Electronics World

MARCH, 1967
60 CENTS

COMPLETE DIRECTORY

including performance characteristics of all

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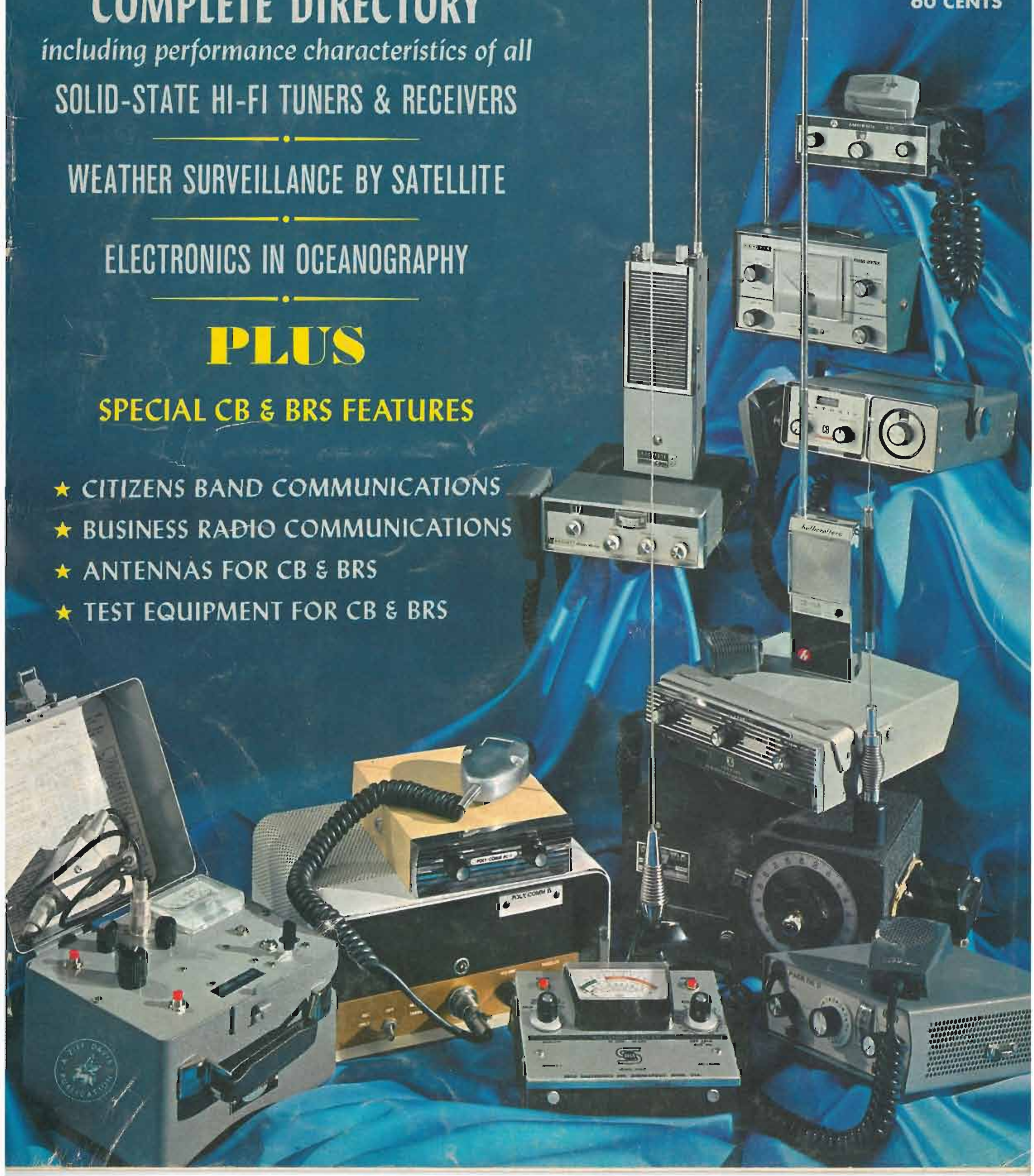
- ★ ANTENNAS FOR CB & BRS
- ★ TEST EQUIPMENT FOR CB & BRS



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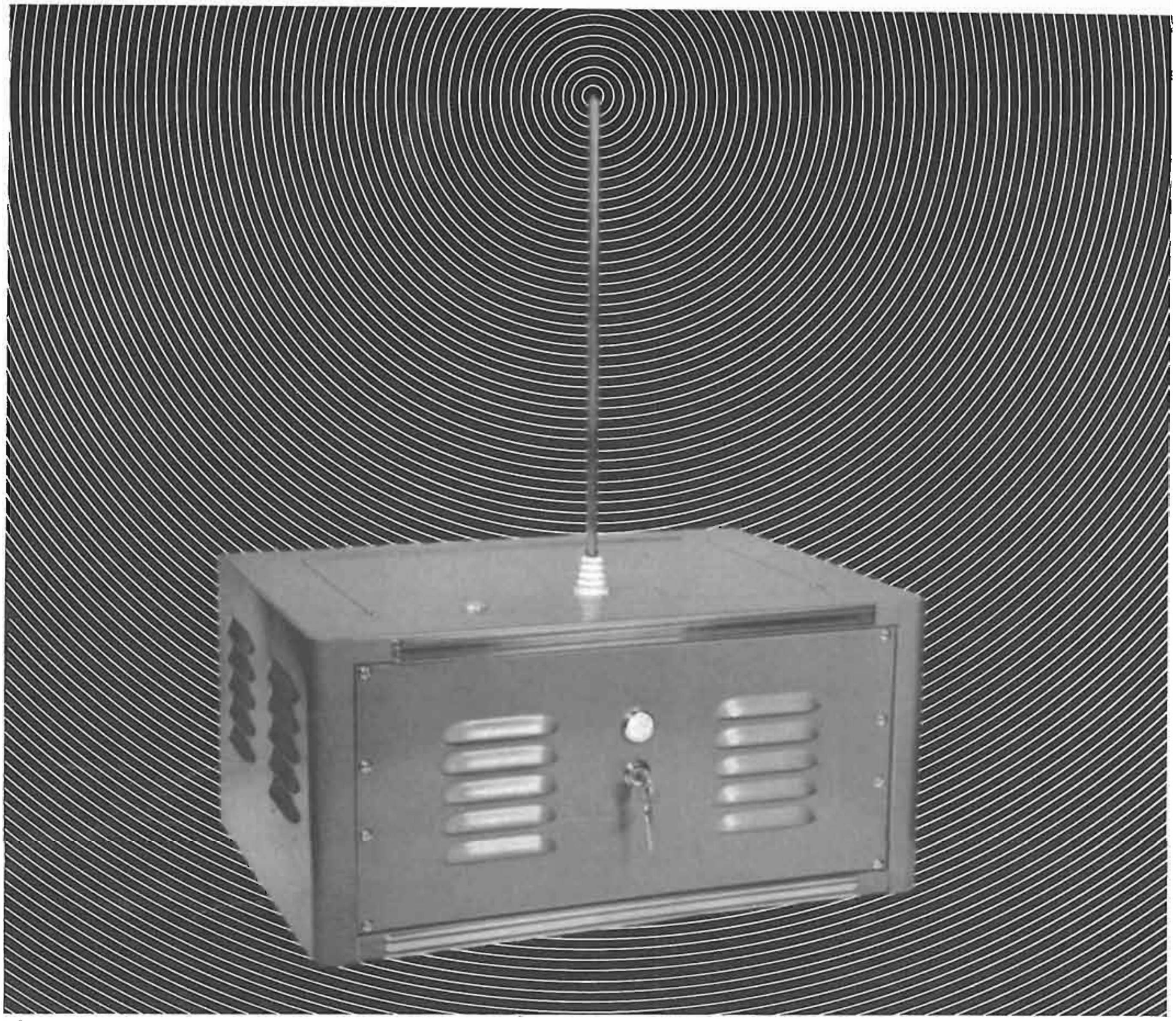

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CIRCLE NO. 196 ON READER SERVICE CARD

THIS MONTH'S COVER shows representative examples of equipment designed for the Citizens and Business Radio bands. Included are transceivers, test equipment, and antennas which are fully described in our cover story on page 28 of this issue. The equipment ties in with the four special features we are running this month on the subjects of Citizens Band communications, Business Radio communications, test equipment for CB and BRS, and antennas for CB and BRS. These articles may be located by referring to the adjacent table of contents. ....(Cover photograph: Bruce Pendleton).

Electronics World

MARCH 1967 VOL. 77, No. 3

CONTENTS

MONTHLY FEATURES

Electronics World: Published monthly by Ziff-Davis Publishing Company at 307 North Michigan Ave., Chicago, Illinois 60601. One year subscription $6.00. Second Class Postage paid at Chicago, Illinois and at additional mailing offices. Subscription service: Portland Place, Boulder, Colorado 80302.

COMING NEXT MONTH

SPECIAL ISSUE: RELAYS

This 24-page section will cover the design and application of all major types of relays. The nine articles, written by industry authorities, include: **Relay Coil Considerations** by M.S. Steinback, Chief Engineer, Magnecraft Electric Co.; **Reed Relays** by Roger L. Rosenberg, Systems Project Engineer, C.P. Clare & Co.; **Mercury-Wetted Contact Relays** by Arthur J. Koda, Senior Development Engineer, C.P. Clare & Co.; **Trade-Offs in Relay Selection** by George C. Underwood of Cornell-Dubilier and a **Checklist for Ordering Relays,** also by Mr. Underwood; **Relay Operate and Release Times** by W. Warren Wright, Assistant Chief Engineer, Guardian Electric; **Time-Delay Relays** by Jerry Elpers, Sales Manager for Solid-State Products at Potter & Brumfield; **Electrical Contact Considerations** by Arthur O. Capp, Jr., Engineering Manager of Fansteel's Electrical Products Division; and **Arc-Surge Noise Suppression** by R.M. Rovnyak, Staff Engineer for Product Design, Automatic Electric Company.

ELECTRONIC EAVESDROPPING

"Bugs" in phones, furniture, cars, offices, and shirt pockets have become commonplace. Robert M. Brown surveys the field and provides detailed descriptions of currently available units, how they operate, and how they can be detected.

INTEGRATED-CIRCUIT I.F. AMPLIFIER USED IN NEW FM RECEIVER

By using four IC's as i.f. amplifiers and limiters in its new receivers, Scott has obtained improved sensitivity and selectivity, more stereo separation and AM rejection, and better capture ratio—all with a basically simpler i.f. strip.

NEW Q-BAND MARINE RADAR

Radar operating at 8-mm (about 35,000 MHz) wavelength is now being used on the crowded European waterways. It provides better resolution, will pick up smaller targets and display their shapes. This article describes the new Model 8GR260 unit developed by Philips.

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

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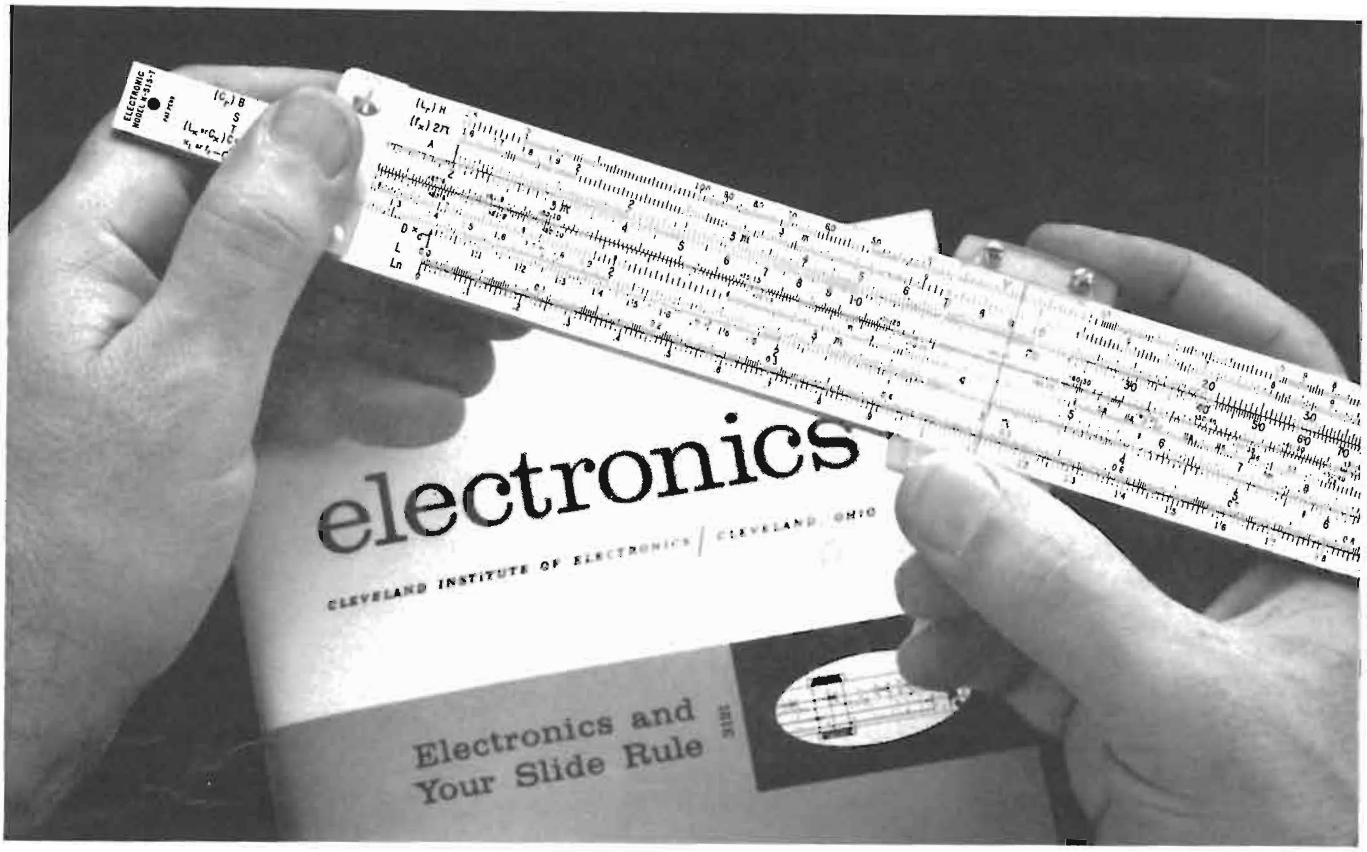

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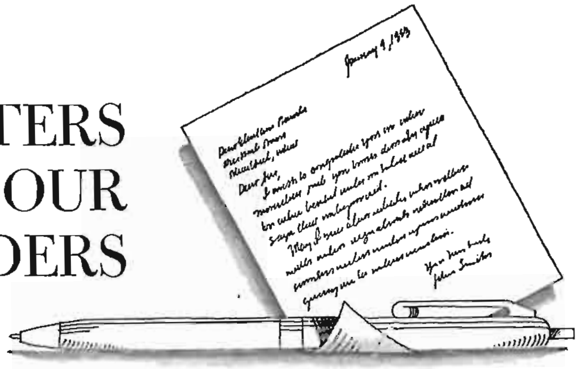
LETTERS FROM OUR READERS



THE HAM AS ENGINEER

Our January "Letters from Our Readers" column contained a letter from Cliff Erickson commenting on John Frye's column "Predicting Academic Success" which appeared in our August issue. Mr. Erickson felt that ham network activity helps prepare men for college engineering courses. Here are some comments from Author Frye:

Dear OM:

I just read your letter in the January issue of ELECTRONICS WORLD—I had not had an opportunity to see it before—and I thought I should do a little explaining. I am afraid, Cliff, you missed the point I was hoping to make; *viz.,* no criterion of expected performance in college works, including the holding of a ham ticket. I freely admit this surprised me, too, for I have always felt that a fellow who passed the ham exam would naturally do well in engineering; but this is not true any more than it is true that the boy who "loves to tinker with cars" can be expected to do well in mechanical engineering.

The really dedicated technician who does much of his experimenting in the ham field cannot be placed in the same category with the run-of-the-mill ham because the former is already on the way to being an engineer when he enters college. In other words, your quarrel is not with me; it is with the statistics carefully collected at Purdue and other universities where they are searching for some reliable indicator of future performance in engineering.

I am not sure if you know I am an amateur, for EW does not use my call; but I have been a ham for 35 years—active all this time except for the period when we were off the air during World War II. I spent many years in the Army Amateur Radio System as a traffic handler on c.w.; I was one of the original members of the Indiana Fone Net and still check into this net daily; my equipment is all *Heath* (SB-100, SB-200, "Monitorscope"), and that is only a cut from "store-bought" equipment. I use *Hy-Gain's* TH4CK tribander beam and 2BDQ 80-40 trap antenna.

So you see, I was not trying to "put down" the hams I mentioned. I simply said you could not depend on their being hams to expect outstanding performance in a college engineering course.

We may as well face it, Cliff; not all hams are budding engineers any more than all pipe smokers and dog lovers are fine fellers. When I lived in Arkansas, I knew more than one pipe smoker and dog lover who was a wife-beater and a child-neglector!

JOHN T. FRYE, W9EGV
Logansport, Ind.

* * *

IC TERMINAL NUMBERS

To the Editors:

The article in the November issue on "Linear Integrated Circuits: What's Available?" by Donald E. Lancaster covers the current items that are available at the present time very well.

I do think that a word of caution must be offered, however, concerning the terminal numbers describing the *Westinghouse* device. The WC183 as described and shown is really the flat-pack WC183G. Since mention was made of the TO-5 can variety, I think the user should first check available data sheets because the terminal numbers of the WC183T are not exactly the same as those for the WC183G. This is also true in the equivalent flat packs and TO-5 can varieties of other manufacturers, since flat packs can have as many as fourteen terminals and TO-5 cans only twelve.

C. N. BUSHEY
Linthicum Heights, Md.

* * *

A.G.C.-OPERATED POWER CONTROL

To the Editors:

Before more letters start arriving from readers, let me note some errors in the drawing and some possibly significant omissions in my article "A.G.C.-Operated Power Control" as it appears in the December, 1966 issue (p. 81).

*C*3 is shown incorrectly polarized. The negative side of *C*3 should be connected toward the plate of the 2D21 thyratron. *C*2, a 0.005-μF capacitor, may be a disc ceramic, mica, or paper with a rating of 200 volts or more. It is not, as indicated, an electrolytic type.

*RL*1 is correctly drawn as an s.p.d.t. but is listed as a d.p.d.t. type. A note

(*Continued on page* 12)

Let's talk sense about color TV lead-in!

The common sense of the situation calls for *two* 82-channel lead-ins for color and UHF TV... one to give a stronger signal in uncongested fringe areas where interference usually is not a serious problem. The other to give a much cleaner signal in congested or close-in areas where serious interference problems are likely to exist. This is why Belden gives you a choice—the *Color Guard Twins.*

8285

*Color Guard Twin—Belden Permohm**

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You get an excellent color image . . . because in a 100-foot run, Permohm delivers 38% to 200% more signal voltage than RG-59/U with matching transformers and 23% to 80% more signal voltage than "Low Loss Coax" with transformers.

Permohm obtains the highest efficiency of any available unshielded 300 ohm line when exposed to weathering and industrial atmospheres. Low loss cellular polyethylene insulation around the conductors provides the necessary protection.

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†Patent No. 3,032,604

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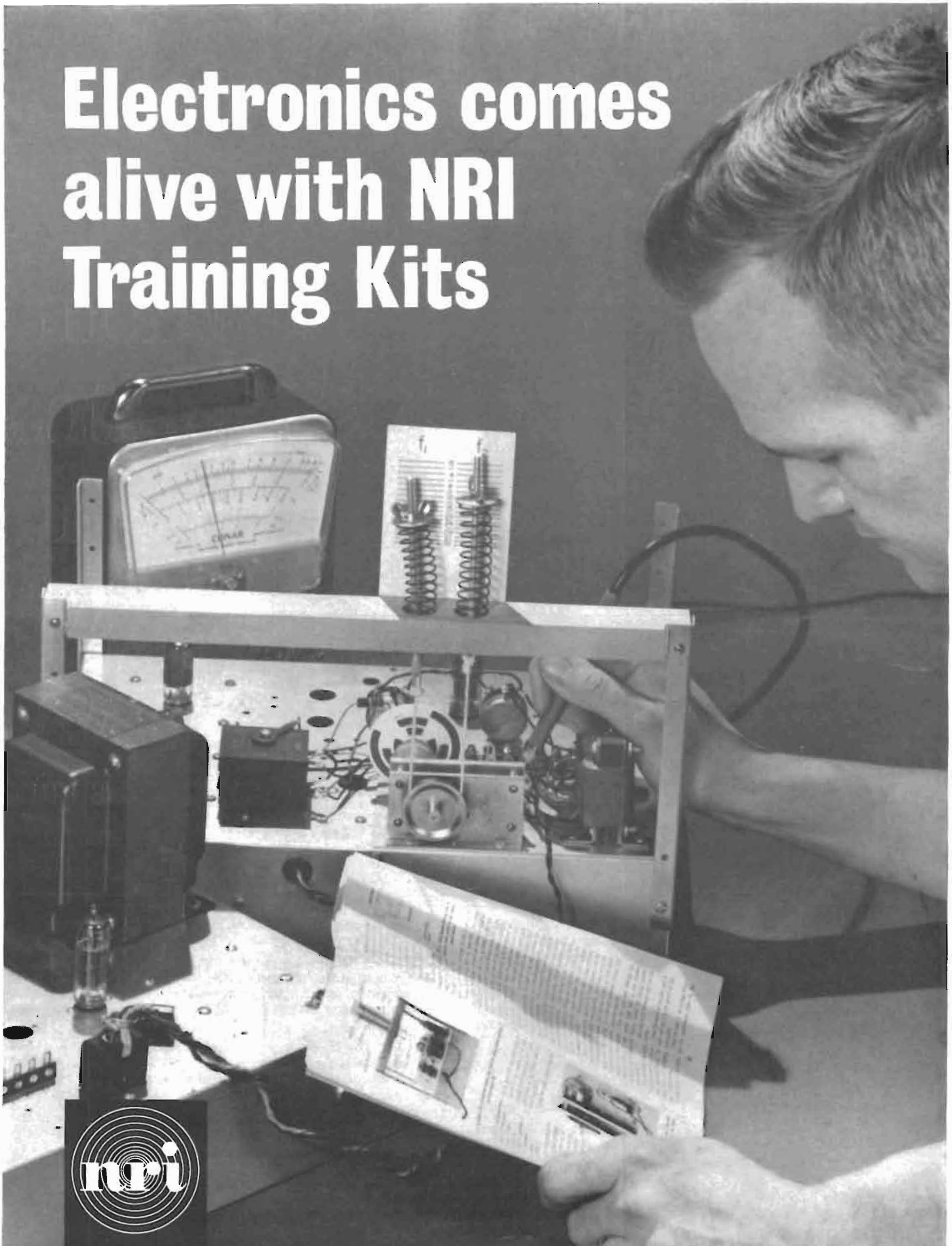
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* You must pass your FCC License exams (any Communications course) or NRI refunds in full the tuition you have paid.

(*Continued from page* 6)

was included with my original manuscript—or should have been—that both sets of normally open contacts are paralleled to prolong contact life and/or to increase the current-carrying capacity.

In editing and shortening the text, some omissions were made. I believe it important to mention that the control range, using the indicated circuit values, is from —0.4 volt to —7.0 volts. This is a considerable range and makes the circuit quite versatile for other uses: industrial, experimental, and so on. Also, the input circuit does not load the circuit to which it connects at all, as it operates on voltage-level changes in the negative region only. No power is taken from the circuit.

It might profitably be mentioned that this circuit was developed to switch on and off a 120-volt a.c., solid-state tape recorder, which recorded the intelligence on the radio channel monitored. Since the recorder required no warm-up and only operated when the desired signals were present, the resulting recording had no blank gaps, nor did it require constant attention. The economies in tape, in tape readout, and in personnel time are evident.

A. W. Edwards
Corpus Christi, Texas

Our thanks to Author Edwards for the additional information.—Editors

* * *

ELECTRONIC METAL LOCATORS

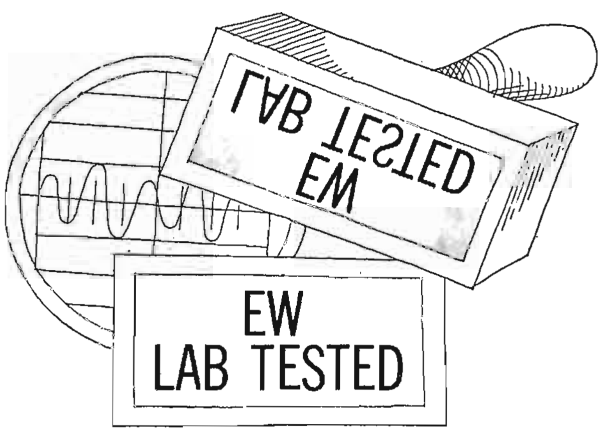
To the Editors:

In your article "Electronic Metal Locators" on page 39 of your December, 1966 issue, the author neglected to include my firm in his listing of manufacturers. We make a "Coin Finder" locator employing a small coil that is especially suited to coin locating. This locator is of the beat-frequency type. We also manufacture a proton magnetometer for use by archeologists.

Art Howe
Art Howe and Co.
811 Kansas Ave.
Atchison, Kan.

We have also received a note from Clarence E. Farris of IGWT Associates *indicating that 8 of the 9 locators produced by this company are beat-frequency types rather than induction-balance units as shown in our table. In addition, this company manufactures an underwater locator.*

We have also heard from Relco Industries, *P.O. Box 10563, Houston, Texas 77018 indicating that this firm is a manufacturer of underwater detectors and has been for a number of years. The company has several such models available, and it also produces special coin- and nugget-retrieval units for underwater and out-of-water uses. —Editors* ▲



HI-FI PRODUCT REPORT

TESTED BY HIRSCH-HOUCK LABS

Scott 342 FM-Stereo Receiver
Ortofon S-15T Phono Cartridge

Scott 342 FM-Stereo Receiver

For copy of manufacturer's brochure, circle No. 33 on Reader Service Card.

THE *Scott* 342 is an FM-stereo receiver featuring field-effect transistors (FET's) in the front end for improved sensitivity and freedom from cross-modulation and having a total music-power rating of 50 watts into 8-ohm loads or 65 watts into 4 ohms. The FET, unlike an ordinary transistor, is able to handle a wide range of signal levels without the annoying cross-modulation which imposes the program of a strong station on that of a weaker station. It also has a very low internal noise figure, allowing sensitivities equaling or surpassing those of the best vacuum-tube tuners.

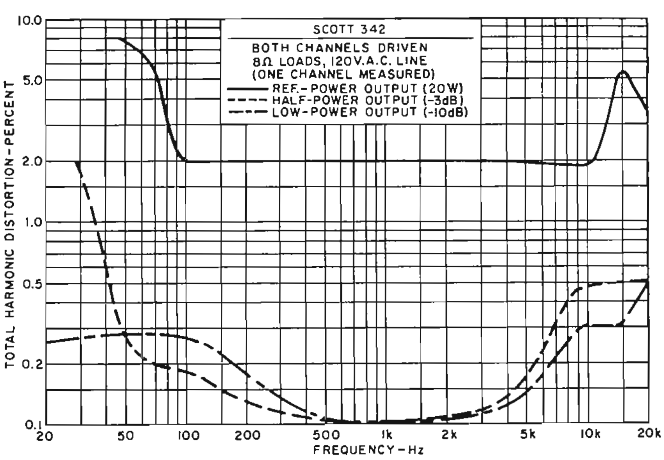
The FM-multiplex demodulator switches automatically to stereo when a 19-kHz pilot carrier is present in the received signal, lighting a blue lamp on the dial face to indicate stereo reception. The automatic stereo switching is completely unambiguous and will not give any indication when it is tuning between stations or when it is being subjected to high-frequency modulation peaks from a mono broadcast. A switch on the panel disables the automatic FM feature and parallels the two channels for noise-free reception of weak stereo signals or for playing mono records with a stereo cartridge when it is desired to cancel vertical rumble components.

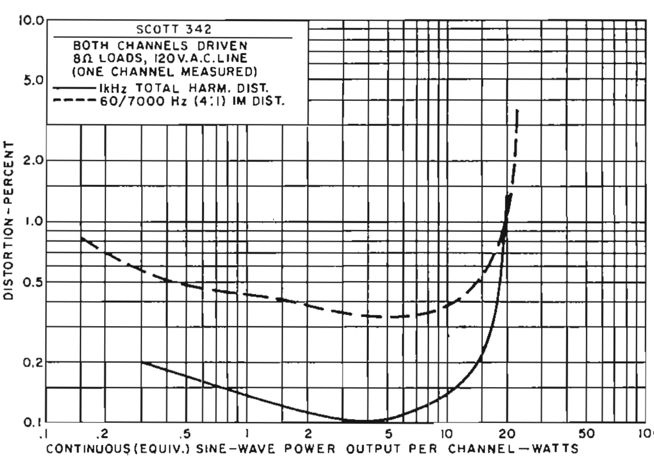
The 342 has inputs for a magnetic cartridge and a high-level extra source, selected by the switch on the panel which can also cut in a sub-channel filter for reduced noise on stereo-FM reception. Two degrees of phono sensitivity can be chosen by this switch to accommodate cartridges with high or low output levels. There are inputs and outputs for a tape recorder, with a front-panel switch to permit monitoring a recording from a three-head recorder while it is being made.

There are two pairs of speaker outputs, either of which can be selected by another switch on the panel. In the "Off" position of this switch, all speakers are disabled, and a pair of stereo phones can be plugged into the low-impedance output jack on the front panel.

The tone controls and volume control are concentric types with slip clutches. Channel balance is accomplished by holding one knob and adjusting the other volume control knob until the same level appears from each speaker. A balance switch on the panel facilitates this comparison by feeding the same signal to one speaker at a time as the controls are adjusted. There is also a noise-filter switch on the panel, reducing high-frequency response.

The tuning dial, a slide-rule type, operates very smoothly and is attractively and softly edge-lit. A tuning meter, indicating relative signal strength,





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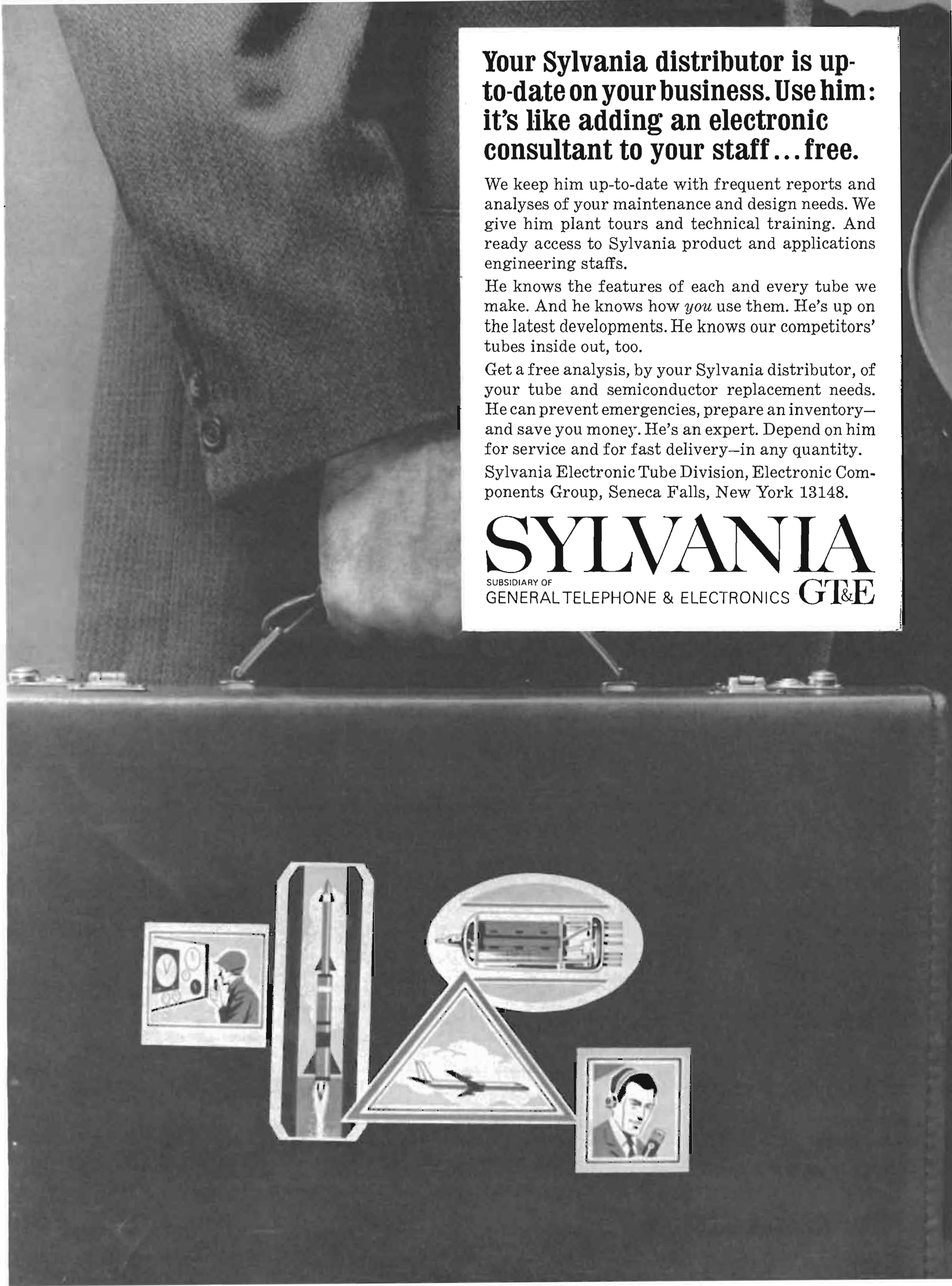
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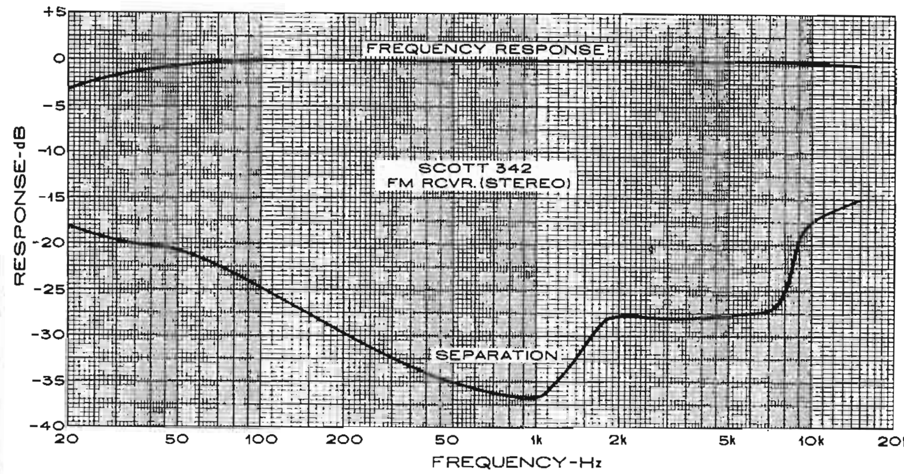
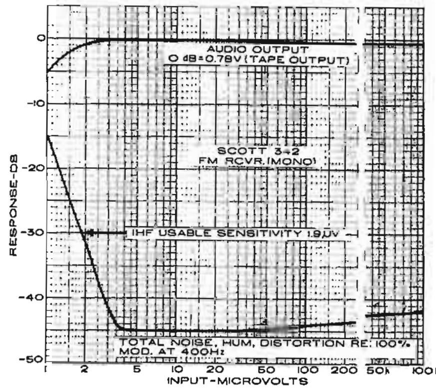


is deeply recessed into the dial area and can only be seen from the front of the receiver. It read nearly full scale on all signals we could hear so that it was not too useful as an aid to antenna orientation, although it served very well to show the optimum tuning point (which was quite non-critical).

In our laboratory measurements, the IHF usable sensitivity of the *Scott* 342 was 1.9 microvolts, slightly better than the rated 2.2 microvolts. The steep limiting curve shows that limiting is complete at 4 microvolts. This was evident in listening tests, in which every signal we heard (and they were many) was of excellent quality, free from background noise. The audio level did not change more than 0.5 dB from 2 microvolts to 200,000 microvolts input, emphasizing the remarkably effective a.g.c. and limiting action of the receiver.

Stereo-FM separation was better than 35 dB at mid-frequencies and better than 25 dB from 100 Hz to 8000 Hz. The audio amplifiers delivered 20 watts (continuous power output) per channel into 8 ohms, about 25 watts into 4 ohms, and 18 watts into 16 ohms. These measurements were made with both channels driven and are consistent with the music-power rating of the amplifier.

Distortion at full power was 2% from 100 Hz to 10,000 Hz. At half power, distortion was under 0.5% from 45 Hz to 20,000 Hz and was in the vicinity of 0.1% over much of that range. At 2 watts output, the distortion was under 0.3% from 20 Hz to 15,000 Hz. Measuring total harmonic distortion at 1000 Hz, we found it to be under 0.2% from 0.3 watt to 15 watts. The IM distortion averaged about 0.5% over most of the power range from below 0.5 watt to 15 watts, reaching 1% at 20 watts output.



For reasons not immediately evident, the designers have applied loudness compensation to the volume control, with no means of disabling it. Since the volume control is normally set below the 12:00 o'clock position, where the bass boost of the compensation becomes quite pronounced, the sound has a heavy quality which we found disturbing. Reducing the bass response with the tone control corrects this effect fairly well, but we wish that a switch had been provided to disable the compensation.

In all other respects, the receiver performed admirably and is difficult to find fault with. Its sensitivity was most impressive, as was the total freedom from crosstalk under conditions which have proved to be too severe for many other receivers we have tested. The audio performance was first-rate, once the bass tone control was set to compensate for the bass boost of the volume (loudness) control. Hum and noise were inaudible.

The price of the *Scott* 342 is $299.95. ▲

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(*Continued on page* 74)

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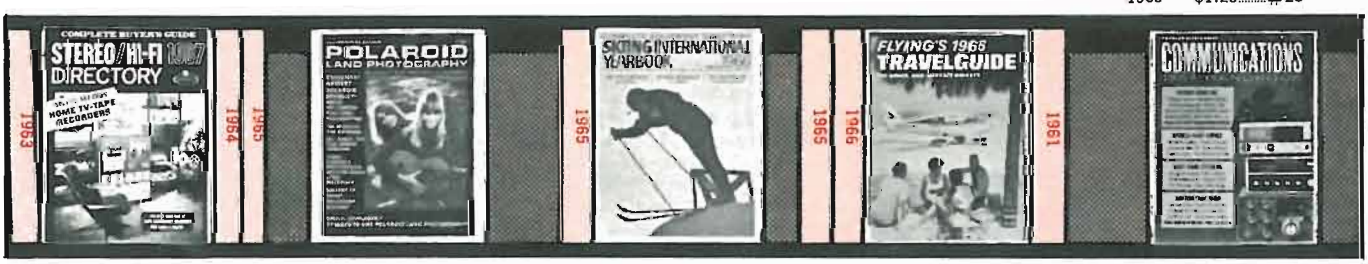

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This has resulted in a gold mine of new business for licensed service technicians. A typical mobile radio service contract pays an average of about $100 a month. It's possible for one trained technician to maintain eight to ten such mobile systems. Some men cover as many as fifteen systems, each with perhaps a dozen units.

Coming Impact of UHF

This demand for licensed operators and service technicians will be boosted again in the next 5 years by the mushrooming of UHF television. To the 500 or so VHF television stations now in operation, several times that many UHF stations may be added by the licensing of UHF channels and the sale of 10 million all-channel sets per year.

Opportunities in Plants

And there are other exciting opportunities in aerospace industries, electronics manufacturers, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal government's FCC exam and getting your license is widely accepted proof that you know the fundamentals of electronics.

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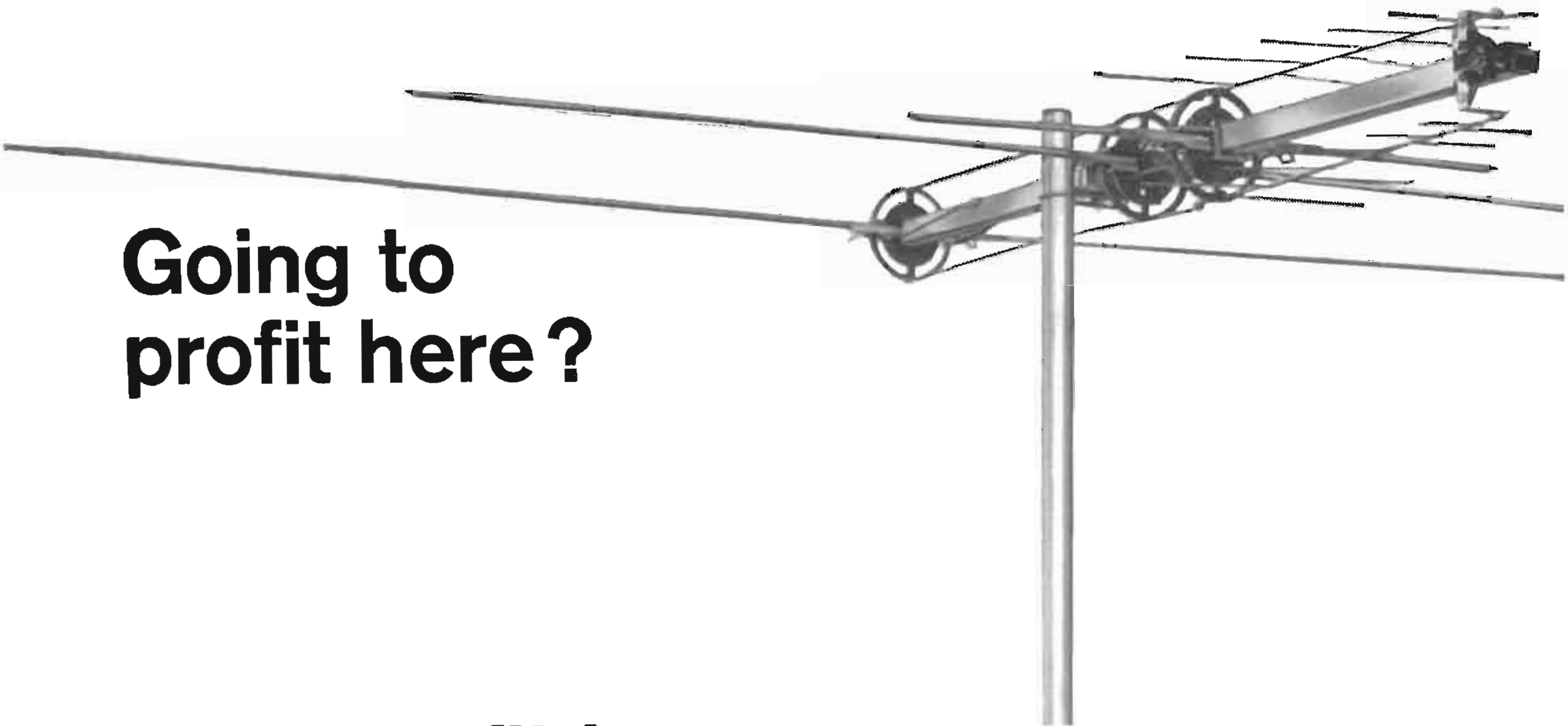

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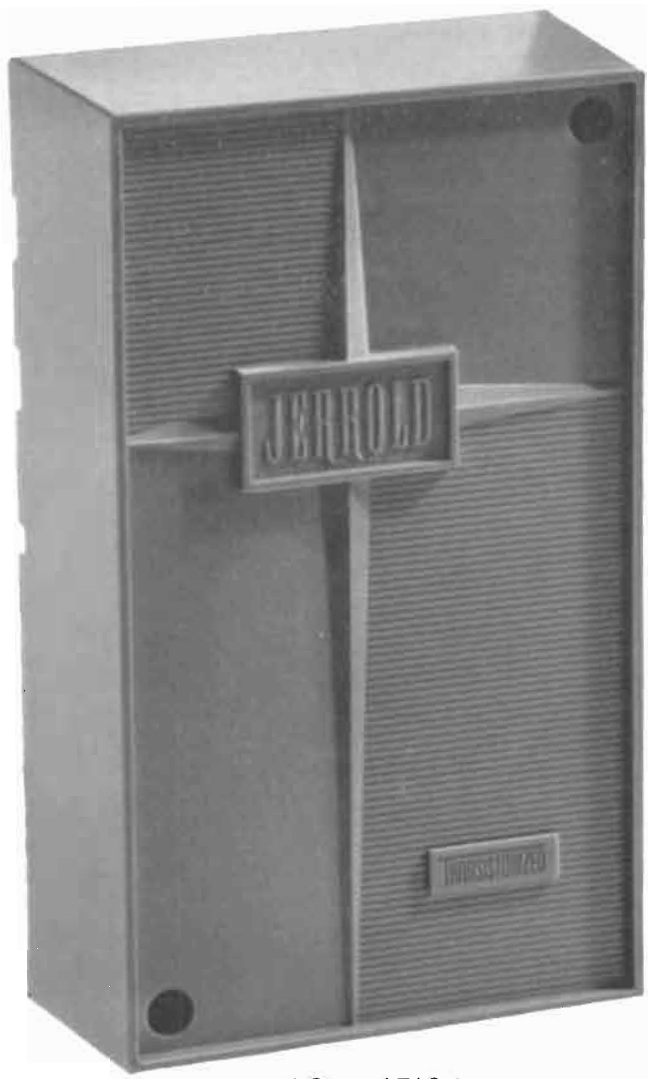

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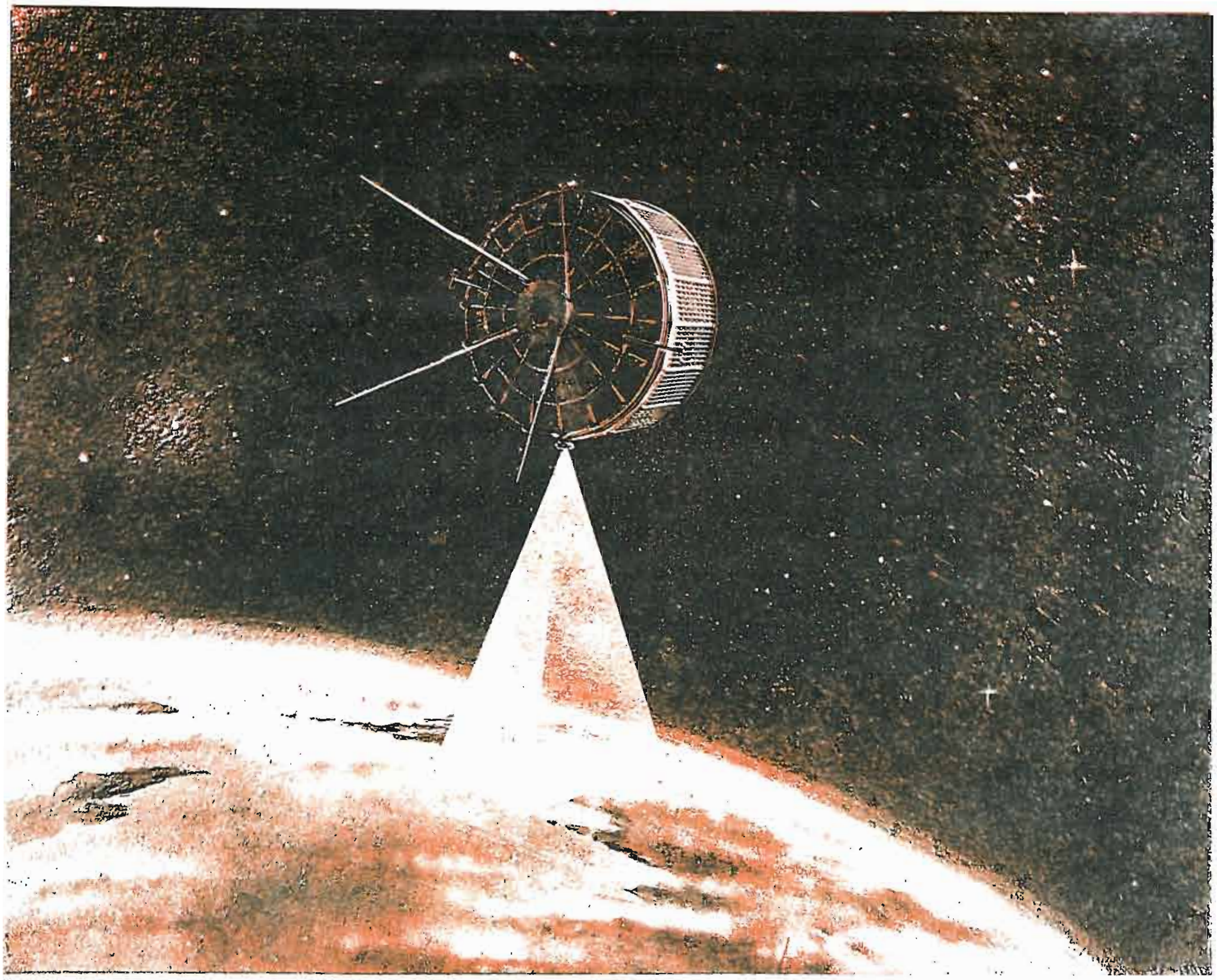


The new "cartwheel" Tiros photographs the earth as the satellite rolls along like a wheel in a near-polar orbit.

Weather Surveillance by Satellite

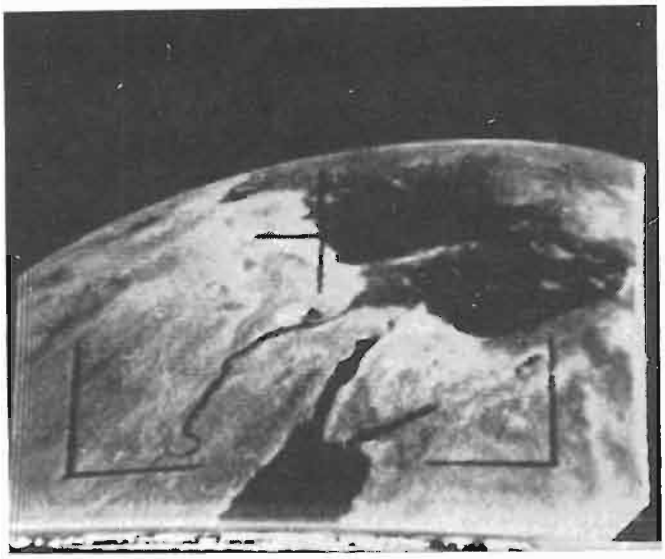
Tiros, Nimbus, and successor ESSA satellites are providing global weather information that may one day lead to global weather control.

By JOSEPH H. WUJEK, Jr.

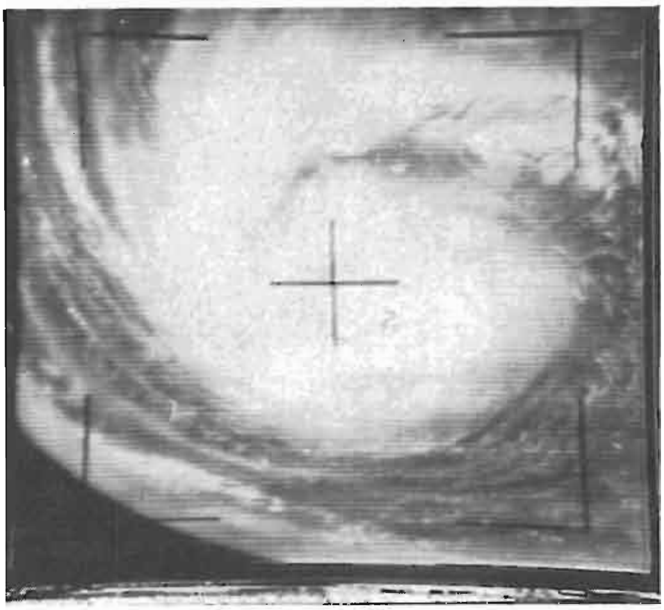
To a great extent, man has learned to use the forces of nature beneficially. A notable exception is our inability to control those forces in nature which we know collectively as *weather*. Weather plays an important part in the social and economic well-being of a nation. Agricultural output is strongly tied to the weather, as is the movement of ships at sea, aircraft, and land transport. Indeed, commerce as a whole depends to some degree on the behavior of the elements. In war as in peace, a nation's fate may be decided by the perversities of the weather. The defeat of the Spanish Armada, as well as the defeat of Napoleon's armies on the plains of Russia, were due in large measure to severe weather conditions.

In view of all this, it is not surprising that meteorologists are continually searching for new tools to aid them in understanding the weather. With increased knowledge of weather comes the ability to predict the kind of weather a region will experience. President Johnson, when Vice-President and Chairman of the National Aeronautics and Space Council, estimated the saving which our nation could realize if accurate weather predictions were available *only five days in advance.* These yearly savings include: $2.5 billion in agriculture; $45 million in the lumber industry; $100 million in surface transportation; $75 million in retail marketing; and $4 billion in water resources management. Beyond these dollar savings, we have the priceless savings in human life which result when hurricanes, tidal waves, and the like are detected in advance. Clearly, then, research into the nature of weather will have a profound effect upon our welfare.

Until early 1960, meteorologists were somewhat earthbound in their measurements of weather phenomena. True, aircraft and weather balloons were launched to measure wind speed, barometric pressure, and other weather variables. Later, sounding rockets were also used to obtain these measurements. But these measurements are somewhat localized in that only a small region of the atmosphere or stratosphere is sampled. And, as we know, weather is by



This view of the Nile River and its Delta, the Red Sea, and the eastern Mediterranean was taken by Tiros III from an altitude of 400 miles.



The vortex of the Hurricane Daisy photographed several year ago off the east coast of the United States by the Tiros V satellite.

no means predictable by immediate local conditions. A storm front in the far reaches of Canada's Hudson Bay on Tuesday can create havoc with cattle ranches in North Dakota on Thursday. Even with many remote weather stations positioned at strategic points around the world, severe weather conditions can be building up while unobserved by these stations. A system for weather surveillance which could survey large sectors of the earth was urgently needed.

The Tiros Satellite System

The Tiros (*T*elevision *I*nfra-*R*ed *O*bservation *S*atellite) series provides a partial solution to this requirement. These vehicles, equipped with television cameras and infrared (IR) radiometers, gather data for analysis by meteorologists within hours after the observation. The first in the series, Tiros I, was launched from Cape Kennedy on April 1, 1960. At this writing, ten Tiros satellites have been launched.

Table 1. Specs for Thor-Delta booster which launched Tiros.

STAGE	FUEL	THRUST (lbs)	BURN TIME
First	Liquid	170,000	2 min, 25 sec
Second	Liquid	7,500	2 min, 40 sec
Third	Solid	3,000	40 sec

The Tiros is an 18-sided vehicle, 22 inches high by 42 inches in diameter, weighing about 300 pounds. Each of the 18 faces of the satellite is an array of solar cells. These 9000 solar cells furnish charging current for the 63 nickel-cadmium cells which furnish power throughout orbit. Two 18-inch receiving antennas extend from the top of the satellite and are used to receive ground commands. Four 22-inch telemetry transmitting antennas are located on the underside of the package. Tiros I through VIII had two vidicon TV cameras mounted on the underside of the satellite. Later Tiros spacecraft have side-looking TV cameras mounted on opposite sides.

The Tiros series is put into orbit by the three-stage Thor-Delta launch vehicle. Table 1 gives important specifications for this space booster. For some perspective, recognize that jet engines used on modern commercial airliners have typical ratings of 16,000 pounds thrust per engine. Hence, the first stage alone of the launch vehicle delivers more thrust than ten of these aircraft engines. Launch vehicles have since been developed which generate more than *two million* pounds of thrust.

Tiros orbits range from 450 miles to 860 miles, with periods (time for one revolution) of 90 minutes to 113 minutes, respectively. At the 450-mile orbit a region on earth of 800 to 1000 miles in diameter is covered by one transmitted TV picture.

Tiros I through VIII were placed in a general east-west orbit, resulting in coverage of about 25% of the earth's surface. Later Tiros launches resulted in a north-south, or polar orbit. The polar orbit permits coverage of nearly all the earth's surface. The polar orbit is also selected so as to be nearly synchronous with the sun. The sun-sync orbit results in backlighting from the sun during the northward pass of the satellite, producing high-quality photographs.

Tiros I-VII made use of a focal-plane shutter in conjunction with the two vidicon TV cameras. Pictures are stored on the tube face and converted to data bits for storage on magnetic tape or direct readout by ground stations. Each orbit results in 64 pictures, or 32 pictures per tape. Transmission of data to the ground station requires about three minutes. The data transmission simultaneously erases the magnetic tapes for the next data-gathering pass. The operation of the readout system as well as the timing of the picture-taking sequence is accomplished by ground command. The ground command sets timers which activate the camera system when the satellite passes over the region of interest.

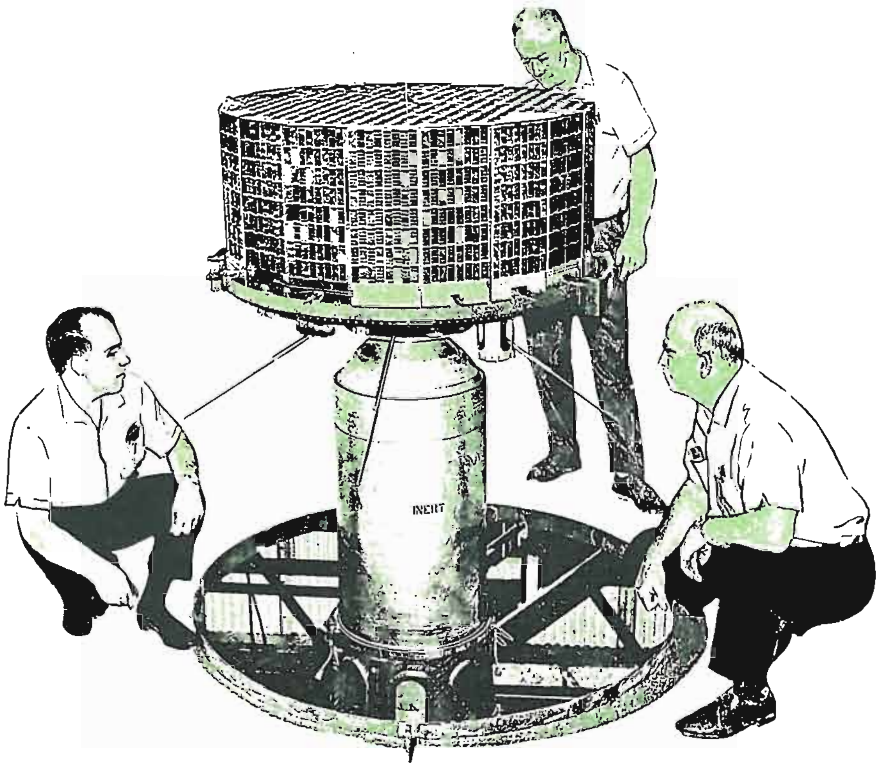
Starting with Tiros VIII, a new system of data readout was used. The new system is designated Automatic Picture Transmission (APT). Rather than construct a TV picture line by line, electronically photograph the screen, and then store or transmit, APT uses a system similar to that used by newspapers and the press services to transmit photos. A facsimile recorder then reproduces the picture as received.

Ground receiving stations for Tiros are Wallops Island, Virgina; San Nicolas, California; and Fairbanks, Alaska. Over-all direction of the Tiros system stems from Goddard Space Flight Center, Greenbelt, Maryland. These stations are capable of receiving data when the satellite draws to within 1500 miles of the station. The received pictures are photographed by 35-mm camera for immediate analysis by meteorologists. In particular, these photos reveal conditions of cloud cover as well as the presence of hurricane conditions.

In addition to the TV camera, infrared radiometers measure the amount of reflected and absorbed solar IR energy. The amount of IR energy absorbed and reflected determines the heat balance of the earth and therefore affects the weather. The IR data is transmitted and received as non-photographic data. This data is later reduced and plotted on weather maps for analysis. While the IR data is not immediately useful to meteorologists, it nevertheless provides a kind of long-range insight into the weather behavior of our planet.

The initial design of Tiros called for a mission life of three to four months. The first Tiros was operational for 2½ months. Later Tiros vehicles operated for well over one year. In the first three years of operation some 300,000 TV photographs were transmitted. Tiros I completed 1302 orbits and relayed 22,592 pictures to ground stations.

As seen in the accompanying photographs, Tiros has produced some startling results. Of particular importance were other photos taken by Tiros III in Sept. 1961. These photos revealed the build-up of Hurricane Carla. As a result of this early warning, approximately 350,000 persons withdrew from the storm region involved and injuries and loss of life were held to an absolute minimum.


The Tiros VII being checked out prior to its launch into space.

Second-Generation Satellites

In addition to the ten Tiros launchings, two each ESSA (Environmental Survey Satellite) and the Nimbus satellites that have been orbited.

The ESSA satellites are similar to the earlier Tiros systems and operate in the "cartwheel" mode. ESSA I was launched on February 3, 1966 and carried two half-inch vidicon TV cameras into a circular 460-mile-high polar orbit, having a period of about 100 minutes. ESSA II carried two APT cameras into a circular 860-mile-high polar orbit with a 113-minute period. NASA plans to keep two ESSA satellites in orbit at all times. As one ESSA vehicle ceases to transmit, a replacement will be launched. The ESSA satellites represent the operational system for which the Tiros vehicles were the research and development packages.

The Nimbus represents a more sophisticated weather satellite system. In particular, Nimbus is not restricted to photographing the earth during daylight. By means of its high-resolution infrared radiometer (HRIR) system, night photos are obtained. These photos appears as dark or light regions, depending on whether more or less heat is radiated, respectively.

In addition to the HRIR system, three vidicon cameras are used. From an orbit of 575 miles, resolution of one-half mile is possible. The APT system was also flown on the Nimbus.

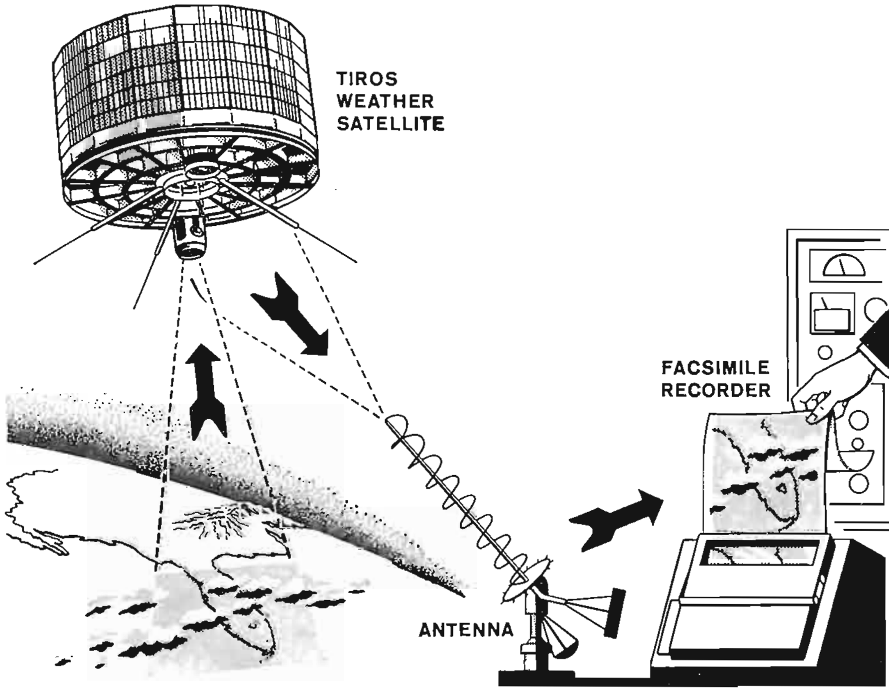
Nimbus I was moderately successful after launch on August 28, 1964. The second stage of the launch vehicle did not burn as long as required, resulting in an elliptical orbit of 252 miles perigee and 578 miles apogee, rather than the planned circular 575-mile orbit. The satellite transmitted many useful photos until a solar panel locked and was thus unable to track the sun. As a result, Nimbus I ceased operation on September 23, 1964.

Nimbus II was successfully launched May 15, 1966, carrying HRIR, APT, and vidicon systems. NASA plans to launch a Nimbus satellite approximately every 18 months. These vehicles will serve to test new systems for improved weather observations.

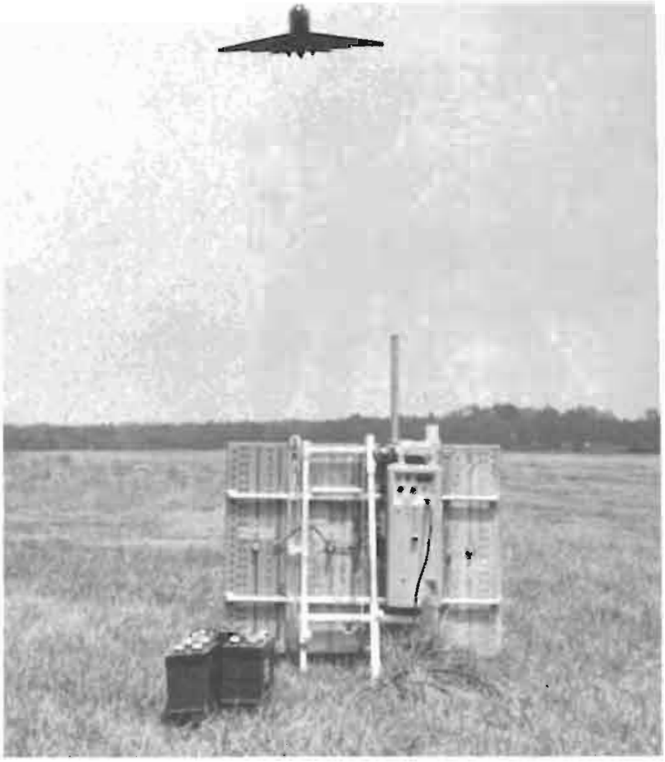
The Tiros vehicles and successors form the Tiros Operational System (TOS), which is a joint undertaking of the U.S. Weather Bureau and NASA. In addition to the benefits already listed, the Tiros system may provide scientists with new insight into such phenomena as clear-air turbulence (CAT) and the nature of the "jet-stream."

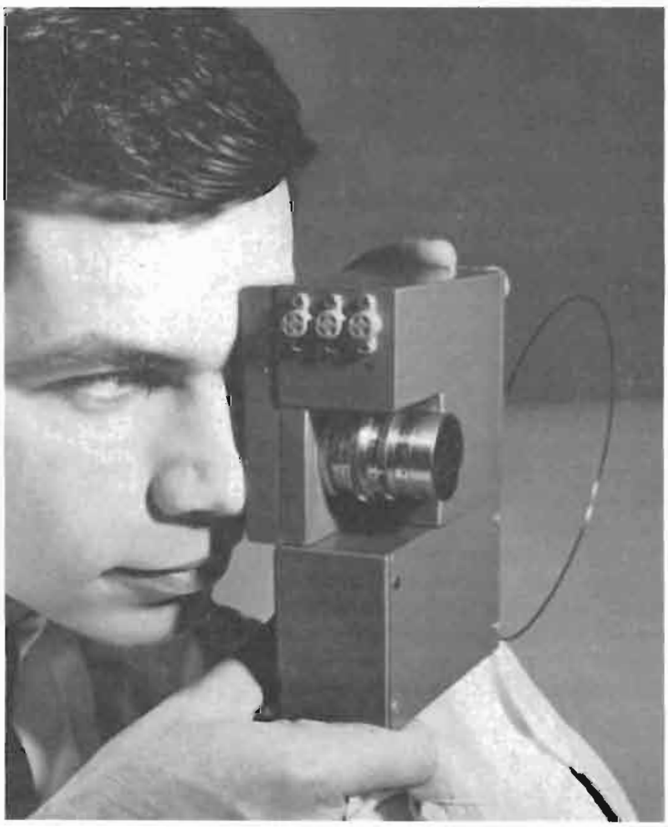
Perhaps history will someday show that Tiros provided a significant advance toward a goal we have desired, *control* of the weather. A system of sophisticated Tiros-like satellites, relaying weather data to a central computer which directs corrective (and as yet unknown) action to smooth the weather, is presently but a dream. But the translation from dream to design to hardware has been foreshortened considerably as our technology advances. ▲

The APT ground receiving system uses fairly simple, inexpensive ground-based equipment which employs conventional facsimile recorder.



APT GROUND RECEIVING SYSTEM





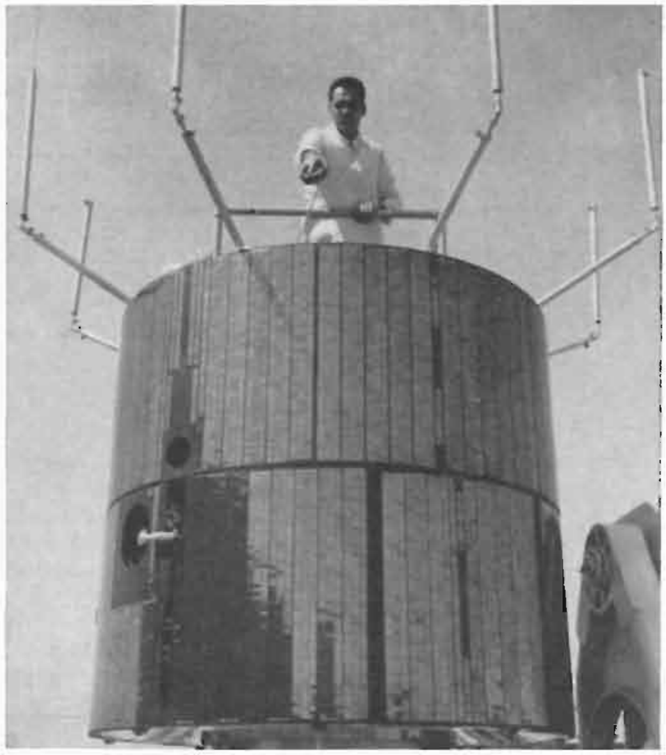
RECENT DEVELOPMENTS IN ELECTRONICS

Portable Landing System. (Top left) An Air Force twin-jet trainer is shown making an accurate approach over a portable ground station during technical evaluation at Wright-Patterson Air Force Base. When interrogated, the ground unit provides range and range rate as well as conventional glide path and localizer information to enable the pilot to remain in full command during approach and landing. The system is being developed by Honeywell to meet pressing military requirements for an effective all-weather landing system in remote combat areas. The system operates on the C band (5100 MHz) and has a range of 10 nautical miles. Four foldable flat-plate antenna arrays are used along with an omnidirectional antenna, control box, and optical boresight, all mounted on a tripod. It can be set up and aligned by one man in five minutes. Power is supplied by a motor generator, with standby 28-volt batteries. The present protoype weight is 55 pounds but this can be reduced.

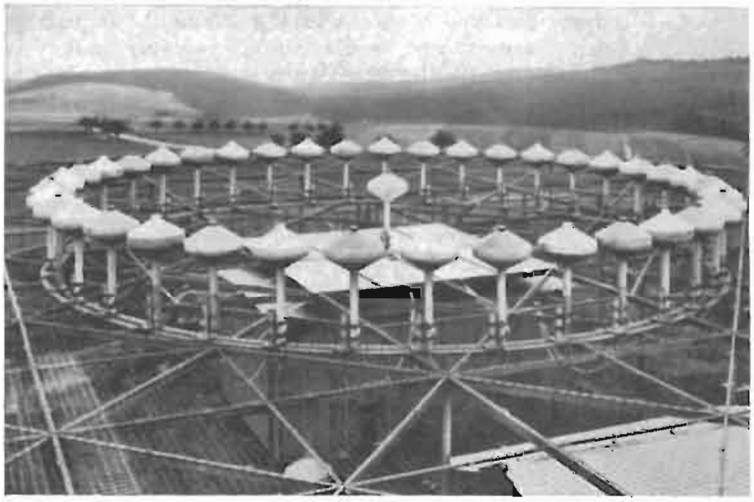
Computer-Generated Vocal-Tract Model. (Center) Accurate synthetic speech is now being produced with the aid of a controllable, computer-generated model of the vocal tract developed at Bell Labs. The model, based on information stored in a computer, is actually a geometric description of vocal-tract areas as they are shaped to produce various sounds. When synthesizing speech, a researcher can see an outline of the vocal tract displayed on an oscilloscope and, at the same time, hear the sound which corresponds to the displayed shape. By operating switches and turning knobs at a computer console, the researcher can change shape and sound simultaneously. Thus, synthetic speech is improved.

Tubeless TV Camera. (Bottom left) A revolutionary tubeless TV camera is being demonstrated here by RCA Laboratories technician, prior to its delivery to the U.S. Air Force Avionics Laboratory, sponsor of the development. The device is described as a first step toward a new era of personal TV communication systems, with eventual application in military, space, medical, industrial, and home functions. The camera employs arrays of 132,000 thin-film elements deposited on four glass slides only one-inch square to perform functions similar to those of a pickup tube and picture-processing elements in a standard TV camera. Contained in the lower portion of the device as shown here is a miniature transistorized transmitter that broadcasts picture signals to a special receiver that is located across the room.

Applications Technology Satellite. (Right) This is the new 790-lb satellite that was launched from Cape Kennedy early in December. This satellite, the ATS-1, is expected to bring practical benefits to mankind from space technology. It has already been placed in a synchronous orbit at the intersection of the Equator and the International Date Line. From this point it has relayed conversations between a ground flight controller in the U.S. to a number of commercial and government aircraft flying over the Pacific and the United States. It has also photographed weather conditions and relayed color-TV signals. Five ATS satellites are being built by Hughes.

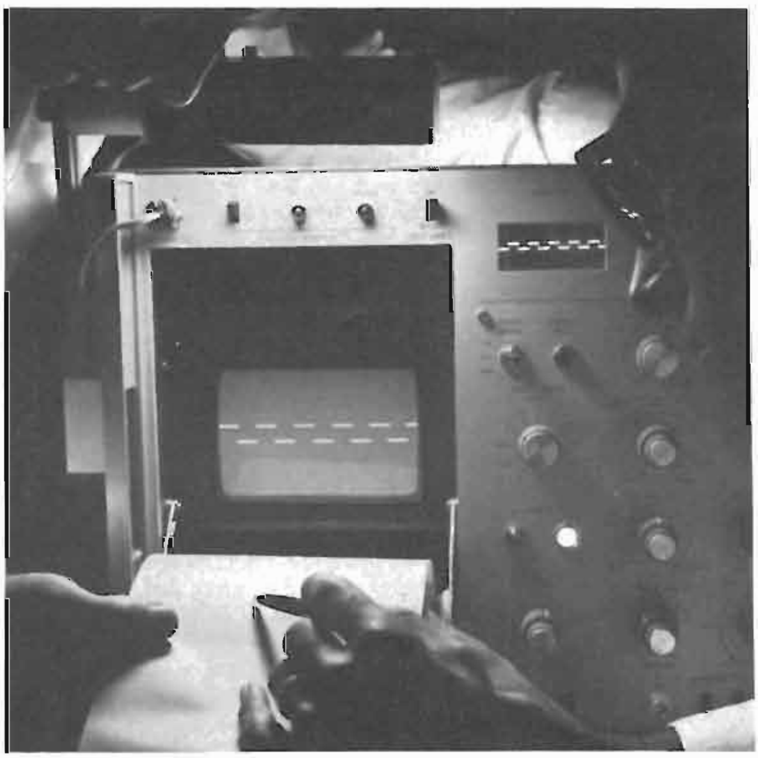


VOR Radio-Range Antenna System. (Center) Resembling a giant mushroom ring, these antennas guide jet aircraft in rugged mountains near Ruedesheim, Germany. Previous systems were afflicted with dangerous errors due to reflections of the radio waves from the craggy mountain peaks. The antenna system, developed by Standard Elektrik Lorenz, ITT subsidiary, is employed in a doppler v.h.f. omnidirectional radio range. The pattern of the new VOR antenna is identical with that of the standard system and aircraft equipment need not be modified.

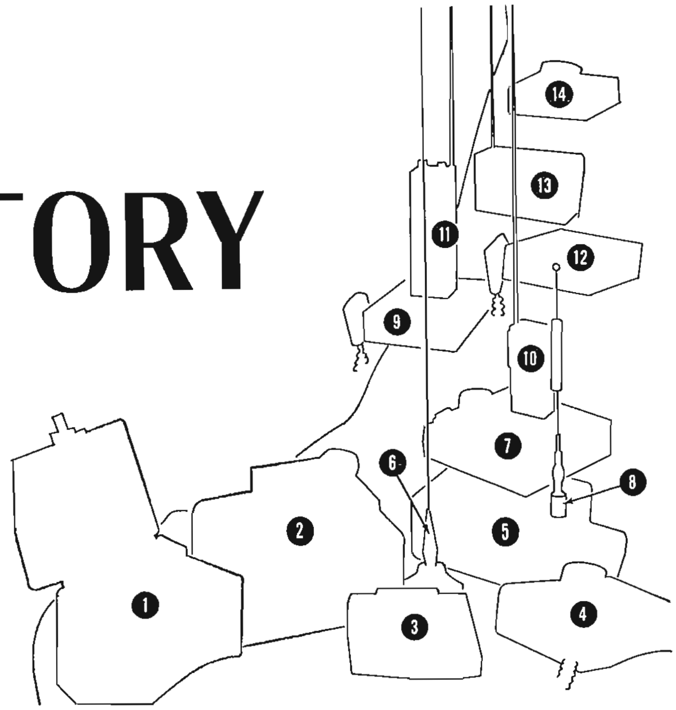


CCTV Weather Briefing System. (Below left) Weathervision—a closed-circuit television system for briefing pilots on weather and flight conditions—is to be used by our Strategic Air Command and Tactical Air Command in the U.S. and Europe. The closed-circuit camera scans information displayed on the console, then relays the picture to monitors in briefing rooms distant from the central control point. Two-way audio hookup permits conversation between briefing officer and pilots. Some 72 such systems are being installed at 67 bases under a $3 million contract awarded to Canoga Electronics.

High-Speed Fiber-Optic CRT Oscillograph. (Below right) A new recording oscillograph which makes use of a special fiber-optic cathode-ray tube to achieve unprecedented direct print-out writing speeds is shown here. The measured signal, also monitored by the small scope at the upper right, is recorded on 6-in-wide photosensitive paper that passes over the face of the tube during operation. The instrument, introduced by Honeywell, will measure and record high-frequency analog data at up to one million hertz, and has a data print-out capability nearly 100 times faster than any other direct-write system on the market. Writing speed is more than a million inches/sec.



COVER STORY



THE group of products on our cover this month are representative examples of Citizens Band and Business Radio equipment. We have included a number of transceivers, as well as some test equipment and antennas for these services. Each product has been keyed with a number to match the descriptions given in the following paragraphs.

(1) *International Crystal* C-12B frequency meter is a portable secondary frequency standard designed to service CB transmitters and receivers. The meter comes with 23 crystals installed covering the 23 channels. Frequency accuracy is ±0.0015%. The beat-frequency method of frequency checking is used with the difference frequency between the unit being checked and the crystal standard being counted directly displayed on a meter. The meter also includes a modulation checker and power-output meter. (Price: $300)

(2) *Polytronics* "Poly-Comm B" and "Poly-Comm RC-1" are a Business Radio transmitter-receiver unit and a remote-control head for this unit. This equipment is designed to transmit and receive phase-modulated signals on one channel in the 27.29 to 35.98 MHz Business Radio band. Plate power input to the final is 18 W with at least 10 W output. The receiver has built-in squelch and a sensitivity of better than 0.25 μV for 20-dB quieting. (Price of Model B is $299.95 and the optional RC-1 is $69.50.)

(3) *Seco* 520-A antenna tester provides direct reading of forward or reflected power and s.w.r. It is designed for 50-ohm lines and equipment operating in the 3.5 to 160 MHz range. R.f. power is measured directly from 0.5 to 1000 watts on three scales. The unit does not require external shunts nor correction charts; it has negligible insertion loss and may be left in the line. (Price: $49.95)

(4) *Pace* II-S is a 5-watt all silicon transistor CB transceiver. An MOS field-effect transistor is used for precise frequency control. The double-conversion receiver has adjustable squelch, a two-step noise limiter, and a signal-strength meter. The unit can also be used as a portable p.a. system. The transceiver operates from a 12-volt d.c. source with either side grounded. ($179)

(5) *Lampkin* 105-B frequency meter has a fundamental frequency averaging from 2330 to 2670 kHz, a spread of 1.14 to 1. By means of harmonics and their combinations, nearby transmitters can be monitored in a continuous range from 100 kHz to 175 MHz. Radio receivers may also be aligned accurately using the meter as an unmodulated signal source. Accuracy is guaranteed to be better than 0.002% on all frequencies. ($295)

(6) *Antenna Specialists* "Mach III" is a base-loaded, shunt-fed, electrical quarter-wave CB whip antenna. The whip itself is 32 inches long and is made of stainless steel. A spiral printed-circuit loading coil is suspended inside the sealed base. The antenna is d.c. grounded. (From $11.20 to $25, depending on hardware.)

(7) *E. F. Johnson* "Messenger 350" is a solid-state single-sideband CB transceiver. Either upper or lower sideband on two channels is available for use. Diode switching is employed rather than mechanical relays. The receiver uses adjustable squelch and noise silencer. The unit can also be utilized as a public-address system, if this is desired. ($299.95)

(8) *Mosley* "Demon" is a short whip antenna designed for CB use. The stainless-steel whip element is about 14 inches long, over-all height is a few inches more. The element is center-loaded by means of a coil. ($13.19)

(9) *Allied* "Knight-kit Safari III" is a 5-watt all silicon transistor CB transceiver in kit form. Receiver has adjustable squelch, signal-strength meter, and fine-tuning adjustment for stations that are slightly off channel. A series-gate noise limiter is also incorporated. Twelve-volt d.c. operation is standard, although a separate a.c. power supply is available. ($84.50)

(10) *Hallicrafters* CB-11A is a pocket transportable transceiver for CB use. It is completely self-contained, with a battery power supply (ordinary 9-V battery), built-in dynamic mike and speaker, battery-replacement indicator, and telescoping antenna. Power input is 100 milliwatts and no license is required for operation. ($74.95 per pair)

(11) *Lafayette* "Dyna-Com 5" is a 5-watt hand-held CB transceiver. It has three crystal-controlled transmit and receive channel positions. The superhet receiver has less than 1-μV sensitivity for 10-dB signal plus noise to noise ratio, and uses a mechanical filter for high selectivity. An automatic compressor provides high "talk power" on transmit. Battery pack consists of 12 nickel-cadmium batteries in a removable holder. ($99.95)

(12) *"Heathkit"* GW-14 is a solid-state 5-watt CB transceiver. The receiver has squelch, noise limiting, and a signal-strength indicator. The transmitter, along with some of the other units shown, features a twin-*pi* antenna matching network for high efficiency and low harmonic radiation. Unit operates from 12 V, negative ground, or from a.c. using accessory power supply. ($89.94 in kit form, $124.95 assembled)

(13) *Eico* 715 "Trans-Match" is a ham and CB transceiver test set. It can measure r.f. output power up to 50 watts, standing-wave ratio, modulation percentage, and field strength. The instrument has a built-in dummy load for power measurements. ($34.95 in kit form, $44.95 assembled)

(14) *Amphenol* 675 is a 5-watt all silicon transistor CB transceiver. The receiver is a double-conversion superhet with automatic noise limiting and squelch. Transmitter uses speech clipping for more "talk power." Like other similar units shown, this transceiver is quite compact. This unit measures only 2½ inches by 6½ inches by 9 inches deep. It operates from a 12-V power source. ($179.95) ▲

A typical transmitter-receiver unit for BRS operation. This is the e.c.i. "Fleet Courier"—30B, a 30-W (input) AM unit operating on 5 channels around 27 MHz. The tube unit is $219.

Business Radio Communications

By ROBERT M. BROWN

Who can use the Business Radio Service? What are its advantages? What frequencies and powers are available? What about performance and its range?

Monitor receiver for the low-band channels. Sonar Radio's Model FR-101X covers the frequencies from 25 to 50 MHz or it may be fixed-tuned by crystal to 1 channel. Price $109.

A high v.h.f. band (152-174 MHz) transmitter-receiver. This Aerotron 625U has 25 watts output on two channels, uses FM modulation, and is transistorized except for final. Price $485.

EVERY business, no matter how large or how small, has much in common. Time is money and lack of control means loss of time. A big restriction on the expansion of many industries by businessmen has been their inability to exercise the same degree of control they once did when the number of their employees and job responsibilities were few. Typically, we find that as the volume of business goes up, the percentage margin of profit goes down. Inefficiency and lack of direction cause the retail price of the service or product delivery to go up, thus losing for the businessman the competitive advantage which enabled growth in the first place.

The ability to communicate with personnel on the job gives absolute control and more effective supervision. There are many other reasons why businesses use two-way radio, but they all add up to the single fact that vehicles become more productive and men become more efficient.

When the FCC created the Business Radio Service (BRS) in the fall of 1958, it was with the understanding that all might take advantage of this new tool. To quote the Rules and Regulations, "The following . . . when engaged in lawful activities are eligible to hold authorization to operate radio stations in the Business Radio Service (1) Any person engaged in a commercial activity. . . ."

Although a multitude of other radio services exists (see Table 1), Business Radio is by far the most prominent since it is non-restrictive and quite accessible. The latest licensing statistics indicate that nearly 45% of all two-way radio applications are for BRS authorizations. This is happening for several reasons, not the least being that many users find it more convenient to obtain a BRS license even though they may qualify in one of the other, more specialized classifications. Additionally, the set manufacturer's representative (dealer), who must be called upon to assist in the preparation of the formal FCC application, is more often than not oriented towards Business Radio and is hesitant about dealing with services unfamiliar to him.

Behind this preference for BRS is the fact that dealers work directly with the FCC in obtaining the license, whereas in other services an intermediate Frequency Coordinating Chairman must "okay" the application before it is forwarded to Washington. This results in a prolonged period of anxiety for the user, during which he may decide to cancel his order. Many dealers report that their area coordinating men turn down applications not specifying a particular "correct" brand of radio. The same people accuse the coordinators of favoring one of "the big three" set manufacturers (*G-E*, *Motorola*, and *RCA*) and using their positions to influence the user to switch dealers.

Prior to soliciting the services of any dealer, who invariably offers only one company's equipment, it is helpful to examine equipment requirements, compare set types, and generally become familiar with the frequencies and the possibilities that are available.

System Considerations

Before arbitrarily specifying radio service, AM or FM equipment, or operational frequency, communications personnel should consider the basics of an intelligent systems analysis. Environment, range requirements, and even reliability can markedly affect the total expenditure of the smallest of systems.

Knowledge of the nature of the specific business involved is the one requisite most often overlooked by planners. In addition to frequently being a deciding factor in radio service classification, it is often found that some types of equipment are better suited for a particular application than others.

Table 1. The major areas of activity in commercial two-way radio use. It should be added that some specific categories in the Industrial Radio Services (example, Relay Press) can operate in the 1.75-1.80 MHz range using radioteletypewriter and SSB with a maximum plate power input of 2000 watts. Vast majority of licensees are licensed under Business Radio rules in the Industrial Service.

	MAXIMUM PLATE POWER INPUTS (WATTS)			
	27.23-27.28 MHz	LOW V.H.F. BAND	HIGH V.H.F BAND	U.H.F. BAND
Industrial Radio Services[1]	30*	500	600	600
Land Transportation Radio Services[2]	30*	500	120	120

1. Forest Products, Industrial Relocation, BUSINESS, Motion Picture, Petroleum, Power, Relay Press, Spec. Industrial, Manufacturers, Tele. Maintenance.
2. Automobile Emergency, Motor Carrier, Railroad, Taxicab.
* Represents the area where most new AM equipment is being employed. Frequency range is also shared with government services. AM transmitters must be FCC Type Approved.

CONDITIONS OF USE	27 MHz	LOW V.H.F. BAND	HIGH V.H.F. BAND	U.H.F. BAND
No restrictions	27.390 MHz 27.410	35.940 MHz 35.960 35.980	151.925 MHz 151.955	
Operation restricted to specific permanent area, maximum 180 watts input	27.430 27.450 27.470	Every 20 kHz from 35.060 to 35.180, plus 35.700, 35.720, 35.880, 35.900, 35.920, 42.960, and 43.000	151.655 151.805 151.685 151.835 151.715 151.865 151.745 151.895 151.775 154.540	Every 50 kHz from 461.05 to 462.00, and every 50 kHz from 463.25[a] to 464.20[a]
Stations that are often transferred from one location to another	27.490	35.040	151.625	464.50[a,b] 464.55[a,b]
Stations outside of metropolitan areas that will not cause interference with stations in Taxicab Service			152.300 152.360 152.560 157.620 157.680	

[a]These frequencies to be shared with stations in the class A Citizens Band Radio Service.
[b]Maximum plate input restricted to 60 watts.

Table 2. Sampling of channel frequencies available to licensees in the Business Radio Service. Most u.h.f. band stations are of a remote-control and repeater variety, since commercial transmitter-receiver manufacture is presently limited to other bands for cost reasons. AM may be used as well as FM on all these channels. Each selection of appropriate channel must be okayed by system engineer (mobile dealer) and the FCC. To change a particular channel later is just as complex and time-consuming as installation, so careful selection is a "must."

27 MHz	LOW V.H.F. BAND	HIGH V.H.F. BAND	U.H.F. BAND
27.51 MHz	30.84 MHz	154.57 MHz	466.50 MHz
27.53	31.16	154.60	466.55
	31.20		466.60
	31.24		466.65
	33.14		466.70
	33.16*		466.75
	33.40*		466.80
	42.98		466.85
			466.90
			466.95

*Restricted to one-half watt input.

Table 3. Recent boom in BRS "personal portables" is largely due to the availability of these channels on which walkie-talkie operation is possible. Maximum power input for these channels is 3 watts and either AM or FM type of equipment is permissible.

Another major consideration is the advance determination of the maximum number of base and mobile units required to do the job while bearing in mind projected future needs. Along with this, an estimate of the most common form of communication (point-to-point, base-to-mobile, etc.) should be made immediately.

Range requirements should be examined in depth, since more than any other factors, these will tend to inflate the over-all system cost when not fairly and realistically approached. If most communications will be over a 15-mile radius but with a need to reach 25 miles in one direction twice a month, specify 15 as the maximum *usual* mileage and 25 as the *absolute* maximum of coverage. In arriving at this figure, be certain to consider the duration of the upper-limit communications as well as their occurrence in relation to the usual radio work.

If directional grouping appears to be a possibility, note the area of needed coverage, (for example, 90° north to east). This element can indicate whether directional high-gain antennas can be successfully employed.

From a purely practical standpoint, it is important to find out just how many people will be operating the sets. This is best averaged on a user-per-unit basis and can tell the planner a great deal about the likelihood of human error. If no more than two persons will be operating each transmitter, a fair degree of complexity in the equipment can be considered. If there will be more operators, then the more conventional, foolproof designs should be contemplated.

Selection of actual operating frequency is often determined by the hours of primary use. Will it be a 9-to-5 or a 2-hour daily workload? This should also be kept in mind when examining equipment designs.

Most commercial two-way radio units are designed for specific applications, with environment a governing factor, and are priced accordingly. For this reason, it is imperative to take into account the amount of shock, vibration, fumes, and high humidity to which the equipment will be exposed.

Finally, it is well to remember that the degree of required reliability for every installation is not the same. A practical appraisal of real need can often result in considerable cash savings over expensive "high-reliability" or "100% performance" designs.

With this basic information at hand, either the manufacturer's representative in the area can be contacted with a fair amount of assurance that requirements are generally known, or the analysis can be followed through to its natural conclusion by converting known facts to figures and doing a conventional job of addition or subtraction. If the latter is attempted, however, the engineer should be well-versed in both "gain" and "loss" conversions and should be equipped to handle such items as actual path loss and realistic antenna system gains in the three fundamental BRS frequency ranges. This procedure, however, is usually left to professional business systems dealers and consultants who make the calculations based upon information supplied by the prospective system user.

Regardless of when the outside representative is called in, the more informed the buyer is, the more liable he is to save money on the over-all system.

The Three Bands

"Low-band" communications (generally accepted as 25 to 50 MHz) occurs between the high end of the class-D CB band and the lower edge of the six-meter ham band. Characteristics here include a signal's ability to achieve substantial distances in rolling or even semi-mountainous terrain. At certain times of the year, though, sporadic-*E* skip will be noted, bringing in unwanted signals from other areas of the country. Unlike CB restrictions, low-band users can employ transmitter power up to 500 watts input on some channels to suit their needs. Although ignition noise and skip interference are common in this range, high-powered equipment, frequently coupled with directional antennas, often overcomes these difficulties.

The "high v.h.f. band" (152 to 174 MHz) is commonly noted for possessing the greatest number of operational advantages in comparison with the other allocations. Rarely affected by noise and never by skip interference, the high v.h.f. band is widely used for urban and densely populated suburban applications. Although the useful range is on the order of 20% less than that achieved in the 25- to 50-MHz region, saturation of a given area is more thoroughly accomplished. The inherent lack of noise in this band makes it possible to design a system utilizing relatively low power equipment, a distinct advantage when considering the effect of battery drain on a vehicle which may stand at a given job for some time. Also, fewer dead spots occur due to the shorter wavelength and tendency of the signal to be reflected from hard surfaces.

The "u.h.f. band" (falling between 450 and 470 MHz) is used most extensively in point-to-point and blanket-coverage applications. Signals here are highly reflective and will effectively saturate populated metropolitan areas. Special BRS provision by the FCC makes this band available for community repeater stations which can take advantage of available high locations for extended line-of-sight work. Little conventional base-to-mobile work is done in this range, primarily because of the lack of available equipment. (Refer to Tables 2 and 3.)

Safeguarding Channel "Privacy"

An increasing problem for the communications industry is the attitude expressed by a number of BRS users that they should "own" or otherwise be insured of privacy on "their" assigned frequency. Indeed, with congestion becoming a factor in large metropolitan areas, customers in many cases are requesting new channels a few kHz removed from their present frequencies in an attempt to "get off" the busy airwaves in their locales. Although there is nowhere the pile-up intensity reached on the 27-MHz Citizens Radio band, the congestion that does, in fact, exist when coupled with the attitude just discussed is making for serious difficulty at the manufacturing level and is well worth considering by the potential system user.

It should be remembered that except in rare instances the actual decision to select a particular frequency for radio use is left entirely up to the set buyer. Obviously, the more thought behind this choice, the better a company's chance of enjoying relatively clear channel use. For this reason, it is suggested that the opinions of several area "experts" be solicited on this point as well as personal observations made through the use of an inexpensive but well-calibrated monitor receiver. An official reassignment at a later date is often a complex procedure and involves a 60- to 90-day waiting period.

Another problem the Business Radio industry faces is a form of fallout from the "congestion crisis." Particularly with small system users not well-versed technically in communications, there is found to be a growing paranoid-type personality evolving which at the very least is difficult to cope with. It seems that whenever one user hears another on "his" channel, the businessman in this category tends to suspect that all of his transmissions are being overheard. What is happening now is that these businesses are climbing on the frequency-reassignment bandwagon to avoid surreptitious monitoring by their competitors across town.

The result at the commercial level has been that the recent trend by manufacturers to low-profile, solid-state equipment has been met by potential buyers with demands for further assurance of privacy with the new units. Two things are being done here to keep sales moving: (1) a compatibility effort at the factory level, and (2) the development of a multitude of tone-signaling devices as optional accessories.

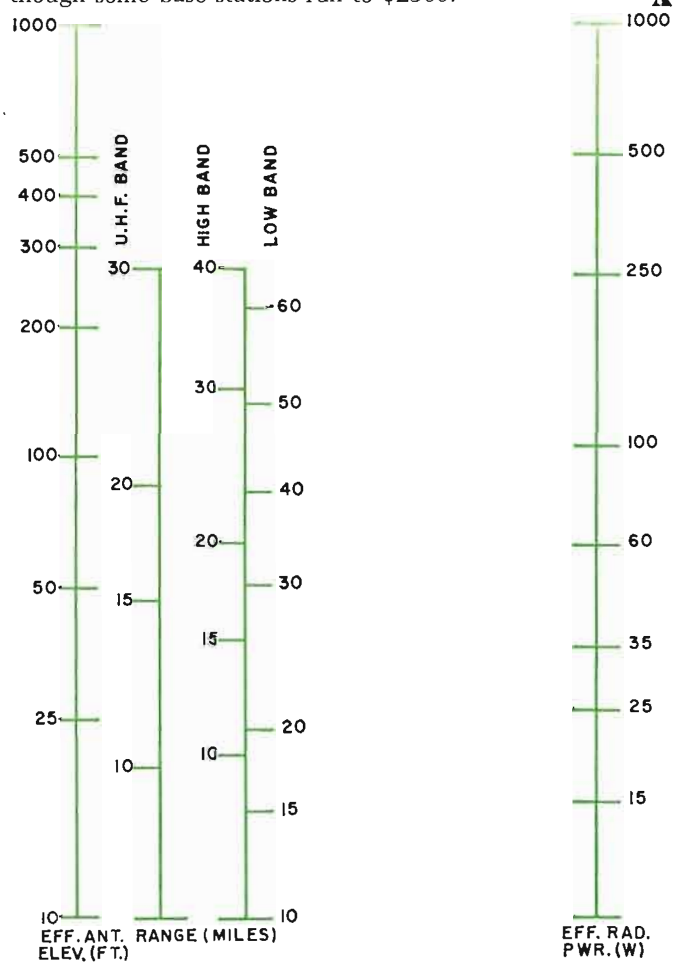
The growth of selective calling in the last few years has been phenomenal. Basically, two design types are available: the tone pulse which affords individual calling of anywhere from 10 to 1500 mobile units, and tone squelches which offer a relatively uncomplicated means of receiver muting. With the latter, a somewhat recent addition to selective calling equipment, the circuit employs a low-frequency tone (67 to 250 Hz) which is transmitted continuously at one-tenth the normal voice level whenever the transmitter is keyed. At the other end, the almost subliminal tone actuates the receiver and is filtered out of the voice signal, permitting normal conversation.

The desire for privacy of transmissions has also helped sales of the "new breed"—the lines of AM BRS equipment made by *Aircraft Radio, Comco, E. F. Johnson,* and others. Although this type of equipment is not nearly as popular as conventional FM, interest in amplitude-modulated radio is growing all the time. One reason for this is the retail price, which is generally much lower than for the FM sets produced by the industry leaders, *G-E, Motorola,* and *RCA.*

Also making a strong bid for lower priced system sales are a number of other companies, many of whom have risen from the ranks of 27-MHz CB manufacture. These include *Aerotron, e.c.i., General Radiotelephone, Gonset, Hallicrafters, Lafayette, Pearce-Simpson, Polytronics,* and *Sonar,* with still more appearing all the time. Some offer both AM and FM units, although most seem to be pushing sets designed for low-power applications.

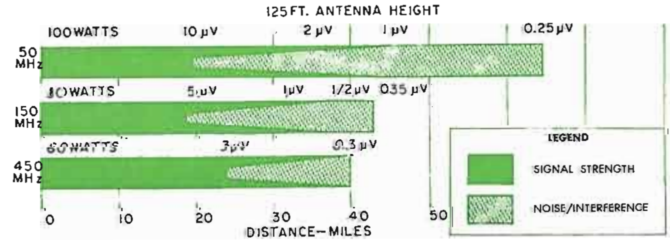
It should be mentioned here that this compulsion on the part of a great number of present buyers for transistors and resonant reeds has resulted in a growing stockpile of the older vacuum-tube sets. This surplus should not be overlooked, especially since 95% of it is still relatively new in terms of useful component life and meets required FCC Type Acceptance specifications. Additionally, enormous savings can frequently be realized with the older radios.

We have been discussing basic fixed stations and mobile units which, in general, cost from \$200 to \$900 each, although some base stations run to \$2500. ▲



Predictable range nomogram. A straightedge between a given value of effective radiated power and a given antenna elevation will indicate approximate ranges for three BRS bands.

This graph, from G-E, is based on actual plate input power, not effective radiated power, and it affords fairly accurate information on Business Radio possibilities with example shown.



TEST EQUIPMENT FOR CB AND BUSINESS RADIO

By DAVID WALKER

Radio Specialty FM deviation meter shows total deviation under actual voice conditions. A special oscilloscope and broadband FM receiver are built in. ($618)

A good selection of generalized and special-purpose test equipment is available for both the user and the service technician who maintains and services CB and BRS gear.

WITH an estimated three million CB transceivers in operation, test-equipment producers offer a variety of instruments to meet every contingency—from tune-up and troubleshooting to the critical measurement of frequency. Another growing branch of communications is the Business Radio Service. Available to anyone engaged in a lawful commercial activity, the BRS offers any business man the benefits of two-way radio. Prior to 1958, neither individuals nor businesses could own and operate communications gear unless engaged in some highly specialized activity.

Since technical specifications affect the choice of test equipment in each category, it is a good idea to obtain a copy of the rules for the desired service. For CB and BRS, respectively, the publications are Volume VI ($1.25) and Volume V ($2.50) of FCC Rules and Regulations. They are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

To keep a CB transceiver from causing undue interference to other stations, the FCC technical regulations are most stringent on input power to the final r.f. amplifier (5-watt maximum), percentage modulation (not to exceed 100%), and transmitting frequency tolerance ($\pm$ 0.005%).

When a CB operator is cited by the FCC for violating any of these limits, he is usually instructed to have the repair made by a licensed technician (one who holds a first or second class radiotelephone ticket). During normal tune-up and servicing, however, there is much that may be done without a license. For example, the receiver, which comprises most of the circuit, may be repaired.

The critical area in a CB transceiver where only a licensed technician may move is in the frequency-determining circuits of the transmitter. This is the transmitter crystal oscillator and its associated components. Mistuning of resonant circuits in this stage could produce an off-frequency condition, which is a shift of about 1300 Hz from the nominal 27-MHz carrier frequency. The rules are liberal in what they permit in the way of adjustments in the transmitter's final r.f. amplifier. Aware that transceiver output should be optimized for a given installation, regulations allow anyone to vary controls which resonate and match the output stage into the transmission line and the antenna.

While much CB service is apparently done by either the transceiver owner or a local service technician, the situation changes for Business Radio. Standards are considerably tighter and there is greater risk of interfering with other services which may share some of the channels. R.f. input power is often many times that of a CB unit, and split-channel operation utilizes critical narrow-band FM. Transmitter tolerance requirements can be as close as $\pm$ 0.0005% (as opposed to CB's $\pm$ 0.005%). For these reasons, it is expected that servicing on BRS equipment will be done by a first or second class ticket holder, or a technician working under the direct supervision of one.

Three Levels of Necessity

Despite the differences just pointed out, much basic test equipment functions for either service. Some items are sophisticated instruments drawn from the field of two-way radio, but refined slightly for CB calibration. There is also an emerging generation of inexpensive test equipment conceived exclusively for CB. Often called the "CB tester," it combines within one instrument functions once divided among separate units.

Whether a particular instrument operates in both CB and BRS is initially a matter of power capacity and frequency coverage. CB and BRS on the low band nearly coincide, but the BRS may extend to u.h.f. R.f. input wattages for BRS might be 180, 500, or even 600 watts, for example, while CB will not exceed 5 watts. Thus the owner of the equipment or the troubleshooter should check the specifications to see which instruments are suitable for the transmitter to be serviced. (The Rules will assist in this choice.) The most significant differences occur when servicing is more than casual, and will include critical measurements of frequency and FM modulation percentage.

The question of which instruments are needed might be answered by examining tests in three categories. First are devices which often prove indispensable during *initial installation* and *tune-up*. The transceiver manufacturer cannot predict precise conditions in the field and his factory adjustments may not be optimum for a specific installation. An antenna might need adjustment, or a loading coil require "pruning." These variables, which significantly affect range, are difficult to monitor and control without suitable instruments.

The next level is *routine servicing* and *troubleshooting*. Here, familiar radio-TV test instruments—v.o.m., v.t.v.m., r.f. signal generator, and oscilloscope—comprise the basic complement for CB and BRS servicing. Finally, there are instruments intended for the *specialist* in CB or BRS service. One is the frequency meter capable of checking a transceiver against FCC standards. Another is the modulation meter to check FM deviation of FM equipment.

One of the most valuable test devices for installing and tuning the new transceiver is the *field-strength meter*. Of-

Allied Radio "Knight-kit Ten-2" CB tester measures s.w.r., percent modulation, r.f. power output, relative field strength, and crystal activity. ($29.95 as a kit or $39.95 assembled)

Cushman Model CE-2B FM communications monitor is a direct-reading frequency meter with accuracy better than .0001% over four bands. It also measures FM deviation and generates highly accurate c.w. and FM signals. (Price of the monitor is $3145)

Pace Model 5404 is a precision CB signal generator providing 24 crystal-controlled channels with variable modulation. ($645)

Singer Metrics "Gertsch" FM-9 combines the functions of direct-reading frequency meter, FM deviation meter, and accurate signal generator. Its accuracy is 0.0002%. ($1595)

ten little more than a whip antenna, diode, and meter movement, it yields a relative indication of r.f. output which serves as a tuning reference. It is positioned near the antenna and viewed for maximum indication as transmitter output controls are adjusted. Since the meter responds to the radiated signal, it is also a check on the condition of the transmission line and antenna.

The passive-type field-strength meter is a useful r.f. monitor, but additional benefits are conferred by models which contain a transistor amplifier. Pickup sensitivity is vastly improved and the meter responds at far greater distances. The active-type instrument is easier to operate when checking a base-station antenna which may be roof-mounted and out of convenient reach. Also, greater physical separation improves accuracy since the meter responds less to an antenna's induction field (which remains close to the antenna) and more to the electromagnetic radiation field which mainly propagates the wave. This advantage might be important in checking lobes of a directional beam, or the pattern of a mobile whip.

The next instrument, an *s.w.r. indicator,* complements the field-strength meter. Readings of field strength alone are relative and yield little clue to the efficiency of an antenna system. Inserted into the transmission line, an s.w.r. indicator checks standing-wave ratio; the amount of forward *vs* reflected power due to impedance mismatch. Transmitter output tuning, antenna elements, loading coils, and coaxial line may be checked or adjusted for a recommended s.w.r. of approximately less than 2-to-1. Although the s.w.r. meter can sometimes substitute for the field-strength meter, the two instruments can be used simultaneously. However, s.w.r. measurement tends to be critical in a less-than-perfect antenna system and readings could prove misleading. A check on the error is possible with the field-strength meter; as s.w.r. reading falls, field strength should rise.

Although it is not specifically a test instrument, the *dummy load* is often used during check-out procedures. An FCC requirement is that radiation be confined except during brief tune-up periods or actual communications. The dummy load dissipates r.f. energy as heat during extended tests. One advantage of a dummy load is that it permits accurate measurements of r.f. output power. The device, with its specially wound wire element, is designed to minimize any inductive effects and presents an accurate 50-ohm resistive load to the transmitter. With this figure fixed, it is an easy matter to measure r.f. output voltage with a high-frequency probe and v.t.v.m., then to calculate the output wattage ($P=E^2/R$).

Equipment described thus far might represent a minimal complement for making an effective installation. The devices also help pinpoint trouble at a future time; *e.g.*, s.w.r. may increase if the antenna system deteriorates, or field strength drop because of a failing component.

Combination Instruments

During the past year, an increasing number of "CB testers" has appeared. They are a combination of circuits useful for both installation and troubleshooting. A principal benefit of these instruments is that they are self-contained, easily portable, and require no a.c. power source. Thus they can be carried outdoors to the CB mobile unit to measure or detect a variety of conditions. Another advantage occurs on the service bench. Since they are expressly designed for CB use, they can often generate or receive signals with less bench set-up time and complexity than for equivalent service instruments. As to be described, some models eliminate the need for an r.f. signal generator, audio oscillator, and oscilloscope.

The CB tester rarely requires internal connections to the transceiver circuits. The usual hookup is to insert the tester into the transmission line with a short length of coaxial cable and appropriate connectors. When the tester serves as a signal generator or field-strength meter, no physical connections are required since signals are received and transmitted *via* a telescoping whip.

There is some variation in the number and type of functions offered by the combination CB unit. Certain features are commonly found on most of these testers; virtually all contain a field-strength and s.w.r. meter, as well as an internal 50-ohm dummy load. Another common feature is a wattmeter directly calibrated in r.f. output watts. Some testers can indicate modulation percentage and include a jack for earphone checking of audio quality as transmitted over the air.

All the functions just mentioned are usually accomplished with passive circuitry; the instrument has a sensitive micro-ammeter driven by r.f. power obtained from the CB transmitter output signal. There is no internal amplifier and thus no batteries are required. This feature—no batteries—might serve as a convenient dividing line for classifying CB testers into passive and active types.

The active CB tester, in addition to functions described, may also include several signal-generating modes. Equipped with an internal transistor oscillator stage, it will generate an r.f. signal on 27MHz. Frequency is controlled by a CB crystal inserted into a (*Continued on page* 77)

BUYING A HI-FI TUNER?

By LEONARD FELDMAN/Engineering V. P., Crestmark Electronics Inc.

The important parameters of an FM or FM/AM tuner—sensitivity, drift, signal-to-noise ratio, distortion, and frequency response—as well as some of the less important characteristics, should be understood prior to the purchase of such equipment. Here is how the IHF specifies them.

WITH FM stereophonic broadcasting stations rapidly approaching the 50% point in terms of total FM stations in the United States, no well-planned home music system can long ignore this increasingly popular program source. Besides pleasurable listening, FM stereo also provides a practical way for the serious tape recordist and music lover to create his own hand-picked library of stereophonic tapes and, *providing the accrued tapes are used only for private listening enjoyment,* such a library can be amassed at the sole cost of the recording tape itself.

FM programming has long been noted for its diversity as well as for its adult approach to musical fare, drama, and better-than-average public affairs content. With the new FCC ruling governing separation of AM and FM programming over jointly owned AM and FM outlets (for at least 50% of all program time), choice of available programs (and hence suitable music) becomes even more varied.

With the increased usefulness of FM and FM stereo as a high-fidelity program source, selection of a tuner must be done with as much care as selection of the other elements of a well-matched high-fidelity stereophonic system. Bear in mind that while today's trend in component manufacture seems to favor the so-called integrated receiver (in which tuner and amplifier are all combined in one chassis), one must still treat the tuner specifications as if they applied to a "separate" tuner component. In general, manufacturers of complete receivers will list the tuner specifications separately from those of the amplifier in any case. (Applicable amplifier specifications were covered in the January, 1967 issue of this magazine.)

Industry Standards

It is now nearly eight years since the Institute of High Fidelity issued standards for measuring and specifying the characteristics of FM and FM/AM tuners. Happily, the intervening years have brought some measure of standardization of specifications, thanks to almost universal adherence to the suggested IHF standards on the part of most reputable hi-fi component manufacturers. Unfortunately, the last eight years have also brought about revolutionary changes in tuner design *per se,* not the least of which are the gradual (and as yet incomplete) transition from vacuum tubes to transistors and the incorporation of FM-stereo circuitry (not even anticipated in the 1958 IHF standards) into all but the least expensive tuners and receivers.

In considering the selection of a tuner (or the tuner section of a receiver) it might be advisable, therefore, to divide evaluation into two distinct areas: those specifications which will help define a quality product for conventional monophonic FM reception (in search of which the original IHF standards will be most helpful), and those additional criteria which will help define quality of stereo FM reception which, for the moment, we shall attempt to enumerate briefly in the last sections of this article.

A manufacturer desiring to rate his tuner product in accordance with IHF standards may list IHF sensitivity, signal-to-noise ratio, harmonic distortion, drift, and frequency response of each tuner model that he manufactures.

Other specifications involving capture ratio (ability of the tuner to reject an interfering signal having the same frequency as the desired station), selectivity (ability of the tuner to discriminate between two stations having closely spaced frequencies), IM distortion (the same as the term used in amplifier evaluation), hum and noise, and the ability of the FM portion of the tuner to suppress AM signal components must also be stated by the manufacturer desiring to give a more complete performance evaluation to his product.

IHF Sensitivity

This specification, when properly expressed, gives a very direct indication of the "station-pulling" abilities of the tuner in question. Stated in "microvolts for least usable sensitivity," the figure denotes how many microvolts of signal must reach the antenna terminals of the tuner to produce a signal which is 30 dB greater than any residual noise and distortion. Such a ratio is considered adequate for satisfactory enjoyment of the incoming program, though it is by no means ideal. Obviously, a tuner capable of yielding such a "quiet" program with only 3 microvolts of antenna input signal is more sensitive than one requiring 5 microvolts of signal input at the antenna.

Signal-to-Noise Ratio

While 30 dB of "quieting" are considered adequate for FM listening, it is of interest to know what the very best quieting capability of a tuner under consideration can be, given a powerful incoming signal from a nearby station. Noise, in this specification, includes both the harsh, random, static kind as well as that caused by the power supply of the tuner, commonly called hum. Here, the higher the signal-to-noise ratio stated, the better the equipment; 50, 60, and even 70 dB of maximum signal-to-noise capability (albeit with a 1000-microvolt input signal at the antenna terminals) is not uncommon in better tuners.

Harmonic Distortion

It may seem odd, at first, that harmonic distortion, normally associated with audio equipment such as preamplifiers and power amplifiers, should be included in a list of tuner specifications. The fact is that while the meaning of harmonic distortion (the presence of undesired harmonics or multiples of the desired musical tone in some fixed, measurable percentage) remains the same for audio amplifiers and tuners, the cause of such distortion in a tuner's output is quite different from that associated with audio equipment.

Usually, the presence of significant percentages of harmonic distortion in a tuner will indicate poor or insufficient bandwidth. FM stations are permitted a maximum frequency deviation (departure from center frequency in the course of imparting information to the radio-frequency energy) of ±75 kHz. The louder the musical passage to be transmitted, the closer the deviation approaches this max-

(*Continued on page* 69)

Hi-Fi Tuner and Receiver Directory

COVERING only solid-state tuners and receivers (all stereo with one tuner exception), this directory lists the electrical characteristics, physical dimensions, and prices of 31 tuners made by 16 manufacturers, and 52 receivers made by 20 manufacturers.

The standard used for tuner measurement is IHF-T-100, which is also used for the measurement of the tuner portions of the receivers.

The audio amplifier portions of the receivers are checked in accordance with IHF-A-201.

Solid-State Tuners

Model	With AM	IHF usable sens. (μV)	IHF capture ratio (dB)	IHF selectivity (dB)	THD @ 100% mod. (%)	FM tuner audio frequency response (mono) @ rated output and 100% mod. (%)	Drift (kHz)	R.m.s. output voltage @ full limiting (V)	Interstation muting	SCA or noise filter	A. f. c.	Physical size (inches) W	H	D	Assembled price ($)	Kit price ($)	Cabinet ($)
ACOUSTECH, INC., Div. of Koss Electronics, Inc., 139 Main St., Cambridge, Mass. 02142																	
VIII	no	2	2	55	.5	20-20 k	10	1	yes	yes	no	15¾	5	10	299.00	—	24.50
BOGEN COMMUNICATIONS, P.O. Box 500, Paramus, N.J. 07652																	
TT100	yes	—	3	—	.7	20-15 k	—	—	—	yes	—	15	3½	11¼	150.75	—	metal inc. wood 26.65
EICO ELECTRONIC INSTRUMENT CO. INC., 131-01 39th Ave., Flushing, N.Y. 11352																	
3200	no	2.4	4.5	45	.75	20-15 k	neg	.7	no	yes	yes	12	3⅛	7¾	119.95	89.95	inc.
ELECTRO-VOICE, INC., Buchanan, Mich. 49107																	
E-V 1155	no	2	2.5	—	1	20-20 k	20	2	no	yes	yes	8¼	3¾	10¾	160.00	—	inc.
FISHER RADIO CORP., 11-40 45th Rd., Long Island City, N.Y. 11101																	
TFM-1000	no	1.8	.8	70	.2	20-15 k	10	2	yes	yes	no	16¼	5⅛	12¼	499.50	—	24.95
TFM-300	no	1.8	2	55	.4	20-15 k	10	2	yes	yes	no	15⅛	4 13/16	11⅛	279.50	—	—
TFM-200	no	1.8	2.2	55	.5	20-15 k	10	2	yes	yes	no	15⅛	4 13/16	11⅞	229.50	—	—
R-200-B	yes	1.8	2.5	50	.4	20-15 k	10	2	yes	yes	no	15⅛	4 13/16	13	349.50	—	24.95
GROMMES, PRECISION ELECTRONICS INC., 9101 King St., Franklin Park, Illinois 60131																	
2000	yes	2	4	50	.5	20-20 k	10	1	yes	SCA	no	15	6½	13½	289.95	—	inc.
C-107	yes	2	4	50	.5	20-20 k	10	1	yes	SCA	no	15	4½	11	199.95	—	inc.
HEATH CO., Benton Harbor, Mich. 49022																	
AJ-43D	yes	2	3	—	1	20-20 k	—	.5	yes	yes	yes	15¾	5½	14¼	—	109.00	6.95 12.95
AJ-33A	yes	3	4	—	1	20-20 k	—	.5	yes	yes	yes	15⅜	3¾	11½	—	94.50	inc
AJ-14	no	5	3	—	1	20-15 k	—	.5	no	SCA	yes	12	3¾	9⅝	—	49.95	3.50 7.95
KENWOOD ELECTRONICS INC., 3700 S. Broadway Pl., Los Angeles, Calif. 90007																	
TK-500	no	1.8	2	20	.6	20-20 k	10	2	yes	yes	no	15¼	5¾	12¼	149.95	—	inc.
KLH RESEARCH AND DEVELOPMENT CORP., 30 Cross St., Cambridge, Mass. 02139																	
18	no	3	4	40	.6	20-15 k	10	.8	no	yes	no	8⅞	4	5⅝	116.95	—	inc.
KNIGHT, ALLIED RADIO CORP., 100 N. Western Ave., Chicago, Illinois 60680																	
KN-265B	yes	3	3	—	.5	20-20 k	25	—	no	yes	yes	13¾	4½	12	149.95	—	14.95
KN-290	no	3	3	—	1	20-20 k	neg	—	no	yes	yes	13	3 11/16	10	89.95	—	14.95
KNIGHT-KIT, ALLIED RADIO CORP., 100 N. Western Ave., Chicago, Illinois 60680																	
KG-790	yes	2.5	2	—	.7	—	neg	1.25	yes	yes	yes	16¼	5	15	—	139.95	19.95
KG-765A	yes	2.5	9	—	1	20-20 k	neg	1	yes	yes	yes	13	2¾	11	—	99.95	12.95
LAFAYETTE RADIO ELECTRONICS CORP., 111 Jericho Tpke., Syosset, L.I., N.Y. 11791																	
LT-325T	yes	2	3	42	.5	20-15 k	—	2	no	yes	no	13	3¼	9⅝	99.95	—	inc.
LT-250T	no	4	3.5	38	.9	20-15 k	—	—	no	yes	no	13	3¼	9⅝	84.95	—	inc.
OLSON ELECTRONICS, INC., 260 S. Forge St., Akron, Ohio 44308																	
RA-940	yes	2	4	—	.5	20-20 k	neg.	.5	no	SCA	yes	14½	4¼	10	54.98	—	inc.
RA-856	yes	3	—	—	1	20-20 k	neg.	.7	no	SCA	yes	6 7/16	9 1/16	6	85.00	—	inc.
RA-803	yes	5	—	—	1	20-20 k	neg.	.5	no	SCA	yes	10¼	3½	8⅛	75.00	—	inc.
H. H. SCOTT INC., 111 Powder Mill Rd., Maynard, Mass. 01754																	
315	no	2.7	6	40	1	20-20 k	20	1	no	yes	no	15 15/16	4 15/16	12¼	184.95	—	13.95
312-C	no	1.7	4	45	1	20-20 k	20	1	no	yes	no	15 15/16	4 15/16	12¼	249.95	—	13.95
LT-112B	no	1.8	4	45	1	20-20 k	20	1	no	yes	no	15 15/16	4 15/16	12¼	—	179.95	13.95
SHERWOOD ELECTRONIC LABS., INC., 4300 N. California Ave., Chicago, Illinois 60618																	
S-3500*	no	1.6	2.2	55	.3	20-20 k	10	1.5	yes	no	yes	14	4	10½	129.50	—	7.50
S-3300	no	1.6	2.2	55	.3	20-20 k	10	1.5	yes	yes	no	14	4	10½	167.50	—	7.50
S-2300	yes	1.6	2.2	55	.3	20-20 k	10	1.5	yes	yes	no	14	4	10½	199.50	—	7.50
V-M CORP., P.O. Box 659, Benton Harbor, Mich. 49023																	
1487	yes	5	—	—	—	20-20 k	100	.25	no	yes	yes	11	3⅛	7	129.95	—	inc.

All information supplied by manufacturer. All tuner measurements in reference to FM section only. It is assumed that among these quality manufacturers, the tuner signal-to noise ratio, IM distortion, hum and noise, and stereo separation are all well within the IHF limits. * Mono.

Solid-State Receivers

Model	With AM	IHF usable sens. (µV)	IHF capture ratio (dB)	IHF selectivity (dB)	Tuner THD (400 Hz) @ rated output (%)	Tuner freq. response @ rated output (Hz)	Drift (kHz)	Interstation muting	SCA or noise filter	AFC	IHF dynamic power (W/chan.)	Continuous power (W/chan.)	Power bandwidth (Hz)	THD @ rated power (1 kHz) (%)	THD @ 1 W (1 kHz) (%)	IM @ rated power (%)	IM @ 1 W (%)
ALTEC LANSING, 1515 S. Manchester Ave., Anaheim, Calif. 92803																	
711A	no	2.2	2.5	—	1.5	20-20k	neg	—	SCA	no	25	—	—	.5	—	—	—
AUDIO DYNAMICS CORP., Pickett District Rd., New Milford, Conn. 06776																	
ADC 606	no	1.6	3	—	.5	30-15k	neg	no	SCA	yes	45	30	20-20k	.5	1	.5	2
ADC-600	no	2.0	3	—	.8	50-15k	neg	no	SCA	[illegible]	30	22	20-20k	.5	1	.8	2
BOGEN COMMUNICATIONS, P.O. Box 500, Paramus, N.J. 07652																	
RT 8000	yes	2.3	2.8	35	.7	30-15k	10	no	both	yes	35	27.5	20-15k	.6	.4	.5	.3
RT 7000	no	2.5	3	35	.5	30-15k	—	no	both	no	32.5	—	20-20k	.8	—	.8	—
TR100X	yes	2.7	3	35	.7	30-15k	—	no	both	no	30	—	20-20k	1	—	1	—
TF100	no	2.7	3	35	.7	30-15k	—	no	both	no	30	—	20-20k	1	—	1	—
CHANNEL MASTER CORP., Ellenville, N.Y. 12428																	
6606	yes	1.2	2	—	1	20-40k	neg	no	both	yes	30	25	20-20k	—	—	—	—
6602	yes	4	2	—	1	50-20k	neg	no	SCA	yes	10	9	50-20k	—	—	—	—
EICO ELECTRONIC INSTRUMENT CO. INC., 131-01 39th Ave., Flushing, N.Y. 11352																	
3566	no	2	1.5	40	.5	20-15k	neg	yes	both	yes	37.5	25	8-60k	.5	.3	1	.3
ELECTRO-VOICE, INC., Buchanan, Mich. 49107																	
EV1177	no	2	2.5	—	1	20-20k	20	no	both	yes	32.5	18	—	1.5	.5	—	—
EV1179	no	—	2.5	—	1.5	20-20k	20	no	both	yes	27.5	15	—	1.5	.5	—	—
FISHER RADIO CORP., 11-40 45th Rd., Long Island City, N.Y. 11101																	
700-T	no	1.8	2	50	.4	20-15k	10	yes	both	no	60	50	20-24k	.8	—	.8	—
500-T	no	1.8	2.2	50	.5	20-15k	10	yes	both	no	45	32	22-30k	.8	—	.8	—
440-T	no	2	2.2	50	.5	20-15k	10	yes	both	no	35	25	22-30k	.8	—	.8	—
220-T	yes	2.5	2.5	50	.5	20-15k	10	yes	both	no	27.5	20	28-30k	.8	—	.8	—
GROMMES, PRECISION ELECTRONICS INC., 9101 King St., Franklin Park, Illinois 60131																	
C 503	yes	2	3	45	.5	20-15k	10	yes	both	no	30	25	20-20k	.3	.1	.3	.2
HARMAN-KARDON, INC., 401 Walnut St., Philadelphia, Pa. 19105																	
SR900	no	1.8	2.5	—	.5	10-20k	1	yes	SCA	no	50	40	3-75k	.5	.1	.1	.1
SR600	no	1.9	2.5	—	.5	10-20k	1	no	SCA	no	40	34	6-50k	1	.1	.1	.1
SR400	no	2.9	4	—	1	10-20k	1	no	SCA	no	30	26	9-24k	1	.1	.1	.1
SR300	yes	2.9	4	—	1	10-20k	1	no	SCA	no	30	26	9-24k	1	.1	.1	.1
HEATH CO., Benton Harbor, Mich. 49022																	
AR-15	yes	1.8	2.5	70	.5	20-15k	low	yes	both	no	75	50	5-25k	.2	.2	.5	.2
AR-14	no	5	3	—	1	20-15k	low	no	SCA	yes	15	10	15-30k	.5	.5	1	1
AR-13A	yes	2	3	—	1	20-15k	low	yes	both	yes	33	20	15-30k	.3	.3	1	1
KENWOOD ELECTRONICS INC., 3700 S. Broadway Pl., Los Angeles, Calif. 90007																	
TK-140	yes	2	2.5	45	.6	20-20k	—	yes	—	—	65	50	20-30k	.5	—	—	—
TK-80	no	2	2.5	40	.7	20-20k	10	yes	both	yes	40	32	20-30k	.9	.15	.5	.3
TK-60	yes	2	2.5	40	.5	20-20k	10	no	both	no	25	20	20-30k	.9	.2	.2	.3
TK-50	no	2	2.5	40	.5	20-20k	10	no	both	no	25	20	20-30k	.9	.2	.2	.3
TK-40	yes	2.5	2.5	45	.6	20-20k	—	—	—	—	15	10	20-30k	.5	—	—	—
KNIGHT, ALLIED RADIO CORP., 100 N. Western Ave., Chicago, Illinois 60680																	
KN-376	yes	3	3	—	.5	20-20k	—	no	no	yes	35	20	20-20k	1	.25	1.6	—
KN-351	yes	3	6	—	.9	20-20k	—	no	both	yes	28	18	40-15k	1	.5	1.5	—
KNIGHT-KIT, ALLIED RADIO CORP., 100 N. Western Ave., Chicago, Illinois 60680																	
KG-964	yes	2.5	8	—	1	20-20k	—	no	both	yes	32	16	25-20k	1	1	1.5	1
LAFAYETTE RADIO ELECTRONICS CORP., 111 Jericho Tpke., Syosset, L.I., N.Y. 11791																	
LR 1200T	yes	1.5	2.2	—	.5	20-20k	—	yes	yes	yes	60	45	—	1	—	.8	.3
LR 900T	yes	2	2.5	—	.6	20-20k	—	no	yes	—	32.5	27	—	1	—	—	.8
LR 450T	no	2	3	—	1	20-15k	—	no	yes	—	15	10	—	1	—	—	.8
OLSON ELECTRONICS, INC., 260 S. Forge St., Akron, Ohio 44303																	
RA-862	no	3.4	3	—	.9	20-20k	neg	no	SCA	yes	20	15	50-20k	.8	.4	.3	.1
RA-860	yes	1.9	2.5	35	.5	20-20k	neg	no	SCA	yes	40	30	30-30k	.8	.25	2.5	.3
RA-845	yes	2	2.5	35	.6	20-20k	neg	no	SCA	yes	22.5	17	30-20k	.8	.25	2.5	.3
RA-830	no	1	1	—	.9	20-20k	neg	no	SCA	yes	25	20	40-20k	.5	.3	2.8	.1
RA-806	no	3	—	—	1	35-20k	neg	no	SCA	yes	10	7	50-20k	.9	.5	.3	.1
PIONEER ELECTRONICS, U.S.A. CORP., 140 Smith St., Farmingdale, L.I., N.Y. 11735																	
SX-1000TA	yes	2.2	3.5	45	.6	20-16k	20	yes	both	yes	45	—	15-40k	.5	.2	1	.4
RCA SALES CORP., 600 North Sherman Drive, Indianapolis, Indiana 46201																	
MT 67	yes	2	6	—	.8	30-15k	neg	no	both	yes	20	—	35-20k	—	1	—	—
MT 60	yes	2	3	—	.8	30-15k	neg	no	both	yes	10	—	40-15k	—	1	—	—
H. H. SCOTT INC., 111 Powder Mill Rd., Maynard, Mass. 01754																	
388	yes	1.7	2.5	45	.8	10-20k	20	no	both	no	60	40	20-20k	.8	.25	.2	.5
348	no	1.7	2.5	45	.8	10-20k	20	yes	both	no	60	40	20-20k	.8	.25	.2	.5
344B	no	1.9	2.5	45	.8	10-20k	20	no	both	no	42.5	25	20-20k	.8	.25	.2	.5
342	no	2.2	3	40	.8	10-20k	20	no	both	no	32.5	18	20-20k	.8	.25	.2	.5
SHERWOOD ELECTRONIC LABS., INC., 4300 N. California Ave., Chicago, Illinois 60618																	
S-8800	no	1.6	2.2	55	.3	20-20k	10	yes	both	no	50	40	12-35k	.3	.1	.8	.1
S-8600	no	1.8	2.4	55	.4	20-20k	10	no	both	no	25	20	16-30k	.6	.2	1	.2
S-7800	yes	1.6	2.2	55	.3	20-20k	10	yes	both	no	50	40	12-35k	.3	.1	.8	.1
V-M CORP., P.O. Box 659, Benton Harbor, Mich. 49023																	
1489	yes	5	—	—	—	20-20k	100	no	both	yes	10	7.5	—	.3	1.5	—	—
1484	yes	1.8	—	—	—	20-20k	100	no	both	yes	37.5	15	—	.3	1.5	—	—

All information supplied by manufacturer. All power bandwidths at better than 1% distortion. All tuner measurements in reference to FM section only. It is assumed that among these quality manufacturers, the tuner signal-to-noise ratio, IM distortion, hum and noise, and stereo separation are all well within the IHF limits.

Freq. response @ 1 W (Hz)	Output impedance (ohms)	Damping factor	Center-channel output	Input sensitivity for rated output: Phono mag. (mV)	Phono ceramic (mV)	Tape head (mV)	High level (V)	Headphone jack impedance (ohms)	Tape-output jack	Tape-monitor switch	Rumble/scratch filter controls	Physical size (inches): W	H	D	Assembled price ($)	Kit price ($)	Cabinet ($)
10-100k	4-16	30	yes	5	—	2.2	.5	4-16	yes	yes	rum.	16 5/8	5 3/8	12 11/16	378.00	—	—
10-60k	4-16	30	no	2	50	no	.1	low	yes	yes	no	17	5	9	279.95	—	inc.
10-60k	4-16	50	no	2	no	no	.1	low	yes	yes	no	14 1/4	5	8 1/2	219.95	—	19.95
15-30k	4-16	40	no	2.5	—	2.5	.2	4-16	yes	yes	no	16	4 5/8	14	319.95	—	29.95
20-40k	4-16	—	no	3	—	3	.2	4-16	yes	yes	yes	16	4 5/8	14	279.95	—	inc.
20-50k	4-16	—	no	2.5	—	—	.125	4-16	yes	no	yes	16	4 1/2	11 3/4	249.95	—	inc.
20-50k	4-16	—	no	2.5	—	—	.125	4-16	yes	no	yes	16	4 1/2	11 3/4	234.95	—	inc.
20-40k	8	20	no	3.8	260	3.8	12	—	yes	no	yes	18	5 3/8	12 1/2	249.95	—	inc.
40-20k	8	10.5	no	5	400	5	4	8	yes	yes	no	15	5	9 1/2	199.95	—	inc.
5-60k	4-16	13.2	no	3	—	—	.18	any	yes	yes	no	17 1/2	5 3/8	13 1/4	325.00	219.95	14.95
20-30k	4-16	35	no	4	—	—	.09	4-16	yes	yes	no	15 3/4	3 7/8	10 1/4	280.00	—	inc.
20-30k	4-16	35	no	4	—	—	.09	4-16	yes	no	no	9 1/2	4 1/8	10	223.00	—	inc.
20-25k	4-16	50	yes	3.5	—	2.5	.2	low	yes	yes	yes	16 3/4	5 1/8	12 7/8	499.50	—	24.95
22-20k	4-16	50	no	3.5	—	2.5	.2	low	yes	yes	yes	16 1/4	5 1/8	12 1/4	399.50	—	24.95
22-20k	4-16	50	no	3.5	—	2.5	.2	low	yes	yes	yes	16 1/4	5 1/8	12 1/4	349.50	—	24.95
30-20k	4-16	20	no	3.6	—	—	.4	low	yes	yes	no	15 1/4	4 13/16	11 11/16	329.50	—	24.95
15-50k	4-16	30	no	3	150	—	.15	16-600	yes	yes	yes	16	4 1/4	12	299.95	—	24.50
2-100k	4-16	—	no	1.5	100	1.5	.15	any	yes	yes	yes	16 1/4	5	11 1/4	429.00	—	29.95
5-60k	4-16	—	no	1.5	100	1.5	.15	any	yes	yes	yes	16 1/4	5	11 1/4	349.00	—	29.95
8-25k	4-16	—	no	2	100	—	.25	any	yes	yes	no	14 1/2	4 1/2	11 1/2	289.00	—	29.95
8-25k	4-16	—	no	2	100	—	.25	any	yes	yes	no	14 1/2	4 1/2	9 3/4	259.00	—	29.95
5-50k	4-16	45	no	2.2	—	200	.2	100	yes	yes	no	16 7/8	4 1/4	14 1/2	—	299.50	19.95
10-30k	4-16	—	no	4	—	—	.3	low	yes	no	no	15 1/4	3 1/4	12	—	99.95	4.95/10.95
15-30k	4-16	20	no	6	—	—	.25	—	yes	no	no	17	5 1/2	14 3/4	—	184.00	—
20-50k	4-16	20	yes	2	—	2.5	—	4-16	—	—	—	16 1/2	5 5/16	13 1/4	339.95	—	inc.
20-50k	4-16	40	yes	2	20	4	.15	4-16	yes	yes	no	17 3/4	5 13/16	14	289.95	—	inc.
20-50k	4-16	20	yes	2	25	4	.15	4-16	yes	yes	yes	17 3/4	5 13/16	14	239.95	—	inc.
20-50k	4-16	20	yes	2	25	4	.15	4-16	yes	yes	no	16 1/2	5 13/16	14	199.95	—	inc.
20-50k	4-16	20	yes	2	—	150	.15	4-16	—	—	—	16 1/2	5	12	189.95	—	inc.
20-30k	4-16	30	—	4	—	4.5	—	4-25	yes	no	yes	16 3/4	5	13	249.95	—	19.95
20-20k	4-16	—	no	5	—	—	.23	4-16	yes	yes	no	16	4 1/2	12	199.95	—	19.95
20-50k	4-16	17	—	3	—	2.5	.5	4-16	yes	no	yes	16 3/4	5	15	—	199.95	19.95
20-50k	4-16	—	yes	2	—	2.5	.28	8	yes	yes	yes	16	5	14 1/4	259.95	—	inc.
20-20k	4-16	—	no	1.5	90	2.3	.12	8	yes	yes	no	16 1/2	4 1/2	12 1/8	199.95	—	inc.
20-20k	4-16	—	no	2.5	90	—	.2	8	yes	yes	no	15 1/4	4 1/2	11 1/2	159.95	—	inc.
30-20k	4-16	—	no	3.5	145	3.5	.145	4-16	yes	no	no	14 1/4	4 3/8	10 3/8	129.98	—	inc.
30-20k	4-16	20	no	3	30	3	.2	4-16	yes	yes	yes	17 3/8	5 1/4	14 3/8	219.98	—	inc.
20-20k	4-16	20	no	3.5	40	3.5	.25	4-16	yes	yes	yes	16 1/8	3 1/4	10 5/8	179.98	—	inc.
30-50k	4-16	—	no	4	150	4	.3	4-16	yes	no	no	10	4 1/2	11	79.95	—	inc.
35-20k	4-16	—	no	4	50	4	.15	4-16	yes	no	no	11 3/4	4 3/4	7 1/2	110.00	—	inc.
20-60k	8-16	30	no	2.5	35	1.5	.2	low	yes	yes	yes	18	5 7/16	13 13/16	360.00	—	inc.
25-20k	8-16	—	no	—	25	—	.3	8-40	yes	yes	no	32	11 11/16	12	275.00	—	—
30-15k	8-16	—	no	—	300	—	.02	8-40	yes	yes	no	31	8 1/4	8 1/2	150.00	—	—
15-30k	4-16	20	yes	3	—	2	.5	low	yes	yes	yes	18 1/4	6 1/4	11 1/4	499.95	—	29.95
15-30k	4-16	20	yes	3	—	2	.5	low	yes	yes	yes	18 1/4	6 1/4	11 1/4	479.95	—	29.95
15-30k	4-16	20	yes	3	—	2	.5	low	yes	yes	yes	15 15/16	4 15/16	12 1/2	374.95	—	13.95
18-25k	4-16	20	no	3	—	—	.5	low	yes	yes	yes	15 15/16	4 15/16	12 1/2	299.95	—	13.95
10-50k	4-16	30	yes	1.6	—	1	.1	40	yes	yes	yes	16 1/2	4 1/2	14	359.50	—	9.00
12-40k	4-16	30	yes	1.8	—	—	.4	any	yes	yes	no	16 1/2	4 1/2	10 1/2	289.50	—	9.00
10-50k	4-16	30	yes	1.6	—	1	.1	any	yes	yes	scr.	16 1/2	4 1/2	14	399.50	—	9.00
40-20k	8	—	no	100	100	600	.6	—	yes	no	no	13 1/2	3 1/4	11 1/2	159.95	—	inc.
40-20k	8	—	no	—	100	600	.6	—	yes	no	no	15 1/2	3 9/16	13 1/2	199.95	—	inc.

Three Andrew base-station antennas are shown mounted on the tower. At the top center is Type 3606 corner-reflector antenna with a 9-dB gain over a half-wave dipole. This antenna is designed for 450 to 470 MHz ($100). The antenna at the left is Type 460, a high-gain omnidirectional unit with 7-dB gain, designed for 450 to 470 MHz. Within fiber glass covering is a multi-element colinear array in conjunction with ground radials ($160). Finally, the antenna at the right is Type 151, a high-gain offset unit with a 7.6-dB gain, designed for 136 to 174 MHz. It, too, is a colinear array within a fiber glass covering employed along with ground radials ($240).

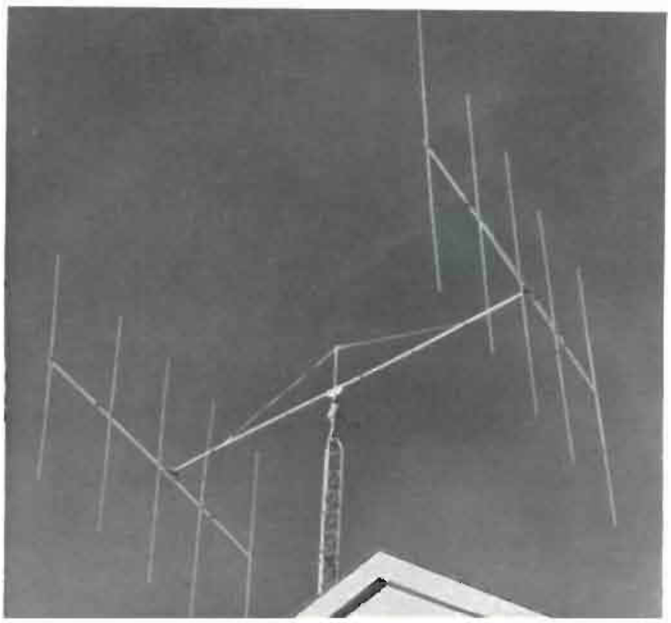
ANTENNAS FOR CB AND BUSINESS RADIO

The proper antenna system will often mean the difference between good communications and none. A large number of suitable units are readily available for any type of coverage that is desired.

IT has been said that the CB operator is never completely satisfied with his communicating range, while the industrial user of two-way radio may rarely exploit his system's maximum distance. One of the significant variables is the antenna system. CB antennas are restricted to a maximum height of 20 feet over a man-made or natural formation and towers are prohibited. The Business Radio antenna, on the other hand, may rise some 170 feet above ground level on its own tower. Another factor is transmitter power. The CB operator is granted a 5-watt maximum input; the BRS transmitter might operate at 500 or 600 watts. These differences in regulations markedly affect the choice and installation of antennas.

CB and BRS antenna systems are, in a way, approached from opposite directions. In CB, conditions such as power and height are fixed. This has led to a diversity of antenna models to satisfy the persistent demand for best possible range under the regulations. CB designs often run to the exotic to exploit every possible improvement in performance. There are models which feature horizontal and vertical polarization, for example, or electronic rotation of the signal.

Hy-Gain Electronics "Duo-Beam 100" consists of two five-element parasitic arrays with reflectors and directors. A heavy-duty rotator is used to orient beam which is said to effectively boost input power of a CB rig from 5 to 120 watts ($99.95).



The approach to a BRS antenna system, however, confronts the installer with a complex set of *variable* factors. Not only can the installer control range by selecting transmitter power but antenna height as well. These interrelated factors must be juggled at the time an antenna design is considered. Since cost often weighs heavily in the BRS system, the installer might want to seek assistance offered by equipment manufacturers. They often make available technical information and charts for calculating range, or provide mobile units to survey the geographic area and test actual conditions in the field.

There are FCC requirements, too. The BRS antenna location must be identified by latitude and longitude (which may require the services of a local surveyor) and there might also be tower painting and lighting requirements. The rules covering these details should be on hand before the installation is contemplated (they appear in Volume V of FCC Rules and Regulations). The CB antenna installation is less formal since the consistent 20-foot height rule (an FAA specification) eliminates any hazard to air traffic.

Many other factors governing antenna systems apply equally well to CB and BRS operation. In general, each signal is mainly propagated *via* line-of-sight despite differences in frequency. CB and low-band BRS signals (about 25-50 MHz) tend to diffract around obstacles and rough terrain somewhat better than high-band BRS (152-174 MHz). BRS on the u.h.f. band (about 450-470 MHz) begins to assume the reflective properties of light which might be an advantage in built-up urban areas. Let's first consider the automobile antenna system for mobile operations.

Mobile Whips

Physical size and mounting point are prime considerations in the mobile antenna. Here the BRS antenna has a slight edge over CB. Since the whip is based on the quarter-wave Marconi (working against the vehicle body as a ground), it grows shorter as operating frequency increases.

The full-size CB whip rises to nearly 9 feet, while the BRS antenna shrinks progressively until it becomes about 1½ feet long in the high v.h.f. band and only some 6 inches long at u.h.f. Thus the BRS whip can often mount inconspicuously on the vehicle roof, front cowl, or rear trunk deck.

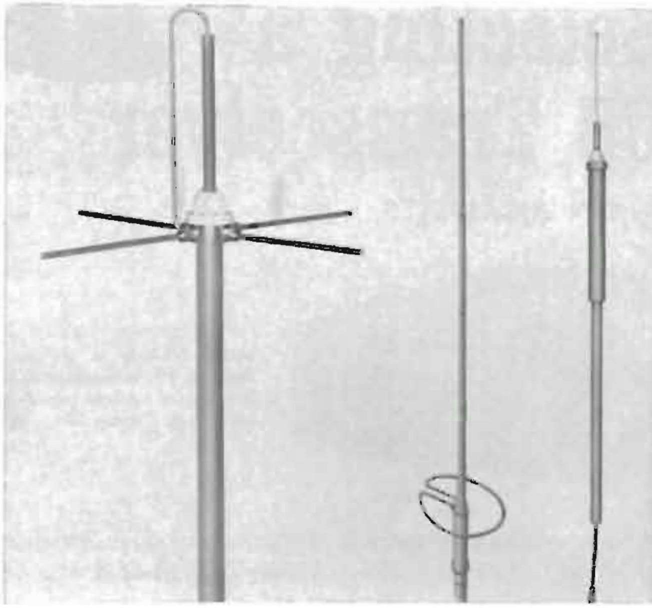
The quarter-wave, or full-size, CB whip represents the most efficient omnidirectional mobile antenna but one that is impractical for roof-top mounting. Positioning its base on the rear bumper may solve the problem of excessive height, but here it encounters another difficulty. Much radiation occurs near the antenna base, point of maximum current feed, and the bumper height is extremely low.

Actual measurements taken by one antenna manufacturer with a full-size whip at six different vehicle mounting points are shown in Fig. 1. The drawing is illuminating in two ways; it reveals the advantage of height and central location. Consider the center-of-roof mounting; the pattern is most nearly equal in every direction. In each of the remaining cases, maximum radiation occurs over the *longest* metal path presented by the car to the antenna. Thus, the antenna on the right rear fender tends to emit strongest signals in the direction of the left front fender. This is due to the ground-plane action of the automobile and should be considered when a whip is not centrally mounted. (In an emergency situation, it might even be possible to communicate with a distant station if the whip's directionality is known. The car is turned and aimed in beam-rotating fashion.) An unequal whip pattern, however, is not normally a significant factor until signals approach marginal strength for good communications. Worst case in the series of Fig. 1 is the highly distorted, narrow pattern of the left rear bumper mount. It reveals the problem of mounting a whip low on the car.

CB antenna makers resort to the loading coil to reconcile conflicting factors of whip length and high mounting point. The loading coil permits mechanical shortening of the whip while preserving its quarter-wave electrical characteristics. Although the coil reduces the antenna's efficiency somewhat, it is believed this is more than offset by higher roof-and-deck-mounting options and less warping of the pattern. The loaded whip may be less than half the length of the full-size 9-foot model.

There are several variations on the loaded whip. Some manufacturers resort to continuous loading, where a spiral of wire is embedded within a glass-fiber rod. One antenna maker utilizes a printed-circuit coil in a plastic housing near the whip's bottom. But the basic division is whether the whip is bottom, center, or top-loaded. There are proponents of each method. The earliest models were often loaded at the antenna base. If placed at a higher point, the coil would be subject to physical damage or excessive sway due to leverage developed when situated high on the whip. Newer coils, however, are usually slimmer, lighter, and sealed in plastic. Since they help eliminate some of the earlier problems, some manufacturers have relocated the coil higher on the whip.

The diagram of Fig. 2 reveals the effect of loading-coil position on radiation. It may be seen that the higher the coil, the more it distributes current, and thus radiation, at higher levels. Adherents of this approach state that range is improved since surrounding obstacles, including the car, are more easily cleared by the signal. Supporters of base loading, however, feel that the coil at the bottom cannot sway as the vehicle moves and thus it maintains a fixed capacitive effect between coil and car body. It is felt that antenna impedance remains constant and the v.s.w.r. stays low. Another benefit of base loading is stated to be the provision for grounding the antenna through the base coil to help short-circuit noise. There is much agreement that range, in any case, improves as the antenna grows longer and is mounted higher.



(Left) Kreco FGP-155 is a ground-plane antenna with a folded vertical element, available for from 108 to 175 MHz ($52). (Center) Cush-Craft "Ringo" CR-1 is a half-wave vertical antenna for CB. Circular element is for impedance matching ($16.95). (Right) Communication Products 83-509 is omnidirectional coax antenna for h.f. and v.h.f. ($52).

A number of refinements in whip antennas improve versatility. A whip might have a fitting which permits it to be "split" and lowered when the car is garaged. One antenna maker features a magnetic base which permits roof-mounting with no need for drilling holes. There are also hole-less mountings which rely on special fittings clamped in the crack between trunk lid or hood and car body. Not to be overlooked in mobile work is the *diplexer,* a small accessory to eliminate the car's regular AM broadcast antenna (which occupies a convenient mounting point for the CB whip). The device contains a simple frequency-selective network that enables the CB antenna to serve both CB and AM. *(Continued on page 84)*

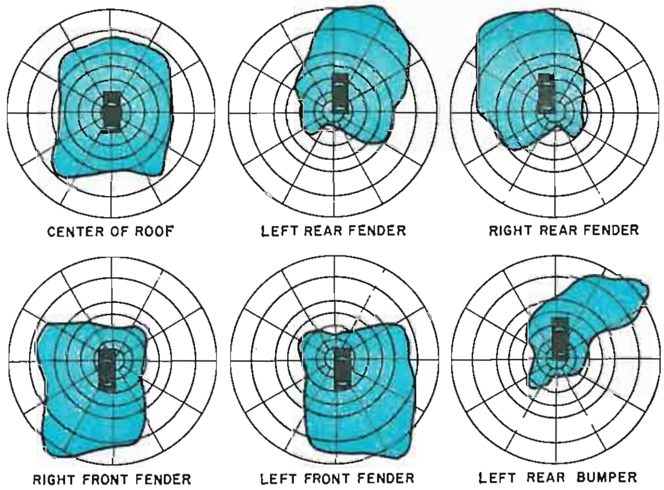
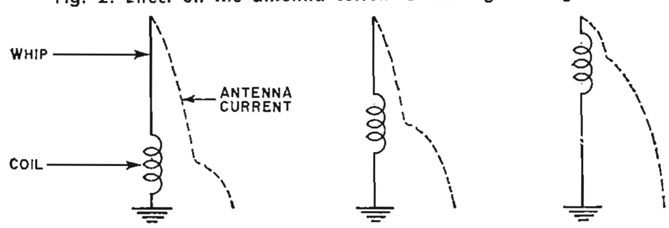
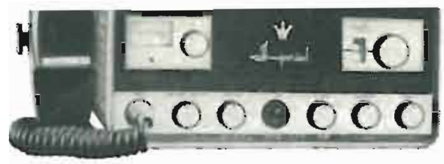


Fig. 1. Measurements made by Hy-Gain Electronics of radiation pattern of 9-ft CB whip at various mounting locations.

Fig. 2. Effect on the antenna current of raising loading coil.



Selecting a CB Transceiver



Regency "Imperial" transmits a DSB signal with either reduced or no carrier, and receives either upper or lower sideband or both sidebands conventionally. ($299)

Squires-Sanders "23'er" is an all-channel solid-state transceiver using speech clipping in the transmitter and a crystal lattice filter and special noise silencer in receiver. ($235)

By LEN BUCKWALTER

Sonar J-23 is a solid-state 23-channel CB transceiver using dual-conversion receiver, squelch, a.n.l., and p.a. operation. ($239.95)

Browning "Eagle" CB base station includes separate receiver (left) and transmitter (right) with 23 crystals. ($359 for both)

A wide variety of special features and circuit improvements make the modern CB transceiver a better buy than it was only a few years ago.

"BUY only the features you need" is the familiar recommendation to the prospective purchaser of a CB transceiver. It is advice which certainly appeals to the sensibilities and the pocketbook. But a meticulous effort to single out features or fit a transceiver to an immediate need could prove to be a risky procedure. For one thing, the CB transceiver doesn't serve up its circuits cafeteria-style. There has been little effort to modularize features and purchasing, say, a crystal filter but no "S"-meter is rarely practical.

Many of today's transceivers, rather, have evolved through a succession of refinements which saw the industry adapt concepts and hardware from the older field of two-way radio communications. Thus, the broad superregenerative receiver yielded to the sharp, dual-conversion superhet. Noise limiters went from simple clipping diodes to automatic, self-adjusting types. Audio modulation acquired a boost in effectiveness.

The point is simply that contemplating isolated features may overlook the heart of the matter. The premium in CB is on sensitivity, selectivity, and maintaining high modulation percentages; which is, after all, what the textbooks have said all along. Hence, a tally of switches, meters, or functions displayed on the front panel could be a poor index to communications effectiveness. More likely, the ability to handle traffic on CB is better described about midway down the spec sheet in small type. Will the circuit reject adjacent channels which may occur just 10 kHz away? Can modulation average 80, not 30, percent? Will the transceiver be versatile enough with respect to frequency coverage?

How Many Channels?

For the serious-minded operator, the ideal transceiver might be a functional, one-channel black box which got the message through. While the logic is sound it may overlook some facts of CB life, plus some pending developments. As the number of licenses hovers near the million mark, CB claims the distinction of being the FCC's largest division. It is some three times larger than ham radio and almost ten times the size of industrial two-way radio. Yet the sprawl of CB, often cited as its bane, is also proving to be its boon.

As the thrill of speaking without wires fades, CB-ers in vast numbers tend to revive their enthusiasm by turning to public service. They have created a diversity of on-the-air services freely available to anyone equipped with the right channels. It is a development worth weighing when considering the number of channels in a new transceiver. Here are some examples of what's happened in the nine years of CB's existence on the 27-megahertz band.

It has been a matter of FCC policy not to allocate CB's 23 channels for special use; *e.g.*, technicians on one frequency, skydivers (known to use CB while in free fall) on another, etc. Yet the Commission has placed no obstacle in the way of local CB groups who wish to contrive their own "assignments". It has led to the development of channel 9 as the unofficial "calling" frequency, and 13 as the marine channel for pleasure boats. At least one CB group maintains a transceiver at a telephone-answering service to provide a 24-hour alert for distress calls. Anyone touring the country by car should increasingly encounter roadside signs informing him that certain channels are monitored. Local CB stations are ready to respond with route instructions, motel reservations, and other helpful assistance.

The transceiver with few channels may provide ample home-to-car communications, but place these other services beyond reach. It might also preclude access to HELP, the *H*ighway *E*mergency *L*ocating *P*lan now being promoted by major Detroit automakers. The auto industry has petitioned the FCC to set aside two frequencies in the CB spectrum for assisting stranded motorists. Many state-level organizations, like the New Jersey Turnpike Authority, are either experimenting with a HELP-type service or operating one on a trial basis. As traffic mounts on the interstate highway system, officials are looking to CB as the answer to detecting emergencies. Regular state police patrols even now prove inadequate.

Today's transceivers resort to a number of systems to provide coverage up to 25 channels. (Although 23 channels prevail, there may be provision for possible additional HELP frequencies.) Most sets employ a straightforward channel selector that inserts the appropriate pair of crystals into receive and transmit oscillator circuits. (One crystal set is usually supplied by the manufacturer; the buyer must purchase additional crystal pairs which are plugged into sockets.) There are enough variations in channel-selecting circuits to cause possible confusion. With careful study of the manufacturer's literature, however, it should be possible to discern which of the following systems is being offered. It could significantly affect price and function.

When a transceiver is listed as "23-channel", determine whether it refers to receiver, transmitter, or both. In selecting a 12-channel transceiver, for example, determine from the literature whether crystal control applies to *both* transmitter and receiver. The transmitter, by law, is crystal-controlled, but the receiver may have only *continuous* tuning. Since the continuous dial is only approximate, it

B&K "Cobra CAM-88" is a transceiver featuring speech compression in transmitter and fine tuning in the receiver. ($214.95)

Multi-Elmac "Citi-Fone SS" is a 23-channel transceiver using frequency synthesis and a double-conversion receiver. ($169.50)

The e.c.i. "Courier TR-23S" is a compact, silicon-transistor CB transceiver measuring only 5¾" x 1⅞" x 6¼" deep. ($169)

Tram "Titan" CB base station uses frequency synthesis, audio compression, mechanical filter in receiver, multi-function meter. ($434)

Eico "Nova-23" is a solid-state 23-channel crystal-controlled 5-watt transceiver using crystal lattice filter. ($189.95, wired)

is not easily preset or useful for quick, precise receiver tuning. Crystal-control for receive is indispensable in mobile operation. If continuous tuning is provided in addition to crystals, it is best considered an extra—with some possible use as a check on over-all band activity. This information might reveal low-activity channels in a specific area and thus help you select future crystal frequencies.

In its own class is the 23-channel rig which is completely crystal-controlled. Here, too, the system must be correctly identified. When the transceiver utilizes "frequency synthesis", all crystals are factory-installed. The reason is that full frequency coverage can be obtained with eleven crystals instead of the customary 46 (2 per channel).

The concept of frequency synthesis is shown in Fig. 1. When the operator selects a channel, a pair of crystals is energized for receive or transmit. A mixing process places the resulting signal on the desired transmit channel, or creates the receiver i.f. frequency for the same channel during receive. By careful calculations, the circuit designer has selected 11 crystal frequencies which ultimately yield 23 channels. A single crystal, for example, may participate in creating five or six different channels (receive or transmit).

Another type of all-channel transceiver is the circuit which provides a dual 23-channel selector switch and 46 crystal *sockets*. Although the manufacturer may provide only one pair of crystals, the remaining sets are at the buyer's option. He may choose any number of desired channels at a later date, up to the full complement.

How many crystal-controlled channels are needed? This is a matter of personal choice. The total, however, should take into consideration the following possibilities. Two channels are desirable for personal use. These would be selected from channels 1 through 8 or 15 through 22, now reserved for intrastation use (units operating under the same call sign). Two frequencies permit a change in channels if communications become difficult due to co-channel interference. Two additional frequencies might be chosen in the *interstation* channel group (9 through 14 and 23) to permit contact with other stations (operating under different call signs).

The most active channels are 9 and 11, and an emergency call for assistance on either is apt to evoke a response in most areas of the country. This could prove helpful during long motor trips. If there is regional monitoring in your locale, a crystal on that frequency is suggested. The boating enthusiast may wish to have communications on channel 13. Thus, there is a potential need for a minimum of five or six channels, not counting the possible introduction of two HELP, or other special CB frequencies.

Receiver Sensitivity

Some CB receivers achieve a bandwidth which rivals that of an expensive communications receiver. Yet there is a frequent argument against high selectivity: "If you live in a sparsely populated area, with little CB activity, good selectivity is a useless, costly feature." The suggestion may have had currency a year or two ago, but a new factor now touches the CB medium. It is the sunspot cycle. It recently passed the trough of its 11-year cycle and is rising toward a peak which should occur in about five years. With each passing month it improves skip conditions on 27 MHz. The sunspot phenomenon will carry adjacent-channel interference to the most remotely located CB installation. Considering that channels are spaced either 10 or 20 kHz on the band, sharp selectivity should be as welcome in New York as in York, Pa. It will result in the rejection of distant stations arriving on adjacent channels, and such stations may easily attain the strength of locals.

Another factor in favor of superior selectivity is the rate of CB expansion which puts more and more stations on the band every day. Despite a series of rules tightening, the imposition of an $8 license fee, the levying of fines for violations (often $100), and stern warnings from official sources, CB continues to be a growth industry. Recent reports show that license applications continue to reach the FCC at a rate of about 16,000 per month.

When exploring the techniques used by manufacturers to shape receiver bandwidth, you'll encounter a number of familiar or possibly surprising circuits. There is the conventional dual-conversion i.f. strip. A recent transceiver typifies the approach: it initially mixes the 27-MHz signal down to 6 MHz, a rather high i.f. frequency which helps reject possible images. The second conversion step reduces 6 MHz to 455 kHz, where tuned circuits operate with good selectivity. Another manufacturer uses a conventional crystal filter for sharpening the i.f. response. But the surprising development is the entry of the mechanical filter into CB circuitry. The device, normally associated with expensive, high-quality communications and amateur gear, has appeared in a number of moderately priced transceivers, for good reason.

The original mechanical filter introduced by *Collins* is a rugged, precise component. To meet military and industrial specifications, it had to offer exceptional characteristics under environmental extremes of temperature, humidity, and vibration. But in evaluating the device for potential CB applications, it was found that conditions were not nearly as stringent. Thus, many cost-boosting, superfluous features were dropped: the high-tensile plated steel casing reverted to plastic; hermetic seals and special shock-absorbants were eliminated. Shape factor of the filter was altered from a narrow 2-to-1 to a wider 3-to-1 by reducing the number of internal metal discs from 7 or 9 to just 5. The revamped filter for CB is rated by *Collins* for selectivity of 6 kHz at −3 dB and 20 kHz at −60 dB, which yields a desirable flat-topped, steep-sided response curve. CB manufacturers were offered the filter at less than $7 in production quantities.

The circuit of Fig. 2 shows how the mechanical filter supplants an i.f. transformer in the receiver. In operation, the electric signal on 455 kHz is converted to equivalent mechanical motion by a coil and driving rod. This energy drives a series of metal discs which start to resonate with high "Q" on 455 kHz, thereby rejecting off-frequency signals. Mechanical energy reverts to an electrical signal at the filter's output by another driving rod and coil combination. There are other versions of the mechanical filter in current CB transceivers. The operating principle is fundamentally the same, but input and output transducers usually differ. Instead of the *magnetostrictive* arrangement, the other filters might use ceramic elements as signal transducers.

The trend toward higher selectivity in CB transceivers has been accompanied by at least one minor difficulty. An incoming signal may only partially squeeze into the receiver's bandwidth. (There is a permissible shift of several kHz due to CB's frequency tolerance of 0.005%.) To prevent loss in received-signal gain, many manufacturers install an additional receiver control labeled "Delta Tuning", "Bandspread", or "Variable Tuning". It is simply a vernier on one of the receiver's local oscillators to permit a variation of about 2 or 3 kHz to properly center the signal in the receiver's passband.

Sensitivity and Noise Limiters

There is some justification in placing less emphasis on receiver sensitivity than on selectivity. Although front-end circuits differ—there may be one or two r.f. amplifiers, a cascode circuit, possibly nuvistors—there is probably no vast difference in the ability of reasonably good receivers to separate signals from noise. Comparing small differences in microvolt rating may be purely academic. What produces a vast impact on receiving is a factor which has little to do with sensitivity: it is man-made noise. The number of microvolts introduced by noise may quickly obliterate any advantage accruing from high receiver sensitivity. The problem is acute during mobile reception,

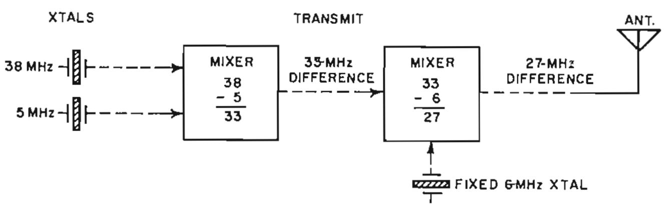
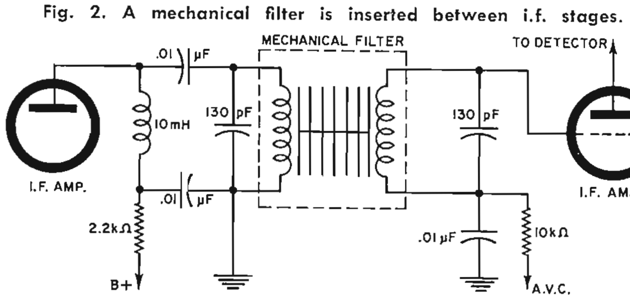


Fig. 1. In frequency synthesis, two crystals mix to ultimately produce transmit frequency. Same crystals can also be employed to create a 6-megahertz intermediate frequency during receive.

Fig. 2. A mechanical filter is inserted between i.f. stages.



where spark plugs, distributor, generator, and other items in the ignition system radiate an inordinate amount of r.f. energy on 27 MHz. For this reason, sensitivity and noise limiters can be considered under a single heading.

Virtually all transceivers utilize noise-limiter circuitry to either clip noise spikes or interrupt ("punch holes" in) receiver response during transient impulse noises. A popular circuit is the series-gate, shown in Fig. 3, which automatically adjusts to signal level and regulates clipping action according to conditions. CB, too, picks up the trend from other services which place the noise limiter further forward in the receiver—away from the detector and into the i.f. strip. The advantage of the system, usually termed a "silencer", is that noise is removed at lower signal levels which prevents distortion products from developing in an i.f. amplifier stage.

But the best noise limiter is not a sophisticated section of receiver circuitry. It is, rather, a thorough job of suppressing every possible noise source in the automobile with conventional techniques of bypassing, filtering, and shielding. Once the car is electrically quiet, the receiver's noise-limiter circuitry can more effectively handle noise radiated from external sources, namely, from nearby vehicles, power-line leakage, or fluorescent lighting. In some recent transceivers a noise-limiter switch on the panel may be omitted. This may simply indicate the circuit is self-adjusting and needs no manual attention.

Audio Improvement

In an increasing number of transceivers there is some system for boosting audio modulation. Its basis is the fact that *average* modulation at normal voice levels may hover around 30 percent. Range and intelligibility enjoy a significant increase when average modulation is raised to more than double that figure. The basic modulator circuitry of many CB transceivers introduces a simple form of limiting. According to law, modulation should not exceed 100 percent and designers often choose modulator arrangements which cannot create voltages which produce overmodulation. This in itself can raise average level—the operator merely speaks closer to the mike, the circuit is self-limiting. The pitfall is that this can also cause distortion and splatter if overdone. Nevertheless, if optimum speaking distance and voice level are maintained, little more is required for effective communications.

Special boost-type circuitry, however, might prove valuable where the transceiver is used by a number of people some of whom fail to observe best mike techniques. Two circuits for achieving the boost are the limiter and compressor. In the limiter, the clipping action of a diode slices all signals exceeding a given level. Due to possible distortion produced by "flattened" audio, a limiter is usually followed by a high-pass filter to attenuate spurious products. The compressor circuit, on the other hand, performs like a.g.c. A portion of the audio signal is sampled at the output, or modulator stage, then rectified to a d.c. control signal. Fed back to an earlier audio amplifier, it can boost soft sounds or reduce loud ones by varying tube or transistor bias. The compressor is less prone to distortion but some operators believe that it produces less audio "punch" than the limiter.

Tube vs Transistor

After a tentative start, the solid-state transceiver is now displacing much tube-type gear in the lines of CB manufacturers. It has been especially welcome in mobile operation where small size and low current drain prove attractive. Yet the tube is far from dead. The acceptance of transistors by today's CB operators is not yet universal. According to the manager of one large CB distributor, solid-state units are being purchased for mobile operation but sales of tube transceivers for home or base-station use are still holding up well. Several causes can be cited.

Some early transistor sets acquired a reputation for not developing full 5-watt r.f. input power. Another criticism has been speaker size. Speakers were "miniaturized" along with cabinet dimensions and were incapable of developing ample audio without high distortion or microphonic ringing. There was also the matter of operating without a load, or antenna. Output transistors cannot tolerate soaring voltage swings produced by no-load conditions and semiconductors have been inadvertently "popped". Also, the hot-cold environmental conditions of the automobile subjected these early circuits to intolerable stress.

Although transistor sets still suffer somewhat from their past reputation, virtually all problems have been solved. The *RCA*-recommended circuit for a 5-watt transmitter, for example (shown in Fig. 4), is stated to have excellent frequency stability with respect to collector supply voltage and temperature and operates well within the 0.005% frequency tolerance. A double *pi*-network in the output provides 50 dB of harmonic rejection. The r.f. *output* power developed by the final amplifier is specified as 3 watts, minimum. One novel circuit refinement is that audio is applied not only to the final r.f. power amplifier, but to the driver stage as well. This assures ample modulation.

Some considerations which may affect the choice between tube and semiconductor are the following. Transistor circuits will probably require less servicing, but call for somewhat more know-how in troubleshooting since circuitry may be less familiar. Also, solid-state sets may have fixed r.f. output coils which could limit the range of adjustment into antenna loads which are not 50 ohms. (Sealing the output coil prevents mistuning and possible damage to the final transistor.) There are signs, however, that the recent solid-state sets are correcting more than just the basic faults which plagued early equipment. One manufacturer claims to have protective circuitry in his r.f. output stage, another states that cabinet dimensions are small, but the speaker is large.

Due to miniaturization possible with transistors, a new and separate generation of CB transceivers has appeared. It is the HELP-type rig, characterized by small dimensions, few controls, and a price tag near or below $100. Given impetus by the Detroit program, it is aimed at the vast potential market beyond the existing borders of CB. The equipment is simple in appearance and function in order to appeal to the non-electronic user—the owners of the nearly 80 million cars operating on the highways.

Sideband Equipment

In an effort to provide more power and less bandwidth, several manufacturers have marketed sideband systems for CB. Only one at this time—double sideband *reduced* carrier—has achieved a degree of success. The reason may be that it most closely resembles conventional CB equipment. Two other systems, double-sideband suppressed carrier and single sideband, have failed to achieve much support thus far, but new developments may alter the pattern.

The DSB reduced carrier unit can be summed up as a system which phases out a small portion of its transmitter carrier and transfers power into the sidebands, which bear the intelligence. The system is fully compatible with other CB transceivers. Compatibility comes at a price; enough carrier must be transmitted to permit conventional detection in the distant receiver. Thus the amount of sideband power gained by the system is limited.

The double sideband suppressed carrier has been announced several times but withdrawn before appearing on dealer shelves. Although it holds the promise of transferring nearly all carrier power into sidebands—and do it with simple circuitry—the problem is in the receiving end. Double-sideband reception requires either elaborate phase-lock synchronous detection (akin to the color demodulator in color TV) or a sharp filter which eliminates one sideband. If such complexity is needed, why not go to a single-sideband system which offers the additional advantage of one-half normal bandwidth?

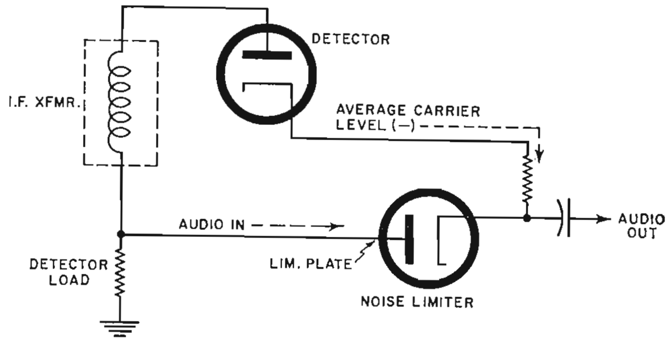


Fig. 3. Series noise limiter. Audio and noise pulses from detector load feed limiter plate. Strong noise pulses drive this plate negative and prevent signal conduction. Circuit is self-adjusting since carrier level reference is also applied to limiter cathode. Therefore, when a stronger r.f. carrier is being detected, noise must attain a higher level in order to be clipped by this circuit.

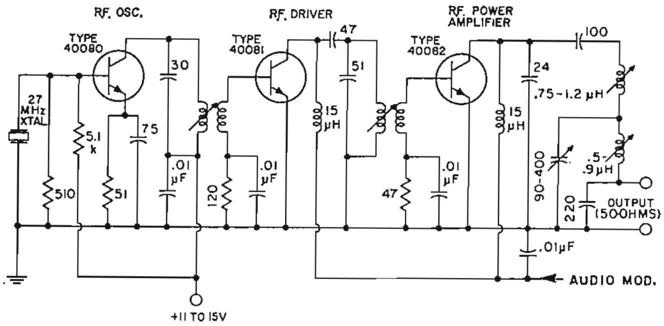


Fig. 4. The r.f. section of a 5-watt CB transistor transmitter.

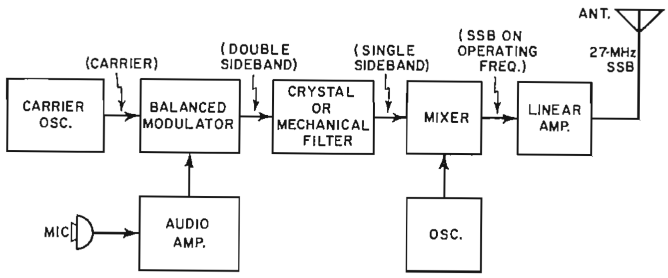


Fig. 5. Block diagram of a single-sideband CB transmitter.

The first commercial single-sideband transceiver failed to win acceptance. The reason is generally assumed to be non-technical. Much CB operation is interstation and the sideband rig could not communicate with any but similar models. Incompatibility apparently doomed the system when it appeared more than two years ago. Recently, two manufacturers announced single-sideband transceivers: one which is not compatible with existing receivers, the other offering a choice of AM or SSB modes. Either sideband system involves additional complexity (as shown in the transmitter diagram of Fig. 5) and cost is higher than for conventional equipment. However, where communications will mainly occur between comparable units, sideband offers a significant increase in range. The halving of bandwidth may not relieve channel congestion at this time (since all CB is not sideband), but the reduced bandwidth of a sideband receiver makes it less susceptible to interference.

It would appear that the route to selecting a CB transceiver might best run from inside of the chassis to the outside of the front panel. Once a basically good circuit design has been chosen, then the user can look for additional features to help him make up his mind. ▲

Electronics in OCEANOGRAPHY

By JOHN ALTHOUSE

A review of the mechanical and electronic instruments that can accurately measure the temperature, pressure, conductivity, speed-of-sound, tide, and wave motion.

"SHORTLY after World War II, attempts were made to introduce electronics into oceanographic instrumentation. The effects were essentially disastrous and resulted in greatly delaying the successful introduction of electronics until 1950 and later." Thus James Snodgrass of the Scripps Institution of Oceanography describes the early history of electronics in the ocean.

Many promising electronic instruments failed to meet the needs of oceanographers in terms of cost, reliability, and accuracy. Since the early days, however, a number of successful electronic instruments have been designed and are in daily use in the ocean. They permit observations to be made rapidly, greatly speed data processing, and have opened several new fields of measurement.

Despite the advantages of electronic measurement, mechanical instruments are still widely used by oceanographers. To shed some light on this paradox, this article will examine several important physical properties of the ocean and describe mechanical and electronic instruments that are used to measure them.

Temperature and Pressure

Knowledge of water temperature is of fundamental importance to oceanographers. Temperature has a great effect on the physical properties of ocean water and, at great depths, temperature variations are quite small. Thus, it is desirable to know temperature to an accuracy of about 0.02° C.

The traditional instrument for measuring temperature is the reversing thermometer shown in Fig. 1. This is a mercury-in-glass thermometer with a mercury column that separates when the thermometer is inverted, locking the reading in place. It is lowered upright to the desired depth, and a metal weight is then sent down the supporting wire to release a trip mechanism which inverts the thermometer. It is then pulled back to the surface to be read.

The thermometers are used in pairs. One is protected against water pressure while the other is not. From the difference in the readings of the two thermometers, it is possible to determine the depth. The depth measurement is important since there is no assurance that the supporting wire will hang straight down, and thus its length is not an accurate measure of depth.

The accuracy of measurement possible with the reversing thermometer (about 0.01° C) has kept it in general use for almost a hundred years. However, it gives a single temperature reading each time it is lowered, not the desired continuous temperature profile.

The electronic bathythermograph (EBT) was devised to provide a continuous temperature record. Temperature is measured with a thermistor or a platinum-wire probe. In several commercial designs, the resistance element is used to control the frequency of an oscillator, as shown in Fig. 2. In this circuit, the frequency of oscillation varies inversely as the square root of the probe resistance. When coupled with the non-linear temperature-resistance characteristic of a thermistor, the oscillator frequency can be made to vary linearly with temperature.

The EBT also monitors pressure. Since the water pressure increases with depth approximately 0.44 psi/ft, the pressure measurement can be used to determine the depth of the probe. A typical pressure transducer utilizes a vibrating wire to control an oscillator. The tension of the wire, and thus the frequency of oscillation, is a function of pressure.

By using a temperature oscillator and a pressure oscillator on different frequencies, their signals can be sent to the surface along a single-conductor insulated wire. The sea water provides the return path. D.c. to power the oscillators can be sent down the same wire.

There is no question but that resistance thermometry, in the laboratory, provides a high degree of accuracy. The accuracy of the EBT, however, is the subject of heated debate.

Errors are introduced in the transfer from resistance to its frequency analog. Furthermore, the high pressures at ocean depths, on the order of 10,000 psi, can distort the resistance sensor and modify its calibration. Nevertheless, the obvious advantages of the electronic method have made the EBT the object of intense development.

Salinity

Salinity, a measure of the salt content of ocean water, is of prime interest to the oceanographer. When ocean water evaporates or freezes, most of the salt is left behind and the remaining water increases in salinity. An influx of fresh water from rivers, rainfall, or melting ice reduces salinity. As water of either low or high salinity moves through the ocean, its path can be traced by taking salinity measurements.

The classical measurement method, still in use, is chemical titration. Typically, a water container is sent down with reversing thermometers. When the thermometers are tripped, the sample bottle is closed, and the sample is then brought to the surface and analyzed. This is an accurate but slow method.

The application of electronic techniques to salinity measurement has produced the induction conductivity meter which measures the electrical conductivity of the water. If water temperature and pressure are measured at the same

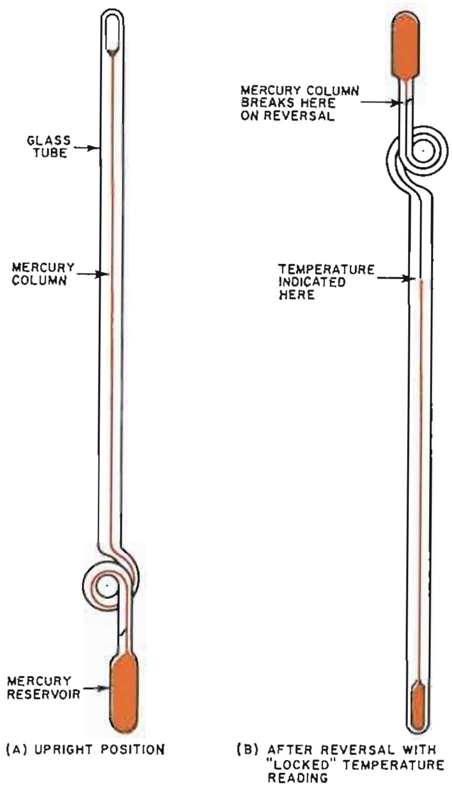


Fig. 1. The reversing thermometer is lowered in the upright position, tripped over to record temperature then pulled back up.

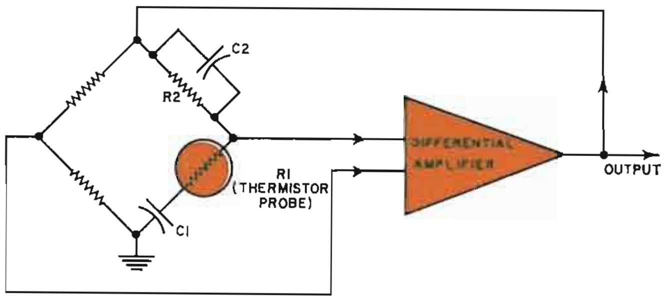


Fig. 2. The electronic bathythermograph uses a Wien-type bridge whose frequency varies with temperature/resistance changes in the thermistor. The EBT also measures water pressure.

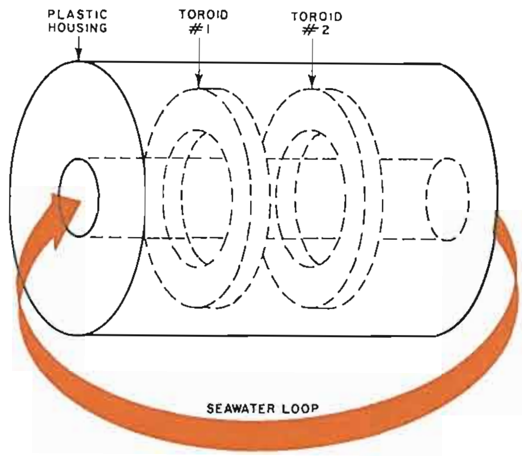


Fig. 3. Probe construction of the induction conductivity meter. The seawater forms the coupling between the toroids.

time, the salinity of the water under test can be computed.

Fig. 3 illustrates the electrical principle of this instrument. Two toroids are encased in plastic, and a hole of known size allows sea water to pass through their centers. The water forms a one-turn conductor that couples the toroids electrically.

If an audio oscillator is connected to a winding on toroid #1, as shown in Fig. 4, current flows through the sea-water loop. The amount of current flow in this loop, as well as the voltage induced in the winding of toroid #2, is proportional to the conductivity of the water. The voltmeter connected to the winding of toroid #2 can be calibrated to read conductivity.

It is important that the area and length of the tube of sea water that couples the toroids together remain constant. One of the design problems is to prevent the high pressure encountered in deep water from distorting the probe.

A more serious problem lies in the fact that the meter measures conductivity and not the desired salinity. The computation of salinity from conductivity requires a very accurate knowledge of water temperature, on the order of 0.02° C. It is difficult to measure temperature to this accuracy in the ocean.

However, the striking advantage of the continuous readout provided by the induction conductivity meter, the availability of computers to perform the salinity calculation, and recent improvements in temperature-measurement techniques have brought this meter into wide use.

Acoustic Velocimeter

Water transmits sound more rapidly and with much less energy loss than air. Thus, sound is used extensively in the ocean for communication and navigation. Sonar, a tracking system using sound, replaces the radar used on land. Water depth is measured with sound pulses, and fishermen use these sonic pulses to find and track fish.

Sonar devices measure the time difference between the transmission of a sound pulse and its reception after reflection from an object. Distance can then be computed if the speed of sound in sea water is known.

The speed of sound in the ocean is about 5000 ft/sec but is by no means constant. It changes with water temperature, pressure, and salinity, and tables are available that give the speed of sound in terms of these variables. An electronic instrument, the acoustic velocimeter, measures sound speed directly with high accuracy.

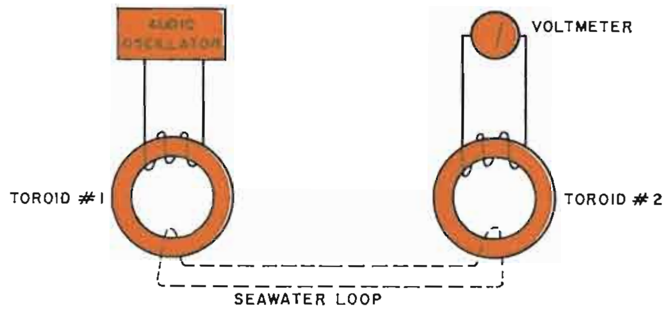
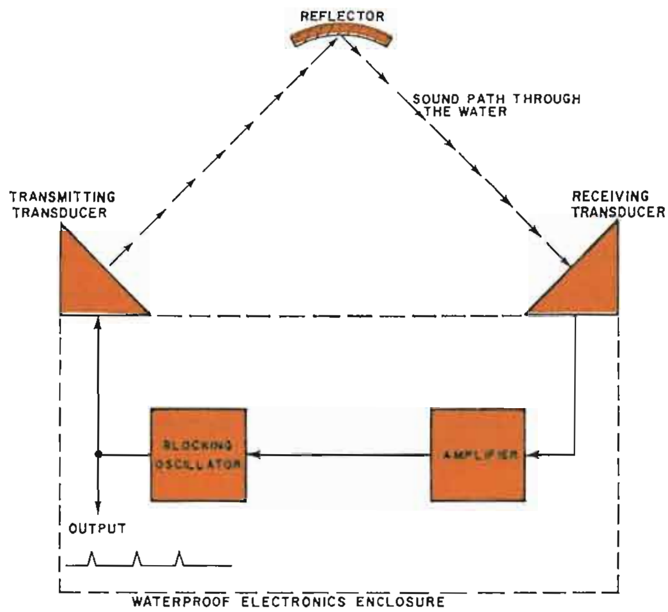


Fig. 4. Electrical operation of the induction conductivity meter. Sea-water conductivity determines induced voltage.

The famous "sing-around" circuit is most often used in

Fig. 5. Block diagram of sing-around acoustic velocimeter.



commercial velocimeters. The circuit was developed at the National Bureau of Standards and is shown in block diagram form in Fig. 5.

A pulse from the blocking oscillator shock-excites the transmitting transducer and the sound pulse thus generated is transmitted through the water to the receiving transducer. Its output signal is amplified and used to trigger the blocking oscillator which then emits another pulse. This sing-around process continues and the blocking oscillator output is a continuous series of pulses. Pulse spacing is determined by the time required for the acoustic pulse to travel through the water.

The length of the water path is held constant by careful mechanical design. The time required for the electrical pulses to go through the amplifier and blocking oscillator is small and constant. Thus, the repetition rate or frequency of the blocking oscillator is a direct measure of the speed of sound in water.

Instruments using this principle achieve accuracies of better than one part in 10,000.

Wave Staff

Measurement of wave and tide height is usually confined to shoreline or shallow water areas where a fixed mounting platform is available. As is common in many geophysical measurements, a 1-Hz wave is of "high frequency." Waves of tidal period, 0.0001 Hz and lower, are of particular interest, and meaningful measurements of such waves are quite difficult to make from floating platforms.

The low frequency of waves has made designers favor mechanical rather than electrical filters. A good example of this is the tide gage shown in Fig. 6 (left). The water level is measured in a pipe which is connected to the surrounding ocean water by small holes below the water level. They act as a low-pass filter to remove high-frequency ripples, and the float sees only low-frequency tides.

As the float moves up and down, a scriber moves with it to mark the chart paper. A clock mechanism advances the chart paper to provide a time record of tide height.

The electronic wave staff has recently come into prominence to measure higher frequency waves, and it can also be used for tidal measurements.

The basic sensor is shown in Fig. 7. A long plastic tube or rod is wrapped with a spiral winding of resistance wire; total resistance is several hundred ohms. When partially immersed in conductive sea water, the portion of the winding below the water level is shorted. Thus, the wave staff is a variable resistor with resistance inversely proportional to wave height.

The response of the wave staff is on the order of 10 Hz and its accuracy is better than 1% of full scale.

Since the wire of the staff is in contact with sea water, it cannot be operated with d.c. because electrolytic action starts and a polarizing voltage appears at the junction of the wire and the water that prevents meaningful measurements.

A typical design using a.c. excitation is shown in Fig. 8. An audio oscillator drives the staff through a constant-current regulator, and the wave-staff voltage is directly proportional to its resistance. A rectifier and filter then produce a d.c. voltage that is a function of wave height.

Telemetering Buoy

The telemetering buoy uses electronic instrumentation and radio transmission to allow long-term data to be collected from a single location in the ocean.

Most oceanographic measurements are taken from shipboard but it is quite expensive to hold a ship on location for extended periods of time. Therefore, recording buoys are often used. The data, recorded on film or magnetic tape, is retrieved at intervals by (*Continued on page* 75)

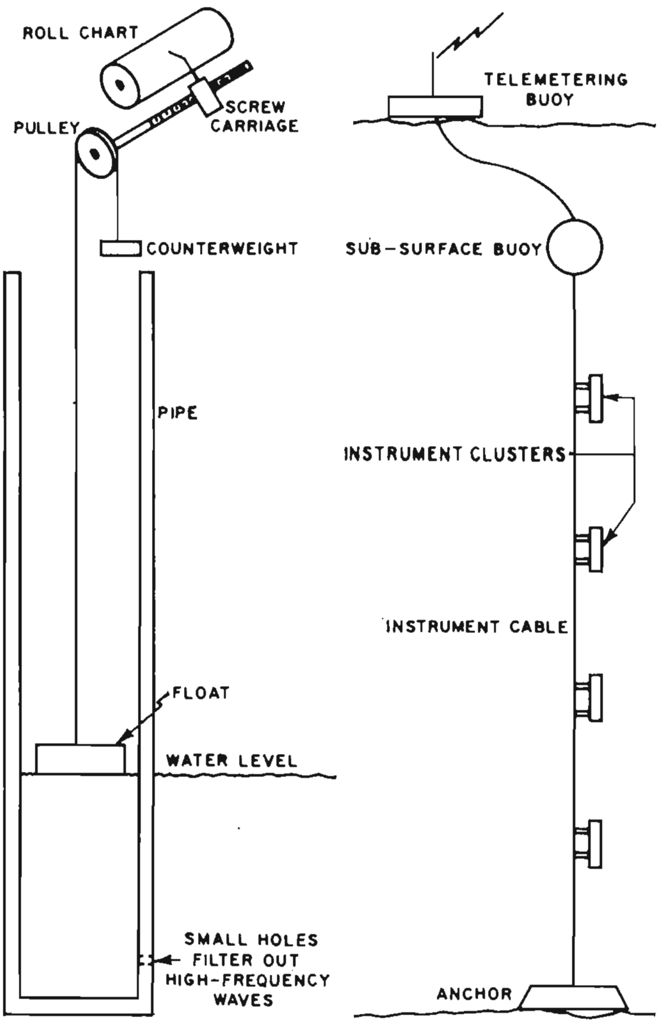


Fig. 6. (Left) The tide gage is a mechanical instrument. (Right) The telemetry buoy stores the data on a film or magnetic tape for later retrieval by surface vessel.

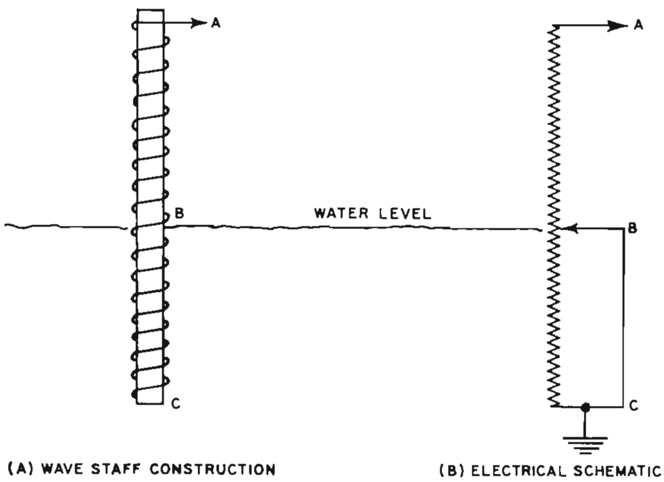
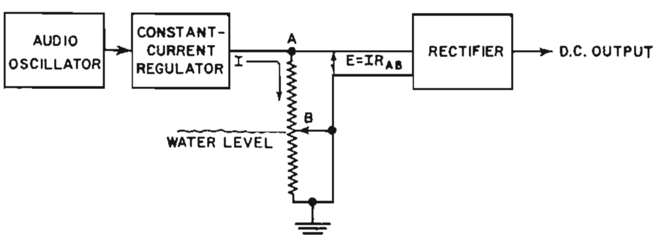


Fig. 7. A wave staff is a water-controlled potentiometer.

Fig. 8. The electronic wave staff uses a.c. to prevent electrolytic action that renders the device unworkable.



DIGITAL PLOTTING TECHNIQUES

By LOUIS E. FRENZEL, Jr.

Curves, charts, maps, drawings, and other displays can be generated as analog plots of digital data from computers. Plotters are employed in weather forecasting, for geophysical and petroleum surveys, to display business financial data, in roadbuilding, and for automatic drafting.

Fig. 1. (Left) A typical eight-channel strip-chart recorder and (right) X-Y plotter.

THERE are many different types of peripheral devices available for today's modern digital computer. These devices perform two basic functions—auxiliary storage and display. Computer data may be stored on punched cards, paper tape, or magnetic tape; and in many large systems magnetic drums or discs are used. Other peripheral units display or read out computer data. The most common displays are the I/O typewriter, the high-speed line printer, and the CRT. Another very useful but perhaps less well-known display device is the *digital plotter*. This is a device which accepts digital data either directly from the computer on-line or off-line from any one of the three most common auxiliary storage devices mentioned above and generates an analog plot of the digital data. An almost infinite variety of displays can be generated from the digital data. Maps, charts, curves, mathematical functions, and drawings of any kind are a few such possibilities.

Why Plot Digital Data?

Today's high-speed digital computers can generate volumes of data in an extremely short period of time. This data is most often read out by feeding it to a line printer or the I/O typewriter. The line printer displays the data in tabular form, which may or may not be the handiest form for easy assimilation. Usually it is not too convenient in this form and to get a picture, graph, or other visual representation of the digital data, one must manually plot the tabular values. This can be time-consuming, especially if there is a lot of data to be processed and analyzed.

Here is where a digital plotter really comes in handy. The plotter will automatically draw the desired curve, chart, map, or other visual display, thus eliminating the need for personnel to do a manual plotting job. It saves a tremendous amount of time and provides a meaningful graphic display for immediate evaluation or approval.

In short, a digital plotter expedites the analysis of computer output results. Some data is meant to be presented in tabular or list form; other data is not. It may not always be obvious to an observer what the tabular line printer readout actually represents. For example, the printout may be the solution to a second-order differential equation which resulted from the simulation of some physical system on the computer. Just looking at a list of numbers will not indicate what the numbers represent, but if a plot of the data is made, the observer might readily recognize the amplitude *vs* time curve obtained as the solution to the differential equation.

Analog Plotters

Whenever one thinks of a display device that generates an analog plot, he usually assumes that an analog signal is driving it from an analog computer, a data-acquisition system, or some other analog source. While it is true that systems and devices which generate or process analog data use analog displays, there is no reason why digital data cannot be converted into analog form for display purposes. And that is exactly what happens in a digital plotter. The digital data is converted to analog form and displayed on an analog plotter.

There are two basic kinds of analog plotters—those that plot data as a function of time and those that can plot data either as a function of time or of another variable. Strip-chart recorders and recording oscillographs are examples of the first kind while the well-known X-Y plotter of analog computer fame is an example of the latter. The X-Y

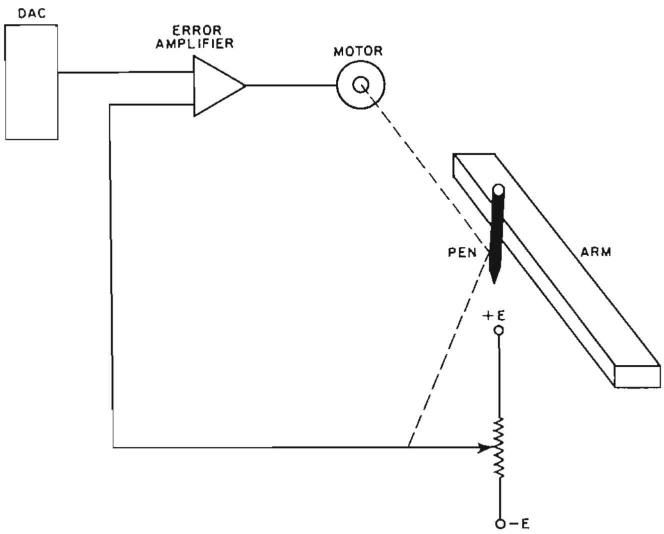


Fig. 2. Simplified block diagram of analog plotting pen servo.

plotter is the most versatile since it can display a signal with respect to time or as a function of another signal. Of course, the strip-chart-type recorders have the advantage of being able to display data over a longer period of time.

Fig. 1 shows both types of analog plotter, the eight-channel strip-chart recorder (left) and the X-Y plotter (right). Digital plotters can use either type of analog display, but the X-Y plotter is the most popular and is the kind which will be discussed here.

The general-purpose X-Y plotter in Fig. 1 contains two complete, independent, and accurate servo-positioning systems. One of these servo systems positions the movable vertical arm above the plotting surface in the left/right or X direction. The other servo system positions the plotting pen on the moving vertical arm in the up/down or Y direction.

How the Digital Plotter Works

A simplified block diagram of one servo system in an X-Y plotter is shown in Fig. 2. It works like any other servo system. The two signals to be plotted are applied to the error-detector amplifier inputs where the error signals thus generated are amplified and used to drive the motors that position the vertical arm and the pen. The arm and the pen move in an attempt to reduce the error to zero and at the same time plot a curve that is a composite of the two inputs that are employed.

Fig. 3. A digital plotting system with magnetic tape input unit.

A typical digital plotting system with its magnetic tape input unit is shown in Fig. 3. The plotter consists of a standard analog X-Y plotter, a digital-to-analog converter (DAC), and the appropriate control circuits. Fig. 4 is a simplified block diagram of a digital plotting system. As can be seen, the plotter may receive off-line inputs from several sources: its built-in programming keyboard, magnetic tape, punched paper tape, or punched cards. On-line it receives its input directly from a digital computer. Off-line use is preferred since the plotter is slow.

The digital input data is converted into analog voltages by the DAC. These voltages are fed to the X-Y plotter as X and Y coordinate values where they position the plotting arm and pen on the plotting surface in order to produce the composite curve.

Another type of digital plotter uses incremental step motors and digital servo systems instead of conventional electrical motors and continuously variable analog servos. One of the digital servos and stepping motors moves the plotting pen while the other moves the paper. Instead of a fixed sheet of paper and a movable arm, a fixed arm with a movable pen is used to plot on graph paper that is moved by means of rollers. The advantage of this particular type of digital plotter is that its accuracy is not dependent on the voltage stability of analog circuits in systems that use digital-to-analog conversion. However, such a system using step motors cannot plot a true straight diagonal line since it can only move in steps. But since the steps are very small, usually a hundredth or several thousandths of an inch, and because the plotting pen is not infinitely fine, a very satisfactory diagonal line can be plotted with this particular system.

Most plotters operate in one of two modes—point plot or line plot. In the point-plot mode the plotter is fed one set of X-Y coordinates. When the arm and pen are properly positioned, the pen is lowered and a point is made. The pen is then raised and the plotter is given a new set of X-Y coordinates. The procedure is repeated until the desired plot is obtained. In the line-plot mode, the plotter is given a starting set of X-Y coordinates. When the position is reached, the pen is lowered. The plotter is then given another set of coordinates. The pen remains lowered and it draws a straight line between the starting point and the next point. New coordinate sets are sequentially fed to the plotter and the pen will trace a line between the points, forming the desired plot. Fig. 5 shows a curve plotted in the line-plot (top) and point-plot (center) modes.

The digital data to be plotted should be stored in the computer or on tape so that it can be given to the plotter sequentially in the form of X and Y coordinate values. This calls for some attention to output programming techniques in the computer. The techniques are certainly not difficult and most digital plotters are supplied with a complete software package.

Many digital plotters also contain a symbol printer usually mounted with or adjacent to the plotting pen on the movable X-coordinate arm. The printer is positioned along with the pen by Y-coordinate selection. The printer consists of a turret of solenoid-operated printed hammers that can print the alphabet, numbers, or special symbols; an automatic take-up ribbon; and the appropriate selection circuitry. The printer is convenient for labeling the pen plots and it saves time by eliminating the need for the plotter to do the lettering in the more time-consuming line-plot mode. The symbol printer can also be used like the pen in the point-plot mode to produce curves or drawings like that shown in Fig. 5 (bottom).

Digital Plotter Applications

As might be expected, the digital plotter is extremely useful and its application as a display device is almost limitless. Wherever digital data is to be displayed in analog form, a plotter can be used, and it will save time and reduce the amount of work required while doing the job. Consider some of these applications.

Fig. 6 shows an isobar-type weather map produced by a digital plotter. The contours were plotted from digital data generated by a digital computer. The computer was programmed to predict weather conditions from given information such as present conditions, past predictions, and other factors. Before the introduction of the plotter, it took several hours to plot one of these maps by hand. Now the plotter does it in a few minutes. Plotters are used extensively in weather prediction and meteorological research.

Plotters are also used quite extensively in the geophysical and petroleum industries, especially where research and oil exploration are concerned. The search for new oil deposits involves the collection of data about the earth's subsurface and then an analysis of this data to determine the exact location and extent of the possible deposit. Digital computers are now widely used to process and analyze the data collected, and digital plotters provide an excellent means of displaying the results of this analysis. Plotters are used to display seismic reflection and refraction traces, isopachous contour maps resulting from well log data and magnetic or gravity measurements, and other similar plots generated by the computer to which the plotter is connected. Fig. 9 shows a typical, large-scale plotter reproducing a geophysical contour map. Here the big advantage of the computer/plotter combination is that it saves a tremendous amount of time in the processing and analysis of the great volumes of geophysical data available.

Business and industry use plotters to display graphs that result from the processing of financial and statistical data. Many companies use computers to keep track of financial and economic conditions and to predict such things as possible sales, profits, losses, inventory, and production. A digital computer would present such information in tabular form, while the plotter will generate an analog curve or graph of, say, profit *vs* time in months. This quick, automatic reduction of a mass of business data enables those concerned to see significant trends and to make rapid appraisal of complex situations.

The civil engineering field makes good use of digital plotters in surveying and in road planning. After a road site has been surveyed, the data obtained is given to a computer for processing. A plotter then makes a complete drawing of the proposed roadway. Cross-sections of the highway at a number of points along its length are also planned on the computer and displayed on the plotter. The planning of new roads, highways, and city subdivisions is done with the help of a computer and the results of such planning can be quickly and accurately displayed.

Clothing manufacturers use computer/plotter systems for automatic pattern grading. The pattern for an item of apparel is copied or "digitalized" by a plotting device and the resulting digital data is stored and fed to a computer. The computer makes calculations and corrections and new results are plotted. The plotter will reproduce a complete run of the original pattern in all the various sizes needed. Automating this process saves time and money for the manufacturer and provides a better fitting item of apparel for the customer.

All of these applications demonstrate not only the usefulness of the digital plotter, but also the versatility of a digital computer when connected to an appropriate peripheral device such as a plotter.

Automatic Drafting

One of the most fascinating applications of electronic plotting equipment is automatic drafting. Drafting is an essential part of any engineering operation since all types of drawings, diagrams, schematics, graphs, and charts are used in designing and producing any component, device,

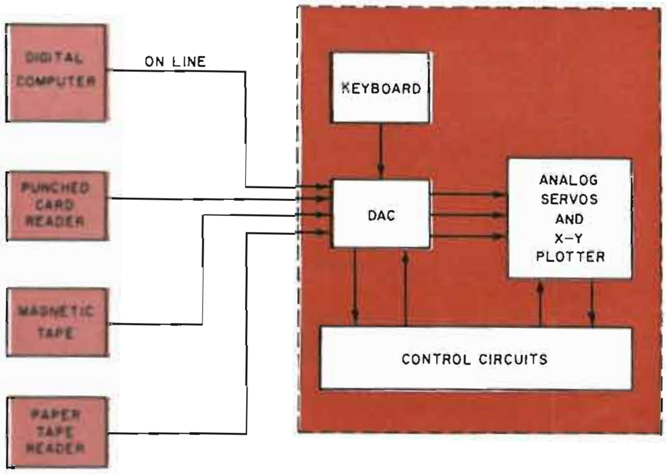


Fig. 4. A simplified block diagram of a digital plotting system.

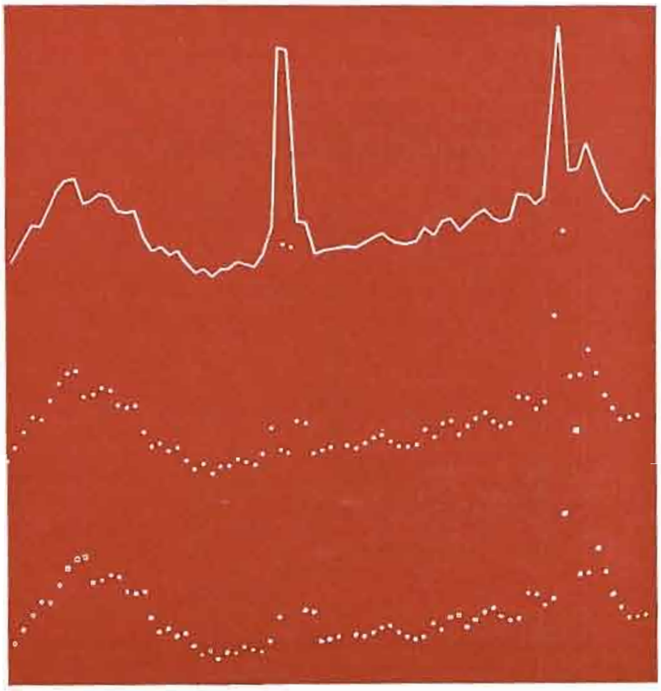


Fig. 5. (Top) Line, (center) point, (bottom) symbol plots.

Fig. 6. Isobar weather map produced by a digital plotter.

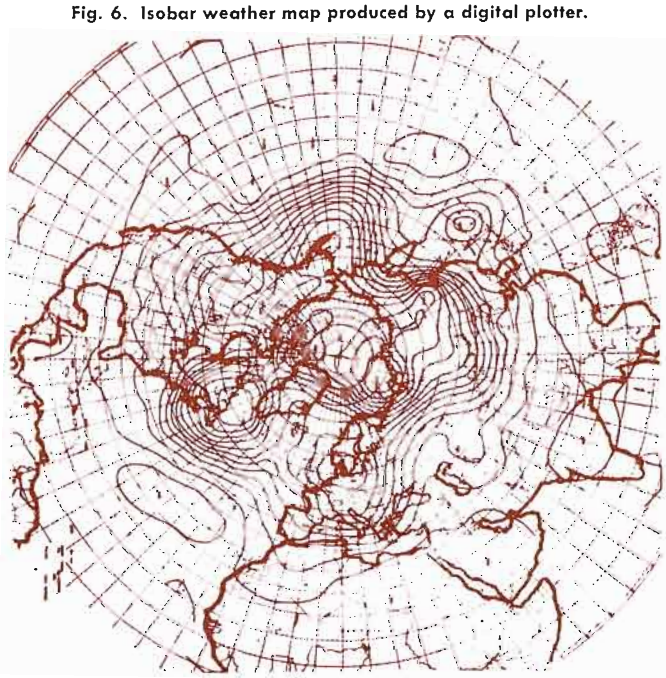


Fig. 7. An automatic drafting machine along with an IBM card punch that is employed to "digitize" drawings.

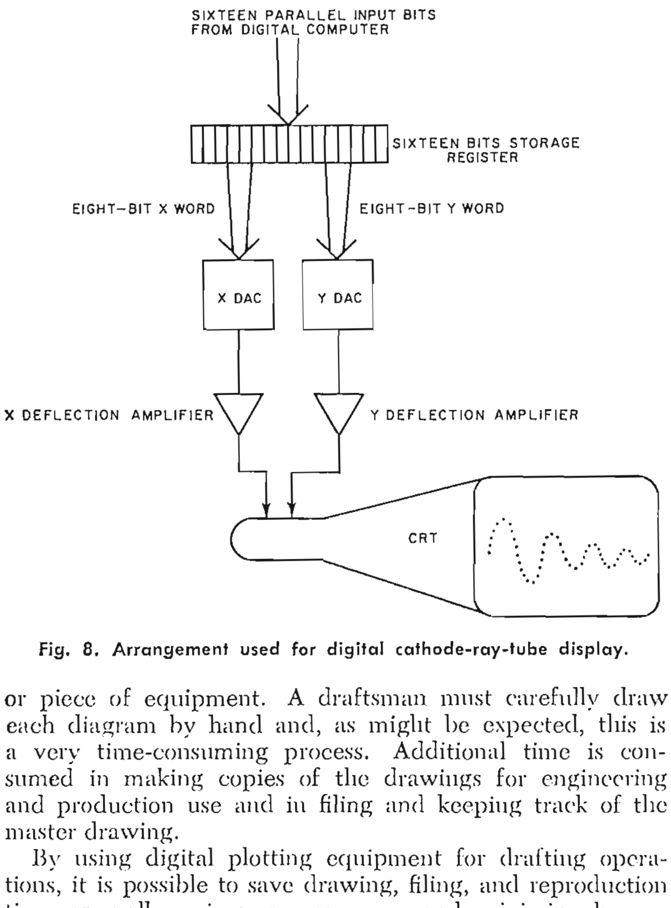


Fig. 8. Arrangement used for digital cathode-ray-tube display.

or piece of equipment. A draftsman must carefully draw each diagram by hand and, as might be expected, this is a very time-consuming process. Additional time is consumed in making copies of the drawings for engineering and production use and in filing and keeping track of the master drawing.

By using digital plotting equipment for drafting operations, it is possible to save drawing, filing, and reproduction time as well as improve accuracy and minimize human error. For example, consider the system shown in Fig. 7. With this system any drawing can be "digitalized" and stored on punched cards or paper tape. To reproduce this drawing, the cards or tape can be read by a card or tape reader feeding a plotter. The drawing will be reproduced by the digital plotter. If desired, cards may be read by a reader and the binary data output of the reader can be recorded on magnetic tape. In this way, many drawings can be stored on a reel of magnetic tape. This type of storage reduces the size of a drawing file substantially and permits rapid location and reproduction of a desired drawing.

Fig. 9. Digital plotter generating geophysical contour map.

By adding a small computer to the automatic drawing equipment many interesting and useful operations can be performed. Consider some of these examples.

1. A master computer program could allow the automatic location and reproduction of any drawing in storage (on magnetic tape). An operator would enter the number of the desired drawing with the computer's input typewriter and immediately the computer would search its memory and output the drawing to the plotter.

2. The computer would allow drawing modifications to be made without actually going back to the original handmade master drawing. Changes in program or data word format would generate the modification.

3. Special computer programs can be used to change a simple front-, side-, and top-view drawing into an orthographic projection or other type of 3-D presentation. This particular operation is really a drafting time saver and in most cases it can be done by a digital plotter with special analog computer circuitry. Of course, a digital computer could be used, but it is not a necessity. In the same way, an orthographic or other 3-D-type presentation can be reduced to a simple top view. A very useful application of this technique is in making top-view maps directly from aerial photographs. By knowing the angle from which the photograph was taken and the altitude and by correcting for factors such as the curvature of the earth and camera focal length, an accurate top-view map can be made of the area photographed.

4. A computer-plotter system can be used to simplify, speed up, and optimize design. For example, when designing digital logic circuitry, it is possible to feed into the digital computer a set of Boolean algebraic equations describing the desired operations and then have the computer generate a complete, but minimized, logic diagram. The logic diagram using standard *and/or* or *nand/nor* gates, flip-flops, and other digital circuit symbols properly interconnected will be reproduced by the digital plotter while connected on-line to the computer. The computer/plotter combination can be used to generate a plot of any mathematical expression which can be stored in (*Continued on page* 67)

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Featuring Tests Never Before Available Outside Of The Laboratory

Why We Make the Model 211 Available Now

Although there are many stereo test records on the market today, most critical checks on existing test records have to be made with expensive test equipment.

Realizing this. HiFi/STEREO REVIEW decided to produce a record that allows you to check your stereo rig, accurately and completely, **just by listening!** A record that would be precise enough for technicians to use in the laboratory—and versatile enough for you to use in your home.

The result: the HiFi/STEREO REVIEW Model 211 Stereo Test Record!

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Warble tones used are recorded to the same level within ± 1 db from 40 to 20,000 cps, and within ± 3 db to 20 cps. For the first time you can measure the frequency response of a system without an anechoic chamber. The frequency limits of each warble are within 5% accuracy.

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All Tests Can Be Made By Ear

HiFi/STEREO REVIEW's Model 211 Stereo Test Record will give you immediate answers to all of the questions you have about your stereo system. It's the **most complete test record** of its kind—contains the widest range of check-points ever included on **one** test disc! And you need no expensive test equipment. **All checks can be made by ear!**

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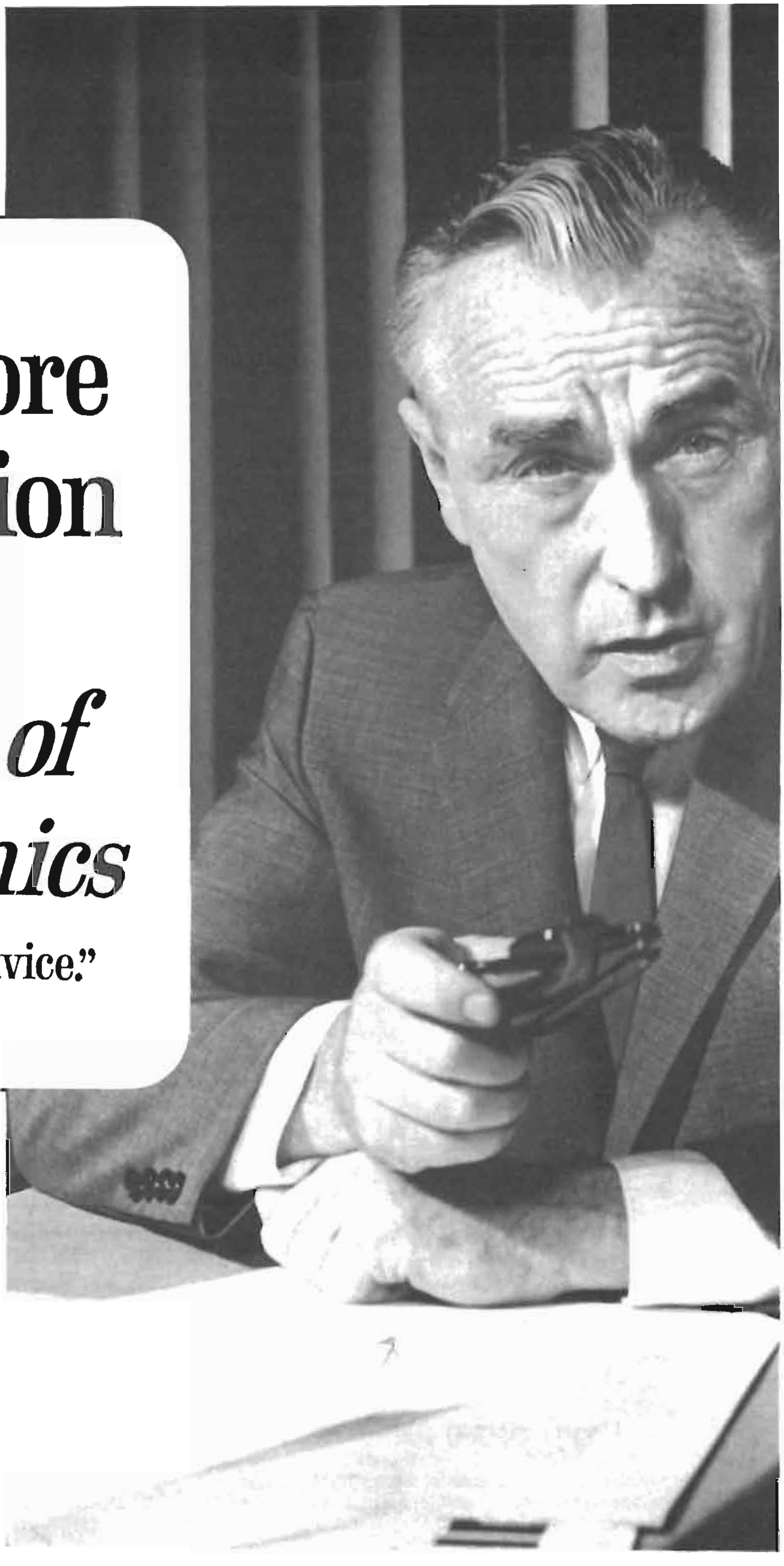

JOHN FRYE

While the newest solid-state transceivers contain highly sophisticated circuitry, IC's promise still more advances.

CB AND INTEGRATED CIRCUITS

BARNEY stood peering out the window of Mac's Service Shop as he listened to the sleet scratching against the plate glass and watched the freezing rain fattening the drooping light wires. "You know, Mac," he called over his shoulder to his employer in the service department, "this weather is almost bad enough to bring on an urge to put up a TV, ham, or CB antenna."

Mac nodded in appreciation. "Why is it most antenna work seems to be done when the weather is worst?" he asked.

"Probably because that's when most of the operating, and consequently most of the thinking about the signal, is done," Barney suggested. "When the weather is nice, we're all picnicking, swimming, going on vacation, and otherwise swinging with the weather. On a day like this, though, about all a ham or CB operator wants to do is tickle the ether waves, and then his fancy lightly turns to thoughts of a new antenna or changing the old one.

"Speaking of the Citizens Band, last night I was at the house of a friend inspecting a posh new solid-state transceiver he had bought, and I continue to be amazed at how sophisticated CB equipment has become in such a short time. This transceiver happened to be a *Lafayette* HB-600, but it is representative of several other new transceivers, both of Japanese and American manufacture, that represent what I would call a 'third generation' of solid-state CB transceivers."

"Why do you say that?"

"Well, the first generation of transistorized transceivers *did* use transistors and *would* receive and transmit after a fashion, but that is about all you could say for them. The receiving portion was temperature-sensitive and drifted badly, while the transmitting-section output did not compare with a tube job. The second generation overcame most of these faults through the use of silicon transistors, zener diodes, and improved circuits. While they may have been a little lacking in ability to handle strong signals without overloading, and they did not always produce high-level linear modulation, their compactness and freedom from tube troubles made up for this. They began giving tube transceivers a real run for their money, especially in mobile installations, where their low current drain was an added advantage.

"But now comes the third generation of solid-state transceivers containing really sophisticated circuitry and prepared to challenge tube transceivers on just about any ground you can mention. Transistorized CB transceivers can crowd a lot of circuitry into a very small space, and this permits them to add multi-stage circuitry without increasing substantially either bulk or weight. The noise-silencer circuit in that HB-600 is a good example. It employs five stages; yet the whole circuit occupies little more space than would a single tube."

"How does it work?"

"Actually, the receiver has both a noise-limiter and a noise-silencer circuit, together with a switch that permits cutting both out, using only the limiter, or throwing both limiter and silencer into operation. The limiter is the conventional automatic type employing diodes that limits the amplitude of noise spikes to a level only a trifle higher than the modulated carrier level. It's effective in reducing noise pulses that greatly exceed the signal level, but it's not so effective on noise just about equal to the signal. The noise silencer does an excellent job on rapid pulses of very short duration, such as an ignition system puts out, because it actually silences the receiver for the duration of each narrow pulse."

"You still haven't told me how it works," Mac persisted.

"Keep your cool. I'm coming to that. Ignition noise covers a wide spectrum; so an input circuit tuned to 25 MHz, just below the CB band, picks off the antenna the identical noise—but without any signal—that is being fed into the receiver. This noise is amplified by two 25-MHz r.f. stages with not too high a '*Q*' because passing noise pulses through highly selective circuits tends to widen the pulses. Then the diode detector changes the a.c. pulse waveforms into d.c. pulse voltages. Finally, these pulses are fed through two noise pulse amplifier stages that shape and amplify them, and then they are put into a balanced second mixer that converts the second i.f. of 6.2 MHz to 455 kHz for introduction into the mechanical filter. This rather unusual mixer stage is so arranged that a negative-going pulse from the final pulse amplifier temporarily back-biases the two diodes used in the mixer and causes it to present a very high resistance to the passage of the signal. That's why it's called a second mixer *and* noise gate. The end effect is that the signal path through the receiver is interrupted at the precise instant each noise pulse is trying to pass. Since these interruptions are of 10 microseconds or less duration, the 'holes' punched out of the signal are hardly noticed."

"Hey, that's clever," Mac applauded. "You virtually make the noise pulses cut their own throats. But is this something new?"

"No, not really," Barney admitted. "The basic idea was introduced to amateur radio in an article by James Lamb in *QST* thirty years ago. Some of the more expensive ham receivers have it or offer it as an option. What impresses me, though, is how simply it is added to this solid-state receiver and the apparently little effect it has on the overall price. One of the 'high-priced-spread' amateur transceivers offers the noise silencer as an option but at a cost more than half as much as the whole CB transceiver costs."

"How does the noise silencer work on static crashes?"

"It doesn't. Neither is it any good on a steady grinding noise such as that put out by neon lights. Noise pulses must be sharp and narrow, lasting no more than 10 microseconds, for the silencer to deal with them; but it certainly does a job on ignition interference. Before I forget it, that CB transceiver has another interesting feature. It uses a single crystal for both receiving and transmitting on a given channel. Since it provides crystal-controlled reception and transmission on all 23 channels, this makes quite a saving on crystals."

"Go on. This is your day to lecture. Tell me how they do it."

"It's really quite simple. Take an example of receiving channel 1 on 26.965 MHz. The receive crystal is on 33.165 so that the difference first i.f. frequency of 6.2 MHz is produced in the first mixer. This frequency is combined in the second mixer with a 5.745-MHz frequency from a crystal oscillator to produce the 455-kHz frequency accepted by the mechanical filter. And, incidentally, this 5.745-MHz crystal is flanked by two others, 2.5 kHz on either side, so that any one of the three can be selected with a three-position switch to provide 'delta tuning' for picking up stations a little higher or lower than the precise channel frequency. This is a good idea because the mechanical filter has a steep-sided response and rejects signals very far off its center frequency."

"How do you get a 26.965-MHz channel-1 transmit frequency out of that 33.165-MHz receive crystal?"

"By mixing the output of the receive crystal with a 6.2-MHz frequency from a crystal oscillator and feeding the difference frequency of 26.965 MHz from the mixer through a passband filter accepting all frequencies from channel 1 through channel 23 into a first transmitter r.f. amplifier. In the same way, a single crystal will do double-duty on any one of the remaining twenty-two channels. See, I told you it was simple."

"I see that some of the manufacturers are coming out with SSB CB transceivers," Mac noted. "Have you had a chance to inspect any of those?"

"Not yet, but I'd like to. My ham station has been SSB for several years, and I know how effective it is there; but I have never even heard a sideband signal on the Citizens Band."

"Wouldn't do you much good if you did. You couldn't copy it on that AM transceiver of yours with no product detector or even a b.f.o. to reinsert the suppressed carrier."

"Oh come *on!* Give me credit for a little resourcefulness. I'll simply use a signal generator to reinsert the carrier right at the antenna. This makes for ticklish signal-generating tuning at 27 MHz, but it can be done."

Mac began rummaging around in a drawer as he answered.

"I've a notion 'you ain't seen nothin' yet' in miniaturized and sophisticated CB equipment. Integrated circuits and CB gear should go together like a folk singer and a guitar. Last night, when you looked inside that transceiver, you saw mostly transistors, diodes, resistors, and capacitors. Well, an integrated circuit can easily produce more than 80 of these components on a silicon chip no larger than one-twentieth of an inch square. Last year more than 35 million IC's were produced; and when you consider that Jack Kirby of *Texas Instruments* developed the first one in the summer of 1958 and that they did not become generally available until four years ago, that's really something."

"I know IC's save space and weight, but in lots of electronic equipment these things are not very important. Why are they so popular?"

"Because they have lots more going for them: things like reliability, low cost, and speed of operation. Remember, electric current travels about a foot in a billionth of a second; so when we get into microwaves or really high-speed computers, lead lengths connecting components together act like unwanted delay lines. In IC's these lengths are only a tiny fraction of an inch long; so IC's are a natural in high-speed or high-frequency service."

"I've read lots of magazine articles on IC's, but most of these stories are apparently aimed at the guy who intends to make, not use, integrated circuits," Barney complained. "Manufacturing details were interesting the *first* time I read them, but what I want now is dope on what IC's can and can't do, equipment to which they are best adapted, and instructions on how to handle, install, and test them."

"Right here you are," Mac said, tossing a booklet from the drawer to the youth. "That's 'Integrated Circuit Projects from Motorola,' a part of their HEP (Hobbyists and Experimenters Projects) program. It contains a good glossary of the most common terms used in IC work; advice on handling the devices; a short resumé of binary computer math; and detailed instructions on how to use *Motorola* IC's to build a binary computer, an organ, a square-wave generator, a code practice oscillator, a glidetone, and an electronic string guitar. It's the quickest way I know for a person to become familiar with integrated circuits. And to back it up," he continued, tossing over another book as thick as a *Montgomery Ward* catalogue, "here's a copy of *Motorola's* 'The Semiconductor Data Book.' You'll find exhaustive data on everything from zener diodes and a full range of transistors to integrated circuits. It goes up there on the shelf beside our *RCA* and *G-E* semiconductor manuals. I'm certainly delighted to see some of the really large manufacturers putting out material of this sort."

"Okay," Barney said with a sigh of resignation. "With outfits like *Motorola, Texas Instruments, Westinghouse, Fairchild, RCA,* and *G-E* all burning the midnight oil to make better IC's and find new applications for them, I'd better take these books home and get a little HEP on them myself!" ▲

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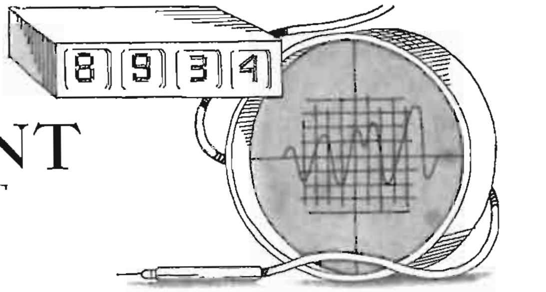

Fairlane Electronics Model LBO-5SA Oscilloscope

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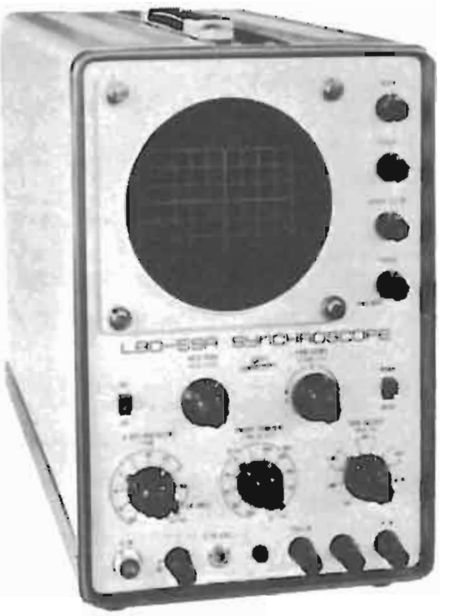


THE *Fairlane Electronics* Model LBO-5SA oscilloscope provides capabilities usually associated with far more sophisticated and more expensive devices with features such as a calibrated and triggered sweep and a rise time of 80 nanoseconds. The a.c. input has sensitivities down to 10 mV p-p/cm. Frequency response is d.c. to 5 MHz.

The instrument may be used to measure d.c. voltages as well as rise time, pulse width, and decay time of voltage or current pulses using the calibrated and triggered sweep. In addition, the scope may be employed for applications utilizing the free-running sweep.

The sweep generator is controlled by a triggering signal which is derived from the input signal as it passes through the vertical-channel amplifier. There are two modes of operation, "Normal" (triggered) and "Automatic" (free-running), depending upon the switch selection. By proper choice of the point on the slope of the waveform, the sweep generator starts the sweep and continues it as long as the input is applied.

The input circuit consists of an eleven-position attenuator composed of resistance-capacitance networks for full frequency compensation. The input probe is simply a 9-megohm resistor shunted by a compensating capacitor.

The vertical amplifier is push-pull and is direct-coupled with three stages. D.c. balance is accomplished by a front-panel adjustment. The frequency response is extended to 5 MHz with peaking coils in the plate circuits of the second and final stages.

The trigger circuit has a three-position switch which can select an input from either the vertical amplifier, the 60-Hz line, or an external source. After amplification and phase conversion, the signal goes to a Schmitt trigger where it is shaped into a rectangular waveform. This waveform is then integrated and fed to a sweep-gating multivibrator which acts as a switch for the time-base generator.

Pulses in the negative direction cut off the disconnect diodes so that the Miller run-up circuit will operate. The positive pulses from the sweep-gating multivibrator act to unblank the CRT.

The Miller run-up circuit consists of the run-up tube, a neon lamp, the disconnect diodes, and associated resistors. The circuit is designed so that the charging current for the timing capacitor through the timing resistor is constant. Thus, the voltage at the cathode of the run-up tube will rise linearly and is used for the sweep. The sweep speed is determined by selection of the appropriate resistance-capacitance combinations by the "Sweep Time/Cm" switch. The "Fine" control is used to vary the sweep speeds between the calibrated steps. The length of the sweep is set by adjusting the voltage which starts the sweep-gating MV.

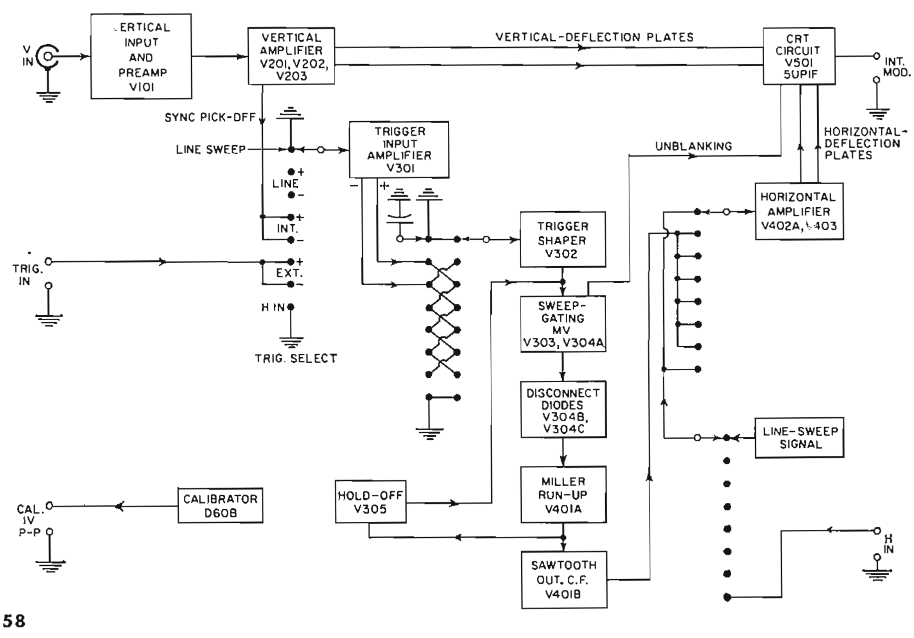
The return trace is blanked by preventing the time-base circuit from being triggered by the hold-off circuit. This is done by keeping the grid at the input of the sweep-gating multivibrator at a high potential, preventing it from being triggered. The time for the hold-off is controlled by the timing capacitor.

In order to maintain control of the triggered operation, the "Stability" control is adjusted so that the sweep-gating multivibrator is prevented from free-running. When this control is set clockwise, the sweep-gating multivibrator will be in a free state, which is similar to the operation of a conventional scope.

The horizontal amplifier produces the deflection of the CRT spot in the horizontal direction and consists of an input cathode follower and push-pull output stage. The sweep magnification switch for "Mag X5" is used to increase the amplifier gain five times by cutting out the input voltage divider.

The one-volt p-p calibrating voltage is derived from a zener diode which is used for clipping the a.c. input.

Price of the oscilloscope is $299.95, and complete specs are available from the manufacturer. ▲



Semitronics Model 1000 Transistor Tester & Set Analyzer

For copy of manufacturer's brochure, circle No. 36 on Reader Service Card.

INCORPORATING eight analyzers in one unit, the new *Semitronics Corp.* Model 1000 transistor tester and set analyzer functions as a transistor tester, diode tester, voltmeter, ammeter, signal generator, in-circuit tester, battery

tester, and a.c. and d.c. *beta* tester. The unit has been designed to be a complete laboratory for the testing, maintenance, and repair of solid-state equipment. It can be used for checking power transistors, small-signal transistors, diodes, and rectifiers (both germanium and silicon) used in radio and television receivers, hi-fi stereo amplifiers, or any other solid-state equipment.

Since many problems in transistorized equipment arise as a result of weak or dead batteries, the tester can be used to check the battery in the receiver. This is done under actual load conditions with the tester functioning as a voltmeter and with the set under test in its "on" position.

With the instrument set in its current-reading position, current drain of solid-state equipment can be checked. Again, this is a "live" test, with the tester leads inserted in series with the battery leads of the equipment. The absence of current flow, insufficient current flow, or excessive current is a direct indication of a defective component or transistor.

The 1000 is also a harmonic signal generator. The fundamental frequency is 5000 Hz, but the signal is so rich in harmonics that it is usable for audio, i.f., and r.f. circuits. No dial setting is required. The signal output can be fed successively into the audio amplifier of a receiver, the i.f., and then the r.f. stages, thus providing an extremely rapid yet highly effective method of locating a defective stage and narrowing the search down to one or more components.

An additional advantage of this instrument is its use as an in-circuit transistor tester, especially for circuits in which transistor leads are soldered into position. The only precaution is to make certain that the transistor is not shunted by any component having a value of 150 ohms or less. In any event, it is much simpler to lift one lead of such a component, permitting the in-circuit test to be performed, than to attempt to remove (and possibly damage) the suspected transistor.

As a continuity tester, the device employs a basic circuit for checking opens and shorts for quick identification of a defective component.

The 1000 can be used for checking germanium diodes or rectifiers but silicon rectifiers can only be tested for shorts or opens. Additional checks for peak voltage and current ratings are necessary. The instrument can also determine whether a transistor is a *p-n-p* or *n-p-n* type. It can be used to test power transistors as well.

The unit comes equipped with non-detachable, insulated clip leads that form an integral part of the instrument. It is readily portable, utilizing a fold-back handle.

The Model 1000 is available for $34.95 completely wired and ready for use. ▲

Wahl Series HS-8 "Heat Spy" Electronic Thermometer

For copy of manufacturer's brochure, circle No. 152 on Reader Service Card.

SELECTIVE non-contact temperature measurement of small components can now be achieved with a completely portable, pistol-type thermometer—"Heat Spy" Series HS-8. The instrument measures the surface temperature of components as small as 0.1" in diameter and is available in four models covering 60 to 1000° F or the centigrade equivalents.

Used for measuring temperature-critical electronic and electrical components during assembly, "breadboarding," and actual use, "Heat Spy" detects temperature by measuring the infrared energy emitted from the surface of any stationary or moving object. The hand-held instrument is operated simply by aiming at the surface to be measured and pulling the trigger. Temperature is indicated on a large direct-reading meter above the pistol grip.

The center of the target area is defined by a light beam which assures accurate aim at the desired component. An emissivity calibration control allows compensation for measurement of various surfaces, making the unit an extremely versatile instrument for temperature detection during quality-control, processing, and research and development operations.

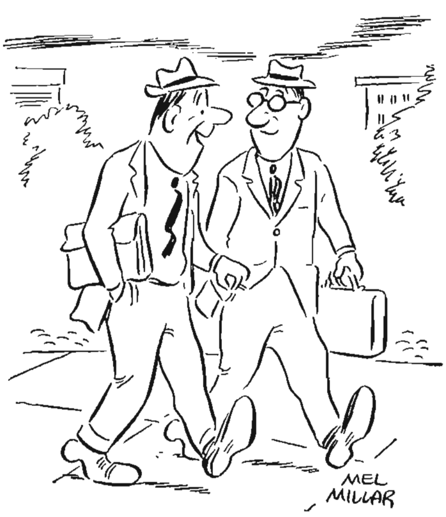
Infrared emissions (from 2 to 20 microns) are focused by the optics (parabolic mirror) of the instrument—after error effects of ambient light have been removed—onto an infrared heat-detecting element. The output is amplified by a battery-powered temperature-compensated solid-state circuit. The output of the amplifier drives the indicating meter.

The only moving parts in the unit are contained in the indicating meter, which is a taut-band meter (as opposed to pivot and jewel) designed to withstand the rugged use to which a portable instrument is subjected. The instrument has an external check switch and zero alignment controls which provide a simple and instantaneous check to assure proper functioning of batteries, meter, and circuitry. Power is provided by two standard mercury batteries which have a normal use life of six months and a shelf life of one year. A safety strap and convenient carrying holster are included with each instrument.

Series HS-8 will measure temperatures in surface spot sizes from 0.1" in diameter at a distance of ½" from the surface to 0.8" in diameter at a 4" distance. The instrument reads the infrared energy in a cone field of view, and the target area must fill this field of view to obtain accurate temperature measurement. Temperature measurement is made with an accuracy of ±2% full scale with a response time of two seconds.

An external emissivity adjustment is provided to allow the instrument to be used with just about any type of material. The recommended environmental operating temperature for the unit is from 60 to 110 degrees F.

Series HS-8 is available directly from the manufacturer at a price of $750. ▲



"I'm a coordinator . . . I have a desk between two expediters."

SILICON-CARBIDE LIGHT DIODE

These new light-generating diodes may create a much simplified, low-cost, 8-mm home movie sound system.

CONVENTIONAL sound-on-film modulation techniques use a source of the sound to be recorded, audio amplifiers, and a light source, usually generated in a relatively high-powered and expensive lamp, and focused through a series of complex lenses onto a narrow area of film adjacent to the frames.

As an alternative in home movies, some film manufacturers have been supplying a film having a magnetic stripe (similar to the magnetic tape commonly used in tape recorders), running down one edge. This requires a modified tape recorder to lay the audio down the magnetic stripe. However, this approach requires a special camera and projector, and is usually considerably higher in cost than similar, silent devices.

A third solution has now been offered by the *Norton Company*. They have developed a tiny (.03 x .03 x .015 inch, less than one thousandths of a cubic inch) silicon-carbide electroluminescent diode that emits a needle-thin beam of cold yellow light capable of being modulated at audio frequencies up to 6 kHz. The diode is capable of being battery operated. The system requires no lenses or optics and requires only the addition of a small solid-state amplifier and microphone to put into operation.

The electroluminescent effect is achieved by passing current through a *p-n* junction of silicon carbide (this is similar to the modulation techniques used with solid-state laser diodes). Both the light and efficiency of the diode are determined by carefully controlled amounts of impurities in the silicon-carbide material. The diamond-hard surface and high temperature stability of silicon carbide makes it into a durable device, and electronic components capable of operating at temperatures up to 500° C are possible.

In operation, the sound is amplified, and then impressed across the diode, which then produces flashes of light at the applied audio rate. Because it produces a very thin beam, and has very little physical volume, the diode can be mounted very close to the film, thus each flash of light is directly recorded on the film, without the use of intervening optics. ▲

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To speed you on your way to a successful electronics career, your "Career Program" will include a variety of RCA Institutes engineered kits at no extra cost—each complete in itself. As a bonus, you will also receive and build a valuable Oscilloscope. You'll get the new Programmed Electronics Breadboard for limitless experiments, including building a working signal generator and a fully transistorized superheterodyne AM receiver and Multimeter.

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To get a head start today on the electronics career of your choice, look over this list of RCA Institutes "Career Programs", pick the one that appeals most to you, and check it off on the attached card:

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- Telecommunications
- FCC License Preparation
- Automation Electronics
- Automatic Controls
- Digital Techniques
- Industrial Electronics
- Nuclear Instrumentation
- Solid State Electronics
- Electronics Drafting

To meet other specific needs, RCA Institutes also offers a wide variety of separate courses which may be taken separately from the "Career Programs". These range from Electronics Fundamentals to Computer Programming. They are described in the material you receive.

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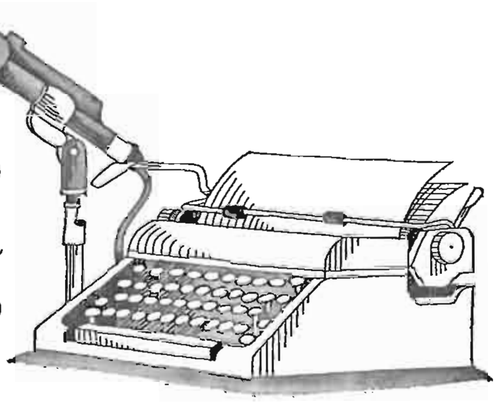
RADIO & TV NEWS



RADIO is still America's most popular entertainment medium. In fact, this country has 25% more radios than people—242 million radios compared to a population of 195 million. The average U.S. family has four radios in its possession.

Price has been a key element in making radios so common, with total sales reaching 34 million annually. A typical U.S.-made transistor set costs just 25% of what it did seven years ago and imports, which account for half of all radios sold in the U.S., have dropped to an average wholesale price of $5.95 with sets from Hong Kong wholesaling at an average price of $2.57.

In the first nine months of 1966, Hong Kong sent 5,500,000 sets to the U.S. while Japanese imports for the same period added up to 9,600,000.

Americans are far ahead of the rest of the world in the use of radios. Compared to more than one set per person in the U.S., there is only one set per three people in Western Europe, one for every six in Russia, and one for every 40 in southeast Asia.

The Long Flight

Mariner IV, launched more than two years ago, has flown more than one billion miles in space and continues to operate properly, reporting its condition to Earth stations three times each week.

Information from the spacecraft indicates that its attitude control system has a nitrogen gas supply capable of keeping it stabilized for more than another year, and that all system voltages and temperatures are as expected.

If Mariner IV continues to function until June 1967, communications with it may be stepped up. Mariner's orbit will bring it to within 30 million miles of Earth in September 1967, when it is planned to attempt several engineering experiments.

During its record flight, Mariner entered a severe solar storm last September, causing a slight loss in power from its solar panels. Because such a probability was expected, the panels were designed to retain their output even with a 20% degradation.

Halfback Telemetry

Did you ever wonder how much punishment a football halfback takes when he is pounced upon by several behemoths from the opposing team? Well, the scientists at Northwestern University did and came up with a special helmet wired to produce an electroencephalogram (EEG).

The purpose of the study was to determine how much the helmet protected the player from head injuries.

The electrodes for the EEG were attached to the player's scalp and connected to a transistorized telemetry transmitter also contained within the helmet.

After one year of study, the scientists concluded that the helmet offered sufficient protection.

The scientists are now using similar devices to test "brain waves" of a number of patients suffering from various ailments.

More Laser Uses

Two more uses for the laser have been reported recently. Engineers at *Space Ordnance Systems, Inc.* have developed a system they call LEED (Laser Energized Explosive Device) in which the electric wire method of detonating explosives is replaced by a fiber optic light pipe with the remote end leading to a laser. More than one charge may be fired at one time.

This system offers complete immunity to any electrical environment thus eliminating the danger of premature detonation by stray electrostatic or r.f. energy of any magnitude. The extremely high temperatures used by the system eliminate the accidental triggering by stray light.

The other use is proposed by the *Westinghouse Research Labs*, and is called LASS (Light-Activated Silicon Switch). Basically, this device is a light-activated SCR triggered on by application of a laser beam. This eliminates accidental turn-on by sunlight or artificial light. This system allows faster turn-on time of the switch and permits firing a stack of them at the same instant by piping the laser light to each *via* fiber optic bundles. ▲

Digital Plotting Techniques

(Continued from page 50)

and programmed on the computer.

These are only a few of the many applications of computer-controlled automatic drafting machines. The possibilities are limited only by the imagination and the ability of the programmer using the system. Computer-plotter drafting systems show promise in revolutionizing drafting departments. Perhaps draftsmen in years to come will be more computer programmer than artist.

The CRT Display

Another type of display that is receiving more attention as a computer output device is the cathode-ray tube display. A cathode-ray tube can also be used to plot digital data in analog form. The electron beam can be focused to a fine point of light on the face of the CRT and with the horizontal and vertical deflection plates in an electrostatic CRT (or with a magnetic yoke in an electromagnetic CRT), the point of light on the CRT face can be positioned as desired. The d.c. voltages applied to the deflection plates determine the exact location of the light point. These d.c. positioning voltages can be derived from digital-to-analog converters that are fed by a digital system.

Fig. 8 is a block diagram of a digital CRT display. The computer is programmed so that the data to be displayed can be outputted to the CRT in the form of X and Y coordinate values. The computer output is a parallel binary word or bit pattern. For example, 16 bits of data from the computer output could represent an X or Y value or both X and Y values if only 8-bit coordinate words are acceptable. In Fig. 8, the 16-bit word from the computer is made up of two 8-bit words, one representing the X value and the other the Y value. The X and Y words feed two digital-to-analog converters which change the binary bit patterns into d.c. analog voltages that position the light spot. If the computer outputs coordinate words at a very high rate, the light point will move rapidly across the CRT screen. Because of persistence of vision and the closeness of the points through proper programming and high-speed output, the curve on the CRT screen will appear stationary even though the coordinate values from the computer are occurring sequentially. The curve can be repetitively displayed if the computer output program is a continuous loop. The output display is actually equivalent to a point-plot type of display on conventional plotters, but it is produced much faster so that instantaneous complete display is the result. Of course, like the plotter, the CRT display may be used on-line or off-line from a magnetic tape or other source. The CRT is much faster than a standard plotter so it will be more economical of computer time when used on-line. Another advantage of the CRT display is that because of its speed, several different curves can be displayed simultaneously by time sharing the computer output through proper programming. This time sharing is known as time-division multiplexing and is similar to that used in PCM telemetry systems.

The big disadvantage of a CRT display is that the image is not permanent like the curve drawn in ink on paper by a conventional plotter. However, if a camera is available, a permanent record can be made by photographing the image.

To produce lettering of a display, special letters and number generators can be built into the CRT deflection circuitry and brought into operation at the desired time and place. The character generators are special circuits that produce the deflection voltages necessary to display a letter or number. Computer programing could also be used in place of special generators if desired. ▲

A Solid-State Microphone "Transformer"

By JAMES B. WOOD / Vidor Corp.

Construction of a 2-stage direct-coupled operational amplifier to match low-Z mikes to hi-Z amplifier inputs.

ONE of the advantages enjoyed by circuits employing solid-state devices over their vacuum-tube counterparts is their ability to provide impedance-matching in varied circuit configurations. This ability has been exploited successfully in providing direct, transformerless drive to loudspeakers, resulting in almost unlimited frequency response and nearly ultimate damping.

The circuit described here may prove valuable to the audiophile who wishes to eliminate all transformers from his sound system. Not only does this device surpass the specifications of the typical impedance-matching microphone transformer, but it can be constructed for about one-third the cost of even an inexpensive one.

The design satisfies the twofold requirement of providing (1) impedance matching for low-impedance (50- to 150-ohm) professional microphones and (2) sufficient voltage gain to drive, as per the author's standard, 1-volt r.m.s. program inputs.

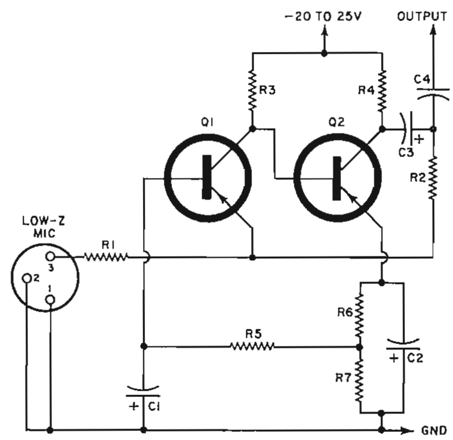
The device is actually a two-stage, direct-coupled operational amplifier with the input transistor (*Q*1) in a common-base configuration. The input resistor (*R*1) is chosen to match the microphone's nominal impedance and the feedback resistor (*R*2) to set the closed-loop voltage gain. By deriving *Q*1's base current from the divider in *Q*2's emitter, a high degree of d.c. feedback is established to compensate for component variations and temperature coefficients. As input and output signals are out of phase, neutralization was found unnecessary for stabilization.

Inexpensive, high-*beta* *p-n-p* silicon transistors were employed in the design of this unit, and types similar to the *Motorola* 2N3906 should be used. Others tried and found to work equally well were the *G-E* 2N2925 and the *Fairchild* 2N3644. *N-p-n* varieties may also be used if all polarities are reversed.

The author constructed five of these units on a single circuit board. The complex was terminated in a patching-jack field and powered by a well-regulated negative 24-volt supply. As 50-ohm microphones were principally employed (the characteristic impedance of most moving-coil assemblies, *sans* transformers), the input resistor in each case was a 51-ohm unit. A feedback resistor of 100,000 ohms provided optimum gain to drive the 1-volt r.m.s. program lines.

Measured frequency response of this device was found to be within ±3 dB from 5 Hz to 250 kHz. Noise is almost entirely dependent upon the power supply used, battery operation being, for all purposes, totally noiseless. ▲

Circuit diagram and parts listing of the two-stage microphone preamplifier.



R1, R2—See text
R3—100,000 ohm, 10%, ½ W carbon res.
R4, R5—10,000 ohm, 10%, ½ W carbon res.
R6—2200 ohm, 10%, ½ W carbon res.
R7—560 ohm, 10%, ½ W carbon res.
C1—30 μF, 6 V elec. cap.
C2—100 μF, 6 V elec. cap.
C3—5 μF, 25 V elec. cap.
C4—0.22 μF, 200 V Mylar cap.
Q1, Q2—2N3906 transistor (or equiv.)

Buying a Hi-Fi Tuner?

(Continued from page 34)

imum. If the tuner in question cannot respond linearly to these large frequency excursions, harmonic distortion will result, and audible distortion will reach the listener during these loud moments of the program.

Actually, most well-designed tuners have bandwidths far exceeding the minimum (150 kHz), but some require large signal inputs before full bandwidth is exhibited. Thus, harmonic distortion should be noted for both weak and strong signals and, of course, the lower the figure (expressed as percentage) the better the product. Distortion of less than 1% for full deviation rivals the equivalent figure for the best amplifiers and preamplifiers.

Drift

The characteristic detuning of a station as the tuner "warms up" (because of increased heat affecting the tuning circuits associated with station selection) has become much less of a problem since the introduction of solid-state tuners because much less heat is generated by transistors as compared with vacuum tubes. However, improperly designed tuning sections can exhibit annoying drift, with its attendant annoyance to the user who has to constantly get up to retune the station, whether they are of solid-state or tube construction. A few kHz of drift from a cold start is not objectionable, since adequate bandwidth of the system will not result in significant detuning of the desired station. Drift of more than 50 kHz before final stability is attained can be quite annoying, however. Some less expensive systems use a.f.c. to counteract drift.

Frequency Response

Since FM stations are permitted to broadcast all audio frequencies from 50 Hz to 15 kHz, while AM is sometimes restricted to a top frequency of only 5 kHz, equipment designed to receive FM signals should certainly be capable of reproducing all transmitted audio frequencies in their proper relative proportions. Response should be flat from 50 to 15,000 Hz "plus or minus" as few dB as possible, and this specification is completely analogous to the one normally associated with other audio components.

Transistors Are Replacing Tubes

As this latest directory of tuners and receivers is examined, it will be noted that the majority of the products listed have made a successful (if sometimes painful) transition from tubes to transistors. The redesign of these products was not without pitfalls. Early attempts at solid-state tuner design often resulted in unforeseen problems such as overloading of r.f. stages and cross-modulation (simultaneous reception of two adjacent stations on the FM band). Performance of even the best transistors intended for high-frequency use left much to be desired.

Today, however, development of certain grades of high-frequency silicon transistors (notably the field-effect type) has made possible r.f. front-end designs fully compatible with the performance expected of a high-quality product. Considering related advantages of longevity of associated parts and decreased drift because of the absence of heat, the modest differential in price between solid-state and tube types (which still abound, if one insists upon them) may well be worth the extra investment.

AM or Not?

Tuners and receivers often include AM radio, and units so equipped are necessarily somewhat more expensive than the FM-only types. Since AM is not truly a high-fidelity source of program material, its inclusion in a purchase will really depend upon other factors, such as whether or not favorite programs are available on FM as well as on AM. If AM is to be listened to a good deal, it is still better to listen to it *via* a high-fidelity system. To whatever degree the AM broadcast does possess limitations, at least they won't be further penalized by the inadequacies of the typical "table-model" AM radio with its minimal amplifier and loudspeaker arrangement.

FM-Stereo Circuitry

Switching from monophonic to stereo FM has unnerved many a seasoned audiophile. In order to squeeze two channels of information onto a single FM frequency, signal-to-noise ratio had to suffer if all other parameters were to remain as good as they were for mono FM. Accordingly, sensitivity and signal-to-noise specs become even more important in the light of stereo FM reception problems.

A good stereo FM tuner will offer at least 20 to 25 dB of separation between left and right channels, though the stereo "effect" is quite discernible with separations of as low as 15 dB. Present-day FM-stereo tuners will invariably feature some form of indicator (such as a light) to advise the user that stereo is being received. Other new features include automatic switching (from mono to FM stereo, in the presence of a stereo signal) and a defeat switch to enable the listener to return to the mono mode if the stereo signal received is not strong enough for satisfactory noise-free listening.

Antennas

While this analysis of tuners is supposed to be confined to the "electronic" specifications, no discussion of FM stereo would be complete without making emphatic reference to the need for a well-placed and properly selected outdoor (if possible) FM antenna. True, one should start with the most sensitive tuner one can afford, but unless all the available signal present in one's location actually reaches the antenna terminals of the tuner or receiver, the most sensitive circuits can do little to provide pleasurable FM-stereo listening.

The proper type of antenna to use will depend upon certain physical circumstances, such as distance from stations, presence or absence of large, reflecting structures which create a form of distortion in FM stereo known as "multipath" (analagous to ghosts in TV), and the presence of stations in many directions. A local dealer can advise as to the preferred type of FM antenna for a particular situation.

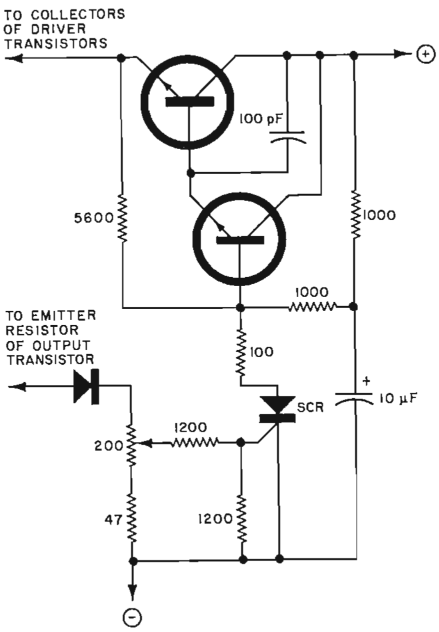
Careful attention to published specifications together with intelligent and extensive auditioning and a review of the hints detailed above should result in selection of a trouble-free tuner or receiver capable of many years of top performance. ▲

SCR PROTECTIVE CIRCUIT FOR HI-FI AMPLIFIER

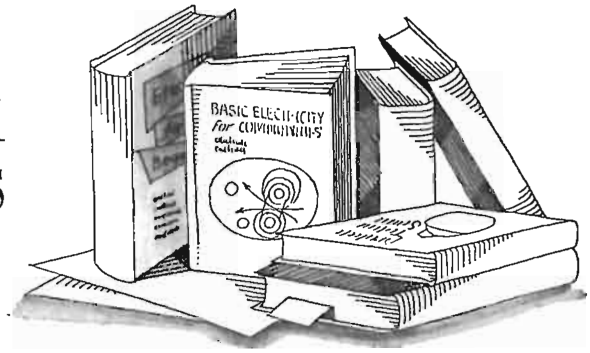
THE new *Sony* TA-1120 solid-state integrated stereo amplifier incorporates an interesting high-speed protective circuit to prevent damage to the output transistors in the event of a short across the output terminals. The circuit, shown below, acts as an electronic fuse that opens the supply to the driver stages within microseconds of an overload. This kills the audio drive instantly and protects the output transistors. The circuit, which employs a silicon controlled rectifier, operates at a much higher speed than would a conventional fuse.

Operation of the circuit, according to *Sony* engineer H. Hasegawa, is as follows. Normally, the SCR is nonconducting, the base voltages of the two "pass" transistors are such that they are turned on. Under these conditions, the positive supply voltage is applied to the driver transistors normally.

In the event of an overload or an output short circuit, current rises in the 0.5-ohm emitter resistors located in one of the output transistors in each of the channels of amplification. This rising current produces a higher-than-normal positive voltage which is applied through the isolating diode to the gate of the SCR. The SCR now fires immediately, reducing its anode voltage to a few tenths of a volt. This drops the base voltage of the upper transistor. As a result, both transistors are cut off and the positive supply voltage is removed from the driver stages. The supply voltage remains disconnected (because the SCR continues to conduct) until the protection circuit is reset by pressing the power switch "off" and then "on" again. ▲



BOOK REVIEWS



"THE EVOLVING SOCIETY" edited by A. M. Hilton. Published by The Institute for Cybercultural Research, 225 E. 63rd St., New York, N.Y. 10021. 410 pages. Price $8.95.

This volume represents the Proceedings of the First Conference on the Cybercultural Revolution which was held in New York City in June of 1964.

The field of cyberculture is concerned with the possible effect the "marriage" of computers and controls, together with their progeny, automation, will have on man and society. Here is a brief sampling of some of the papers presented by the experts at the Conference: "The Revolution in Communications" (W.S. Caldwell), "Computer Machines in Medicine" (R.S. Ledley), "Intelligent Machines" (P. Armer), "Production Control" (T.F. Silvey), "The Social Cost of Cybernation" (B.S. Seligman), "Our Concepts of Man: Rational or Reasonable?" (J. Garai), and "Evolving Structures of Men and Machines" (L. Sutro).

Anyone concerned with the impact of automation on our way of life—and, indeed, we cannot help but be concerned—will find this book most stimulating.

* * *

"ELECTRONICS & NUCLEONICS DICTIONARY" by John Markus. Published by *McGraw-Hill Book Company,* New York. 752 pages. Price $16.50.

This is the revised and updated Third Edition of a book which originally appeared in 1945 and has been used as a reference source ever since. Almost 16,000 terms as used in medical, industrial, space, and military electronics; television; radio; avionics; radar; nuclear science; and nuclear engineering are included. There are 1500 illustrations, judiciously scattered throughout the book, to clarify and enhance certain of the definitions.

The terms are alphabetized letter by letter, ignoring spaces and hyphens, to give a consistent sequence and to expedite reference. Each definition is given only once—with synonyms listed in their own alphabetical order, followed by the generic term, in italics, for which the complete definition is given.

Each term being defined is printed in clear, bold-face type making it easy to find the required listing. The only improvement we can suggest would be thumb indexing to make the book easier to handle.

* * *

"DESIGNING TRANSISTOR I.F. AMPLIFIERS" and **"TRANSISTOR BANDPASS AMPLIFIERS"** by W. Th. Hetterscheid. Published by *Philips Technical Library.* Distributed in the U.S. by *Springer-Verlag New York Inc.,* 175 Fifth Ave., New York, N.Y. 10010. 330 and 312 pages, respectively. Prices $11.40 and $12.00, respectively.

Both of these volumes are addressed to engineers who are involved in the design and construction of i.f. amplifiers and bandpass amplifiers used in transistorized radio, television, and radar receivers.

The author's treatment is painstaking and thorough, and for those with the requisite engineering and mathematical background these volumes constitute excellent "how-to-do-it" handbooks for designing radio and television sets.

A bibliography is appended to each chapter but since the bulk of the references are to European publications, American engineers may find this less helpful than anticipated unless they work for firms with extensive reference libraries.

* * *

"GREAT IDEAS IN INFORMATION THEORY, LANGUAGE AND CYBERNETICS" by Jagjit Singh. Published by *Dover Publications, Inc.,* New York. 332 pages. Price $2.00. Soft cover.

The author, winner of UNESCO's 1963 Kalinga Prize for outstanding achievement in disseminating scientific information to the public at large, has written this volume for researchers and students in such fields as social engineering, linguistics, government, business administration, etc.

The book surveys the work being done in the different areas of computer technology, such as the digital computer, learning machines, information retrieval, game-playing machines and their potential extension into models for decision-making processes and self-organization, much like those made by the human brain.

While the author was forced to resort to some mathematics, his accompanying explanations are disarmingly simple and, as he remarks, anyone with a grasp of the principles of the race track, the slide rule, the chartroom, and the classroom should be able to understand this volume.

* * *

"101 QUESTIONS AND ANSWERS ABOUT TRANSISTORS" by Leo G. Sands. Published by *Howard W. Sams & Co., Inc.,* Indianapolis. 108 pages. Price $2.50.

This little volume follows this publisher's earlier "101" format and it works surprisingly well in presenting information about transistors and their applications. The treatment is non-mathematical and for the most part, not-too-technical.

The first part of the book covers questions about basic transistor types, functions, characteristics, and testing while the remaining four parts deal with applications. The text material is well illustrated by photos, graphs, line drawings, and schematics or partial schematics.

* * *

"ELECTRONIC TROUBLESHOOTING" by Staff of *Philco Technical Institute.* Published by *Prentice-Hall, Inc.,* Englewood Cliffs, N.J. 276 pages. Price $12.50.

This is another of *Philco's* excellent programmed texts which can be adapted to self-instruction as well as classroom use. Because of the complexity of today's commercial and military electronic systems and equipment, there is a crying need for highly trained, skilled maintenance technicians.

The text is divided roughly into two parts—the first part being concerned with locating the problem and the second dealing with troubleshooting. The well-illustrated text and the authors' clear and concise writing makes this a fine "do-it-yourself" volume for the man who wants to upgrade his vocational skills.

* * *

"APPLICATIONS OF NEON LAMPS AND GAS DISCHARGE TUBES" by Edward Bauman. Published by *Carlton Press.* Available from *Signalite Inc.,* 1933 Heck Ave., Neptune, N.J. 07753. 160 pages. Price $2.95 plus 25 cents postage and handling.

This volume is written by the vice-president of engineering for *Signalite* and covers application data on a wide variety of neon glow lamps in electronics. The text material is lavishly illustrated with many practical circuit diagrams which can be immediately adopted by engineers, technicians, and students.

The author provides a number of specific examples of actual circuit designs using close-tolerance neon glow lamps as oscillators, timers, switches, voltage regulators, etc. ▲

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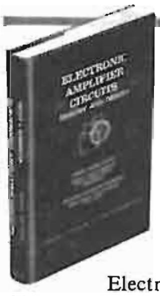

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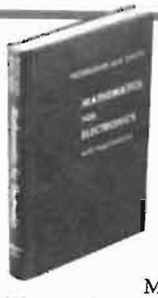

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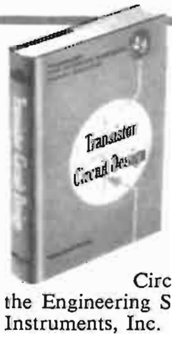

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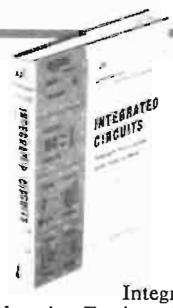

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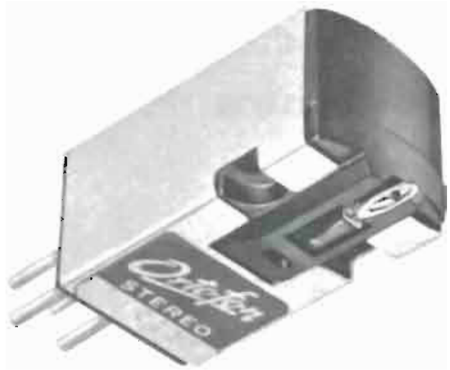


gram (slightly less than the company's earlier Model SPE/T, which is still available). Its static compliance is 20×10^{-6} cm/dyne, a twofold increase over the SPE/T. The rated tracking force is 1 to 2 grams, with the latter figure preferred.

The stylus cantilever of the S-15T is protected by a rigid tubular sleeve, whose end is shaped to allow the stylus to retract if excessive vertical force is applied. When this happens, the polished end of the protective tube rides on the record surface, preventing damage to stylus or record. Should the stylus ever require replacement, the entire cartridge must be returned to the importer, *Elpa Marketing Industries, Inc.* Only two days are normally required for stylus replacement.

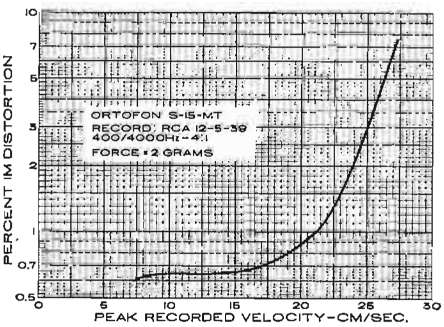
The cartridge contains a pair of Mu-metal shielded step-up transformers for raising the very low output from the moving-coil elements to about 4 to 5 millivolts. A portion of the internal wiring (from coils to transformers) uses a tiny printed board for increased ruggedness. Because of the built-in transformers, the cartridge weighs 18.5 grams compared with the 6- to 12-gram weight of most magnetic cartridges. Certain tonearms may require additional counterweights for static balance when the S-15T is actually installed.

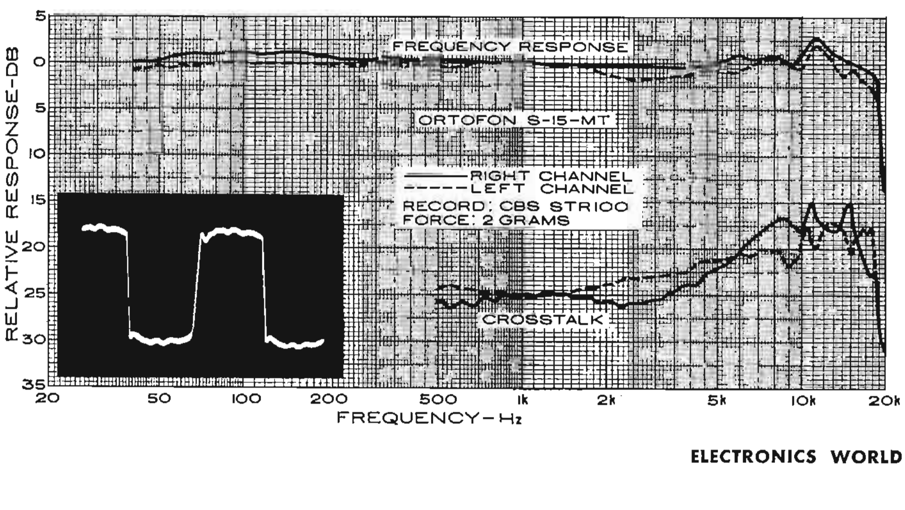
Our frequency-response and crosstalk measurements were made with the *CBS* STR100 sweep record and the *General Radio* 1521-B level recorder. No equalization was used, and the ideal response would be a horizontal line above 500 Hz and a 6 dB/octave downward slope below that frequency. *(In reproducing the curves, we have replotted values below 500 Hz with respect to the zero-dB reference line. Hence, ideal response would be a straight horizontal line.—Editor)* The cartridge had a response within ±2 dB of the ideal curve, from 40 Hz to 16,000 Hz, and was down only 4 dB at 19,000 Hz. The smoothness of the response curve was noteworthy, with no peaks larger than 2 dB. The crosstalk was about —25 dB from 500 Hz to 2000 Hz and was not less than —15 dB over the entire useful audio range.

A low-frequency sweep, from 200 Hz to 10 Hz, did not reveal any resonance in that range (with the cartridge installed in an *SME* 3012 arm). This is consistent with the high stylus compliance and relatively large arm/cartridge mass, which we would expect to resonate slightly below 10 Hz.

Prior to testing the cartridge, we listened to it briefly. It was immediately apparent that this was an exceptionally fine cartridge. The frequency-response curve, excellent though it was, did not fully explain the outstanding quality which we heard. However, the square-wave and intermodulation-distortion tests provided the corroborative evidence.

The 1000-Hz square wave (see photo) from the *CBS* STR110 test record was reproduced with near-perfection. There was a very slight ringing, which appeared to be at 8 or 9 kHz.





We have rarely seen as good a response to this record with other cartridges.

The IM distortion, playing the *RCA* 12-5-39 record, was the lowest we have ever measured from a phono cartridge. In fact, we did not know that the residual distortion of the record itself was that low. At almost any velocity likely to be encountered (up to 17 cm/sec), the IM was under 0.65%. It reached only 2% at 23.7 cm/sec, corresponding to the loudest momentary peaks on a few heavily recorded discs.

The measurements clearly indicate that the S-15T is a top-flight cartridge. It sounded every bit as good as it tested, with superb definition. We were soon aware that it did not sound strained even on the loudest portions of some records which sounded fuzzy or hashy when played with most other cartridges. Although the price makes it a connoisseur's cartridge, its sound quality is consistent with its price tag.

The *Ortofon* S-15T sells for $80. It can be purchased installed in an *Ortofon* plug-in shell, as the S-15MT, for $85. This shell plugs directly into an *Ortofon* or *SME* arm. ▲

Oceanography
(*Continued from page* 46)

ship. Unfortunately, buoys left unattended in the ocean often disappear, and if the recording buoy is lost, so is its data.

The telemetering buoy can be interrogated at intervals and its data recorded on land. Thus, even if the buoy is lost, all data collected to its last interrogation is saved. Also, periodic examination of the telemetered data gives warning if one or more sensors are malfunctioning.

A typical telemetering buoy installation is shown in Fig. 6 (right). An anchor at the sea floor holds the assembly at a fixed location. A buoy below the surface, where it is not subjected to wind and wave forces, attempts to hold the instrument cable in vertical position. Instruments are placed along the cable at various depths and are wired to the subsurface buoy.

The telemetering buoy floats on the surface. Typically, it will contain a recorder, receiver, transmitter, antenna, and meteorological sensors.

Data is recorded at the buoy as programmed by the timer. When interrogated by radio, the recorded data is transmitted to shore to be recorded and processed there.

Present designs utilize the 2- to 20-MHz band for transmission, have transmitter power in the 25- to 100-watt range, and can be interrogated at distances of more than 1000 miles. ▲

LASER-RECORDED DIGITAL MEMORY

Capable of storing 645,000,000 bits of digital information per square inch, one reel of this tape can store as much information as 47,500 similar reels of conventional tape.

IT has been estimated that the average American will generate about 500 pounds of printed or written material during his lifetime, of which about 10% will become permanent or semi-permanent documentation. Also consider that it has been estimated that throughout the world some 100,000 pages of information are generated every hour, and that this volume is expected to double within 10 years.

Storing all this information has become a problem. For example, 100 years ago the Library of Congress was contained in shelves occupying about 500 feet of floor space. Today, its 44 million items, even with microfilm storage, occupy several large buildings.

A key to mass storage and processing of information was found in translating it into binary form and storing it on punched paper. This produced a storage density of about 10 bits of digital data per square inch. The next step was the use of magnetic tape which increased the storage density up to about 5600 bits per square inch.

Now the laser has entered the picture. The *Precision Instrument Co.* has reported the use of a laser digital recording system that has produced a storage capacity of 645,000,000 bits of digital information per square inch packing density. One standard 2400-foot reel of the special tape used in this system can store as much data as 47,500 similar reels of conventional magnetic tape.

Called the UNICON (unidensity coherent light recording) process, it is not a photographic method but makes use of the laser to burn minute holes in the tape storage medium.

The laser's continuous radiation is gated by an electro-optical modulator to produce bits corresponding to the digital data input. The opaque coated polyester tape is moved by a helical-scan transport system (in a similar manner to the tape path taken in a helical-scan video tape recorder) around the imaging circle of the laser aperture. The laser aperture is imaged to produce a one-micron image having a temperature of 3000°K (over 4500°F) on the 4 micron thick opaque tape coating. As each laser burst strikes the tape, it vaporizes the coating to produce a hole (as shown in the accompanying photo). The clear polyester tape backing itself is not harmed, but the image is permanently recorded by the hole in the coating.

Due to the scanning-like process, each line has the capacity of over 600,000 holes. As the tape advances, successive parallel lines are recorded. A control track running along one edge provides a binary file accession code to locate each individual track for readout.

As the light passes through the vaporized holes in the tape, it is collected in a light pipe and conducted to a photomultiplier and converted into electrical pulses. These are compared, in real time, with the data input to verify the recording. An alarm circuit signals the failure of the detected light bits to correspond to the digital input at the modulator. This provides the read-while-write capability that has been the ultimate objective of memory system designers.

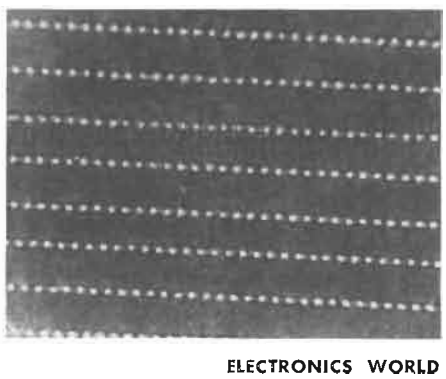
Retrieval is accomplished by a similar helical-scan transport with the tape breaking the light path of a low-power laser. Light passing through the holes is detected to produce the same bits as were recorded. The power output of the readout laser is insufficient to alter the opaque coating of the tape.

The company estimates that the entire Library of Congress collection could be included on 5½ UNICON mass memory reels.

Precision also points out that besides the 645 million bits per second storage density, recording speeds of 12 million bits per second are demonstrable. Also, because the information is stored in the form of holes, it cannot be accidentally erased, it will not fade with the passage of time, and has no print-through problem.

The development has reached the stage of laboratory models that demonstrate all the functions of the process except elements of the tape transport mechanism. These are still in the development stage. ▲

The array of 1.5-micron holes produced by the laser on the tape opaque coating.



Test Equipment for CB and BRS

(*Continued from page* 33)

panel socket. That signal can be used as an approximate check on a receiver's performance or for alignment. When the instrument is capable of generating r.f., it often includes an audio oscillator stage for tone modulation. The pure audio tone is also made available separately for checking a transceiver's audio section. Typically, instruments in this class can read relative activity of a crystal.

The choice between active and passive CB testers may relate to individual need. Fewer functions of the passive instrument tend to limit it primarily to installation and tune-up, and possibly to help detect troubles like faulty connectors and cables. The more elaborate tester, with its signal-generating features, could conceivably be used for much troubleshooting and alignment, with little more required than a v.t.v.m. for voltage and resistance checks. Also, an active instrument may ease the load on a test bench tied up with radio and television servicing.

Service Specialist

The licensed technician who wishes to specialize in CB and BRS servicing can make many essential adjustments with the test equipment already described. Power input is measured by voltmeter and ammeter, output voltage with an r.f. v.t.v.m. and dummy load. Modulation percent of an AM signal is readily viewed and measured on any service scope with provision for direct connection to its vertical deflection plates. The only other major instrument for CB servicing is the frequency meter. With a minimum accuracy of ± 0.0025% it can be used to peak and resonate the transmitter's crystal oscillator, especially after servicing in that circuit. Not only does the instrument serve as a signal generator, but for running frequency checks on transceivers which are apparently in good condition. (It is generally recommended that such checks be done at intervals of six months.)

There are two main types of frequency meter available to the CB service technician. One is a CB-only version which contains a highly accurate crystal on each assigned channel. Crystals are switch-selected and may be guaranteed accurate to within ± 0.0015% when the instrument is operated within an ambient temperature of 50 to 100 degrees F. The other type is the frequency meter intended for general two-way radio service. Its circuitry may be of the heterodyne or frequency-counter type, but the instrument is characterized by extremely wide frequency coverage and accuracy well within FCC requirements. It may be used to service virtually all two-way radio equipment the technician is apt to encounter, including CB, BRS, marine, aviation, and land mobile. Manufacturers may provide special calibration for convenient selection of CB frequencies, or adapters for accurate frequency checks in the higher v.h.f. and u.h.f. bands.

Another instrument which can be classed as "professional" is the modulation meter. It is required for BRS service where bandwidth of the FM signal must be checked. In the narrow-band or split-channel mode, the meter must measure maximum transmitter deviation of ± 5 kHz. A typical modulation meter might accept a transmitter signal anywhere from 25 to 500 MHz and read out its frequency deviation directly in kHz.

Thus the choice of test equipment largely depends on the intended degree of servicing. Much can be done to maintain CB equipment with relatively inexpensive and simple instruments. But when total service of CB and BRS transceivers is contemplated, professional instruments—including a frequency and modulation meter—are a necessity. ▲

New Frontiers in Semiconductors

New materials, combined with new techniques, can produce transistors capable of operating at several GHz, and microwave diodes that can deliver 1.1 watts at 12 GHz.

WITH the increasing sophistication of fabrication and deposition equipment, and with the constant search for new materials, scientists are now able to produce many advanced forms of semiconductors that far outstrip their predecessors.

Transistors

At *Westinghouse,* they have been using a material called indium arsenide to produce a thin-film transistor capable of operating to several GHz, at temperatures between −452°F (close to absolute zero), up to 300°F.

This new transistor also points the way to a new capability in integrated circuits.

Although not yet commercially perfected, the indium arsenide transistor demonstrates the feasibility of a thin-film device that should outperform conventional silicon transistors in high-frequency response, in resistance to damaging radiations, in stability over a very wide temperature range, and, ultimately, in cost.

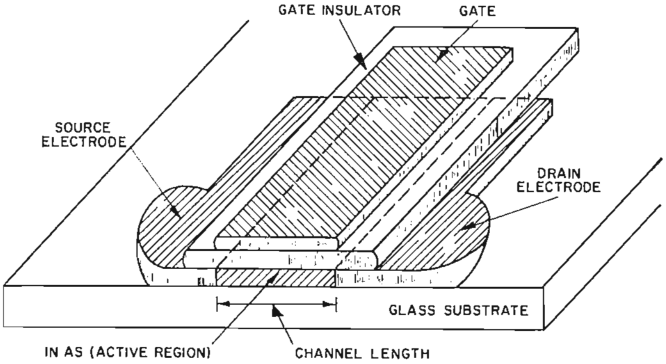
Up until this time, thin-film IC's have had little impact on microelectronics mainly because there has been no satisfactory thin-film amplifier that compares in performance with the transistors incorporated into the silicon circuits.

At best, thin-film IC's have been "hybrids" in which separate, soldered-in transistors and diodes are interconnected between thin-film passive elements. This technique sacrifices the economic and technical advantages of an all-integrated thin-film structure. It is hoped that the idium arsenide transistor will change this picture, bringing about what might be termed the "second generation" of these increasingly important devices.

By evaporating successive layers of various materials through the proper masking technique, an integrated thin-film circuit that includes both passive and active devices can be made, having characteristics not obtainable with the older silicon technique.

A typical FET-type transistor, shown in Fig. 1, is fabricated by evaporating a layer of indium arsenide on the quartz or glass substrate, *via* the desired masking shapes, evaporating the connecting element metal ohmic contact, then an insulating layer over these, and finishing up with another metal layer to form the gate electrode. The layers are typically five to 10 millionths of an inch thick.

Fig. 1. This indium arsenide thin-film FET transistor uses layers only five to 10 millionths of an inch thick.



Meanwhile, scientists at *Bell Telephone Labs.* are reporting transistors having a cut-off frequency of more than 7 GHz with a power gain of more than 4 dB at 4 GHz. Improved fabrication techniques that allow the internal dimensions of the transistor to be greatly reduced are responsible for the high gain and high cut-off frequency.

To obtain good operation at the very high frequencies, the transistor must have a very thin base layer (about 0.1 micron thick), and a narrow emitter strip (about 1 micron wide) as shown in Fig. 2. These dimensions are held without resulting in emitter-collector shorts, which can be caused during the base and emitter diffusions by the use of a new technique in precisely controlled shallow diffusions.

This technique also meant that improved optical systems using high resolution lenses to fabricate the more precise masks had to be produced.

Another new technique, the deposition of a thin metallic (nickel or chromium) film between the silicon dioxide layer and the photoresist layer, increased the resolution of the photoresist layer. Without this metallic deposition, incident light waves interfered with reflected light from the silicon surface, and sufficient definition could only be obtained for a strip about 2 microns wide.

Another fundamental problem—base-to-emitter shorts through the overlay contact—was minimized by using an extremely thin layer of phosphorus glass as a source for the emitter diffusion. Because only negligible interaction occurs between a very thin layer of phosphorus glass and the silicon dioxide layer, the protective silicon dioxide layer is preserved during the diffusion.

Diodes

In the area of diodes, *Bell Labs.* also has developed silicon diodes that are used with external microwave circuitry to operate as an oscillator, that generate 1.1 watts of continuous-wave power at 12 GHz, with 8% efficiency. This performance represents the highest c.w. power reported at this frequency for semiconductor microwave oscillators.

This power is twice as great as previously reported at 12 GHz for silicon *p-n* junction diodes, and nearly eight times greater than that reported for Gunn-effect devices. The diode's efficiency is about 2% greater than that of previous silicon diodes and more than double that of c.w. Gunn-effect devices at 12 GHz.

Bell credits the better performance primarily to improvements in mounting and bonding, resulting in a more efficient heat flow away from the diode, and closer control

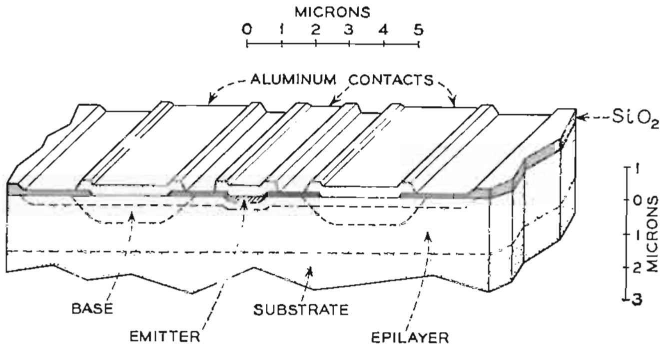


Fig. 2. Base layer of this new high-frequency transistor is 0.1 micron thick, emitter is only one micron wide.

of processing techniques resulting in increased efficiency.

As shown in Fig. 3, the diodes are mounted "upside down" in their metal housings, a complete departure from conventional diode mounting practices. This upside-down arrangement places the *p-n* junction closer to the metal mount, thus reducing thermal resistance between the junction and the metal.

Better device efficiency is produced by controlling the impurities, or doping profile, of the semiconductor, and by reducing the *n*-type region of the diode to the minimum necessary thickness. Controlled doping enables the diodes to attain peak efficiency under normal operating conditions (efficiency of the earlier diodes increased as the input voltage to the diode increased, but the diodes usually burned out before reaching their peak efficiency). The reduction in thickness of the *n*-type region reduces the electrical resistance of the diode.

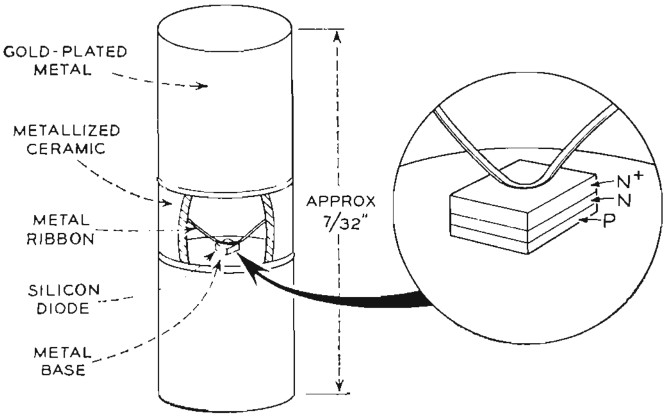
The devices used in the *Bell* experiments are simple *p-n* junction diodes that generate microwaves by combining the effects of avalanche and transit time.

Avalanche is a high field discharge caused by impact ionization of carriers; that is, under the influence of a high field, the carriers acquire enough energy to knock valence electrons into the conduction band. This generates new carriers, which by the same process, create still new carriers.

Transit time is the time it takes electrons to travel through a region in the semiconductor material.

By applying a reverse bias to the diode, for example, avalanche occurs principally at the *p-n* junction producing electrons and holes. Electrons travel through the *n*-type region of the diode and produce power. The holes are collected through the *p*-type region but contribute only in a minor way to the power. The operating frequency of the diode is dependent on the time required for the electrons to travel through the semiconductor—the faster the transit time, the higher the frequency. ▲

Fig. 3. This "upside-down" mounted diode can oscillate at 12 GHz and deliver 1.1 watts of power. In conventional diodes, "N+" substrate is bonded to metal base.



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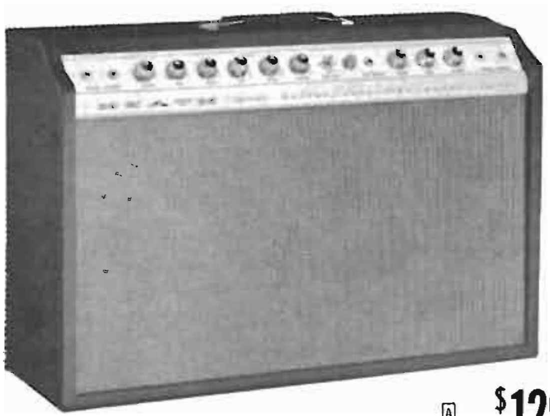

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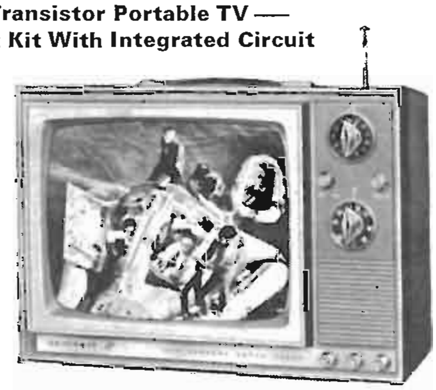

Plays anywhere . . . runs on household 117 v. AC, any 12 v. battery, or optional rechargeable battery pack ($39.95). New integrated sound circuit replaces 39 TV parts; 3-stage IF for maximum gain with controlled bandwidth; gated AGC for steady, jitter-free pictures; instant "on" AC operation; preassembled & aligned tuners for peak performance; transformer-operated power supply; front panel speaker; 12-hour assembly; rugged plastic cabinet. 11½″ H x 15¾″ W x 9⅜″ D. 27 lbs.

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23-Channel 5-Watt Transistor CB Transceiver

Assembled GWW-14
$124⁹⁵

(Kit GW-14 $89.95)

23 channel crystal-controlled transmit & receive. Only 2⅞" H x 7" W x 10½" D . . . ideal for car, boat, any compact installation. Front panel "S" meter, adjustable squelch, ANL, built-in speaker, PTT mike, aluminum cabinet. Operates on 12 v. DC. 8 lbs. GWA-14-1 AC power supply, 5 lbs. . . . $14.95. GWA-14-2, 23-channel crystal pack, 1 lb. . . . $79.95, GWA-14-4, 6 to 12 v. DC converter, 3 lbs. . . . $14.95.

2-Watt Walkie-Talkie . . . Completely Assembled

Assembled GRS-65A
$99⁹⁵

Up to 6 mile inter-unit range . . . up to 10 miles with 5-watt CB base station; $20 rechargeable battery; 9 silicon transistor, 2 diode circuit; superhet receiver with RF stage; adjustable squelch and ANL; aluminum case. 3 lbs. Optional 117 v. AC battery charger plus car cigarette lighter cord $9.95. Crystals extra .. $1.99 each with order.

NEW! Deluxe Solid-State FM/FM Stereo Table Radio

Kit GR-36
$69⁹⁵

Tuner and IF section same as used in deluxe Heathkit transistor stereo components. Other features include automatic switching to stereo; fixed AFC; adjustable phase for best stereo; two 5¼" PM speakers; clutched volume control for individual channel adjustment; compact 19" W x 6½" D x 9¼" H size; preassembled, prealigned "front-end"; walnut cabinet; simple 10-hour assembly. 24 lbs.

NEW Transistor Portable Phonograph Kit

Kit GD-16
$39⁹⁵

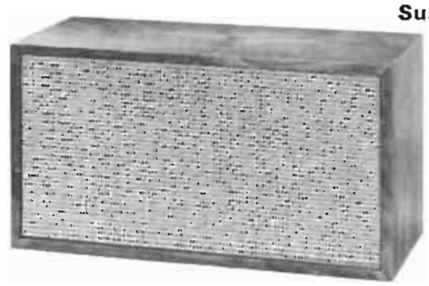
Worth At Least 50% More! And it sounds better. Assembles in just 1 to 2 hours . . . simply wire one small circuit board, mount the 4" x 6" speaker and plug in the preassembled changer . . . ideal beginner's kit. Features automatic mono play of all 4 speeds; dual Sapphire styli for LP's or 78's; 45 rpm adapter; olive and beige polyethylene over sturdy, preassembled cabinet. Operates on 117 v. AC. 23 lbs.

30-Watt Solid-State FM/FM Stereo Receiver

Kit AR-14
$99⁹⁵
(less cabinet)

World's Best Buy In Stereo Receivers. Features 31 transistors, 10 diodes for cool, natural transistor sound; 20 watts RMS, 30 watts IHF music power @ ±1 db, 15 to 50,000 Hz; wideband FM/FM stereo tuner; plus two preamplifiers; front panel stereo headphone jack; compact 3⅞" H x 15¼" W x 12" D size. Custom mount it in a wall, or either Heath cabinets (walnut $9.95, beige metal $3.95). 18 lbs.

NEW! Compact 2-Way 2 Speaker System With Acoustic Suspension Design



Kit AS-16
$49⁹⁵

Handles 10 to 25 watts of program material. Features wide 45 to 20,000 Hz response; 8" acoustic suspension woofer with 6.8 oz. magnet; 3½" tweeter with 4.8 oz. magnet; high frequency level control; 8 ohm impedance; 1500 Hz crossover frequency; assembled walnut veneer cabinet has scratch-proof clear vinyl covering for easy cleaning. Measures 10" H x 19" W x 8½" D. Speakers are already mounted; just wire the crossover and connect cables — complete in one or two hours! 17 lbs.

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CIRCLE NO. 114 ON READER SERVICE CARD

Antennas for CB and BRS

(*Continued from page* 39)

Since CB is essentially a mobile medium, and position and distance between base station and car vary, the standard base-station antenna is nondirectional and vertically polarized. One of the earliest CB base antennas, the ground plane, survives today. It is a 9-foot vertical radiator with several radial elements protruding from the lower portion to simulate an electrical ground. The reason for its popularity is that of cost; it is simple in construction and offers a straight-through match to the 50-ohm transmission line. But the ground plane has been outpaced by the taller half-wave end-fed and colinear (5/8-wavelength) types. These rise to 18 or 20 or more feet.

The advantage of the longer antennas relates to their radiation angles. The ground-plane antenna has the relatively high radiation angle of about 5 or more degrees. Thus a portion of its signal is emitted skyward and is lost. The longer antennas, however, concentrate the pattern at lower angles which places more signal within the communicating area (Fig. 3). The matching networks found in the base of these antennas usually provide a d.c. ground for static and some protection against nearby lightning strikes which may induce voltage in the antenna elements.

One antenna type, the *coaxial*, has found limited acceptance in the CB field. It is essentially a half-wave vertical about 18 feet in length with a "skirt" encircling the lower half (for decoupling the transmission line from the antenna). Although a rather efficient antenna, its high radiation angle is the limiting factor. At least one manufacturer, however, offers a coaxial antenna for small-boat installation. The advantages in this special application are no protruding radials of any kind and the elimination on a ground plate on the bottom of the boat. Radiation angle should present little problem in CB marine work since range over water is excellent, often three times that over land.

Base antennas for CB have their counterparts in the BRS. For the business band, however, there are several types which have proved to be mainstays in the over-all field of two-way radio. One reason for the difference between CB and BRS antennas is that smaller physical size (due to higher frequency) permits additional stacking of elements in the BRS service. The *duo-ground* plane, for example, employs two sets of ground-plane radials spaced about a quarter-wave apart to obtain a simple antenna of lower radiation angle than the conventional type mentioned earlier. The *unipole* antenna is actually a ground plane with a folded upright element (half of a folded dipole) which provides a d.c. path to ground for static discharges and a good impedance match from the feedline. The *co-plane* antenna places ground-plane radials below a half-wave coaxial radiator for achieving low radiation angles.

The BRS antennas, incidentally, are ordered cut to a specific frequency. These antennas, in general, are priced 20 to 30 percent higher than their CB counterparts, but many of them appear to be somewhat better constructed and more conservatively rated in terms of gain.

In the effort to increase communicating range on CB (which is permitted to extend a maximum of 150 miles) manufacturers offer a number of directional, or beam, antennas. These systems multiply power of a radiated (and received) signal by concentrating the nondirectional pattern into less than 360 degrees. The gain and sharpness of a beam increase with the number of elements.

The heart of one common type of directional beam is a half-wave driven dipole (about 18 feet) to which is added one reflector at the rear and one or more director elements at the front. By mounting two such multi-element beams side by side, additional gain and directivity are realized. Among the largest models now offered is a twin 5-element model.

In nearly all cases a mechanical rotator is needed to orient the beam to the desired direction, especially when communications are between base and mobile units. A fixed beam is solely for point-to-point use. Since it is often impossible to predict a vehicle's location, some CB operators use a nondirectional antenna to acquire the mobile signal, then switch over to the beam (which is oriented) to continue communications.

Other directional antenna systems in CB eliminate mechanical rotation by utilizing some form of phasing or element switching. In the phasing system, two conventional vertical antennas are mounted a specific distance apart. A control box mounted near the transceiver may switch-select a network (consisting of varying lengths of coaxial cable) which phases the signal feed.

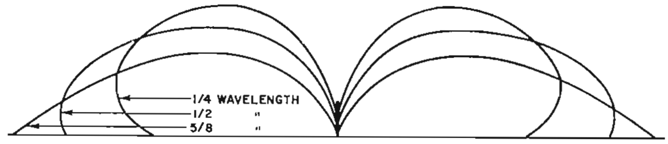
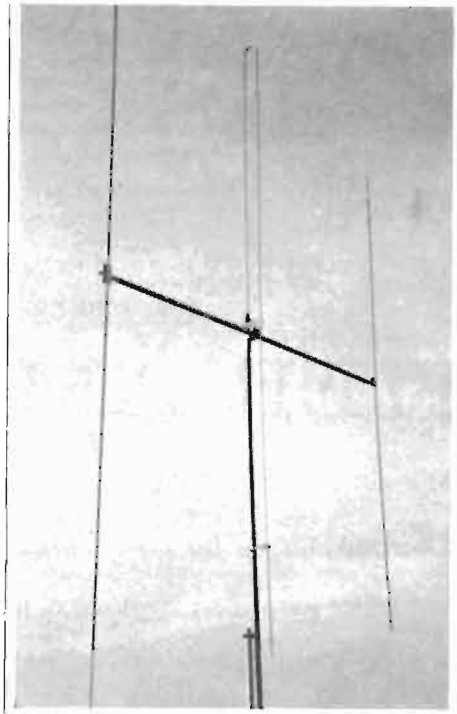


Fig. 3. Longer base-station antennas produce lower radiation angles shown here.



Mark Products MJ-3 is a 3-element parasitic CB beam with folded driven element, reflector, director ($39.95).

Interacting fields at the antennas aid or cancel in the desired directions. The second method of rotating of a pattern electronically is accomplished by one model with three half-wave verticals closely spaced in a circle. Relays controlled by the operator permit any single element to become active; the remaining two serve to shape the pattern into one or more directions.

Comparable directional antennas are used for business radio applications. (A difference occurs at higher frequencies where small u.h.f. dimensions permit the use of screen reflectors similar to those used for u.h.f. TV reception.) In BRS service there is usually a greater selection of antennas which offer figure-8 (or bidirectional) and cardioid patterns to enable the installer to shape radiation. This not only reduces signal in undesired directions, but helps to attenuate interfering signals arriving from some directions.

It may be seen that the choice of CB or BRS antenna may take into account matters of coverage area, gain, pattern, and interference. For CB, the typical installation can be handled by selecting a nondirectional antenna of low radiation angle and the highest possible mounting point. It is generally believed that additional losses introduced by a longer transmission line may be offset by the height advantage and use of lower-loss coaxial cable (such as a foam-filled type). Planning the BRS installation, however, will require a careful evaluation of additional factors, namely, tower height, operating frequency, and transmitter power, which combine to determine ultimate range. ▲

Characteristics of LIMITER AMPLIFIERS

Maintaining a constant output for great variation in input level is the job of the limiter amplifier. However, some distortion can arise even when the limiter amplifier is functioning correctly.

THE limiter amplifier is a specialized member of the amplifier family. Any amplifier which, without human intervention, acts to change the amplification in a patterned manner is known as an automatic gain control (a.g.c.) amplifier. A.g.c. amplifiers are generally divided into two broad groups: those which act to increase the dynamic range of an audio program and those which act to reduce the dynamic range. The latter are called gain-reduction amplifiers.

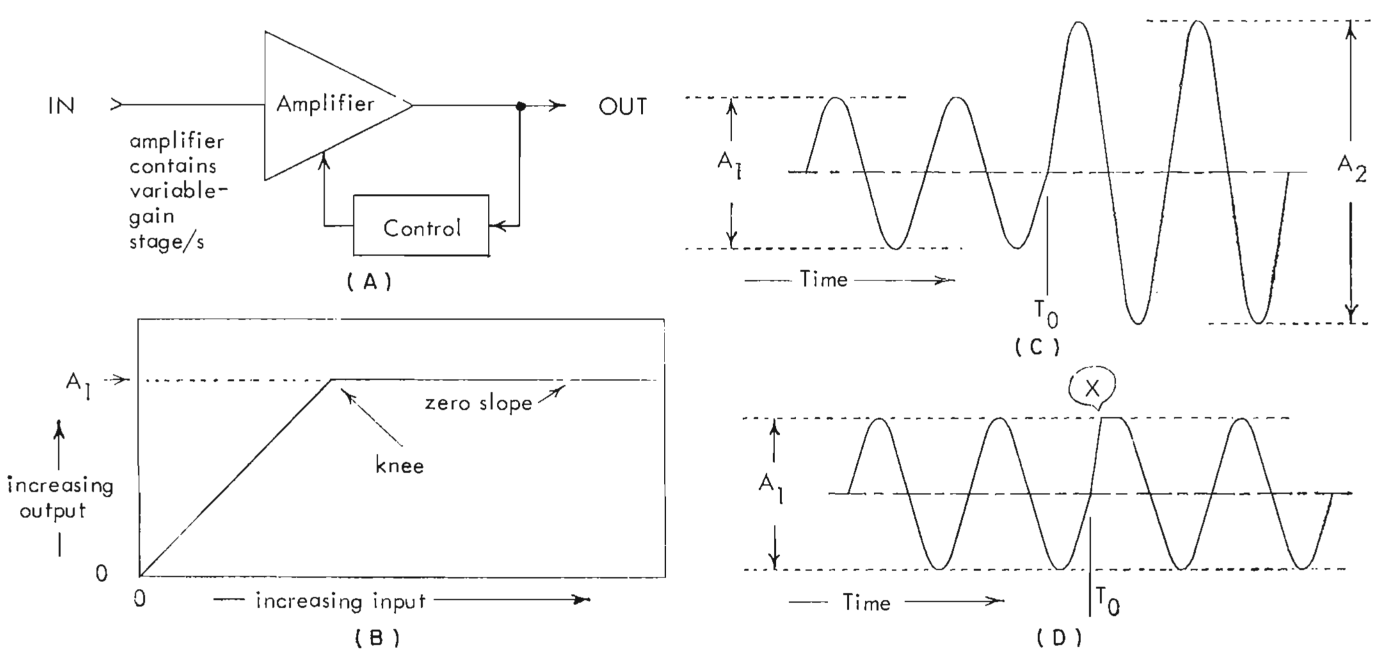
Some gain-reduction amplifiers are designed to compress the over-all amplitude fluctuations of an audio program into a lesser range and are aptly called compressor amplifiers. These usually have a rather slow acting time. But others are meant to act extremely fast and only when the audio signal reaches certain well-defined amplitudes. These last amplifiers are called limiter amplifiers.

The definitions contained in the foregoing two paragraphs are difficult to apply to many commercial units because the ingenuity of design engineers has resulted in "combination" devices. Unfortunately, even a bare listing of the various units which have appeared on the market would require much space.

Limiter amplifiers have been made in forward-acting and reverse-acting versions. The former reduces gain when an input signal reaches a certain amplitude, and the latter acts on the amplitude of the output signal. It is the reverse-acting type that we will discuss.

Fig. 1A depicts the system of the type of limiter under discussion. This is a feedback circuit in that a portion of the output is sampled to correct an "error." The error is defined as the degree to which the output signal amplitude exceeds the set "limit." No feedback system can ever completely

Fig. 1. (A) Block diagram of limiter. (B) Idealized limiting characteristics. (C) Input wavetrain. (D) The output wavetrain.



eliminate error; it can only reduce it. However, because good design can reduce limit overrun to a negligible factor, this property is not to be considered as a defect that is inherent in the system. It is only something to be recognized and minimized. (It is theoretically possible to design a forward-acting unit that has no increase or decrease in output past the limit point, but the problems entailed are formidable.) As a matter of fact, the limiter has only one inherent fault and that is the unavoidable generation of an unwanted transient signal when it "attacks." (It may be argued that the main defect of a limiter is that it does indeed change gain, the very purpose for which it is designed.)

Fig. 1B shows the input/output characteristic of the limiter amplifier shown in Fig. 1A. It is idealized, showing perfect limiting action and a perfectly sharp "knee." The 0 input point may be assumed to be the system background noise (lower limit of the possible dynamic range), and the *A*1 output point is defined as the desired upper amplitude limit to be imposed on system output. Practical units have sharp knees and low slopes; thus the idealized characteristics will suffice as a basis for discussion.

Let us examine what happens when the wavetrain in Fig. 1C is introduced to the input of the limiter. Note that the initial amplitude just reaches the output limit and that at time T_0 it increases from this value (*A*1) to a greater value (*A*2). The amplitude change occurs at the base line of the waves. The two amplitudes are assumed to be of perfect sine function, thus facilitating limiter action analysis. Further assumptions that apply to our "perfect" limiter amplifier are (1) the attack time (time required for the effective reduction of gain), which is zero, and (2) harmonic generation (except that associated with the limiting action itself), which is zero.

Fig. 1D shows the waves after passage. Amplitude *A*1 is unchanged, but *A*2 has been reduced to the level of *A*1, a change in gain having occurred at point *X*.

Our immediate interest is in the shape of the segment existing from T_0 to a point 90° later. It is evident that a transient signal has been generated and added to the wanted signal.

Bear in mind that this was done by our "perfect" limiter amplifier. The device has done exactly what it was designed for; it held the output to the "limit level." The gain change was not instantaneous; it began gradually at point *X* and stopped at the crest of the *A*2 input wave. Let us suppose for a moment that the output wave of Fig. 1D was not the result of action by an automatic reduction amplifier but resulted from the action of an incredibly agile human operator who turned down an attenuator control at precisely the right moment and at exactly the correct rate. The same transient would have been generated.

An enlargement of detail from Fig. 1D is shown in Fig. 2B. The rise portion of the wave is sinusoidal, for it is identical to the *A*2 wave in Fig. 1C. The falling portion (after the flat portion) is also sinusoidal. Fig. 2A shows the shape of the generated transient. It is also composed of two sine functions, being computed by subtracting a sine half-cycle from the wave in Fig. 2B. The amplitude A_x may be shown to be $A_x = A1\ [1-(A1/A2)]$. The formula is accurate for gain-reduction conditions: *A*2 must be greater than *A*1.

Overshoot, which is the result of long attack time, is shown in Fig. 2C. This generally occurs at very high audio frequencies in limiter amplifiers. However, long attack time is sometimes designed into compressor amplifiers, and overshoot may occur at frequencies above the mid-range. Overshoot is not particularly objectionable, providing the attack time is at least reasonably short. However, it may cause overmodulation of a radio station or overcutting of a disc recorder. Note also that the gain-change transient (Fig. 2A) is greatly suppressed by the overshoot.

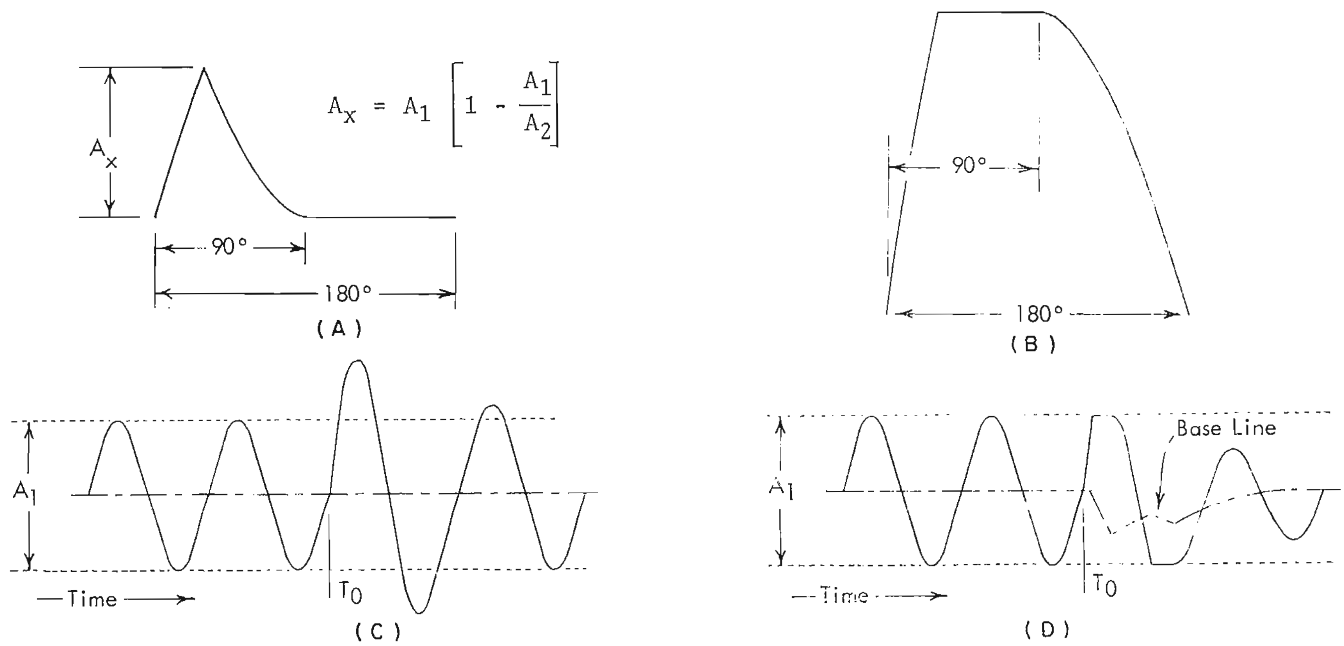
Fig. 2D shows a condition known as thump or pop. It is the result of the gain-control signal getting into the program signal. (This was quite common with electron-tube limiter amplifiers.) Gain-reduction amplifiers which are subject to thump generation are generally equipped with balancing controls so that the user may adjust for the minimum effect.

The thump shown in Fig. 2D is actually quite moderate. Referring back to Fig. 1A, it will be seen that any gain-reduction amplifier which is subject to thump is actually regenerative for control signals and may actually be completely cut off by sharp transients.

Good gain-reduction amplifiers are difficult to design. To this date there has never been a good limiter amplifier on the market (domestic or foreign) that could be called adequate by discriminating audio technicians. This statement is made with full realization of the brilliant and ingenious design work which has resulted in the various highly useful limiter amplifiers in present use.

The above article was taken from the *Langevin* Engineering Letter (published by *Langevin*, 1801 E. Carnegie Ave., Santa Ana, Calif. 92705) of September, 1966. ▲

Fig. 2. (A) A transient pulse. (B) Detail of Fig. 1D. (C) Example of overshoot. (D) An example of a thump transient.



NEW PRODUCTS & LITERATURE

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, fill in coupon on the Reader Service Card.

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

SOLID-STATE VTR SYSTEM

A new, solid-state video tape recorder system designed primarily for the educational, business training, and industrial markets has just been introduced in two models—a portable 3-piece unit and a mobile console.

The basic VTR system is made up of a recorder, a CCTV camera, and a 12-inch monitor (74 square-inch viewing area). Accessory equipment includes a microphone, tripod, connecting cable, and recording tape.

The distinctive feature of the new system, according to the company, is its simplicity and ease of operation. The solid-state camera may be operated by anyone: there are only two controls—the "on-off" switch and a focus knob. It is equipped with a crystal oscillator to provide optimum picture stability. Camera resolution is approximately 500 lines when displayed on a standard video monitor. General Electric

Circle No. 1 on Reader Service Card

EPOXY-MOLDED TRANSISTORS

A new line of ten low-cost "n-p-n" and "p-n-p" general-purpose transistors with unit prices on the order of 25 cents each has just been introduced.

The "Gem" transistors have all of the inherent performance and stability characteristics of silicon devices, according to the company. Their extremely low cost has been made possible by the use of new materials in manufacture, improved assembly techniques, and the use of automatic testing on the assembly.

The line includes low-level/high-gain units, u.h.f. transistors, and diffused epitaxial types for a variety of uses in data processing, communications, radio, television, and home-entertainment electronic equipment. Type numbers include 2N3793, 3794, 4284, 4285, 4286, 4288, 4290, 4291, 4292, and 4293. Power dissipation for these devices is typically 250 mW. National Semiconductor

Circle No. 126 on Reader Service Card

IR TESTING WINDOW

The problem of checking electronic circuits after they are fully enclosed in a cabinet, rack, or console has been solved inexpensively by leaving out one side of a cabinet and substituting a sheet of clear polyethylene which permits a "Thermograph" infrared camera to "see" the electronic circuitry without interference.

The major usefulness of infrared thermograph is its ability to reveal areas that are hotter or colder than expected, thus indicating conditions that were not anticipated in the equipment's thermal design. Moreover, once acceptable gradients have been established, any deviations are symptomatic of abnormal operation and locate areas of potential failure.

The Model T-4 camera used with this technique creates a thermogram in much the same manner as a TV picture and displays the result of up to 60,000 individual temperature measurements. Over-all range of the camera is −170 to +250 degrees C, the specific black-to-white picture range being adjustable from 1 to 250 degrees C. Barnes Engineering

Circle No. 127 on Reader Service Card

HIGH-POWER BATTERIES

The new "Vidor" high-power batteries are a third generation development designed for applications requiring relatively high current for long periods and where voltage maintenance is important. According to the company, they offer the benefits of increased stability, power, and longevity without the expense of alkaline or mercury systems.

Three 1½-volt styles are available: HP2 ("D" size), HP11 ("C" size), and HP14 ("AA" size); all use an electrolytic manganese system. IRC

Circle No. 2 on Reader Service Card

VIDEOTAPE RECORDER/RECEIVER

A new closed-circuit videotape recorder/TV receiver combination which permits the recording of television broadcasts for instant replay has just been introduced as the VR-6175. The new recorder/receiver is designed for commercial, industrial, and home use. It is housed in an oiled walnut furniture cabinet.

The 21" television receiver, Model TR-821, is made by Motorola and modified so that, when used with a recorder, no additional equipment or professional installation is required to record and play back television programming. The TV receiver is available separately as is a companion camera, the CC-6450, which allows the user to make his own live recordings. Ampex

Circle No. 3 on Reader Service Card

ULTRASONIC "BIRD CHASER"

A new bird repeller which provides an ultrasonic output of 134.8 dB (at 20 kHz) is now being marketed as the "Ultrason-A2". Newly engineered circuitry permits a reduction in compressed air and eliminates the need for an air pressure regulator.

The unit maintains a constant, continuous u.h.f. sound output when powered by air pressures ranging anywhere from 10 psi to 55 psi. The repeller has no moving parts and is not affected by weather extremes. It is constructed of stainless steel and aluminum. One unit will cover an area of up to 6000 square feet. Bird-X

Circle No. 4 on Reader Service Card

INTEGRATED-CIRCUIT V.H.F. AMPLIFIER

The Model E13-711 linear integrated circuit is suitable for oscillator, video, and i.f. amplifier applications, including frequencies in the v.h.f. band.

Output characteristics of this new device include a dynamic range of 3.0 minimum and 4.0 typical volts peak-to-peak at 25° C and 2.5 minimum and 3.5 typical over the operating range of −55° C to + 125° C. The d.c. level at 25° C ranges from a minimum of 2.4 to a maximum of 3.4 volts, with 3 volts the typical characteristic.

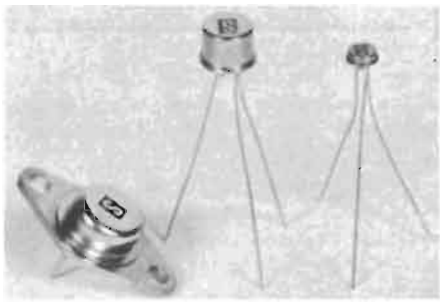
Output capacitance and admittance range from a typical 7 to a maximum 15 pF and from 0.6 typical to 1.5 maximum mmhos. Input characteristics are −10 minimum and −25 pF typical and 10 mmhos typical. Voltage gain ranges from a minimum 13 to a maximum 17 dB with 15 dB typical. Bandwidth (−3 dB) is typically 110 MHz, with 60 MHz minimum.

Complete specifications, including diagrams and performance curves, are available on request. Amelco

Circle No. 128 on Reader Service Card

SILICON POWER TRANSISTORS

Three new JEDEC-registered "n-p-n" power transistors, intended primarily for power amplifier applications, have been introduced. The 2N4862 is in a TO-46 package for use where minimum space is available; the 2N4863 is in the popular TO-5 package; and the 2N4864 is in a TO-66 package to utilize full power capabilities of the transistor (28 W at 25° C case).



These 2-amp transistors have a 120 V minimum sustaining voltage and are characterized at 0.5 A collector current with h_{FE} of 50-150, $V_{CE(sat)}$ of 0.2 V maximum, and $V_{BE(sat)}$ of 1.2 V maximum. Minimum cut-off frequency is 50 MHz. Solitron

Circle No. 129 on Reader Service Card

TV-FM ANTENNAS

A new, improved line of color-TV antennas is being marketed as the "Paralog-Plus" series. Special features of the new line include extra high gain for sharp directivity, flatness within ± 1 dB per channel, and match for both 300- and 75-ohm outputs.

The new antennas incorporate a unique "Bi Modal" director system whose parasitic elements combine two high-band directors into a single director covering the entire low band, plus all FM channels.

There are eight models in the new series including four, five, seven, eight, and ten driven elements with various parasitic elements. A four-page data sheet containing full specs on each model will be forwarded on request. JFD

Circle No. 5 on Reader Service Card

LOW-COST TUNNEL DIODE

The first practical low-cost tunnel diode—priced as low as 50 cents in large quantities—is on the market as the TD700 line. The new devices are available either in an axial lead package for conventional circuits or in pellet form for use in hybrid integrated circuits.

A combination of planar and thin-film fabrication techniques is the basis for the new line. The key development is a new technique used to form the tunnel junction with the germanium.

The TD700H line consists of high temperature germanium tunnel diodes which are designed to meet military specs and are capable of operating at 125° C. Both the TD700 and TD-700H lines are available with peak currents of 0.5, 1.0, 2.2, 4.7, and 10 milliamperes. General Electric

Circle No. 130 on Reader Service Card

RC GARAGE-DOOR OPENER

A new radio-controlled automatic garage door opener system, the "Genie Model 401", features a one-piece cover removable with a single screw for faster, easier access to the interior. It uses front mounting of all circuit components for easier servicing.

In addition, there is a built-in time delay for the garage light and a new streamlined housing. The control may be actuated by either push-button or by a small RC radio transmitter that may be carried in car, purse, or pocket.

The receiver uses nuvistors in a newly developed circuit which is said to provide increased reliability and longer life. Alliance

Circle No. 6 on Reader Service Card

COMPACTRON TEST ADAPTER

A new compactron tube test adapter, designed for measuring the cathode current of 6JS6 and 6JM6 horizontal output tubes in color sets, is now available as the Model 2712.

The unit provides alligator test leads running from the interrupted No. 2 pin of the adapter. When the test adapter is installed between tube and tube socket, the technician can measure cathode current and adjust the circuit to operate within specifications. Pomona Electronics

Circle No. 7 on Reader Service Card

MICROMINIATURE POT

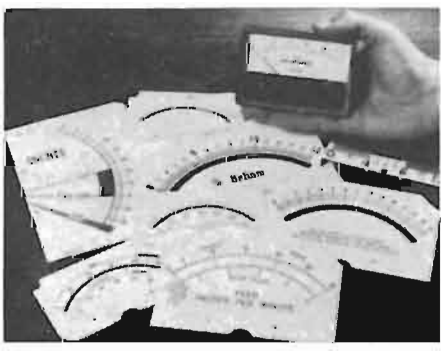
The Model 3282 microminiature adjustment potentiometer with "Palirium" resistance elements measures only 3/8" square and weighs approximately 0.1 ounce. The new unit provides infinite resolution, has a standard resistance range of 2000 ohms to 1 megohm, and an operating temperature range of −65° C to + 175° C. Resistance tolerance is ± 10% standard with closer tolerances available. The insulation resistance at 500 volts d.c. is a minimum of 1000 megohms.

The Model 3282 has positive wiper stops at both ends of travel and, to prevent damage from forced adjustment, the wiper assembly idles at both ends of travel. The model is available in five configurations and is guaranteed under the company's Reliability Assurance Program. Bourns, Trimpot Div.

Circle No. 131 on Reader Service Card

CUSTOM METER SCALES

A customized meter scale service which permits electronic equipment designers to indicate meter quantities such as MHz, dB, pH factor, etc.



is now being offered. In addition to the custom designations, the scale design may include the company name, logo, or trademark—all in a variety of printing colors.

The artwork from which the engravings are made is retained by the manufacturer so that the customer may reorder without delay. Information on this new service will be forwarded on request. Triplett

Circle No. 132 on Reader Service Card

HI-FI—AUDIO PRODUCTS

RADIO/RECORDER/PLAYER

The new "Radiocorder" functions as an AM radio, a tape recorder, and a tape player—all in a compact package weighing 5 pounds. It can be used to record directly from the radio, to play previously recorded tapes, for regular radio listening, and as a geneal tape recorder. Operation is by means of push-buttons. Since the unit operates on both batteries and household current, it can play and record anywhere. An added feature of the instrument is a dynamic microphone with remote control for taping "live" performances or party activity.

The unit uses standard size tape and may be operated at either 3¾ or 1⅞ ips. Each reel provides over two hours of playing time. The instrument measures 10" long x 9½" high x 4½" deep and comes equipped with recording and battery level meter and an outlet for use with extension speakers. Concord

Circle No. 8 on Reader Service Card

CONSOLE SPEAKER SYSTEM

The Model V is the latest addition to the "Concertmaster" line of speaker consoles. It features a 24-inch woofer (the 224MS) made of "polymer formulas", a cast aluminum frame, a 14-pound magnet of Alcomax II, and "Magnetic Suspension".

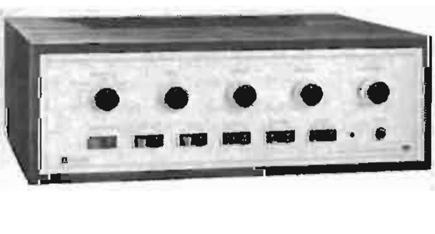
Frequency response is from 16 to 25,000 Hz with crossover at 350 Hz with a 12 dB droop per octave. The enclosure is treated with "Soundsorbers". The cabinet is of oiled rubbed walnut veneer and measures 39" high x 29" wide x 18" deep. Hartley

Circle No. 9 on Reader Service Card

SOLID-STATE STEREO AMP

The "Knight" KN-975 is a 75-watt stereo amplifier which incorporates all of the advantages of solid-state design. Twenty-one semiconductors are used in the circuit. With temperature-control convectors and a spacious chassis, all transistors operate at full efficiency.

Frequency response is 20-22,000 Hz ± 1 dB; harmonic distortion is less than 1%; hum and noise is −80 dB tuner and −65 dB magnetic phono; tuner sensitivity is 0.25 V. Inputs include: magnetic phono, tape head, tuner, aux. #1, aux. #2, tape monitor, while outputs are 4, 8, or 16 ohms; two high-Z to recorder; low-Z stereo headphones. Controls are bass, treble, balance, loudness-volume, hi-cut and low-cut, mono/stereo, tape monitor, loudness, speaker main/remote, and selector.



The amplifier measures 4¼" high x 13⅞" wide x 12¾" deep. Optional walnut wood and brown metal cases are available. Allied Radio

Circle No. 10 on Reader Service Card

130-WATT AM-FM RECEIVER

The Model TK-140 is a solid-state, AM-FM-FM stereo receiver with 130 watts of power and a number of new engineering features. According to the company, the four-gang FET front-end provides excellent sensitivity and image rejection. Five i.f. stages with four limiters and wide-band ratio detector provide 45 dB alternate channel selectivity and freedom from noise and interference.

Frequency response of the all-silicon-transistor amplifier is 20 to 30,000 Hz. There is automatic "stereo-mono" mode switching with a stereo light indicator, interstation muting circuit, a four-diode time-division multiplex circuit for 38 dB channel separation, and a patented blow-out-proof automatic circuit breaker to protect power transistors.

The "Feather-Touch" control panel incorporates a loudness control, tape monitor switch, muting circuit switch, and high- and low-filter switches. There are four sets of speaker terminals and a front-panel speaker selector switch.

The receiver is housed in a walnut-finished case which is included in the basic price of the instrument. Kenwood

Circle No. 11 on Reader Service Card

GUITAR AMPLIFIER

A fully portable, four-input solid-state guitar amplifier is now on the market as the "Caballero". The amplifier provides instant sound on either battery power or its own built-in a.c. power supply. It accepts up to four guitars or any combination of instruments and microphones simultaneously.

Output is 15 watts on battery and 50 watts on

a.c. with separate control and mixing of the four inputs. The amplifier also has bass and treble controls, a 12" speaker, and tremolo with speed and strength controls which may also be operated by a foot switch. The cabinet is of hardwood in black with gold trim and a blue and gold control panel. Sparks Communications

Circle No. 12 on Reader Service Card

SOLID-STATE SCA TUNER

An all-silicon, solid-state SCA multiplex tuner designed expressly for the background music industry has recently been introduced as the Model ST-300.

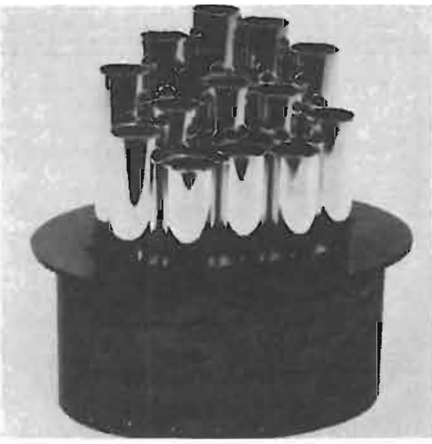
The new tuner features FET's in the front end. Double r.f. stages eliminate cross modulation and provide increased sensitivity and selectivity. Crystal-controlled oscillators eliminate frequency drift; all i.f. transformers contain silver mica capacitors for highest "Q"; a unitized circuit board is used for rugged, uniform construction; 100% electrostatic circuit shielding is provided; while an emitter-follower output permits both remote installation of the tuner and prevents possible component damage through error or short-circuit.

Detailed specifications on the Model ST-300 will be forwarded on request. Browning

Circle No. 13 on Reader Service Card

AUTO/HOME SPEAKERS

"Stereo Modulators", a new concept in auto/home speakers, are now on the market. Designed to replace conventional type speakers for use with tape cartridge systems or other electronic components, the new units consist of 13 frequency-tuned pipes. Each of the pipes, which



vary in length, reproduces a different frequency.

The "Modulators" have a frequency response of 40 to 13,000 Hz. Dimensions are 6¼" deep x 8⅜" wide x 10" high. Weight is 2 pounds. The units can be mounted in the auto's rear deck, between the rear seat and the back window, extending only a maximum of 5" in height and thus avoid cutting into doors where many conventional speakers are placed. Each kit comes complete with mounting plate and other materials needed for installation. Capitol Records

Circle No. 14 on Reader Service Card

WIDE-BAND AUDIO TRANSISTOR

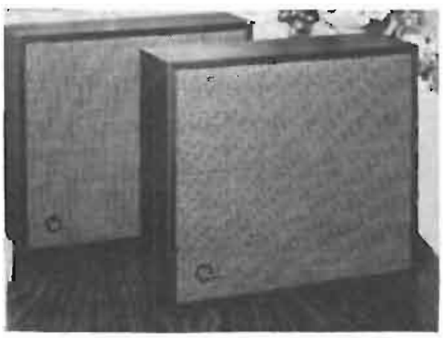
A new wide-band audio transistor with high gain, low distortion, and more than 1 watt of audio power handling capability is now available as the MM2264.

This "n-p-n" silicon "Annular" transistor has an extremely flat beta characteristic over the collector current range of 1 mA to 500 mA to insure linear amplifier operation in large signal audio applications. The company suggests its suitability for the audio output stages in radios, TV sets, and as driver transistors in higher power, high-fidelity entertainment circuits. Motorola

Circle No. 15 on Reader Service Card

SELF-ENERGIZED SPEAKER SYSTEM

The Model 4400 is a self-energized stereo speaker system consisting of two walnut speaker enclosures of bookshelf size. Each contains an 8" woofer and 3½" tweeter with crossover network.



The enclosures are acoustically matched to the speakers. A 60-watt solid-state stereo power amplifier is built into one of the enclosures. The amplifier feeds both speakers and comes with "on-off"/volume control, bass-boost switch, and stereo headphone jack.

Each speaker enclosure measures 16" x 14⅛" x 5" deep. Viking of Minneapolis

Circle No. 16 on Reader Service Card

200-WATT AMPLIFIER

A 200-watt all-silicon-transistor amplifier which may be operated from either a.c. or d.c. power sources is now in production as the Model 1590A. The new instrument is designed to provide full output with a 0.8-volt r.m.s. input. The circuit features an exclusive solid-state dissipation-sensing device which provides protection for any load impedance, including short-circuit, at any driving level. When the load is partially short-circuited, the driving signal is temporarily cut off if it reaches a level which endangers the output transistors. The amplifier recovers its normal function automatically as soon as the output fault is removed.

An engineering information data sheet on the Model 1590A is available on request. Altec Lansing

Circle No. 17 on Reader Service Card

HEAVY-DUTY 10" SPEAKER

A heavy-duty musical instrument speaker, designed specifically for use with guitars and organs, features a 20-ounce magnet and a 1½-inch voice coil. The speaker will handle up to 32 watts peak audio.

Total depth of the new speaker is only 3⅞" so that it will fit into most cases which originally housed speakers with 10-ounce magnets. Rubberized cone edges and cotton-covered, 66-strand voice-coil leads prolong operating life. Impedance is 8 ohms. Utah

Circle No. 18 on Reader Service Card

SOLID-STATE AMPLIFIER

The Model 6552-1 solid-state audio amplifier is designed for screen room use in performing audio frequency susceptibility tests per MIL-I-6181D, MIL-I-26600, MIL-STD-826, and other RFI specifications.

The unit has a wide frequency response and provides up to 100 watts at 1000 Hz into 2.4 ohms at low distortion levels. The unit requires 0.6-volt input for maximum power output at 1000 Hz. A feedback circuit is incorporated for flat response within 1 dB from 30 to 100,000 Hz at reduced levels. There is no output protective circuit.

The amplifier measures 8⅛" wide x 9" high x 14⅝" deep. Solar

Circle No. 133 on Reader Service Card

MULTICELL HORNS

A new line of multicell horns which incorporate six improvements over conventional horn structures is now on the market.

Among the new features are changes in the couplings between cells and electro-mechanical drivers; greater precision in the shaping and assembly of the cells; closer dimensional tolerance for the throat openings of individual cells; improved insulation; and horns fully enclosed on four sides to reduce vibration and prevent incursion of wind, rain, snow, and ice between the cells.

These new "Medallion" horns are offered in seven sizes from three to fifteen cells, with 20-degree angular dispersion per cell. DuKane

Circle No. 19 on Reader Service Card

MINIATURE AUDIO AMP

A miniature audio amplifier for use as a tape record, power, and line amplifier and as a mike preamplifier, tape playback, and magnetic cartridge preamplifier is now in production as the Model 614A. The unit is also suitable for use with hydraphones, accelerometers, biomedical sensors, and transducers.

The amplifier mounts in any standard nine-pin miniature tube socket or may be used with a printed-circuit board. It has a flat frequency response from 6 to 100,000 Hz ± 0.25 dB. With a 600-ohm source and 600-ohm load operating at 40 V, the open loop gain tested at 57 dB with noise at — 130 dBm. American Nucleonics

Circle No. 134 on Reader Service Card

PORTABLE P.A. SYSTEM

A solid-state personal, portable public-address system, the "Escort" Model 802, weighs only 9 pounds and measures 11½" high x 6½" wide x 14" deep. A low-impedance, 5½-ounce dynamic microphone is used with the system feeding a high-quality 8" cone speaker. There are two phone jacks for extension speakers and a tape recorder. Controls include an "on-off" switch

and volume control. The unit is powered by a self-contained supply using two 6-volt lantern batteries.

The system is housed in a vinyl covered luggage-type case with brass hardware. Van San Assoc.

Circle No. 20 on Reader Service Card

LOW-POWER AUDIO AMPLIFIER

A five-transistor, solid-state audio amplifier which can be used in low-power p.a. systems, as a guitar amplifier, in alarm systems, as a monitor or earphone amplifier, in science projects, or ham-radio applications is now on the market as the AA-100.

The amplifier, which measures 5½" long x 1¾" wide x 1" high, delivers 200 mW of power. Frequency response is 100-12,000 Hz with a distortion figure under 3%. The unit may be powered from any well-filtered 9 V d.c. source or can be operated from any 9 V battery capable of delivering 50 mW. A volume control is premounted on the circuit board. Round Hill

Circle No. 21 on Reader Service Card

CB-HAM-COMMUNICATIONS

SSB TRANSCEIVERS

The new "Single-Banders" provide high-performance SSB communications on 80, 40, or 20 meters; offer front-panel selection of upper or lower sideband operation; feature improved audio and a.v.c. response; provide microphone and gain control, plus bias adjustment on the front panel for convenience in changing from fixed to mobile operation.

The location of the front panel controls has been improved over earlier models to provide more convenient operation. The units are housed in modern, streamlined enclosures.

The "Single-Banders" provide a full 200 watts p.e.p. SSB fixed or mobile. Over 90% of the components are mounted on a heavy-duty circuit board for reliable performance. The receiver is a 14-tube superhet with 1 μV sensitivity, 2.7 kHz selectivity, and slow a.v.c. action for optimum SSB reception. The v.f.o. dial is calibrated in 2 kHz divisions. A crystal lattice filter produces identical characteristics for upper and lower sideband signals for clean transmitted signals, with the carrier and unwanted sideband at least 45 dB down.

The kit is available in 75 meter, 40 meter, and 20 meter models with mobile and fixed-station power supply kits also available as accessory items. Heath

Circle No. 22 on Reader Service Card

NAVIGATIONAL INSTRUMENT

A solid-state, transistorized marine navigational instrument which indicates at a glance speed, distance, depth of the bottom, and gas vapor leakage is now offered as the Model "300".

This compact unit features a unique modular circuit board for the various functions which enables the user to select the information best suited to his requirements. The boat speed and water depth information can be switched from normal scale to expanded scale when ultra-fine sensitivity is desirable. Another feature is the boat-speed through-hull fitting—a unique non-fouling water wheel—which is hydrodynamically designed to present almost unmeasurable resistance. Unipas

Circle No. 23 on Reader Service Card

100-mW TRANSCEIVER

An inexpensive 100-milliwatt hand-held transceiver with special applications in business, personal, and agricultural fields has been recently introduced.

This transceiver features a crystal-controlled superhet receiver with excellent sensitivity. Audio output is more than adequate to permit operation in noisy areas. There is a built-in battery meter for easy checking on battery strength and a rugged case, complete with leather carrying strap.

No license is required to operate this transceiver. E.F. Johnson

Circle No. 24 on Reader Service Card

SOLID-STATE CB RADIO

The Model J-23 Citizens Band radio comes complete with all 23 channels installed. Power output is 3.2 watts nominal from a 12.6 V d.c. source for 5 watts input. Modulation is 100% class B. The unit is designed to operate over a temperature range of −20 to +50 degrees F.

The radio may be used as a p.a. unit with an output of 2½ watts into a 3.2 ohm speaker. The receiver section provides adjacent channel rejection of at least 60 dB, spurious rejection of at least 55 dB, and 455 kHz i.f. rejection of 100 dB. Audio output is 2 watts at 0.3 mV 100% modulation. Audio response is 250 to 3500 Hz. A special automatic noise limiter provides positive noise elimination with no audio loss, according to the company.

The unit is housed in a heavy gauge all-aluminum enclosure which also contains a 2" x 6" oval speaker. An a.c. power supply is available for base-station applications. Sonar

Circle No. 25 on Reader Service Card

MANUFACTURERS' LITERATURE

R.F. CONNECTORS

A new 12-page illustrated catalogue (No. SC-1) covering the "SUBminax" 27 Series and 5116 Series of subminiature r.f. connectors is now available. Both screw-on and push-on coupling styles are offered.

Also included in the booklet is a section on coaxial cables which describes available dielectric and cable jacket combinations. Amphenol RF Div.

Circle No. 135 on Reader Service Card

TWO-WAY RADIO

A new 10-page illustrated brochure (No. TIC-2033B) detailing the advantages of the HT Series "Handie-Talkie" two-way FM radios has been published. Entitled "Instant Communications for Your Men on Foot," the booklet describes three basic models as well as a variety of accessories. Motorola Communications Div.

Circle No. 26 on Reader Service Card

INDICATOR LIGHTS

A complete line of one- and two-terminal subminiature indicator lights for translucent-panel edge-lighting applications is presented in a new 8-page illustrated catalogue (No. L-158F).

Also offered are light-emitting or inset lens top indicator lights and dimming and non-dimming lights with extended necks. Dialight.

Circle No. 136 on Reader Service Card

TV LENSES

More than 1000 different lenses, including zoom optics, cine camera types, and cine and slide-projector lenses, are listed in a new TV lens guide. The lenses range in size from ½" to 40", and the cover page of the guide gives tips on how to select and use lenses for various effects. Burke & James

Circle No. 137 on Reader Service Card

PRESSURE-SENSITIVE TAPE

A new full-color foldout brochure describing the entire line of pressure-sensitive "Curve-Line" tapes in handy dispensers is now available. This new product is especially suited for use on charts, graphs, and maps.

The selection includes glossy- and matte-finish tapes in a wide range of colors, fluorescent tapes in 4 colors, transparent tapes in 11 projectable colors, chrome and gold tapes, and 10 different projectable pattern tapes in 7 colors. Chart-Pak

Circle No. 27 on Reader Service Card

TEST EQUIPMENT

A complete line of test equipment is described and illustrated in a new 16-page 1967 catalogue. Included are tube testers, a solid-state color generator, an in-circuit capacitor tester, a v.t.v.m., a v.o.m., a component substitutor, and a signal generator. Mercury

Circle No. 28 on Reader Service Card

OPTO-ELECTRONIC DEVICES

A new short-form catalogue covering the company's line of "Raysistor" opto-electronic devices is now available. Raytheon

Circle No. 138 on Reader Service Card

FIBER OPTICS

The properties and applications of flexible optical fibers—glass fibers that may be bent or twisted without interruption of light transmission —are discussed and illustrated in a new 2-page data sheet. Corning

Circle No. 139 on Reader Service Card

MASTER RECORDER

A new 8-page illustrated brochure describing the features of the new all-solid-state Model AG-300 console recorder for master-recording applications in recording studios, broadcast stations, and school systems is now available. Ampex

Circle No. 29 on Reader Service Card

TAPE RECORDER CATALOGUE

A new 20-page illustrated 1967 tape recorder catalogue has been published. Featured are portable "sound cameras" for use by photographers, tape recorders with built-in radios for instant recording of broadcasts, cartridge units, conventional console types, and solid-state stereo tape recorders. Concord

Circle No. 30 on Reader Service Card

POTENTIOMETERS

More than 25 bushing-mount, servo-mount, and clock-face precision potentiometers are described and illustrated in a new 8-page short-form catalogue (No. 4).

In addition, the booklet lists a variety of accessories and special products, including turns-counting dials, adjustment potentiometers, time delays, voltage sensors, and microcomponents. Bourns, Trimpot Div.

Circle No. 140 on Reader Service Card

TOOL CATALOGUE

Over 1500 items are listed in a new 58-page illustrated catalogue (No. 266) of tools for electronic assembly and precision mechanics. Included are screwdrivers, wrenches, pliers, tool kits, drills, and soldering equipment.

The booklet also contains 4 pages of technical data on tool selection, known as "Tool Tips," which cover, in part, metal conductivity, color coding, wire and insulation data, temperature conversion, and drill sizes. Jensen

Circle No. 31 on Reader Service Card

MINIATURE COMPONENTS

A new 52-page engineering catalogue of miniature electrical and electronic components (No. G-304) has been published. Presented in the booklet is a wide selection of push-button and rotary switches, binding posts, test jacks, sockets, and module cases. Grayhill

Circle No. 141 on Reader Service Card

MICROWAVE EQUIPMENT

A new 8-page foldout brochure describing a line of components that can be employed in laboratory experiments and for evaluating the use of microwave energy in industrial processes has been issued.

Presented in the brochure is a variety of power packs, applicators, microwave hardware, and suggested test setups for lab experiments in the chemical and plastics fields. Eimac Div. of Varian

Circle No. 142 on Reader Service Card

OSCILLOSCOPES

A new 6-page illustrated brochure which describes a complete line of oscilloscopes and accessories has been issued.

The booklet covers two broad classes of instruments—plug-in amplifier types and built-in amplifier types. Single- and dual-beam oscilloscopes are available in both classes. Data Instruments

Circle No. 143 on Reader Service Card

FLUIDICS PUBLICATION

A new bulletin of interest to persons working in the technology of fluidics is now being published quarterly in newsletter form. The first issue of "Fluidics Forum" appeared in November.

The new publication will serve as a medium of exchange for ideas and experiences between users of fluidic systems and the company, and it will feature readers' reports and schematic drawings of significant fluidic applications. Fluidic Products Dept., Corning

Circle No. 144 on Reader Service Card

COLORIMETRY EQUIPMENT

Complete technical information on a line of quality-control instruments for appearance measurements is provided in a new 52-page illustrated 1967 catalogue.

Included are reflectometers, colorimeters and color-difference meters, glossmeters, special-purpose instruments, and visual color instruments. Gardner Laboratory

Circle No. 145 on Reader Service Card

PLASTIC POTENTIOMETERS

A complete line of precision conductive plastic potentiometers is presented in a new 12-page illustrated catalogue (No. K-1).

The components described in the booklet are available in standard resistances ranging from 500 ohms to 100,000 ohms, and all units can be provided with bushing or servo mounts. Keltron

Circle No. 146 on Reader Service Card

ELECTRONICS EDUCATION

A new 4-page illustrated brochure (No. S/R-1001) entitled "Today's Challenge in Electronics Education" is now available. The booklet describes a flexible program of training in electronics which can be planned to prepare high-school students for college or employment.

Courses in the program include all training aids, equipment, textbooks, and teacher training. Simpson Educational Systems

Circle No. 32 on Reader Service Card

TECHNICAL GLOSSARY

The revised second edition of the "Glossary of Instrument Terms" has been announced. The new 8-page booklet contains 155 technical words or phrases which are peculiar to electronics, electromechanics, theoretical mechanics, biophysics, and electrical engineering. Brush

Circle No. 147 on Reader Service Card

COMPONENT SUPPLEMENT

A new 16-page supplement to the 1965-66 component selector is currently being offered. Designed to bring the component selector up to date, the supplement contains new products that have been introduced by the company since the selector was published. Cornell-Dubilier

Circle No. 148 on Reader Service Card

RELAY CATALOGUE

Approximately 1700 different relays are described and illustrated in a new 50-page catalogue. The products are divided into 23 classifications, and complete engineering data is provided for all devices listed. Standard Relay

Circle No. 149 on Reader Service Card

COMPONENTS CATALOGUE

A complete line of single- and multi-turn wirewound precision potentiometers, Cermet trimming pots, non-wirewound precision pots, special devices, and dials is offered in a new 72-page color-coded illustrated catalogue. Helipot Div., Beckman

Circle No. 150 on Reader Service Card

RFI FILTERS

A new 16-page RFI filter catalogue has been prepared to help the design engineer select the proper filter for specific applications. The booklet contains the company's line of stock standard filters. Cornell-Dubilier

Circle No. 151 on Reader Service Card

ELECTRONICS STUDY COURSE

A new three-part self-study course in the fundamentals of basic electronics is now being offered. It is designed to give the user a general familiarization with electronics and is also suitable as a refresher course.

Three separate handbooks are offered, covering general fundamentals, fundamentals of electronic tubes, and fundamentals of semiconductor devices and molecular electronics.

The complete three-handbook study course costs $3.00 and is available from Basic Electronics Course, Westinghouse Electric Corp., Printing Div., Box 398, Trafford, Pa. 15085. Orders should specify handbooks SA-9498, SA-9498 Pt. A, and SA-9498 Pt. B. ▲

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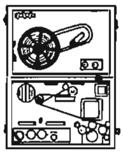

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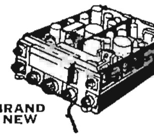

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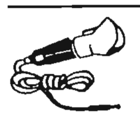

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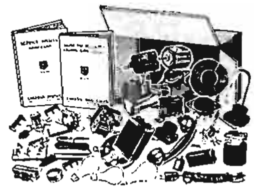

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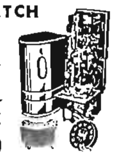

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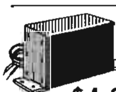

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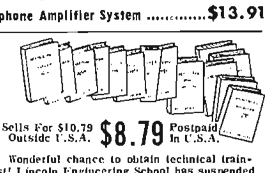

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DC Amperes:	0-10 at 250 Mv.
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