covering the broadcast band.

FM TWO-WAY BUSINESS RADIO

40 **General Electric's** Communication Products Department has engineered a new low-priced, compact FM two-way mobile radio for businesses. To be marketed under the name "Accent 450," the new unit operates in the 450-mc. band.

A new plug-in speaker-control head combination is used to provide the unit with mounting



flexibility. The speaker is built into the control head itself and the same combination is used for either dashboard or trunk installations. The chassis is designed for snap-in, snap-out installation.

The radio is housed in a moisture-proof, dust-resistant aluminum housing. It comes complete with a new high-gain mobile antenna, a battery-saving circuit, and completely transistorized power supply.

SOLID-STATE POWER CONVERTER

41 **Linear Systems Inc.** is now offering a solid-state converter which operates on a 12- to 15-volt d.c. input and provides a series of three d.c. outputs. These include a high-voltage output ranging from 650 to 850 volts d.c. at 500 to 400 ma., a low-voltage output ranging from 250 to 325 volts d.c. at 200 ma., and a bias output from 0 to 120 volts negative at 20 ma.

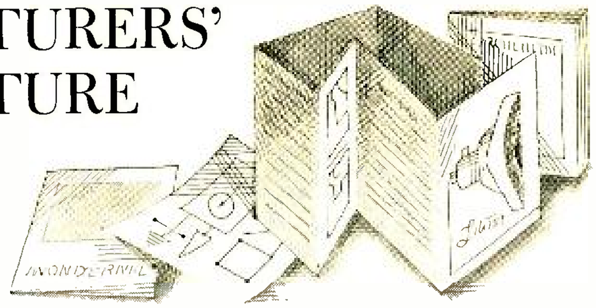
This "Century" model is suited to mobile radio services of all types including aviation, commercial, marine, industrial, emergency, and amateur. Special new circuitry has been developed to give the unit the capability of operating at 91 percent efficiency with 275 watts output and similarly high percentages over a substantial range of power on either side of this point.

DEPTH RECORDERS

42 **Bendix-Marine** has returned the Models DR-7A and DR-9 depth recorders to its line with both units featuring a new type of transducer of greatly increased sensitivity.

Basic range of the DR-7A is 0 to 100 fathoms with an extended range to 200 fathoms. The DR-9 has a basic range of 0 to 200 feet with an extended range to 400 feet. This unit is especially well suited to shallow fishing areas. Presentation of the recordings of either model is on a 7-inch chart paper viewed through a 8" x 7" window. Speed of paper travel is ½" per minute and 43 hours of continuous recording are available from one roll of paper. Power supplies are available for 12, 24, 32, or 110 volts d.c. ▲

MANUFACTURERS' LITERATURE



TRANSISTORIZED SUPPLIES

48 **Acopian Technical Co.** is offering copies of its new four-page, two-color data sheet which provides complete technical details and prices on the firm's line of dual-output a.c.-to-d.c. transistorized, regulated plug-in power supplies. Individual outputs are listed in nominal voltages from 1.5 to 100 volts. Two outputs may be selected from the list for a dual-output regulated supply in a case size only 3-5/16" x 4-5/32" x 4-3/4".

AUDIO NOISE GENERATOR

49 **Elgenco Incorporated** is offering copies of its Bulletin EI-331A which describes the firm's audio noise generator in detail. The instrument features highly regulated r.m.s. level and greatly improved noise characteristics. The output spectrum is uniform to ±0.5 db from 10 to 20,000 cps. Other versions are available and are described in this publication.

MICROWAVE EQUIPMENT

50 **RCA** Microwave Department has issued a technical brochure describing operation of its Type CW-60 microwave equipment of all-solid-state design.

The brochure provides data on terminal and repeater equipment and includes basic functional diagrams. Standby equipment, station assemblies, and cabinet configurations are also shown.

COMPONENT CATALOGUE

51 **General Instrument Corporation** has issued a 23-page catalogue in handily indexed form, listing the entertainment products manufactured by the company. These product lines include radio-TV silicon and selenium rectifiers, entertainment diodes and transistors, silicon tube replacement rectifiers, electrolytics, molded and gold-dip Mylar capacitors, tubular paper capacitors, and a custom-line of u.h.f. converters.

This publication carries a full description of all the products, types of packaging, characteristics, and components which they can be used to replace, as well as dealer net prices.

LOUDSPEAKER TIPS

52 **Acoustic Research, Inc.** is offering copies of a four-page reprint carrying the article "How To Get the Most from Your Loudspeaker" which appeared in "HiFi/Stereo Review."

In the article, E. Villchur of the company presents simple principles and methods of setting up loudspeakers in a living room—placement, phasing, level adjustment—and describes some of the inaccurate old wives' tales about speakers.

SILICON RECTIFIER BULLETIN

53 **National Transistor** is offering copies of a new engineering bulletin, B-113, which describes a line of silicon entertainment rectifiers available from the company.

The bulletin gives electrical and mechanical specifications for 50 rectifiers ranging in p.r.v. from 100 to 1000 volts at a forward current of 0.5 amp. Five case styles are listed conforming to JEDEC standards DO-1, 2, 3, 7, and 13. Characteristic curves are shown for a wide variety of operating conditions, including temperature, d.c. load current, input capacitance, and for half-wave as well as voltage-doubler operation.

CONNECTOR SELECTOR

54 **Methode Electronics, Inc.** has recently published a 20-page catalogue that is designed to facilitate the quick selection of miniature size environmental connectors and termination accessories to fit the requirements of the design, evaluation, or procurement engineer.

The three-color catalogue, No. 482, is punched for three-ring binder. It contains all of the information required to enable the designer to put together a complete environmental connector using the proper part numbers.

COAXIAL CONNECTOR CATALOGUE

55 **Micon Electronics Inc.** has issued a 30-page catalogue describing its line of coaxial connectors. Lines include 50- and 75-ohm subminiatures, 50-ohm microminiatures, coaxial adapters, stripline connectors, and special coaxial devices. Dimension diagrams of all units are included in Catalogue 103 along with complete engineering specifications and assembly data.

TANTALUM CAPACITORS

56 **Astron Corporation** has issued a new engineering bulletin, No. B 401-1, covering its line of solid electrolyte tantalum capacitors.

The 16-page publication contains complete in-

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Mail to: ELECTRONICS WORLD, 434 So. Wabash Avenue, Chicago 5, Illinois formation on performance characteristics and application test specifications for the firm's Type TES units. The bulletin also includes curves illustrating typical performance in addition to a handy reference on MIL-C-26655 type numbers for ready identification.

PULSE GENERATOR DATA SHEET

57 **Servo Corporation of America** has published a new technical data sheet which contains comprehensive descriptive material on its new 9000 Series all-transistor line of pulse generators for general-purpose use.

The data sheet gives detailed information and prices covering a variety of available modules. These include three different time-delay modules, two input-amplifier modules, three time-base modules, three pulse-width modules, and two output-amplifier modules.

V.H.F. RECEIVER DATA

58 **Regency Electronics, Inc.** has issued a two-color, two-page technical information sheet on two of its newest v.h.f. aircraft receivers for flight monitoring applications.

Complete electrical, mechanical, and physical characteristics are provided on the AR-132 and "Flight Monitoradio" receivers. Additional information is also included on the firm's AA-1 v.h.f. antenna for use with the "Flight Monitoradio" unit.

BOLTED CONNECTION DATA

59 **Elastic Stop Nut Corporation of America** has issued a comprehensive illustrated booklet on bolted connections. This 40-page booklet, illustrated with simple line drawings and written in non-technical language, gives detailed information on the simple mechanics of a nut and bolt connection, explains why they loosen, and suggests how to obtain reliable joints.

The digest covers bolting requirements, methods of preventing nut loosening, a review of nuts, and includes a specific glossary of fastener terms.

RECEIVING-TUBE CHART

60 **General Electric** Tube Department has issued a new receiving-tube selection chart entitled "High Reliability Tubes for Critical Applications."

Chart ETR-3559A lists prototypes and essential characteristics of the complete line of 59 types of "Five-Star" receiving tubes which are specifically constructed for use in military, aircraft, and other critical applications. The four-page 8½" x 11" chart also includes basing diagrams.

DUMMY-LOAD DATA

61 **Trylon, Inc.** has published a four-page technical bulletin, No. C8253, outlining application advantages, electrical and mechanical characteristics of its dissipation resistors and dummy loads for antennas and transmitters.

The bulletin includes information on both deposited-film and wire-wound types of dissipation resistors. Over-all specifications, mechanical details, and performance data in tabular form are included in this publication.

PRECISION INSTRUMENTS

62 **Wayne Kerr Corporation** has issued a six-page, two-color illustrated short-form catalogue which covers its entire line of precision instruments.

The instruments are briefly described with condensed specifications given on transformer ratio-arm bridges, instruments for analog analysis, distance and vibration instrumentation, low-level d.c. instrumentation, primary standard instrumentation, audio instrumentation, video instrumentation, and temperature-salinity instrumentation and electronic thermometers.

ELECTRICAL TERMINALS

63 **Tri-Point Industries, Inc.** is now offering a four-page cross-reference guide for miniature and subminiature Teflon-insulated electrical terminals.

This new bulletin lists over 300 sizes of insulated terminals in 33 types showing their numerical equivalent available from other sources with some not available from other suppliers. Specifications and pictorial descriptions are also included.

MAGNETOSTRICTIVE DELAY LINES

64 **Ferranti Electric Inc.** has published a booklet for design engineers, entitled "A-B-C's of Magnetostrictive Delay Lines," which contains illustrations and drawings of various waveshapes under various modes of operation. It covers RZ and NRZ recording methods and includes an informative glossary of magnetostrictive delay-line terms as well as a summary of measurement practices.

TRANSISTOR CIRCUITS

65 **Sylvania Electric Products Inc.'s** Semiconductor Division is offering a free brochure containing eight typical circuits for its "n-p-n" germanium alloy transistors. In addition, the brochure includes characteristics of these industrial and entertainment transistors.

RACK/PANEL CONNECTORS

66 **ITT Cannon Electric Inc.** has released a new catalogue which describes the firm's DPYC rack/panel connectors in detail. The DPYC is a miniature connector in a square configuration which incorporates the "Little Caesar" rear release system. The insulator is diallyl phthalate, the shell is die-cast aluminum finished with yellow chromate over cadmium, and keystone configurations are provided for necessary polarization.

The catalogue provides full details on available units along with application data.

CAPACITOR PERFORMANCE CHART

67 **Corning Electronic Components** has issued a double-sided chart which shows glass-dielectric capacitor failure rates at a glance in percent per 1000 hours at various voltage and temperature stresses. On one side the chart shows plots for 90 percent confidence while on the other side are plots for 60 percent confidence.

The chart is entitled "Failure Rate for Corning CYFR Capacitors" and is available without charge.

PHYSICAL CONSTANTS

National Bureau of Standards has issued a handy pocket-size card which lists on one side selected physical constants, recommended by the National Academy of Sciences-National Research Council and adopted by NBS, and on the other side recommended unit prefixes as well as defined values and conversion factors.

The card, NBS Misc. Publ. 253, is available from the Superintendent of Documents, U.S. Govt. Printing Office, Washington 20402 for 5 cents each. ▲

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TRANSISTORIZED Products Importers catalog. $1.00. Intercontinental. CPO 1717, Tokyo, Japan.

DIAGRAMS for repairing Radios $1.00. Television $2.50. Give make model. Diagram Service, Box 1151 E, Manchester, Connecticut 06042.

ART-13 Excellent condition $39.50 BC-433F Receiver with shock mounts $12.50. Ace Electronics, 1422 Market Street, San Francisco, Calif.

TV CAMERAS and parts at lowest prices. Catalog 10¢. Vanguard, 190-48—99th Ave., Hollis, N.Y.

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TRANSISTOR Television Translators. Rebroadcast 25 miles. Meets F.C.C. specifications, battery powered. Keith Anderson Company, Piedmont, So. Dak.

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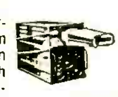

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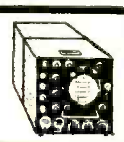

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SCR-522 2-METER TRANSMITTER-RECEIVER

Terrific buy! VHF Transmitter-Receiver. 100-156 Mc. 4 channels. Xtal-controlled. Amplitude modulated voice. Complete with all 18 tubes, top rack and metal case. LIKE NEW!
SPECIALLY PRICED .... **P.U.R.**

SCR522 as above, exc. used **$32.50**

BC-624 Receiver only, with all tubes (of SCR-522 above). Clean.
LIKE NEW condition **$24.50**

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AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc

$79.50 EXC. USED

complete with Tubes

Famous Collins Autotune Aircraft Transmitter. AM CW. MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP811s modulate 813 in final up to 90% class "B." A Real "HOT" Ham buy at our low price!

AN/ART-13 XMTR, as above. In LIKE NEW condition, with all tubes and crystal **$89.50**

0-16 Low Freq. Osc. Coil for ART-13 ...... 7.95
24V Dynamotor for ART-13 .... 11.95

We carry a complete line of spare parts for above.

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ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 MC	12.45	17.95
BC-455	Receiver 6-9 MC	11.50	13.95
1.5 to 3 MC.	Receiver Brand New		$17.95

110 Volt AC Power Supply Kit for all 274-N and ARC-5 Receivers. Complete with metal case. Instructions **$8.95**
Factory wired. tested. ready to operate . $12.50

SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only .... **49¢**

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BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal. BRAND NEW **$9.75**
Like New $7.95

BC-458 **TRANSMITTER**—5.3 to 7 Mc. Complete with all tubes and crystal.
BRAND NEW **$10.95**
Like New $7.95

BC-696 TRANSMITTER 3-4 Mc Complete with All Tubes & Crystal. Like New **$11.95**

BC-456 Modulator .... **USED 3.45 NEW** 5.95

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BRAND NEW! 15 Tubes 435 to 500 MC

Can be modified for 2-way communication, voice or code, on ham band 420-450 mc, citizens radio 460-470 mc, fixed and mobile 450-460 mc, television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE-316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton.

Shipping weight 25 lbs. **SPECIAL!** ... **$19.50**

PE-101C Dynamotor, 12/24V input **$7.95**
UHF Antenna Assembly **2.45**
Complete Set of 10 Plugs **5.50**
Control Box **2.25**

SPECIAL "PACKAGE" OFFER

BC-645 Transceiver, Dynamotor and all accessories above. COMPLETE, BRAND NEW
While Stocks Last **$29.50**

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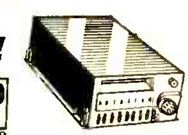
Airborne Radar Video Transmitter, 465 to 515 Mc. Power Output 15 Watts. Complete with 15 tubes, **BRAND NEW** **$69.50**

PP-104/APT-5 RECTIFIER POWER UNIT for above. Complete with 4 tubes, BRAND NEW **$29.50**

APN-1 FM TRANSMITTER-RECEIVER

420 to 460 Mc Aircraft Radio altimeter equipment. Tubes: 4-955, 3-12SJ7, 4-12SH7, 2-12H6, 1-VR150; Complete with tubes, Like new **$8.95**
APN-1 Brand new **$11.95**

ARC-3 RECEIVER!



Complete with All Tubes Exc. Used **$21.50**

Like NEW **$33.50**

Crystal-controlled 17-tube superhet, tunes from 100 to 156 MC., AM., on any 8 preselected channels. 28-volt DC power input. Tubes: 1-9002, 6-6AK5, 1-12SH7, 3-12SG7, 1-9001, 1-12H6, 2-12SN7, 1-12SL7, 1-12A6.

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Companion unit for above tunes 100 to 156 MC on any 8 pre-selected channels. 9 tubes, crystal controlled, provides tone and voice modulation. 28V DC Power input. Complete with all Tubes: 3-6V6, 2-832A, 1-12SH7, 1-6J5, 2-6L6. Exc. Used .... **Only $18.95**
Like new condition **$28.50**
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AN/ARN-7 RECEIVER

Frequency range 100 Kc to 1750 Kc in 4 bands. Aircraft navigational instrument comprising superhet receiver and additional circuits. Complete with tubes, exc. cond. **$29.50**
Accessories for above, available.

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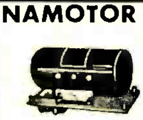
Complete portable outfit in original packing, with all accessories. Brand New **$29.50**

MOBILE-MARINE DYNAMOTOR

Model DM35

Input 12V DC. Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation.

Shpg. wt. 14 lbs. BRAND NEW **$19.50**



DYNAMOTOR VALUES:

Type	Input	Output	Excellent Used	BRAND NEW
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DM-33A	28V 5A	575V .16A		
	28V 7A	540V .25A	2.95	4.45
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-36	28V 1.4A	220V .080A	1.95	2.95
DM-43	28V 23A	925V .220A		
		460V .185A	—	7.95
DM-53A	28V 1.4A	220V .080A	3.75	5.45
PE-73C	28V 20A	1000V .350A	8.95	14.95
PE-86	28V 1.25A	250V .050A	2.75	3.85

DM-37 DYNAMOTOR. Input 25.5 V DC @ 9.2 A. Output 625 V DC @ 225 Ma. BRAND NEW. Each **$3.25**

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Model	Description	EXC. USED	BRAND NEW
T-17D	Carbon Hand Mike	$4.45	$7.95
RS-38	Navy Type Carbon Hand Mike	3.95	5.75

HEADPHONES Checked Out, Perfect

Model	Description	EXC. USED	BRAND NEW
HS-23	High Impedance	$2.79	$4.95
HS-33	Low Impedance	3.15	5.45
HS-30	Low Imp. (featherwt.)	.90	1.65
H-16/U	High Imp. (2 units)	3.75	7.95

TELEPHONICS—600 ohm Low Impedance HEADSETS. BRAND NEW. PER PAIR **$3.95**
CD-307A Cords, with PL55 plug and JK26 Jack **.99**
Earphone Cushions for above—pair .... **.50**

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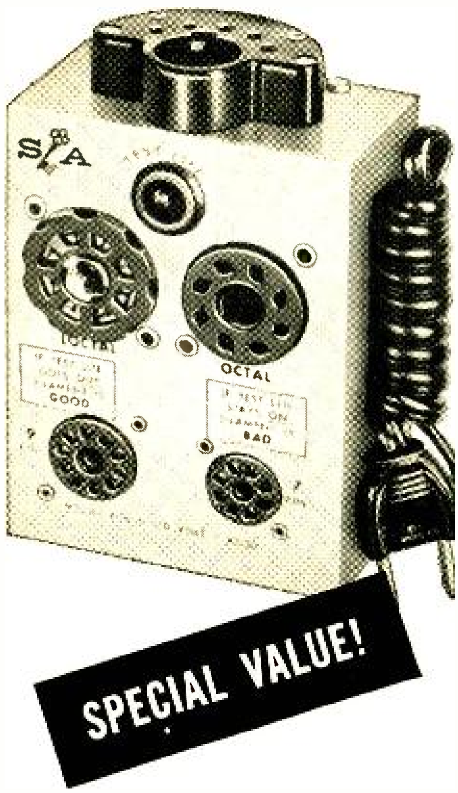

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FULLY GUARANTEED! ORDER TODAY!

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New York 12, New York

Please send me _______ Continuity Testers at $3.95 each (N.Y.C. residents please add 4% Sales Tax). My check (or money order) for $__________ is enclosed. I understand that you will pay the postage and that each Continuity Tester is fully guaranteed.

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QUICKSILVER. Platinum, Silver, Gold. Ores Analyzed. Free Circular. Mercury Terminal, Norwood, Mass.

CASH Paid! Sell your surplus electronic tubes. Want unused. Clean radio and TV receiving, transmitting special purpose. Magnetrons, Klystrons, broadcast types. Want military and commercial lab/test equipment. Want commercial Ham Receivers and Transmitters. For a Fair Deal write: Barry Electronics, 512 Broadway, New York, New York 10012 (Walker 5-7000).

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D.C. Power Supply: Output 330&165VDC @ 150 Ma, Input 115v 60to800cys. Cased! Special $5

"SCR" SILICON CONTROLLED RECTIFIERS!

PRV	7A	16A	25A	PRV	7A	16A	25A
25	.75	1.25	1.60	250	3.00	3.50	4.00
50	1.25	1.70	2.00	300	3.35	3.85	4.35
100	2.00	2.50	3.00	400	4.25	4.50	4.95
150	2.25	2.85	3.50	500	5.10	5.35	5.60
200	2.50	3.10	3.75	600	5.85	6.00	6.25

SCR KIT UNITS UP TO 25 AMPS UNTESTED 4 for $2

SILICON TUBE REPLACEMENTS!!!
5U4 1120 Rms 1600Piv $3 @, 4 for $10
5R4 $5 @!! OZ4 $1 50 @, 4 for $5! 866A $10!

"TAB", SILICON 750MA* DIODES

Factory Tested! Gtd.!

*NEWEST TYPE! LOW LEAKAGE!

Piv/Rms	Piv/Rms	Piv/Rms	Piv/Rms
50/35 .05 ea.	100/70 .09 ea.	200/140 .12 ea.	300/210 .18 ea.
400/280 .23 ea.	500/350 .28 ea.	600/420 .38 ea.	700/490 .50 ea.
800/560 .58 ea.	900/630 .68 ea.	1000/700 .78 ea.	1100/770 .88 ea.

ALL TESTS AC & DC & FWD & LOAD!

400 Piv 750Ma Quantities 1000 $200
600 Piv 750Ma Quantities 1000 $300
1100 Piv 750 Ma Quantities ....15 for $ 10

Kit TO3 Power Transistors Untested! ..10 for $1
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D.C. Amps	50Piv 35Rms	100Piv 70Rms	150Piv 105Rms	200Piv 140 Rms
3	.15	.25	Query	.40
12	.60	.80	.90	1.00
*18	.35	.55	.70	.95
35	1.30	1.55	1.75	2.00
100	2.25	3.00	3.50	4.00
240	4.50	5.70	6.90	8.40

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12	1.25	1.50	1.75	2.00
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Primary 110V. 60 Cy. Secondary 1125-0-1125 @ 250 MA ....ea. **$9.95**

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Sec. 12.6 V. 5 A ....$ 2.95
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210 Pri. 60 cy. Sec. 1.6 V 1100 amp....$18.95

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PA AMPLIFIER—Complete except for Mike, Battery and Speaker.........ea. **$1.98**

PHONO AMPLIFIER—Complete except for 1 Meg Vol. Cont., Battery and Speaker ....ea. **$3.49**

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BRAND NEW OIL CONDENSERS

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2½" Meter 100-0-100 Microamps..........2.95
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CIRCLE NO. 126 ON READER SERVICE PAGE

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PRV	7 Amp	25 Amp	2 Amp	6 Amp	12 Amp
70	1.35	2.60	—	—	.45
140	1.85	3.10	—	—	—
200	2.10	3.25	.40	.45	.70
250	2.60	3.60	—	—	—
300	2.85	3.85	.50	.60	—
350	3.35	4.25	—	—	—
400	3.85	—	.60	.75	—
450	4.25	—	—	—	—
SCRs 500	4.60	—	.70	.90	—
600	5.35	—	.80	1.00	—

VARIACS

2 AMP 7.50
3 AMP 8.95
10 AMP 18.95
20 AMP 24.95
20 AMP (Cased) .. 29.95

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Pri 115 V or 230 V Sec—3 x 6.3V8A, 230 V 450 Ma Epoxy Encapsulated .... $6.95 ea.
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Stancor #PM8418 460 VCT @ 50 Ma & 6.3 V @ 2.5 A .... 2.95 ea.
Plate tsfmr. 1100 VCT 250 Ma .... 6.49 ea.

VARIAN FOCUS MAGNETS

#1504-A New .... $975.00 Pair

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0-1MA .... $3.25 ea.
0-2MA .... $3.25 ea.
0-100 MV .... $3.25 ea.
0-500 MMA ... $3.25 ea.

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DC-MA 0-50 or 100 .... $5.95 ea.
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3"
0-30 VDC .... $4.95 ea.
0-5 MA DC ... $3.95 ea.

ROUND

2"
0-200 VAC .... $4.49 ea.
"S" meter 0-9 . $3.95 ea.

0-200 MA DC .. $4.25 ea.
0-200 MMA ... $4.95 ea.
0-100 MMA ... $5.25 ea.
0-1 MA (Arbitrary Scale) ..... $3.95 ea.
0-4 A-RF ..... $3.50 ea.

3"
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200-0-200 VDC . $3.95 ea.
0-75 VDC ..... $3.95 ea.

4"
AC Volts 0-50 .. $3.50 ea.
AC MA 0-150 .. $3.50 ea.
DC Volts 0-25; 300; or 500 .... $3.50 ea.

4½"
0-50 VDC (4 scales basic 0-1 MADC) .. $4.50 ea.

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ALNICO V MAGNETS

Horseshoe type facing 2⅛"x⅝"x1⅜" high . 3.95 Pr.
NPN-Germanium MESA Transistors F max—250 Mc-BV-10V 10/4.00 100/35.00
Germanium Diodes .... Computer type—$8./100

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79 Cortlandt St., New York 7, N.Y. RE 2-0270

CIRCLE NO. 103 ON READER SERVICE PAGE

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CIRCLE NO. 146 ON READER SERVICE PAGE

In April POPULAR ELECTRONICS:

— the "Car Battery Saver"

Are you in the habit of leaving the parking lights turned on when the engine isn't running? Have you ever gone to the garage to find the headlights glowing and not enough battery capacity to turn the engine over? If so, you'll want to build this ultra-simplified construction project in a hurry. The "Car Battery Saver" consists of a single transistor, one capacitor, a miniature speaker, and three resistors.

PLUS: Five Special CB Features on Improving Your CB Receiver Performance

Don't miss April **POPULAR ELECTRONICS**

Now on sale

PATENTS

INVENTIONS: Ideas developed for Cash Royalty sales. Raymond Lee, 2104G Bush Building, New York City 36.

PHOTOGRAPHY—FILM, EQUIPMENT, SERVICES

MEDICAL FILM—Adults only—"Childbirth" one reel, 8mm $7.50; 16mm $14.95. International W, Greenvale, Long Island, New York.

SCIENCE Bargains—Request Free Giant Catalog "CJ"—148 pages—Astronomical Telescopes, Microscopes, Lenses, Binoculars, Kits, Parts, War surplus bargains. Edmund Scientific Co., Barrington, New Jersey.

STAMPS

WOW! 110 All Different Germany 10¢! Zeppelins, Semi-Postals, Airmails, High values, etc. Giant Catalog, bargain lists included with beautiful approvals. Jamestown Stamp, Dept. A44EG, Jamestown, N.Y.

U.S. STAMPS Plus Complete U.S. Catalog. All for 10¢ Four sensational offers in one: 1. Genuine centennial postage stamp, picturing first U.S.A. (issued 117 years ago!) 2. Valuable collection all-different U.S.—Ancient 19th Century, $1.00 stamp, etc. 3. Collection beautiful commemoratives: American Revolution, Wild West, 1893 Columbian, many others. 4. Collector's Guide; exciting stamp offers for your inspection; Big new U.S. Bargain Catalog. Send only 10¢. Act Now! H. E. Harris, Dept. C-605, Boston 17, Mass.

MISCELLANEOUS

WILD Labels, bumper strips! Strange, startling, unconventional! Krazy Labels, Box 15-H, Olympia, Washington.

$130 AVERAGE Race Day Profit with $50.00. 25 years results in amazing copyright book. Hitchings, Box 5715-47A, Carmel, Calif.

HERE IN ONE PUBLICATION

1964 CAR and DRIVER YEARBOOK

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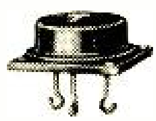

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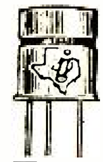

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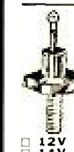

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☐ 6	400	.59	☐ 12	100	.69	☐ 25	100	1.29
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CIRCLE NO. 140 ON READER SERVICE PAGE

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ELECTRONICS WORLD APRIL 1964
ADVERTISERS INDEX

Printed in U.S.A.

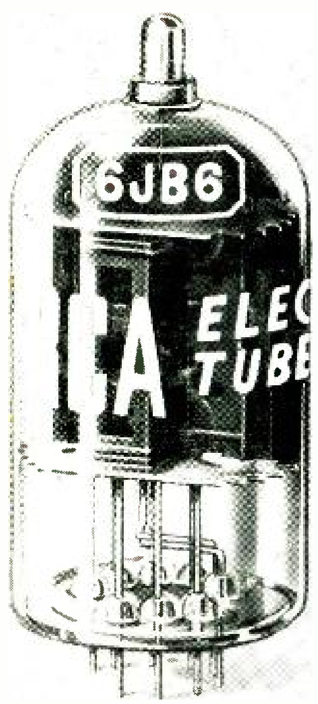
SEE HOW RCA RECEIVING TUBES KEEP GETTING BETTER

1959–*N-132 Cathode Base Material*

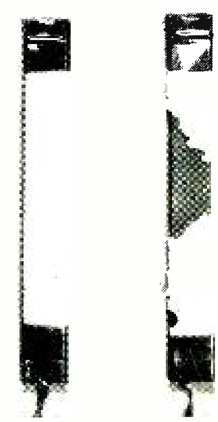
1960–*S-311 Plate Material*

1961–*RCA Dark Heater*

...*AND* 1963



THE BONDED CATHODE



Ends cathode peeling, even after long periods of high-temperature, high-voltage tube operation.

Picture on right is an example of peeling which may occur in non-bonded cathode of a horizontal-deflection-amplifier tube after several hundred hours of operation in a TV receiver.

From RCA research comes another major contribution to electronic performance and reliability: the <u>bonded cathode.</u> Its emissive coating will not peel even after extended service under high-voltage, high-temperature conditions encountered in TV horizontal-deflection-amplifier tubes and damper diodes. Permanent adhesion of the emissive-oxide coating of the RCA bonded cathode improves over-all tube performance and reliability. Here's why:

THE NEW RCA BONDED CATHODE:

- virtually eliminates peeling of emissive oxide coating
- reduces cathode interface-type impedance effects during life
- reduces grid-to-cathode shorts during life
- improves stability of cathode-to-grid spacing
- improves anode-voltage-per-mil-spacing safety factor in damper diodes
- transmits heat more efficiently and uniformly—thereby providing more uniform cathode-current density

The RCA bonded cathode was first applied with outstanding success in beam power tube types 6DQ6-B and 6JB6 and half-wave vacuum rectifier types 6AU4-GTA and 6AY3. This new development is now being incorporated in a growing number of types where service conditions show a need.

Such RCA developments as the bonded cathode result in reliable components for you to sell and install. Use RCA receiving tubes for all replacements. You have the benefit of continuing tube improvement from the research, design and development facilities of the world's broadest-based electronics company—RCA!

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N. J.

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