Electronics World

AUGUST, 1966
60 CENTS

RADIATION MEASUREMENTS IN SPACE

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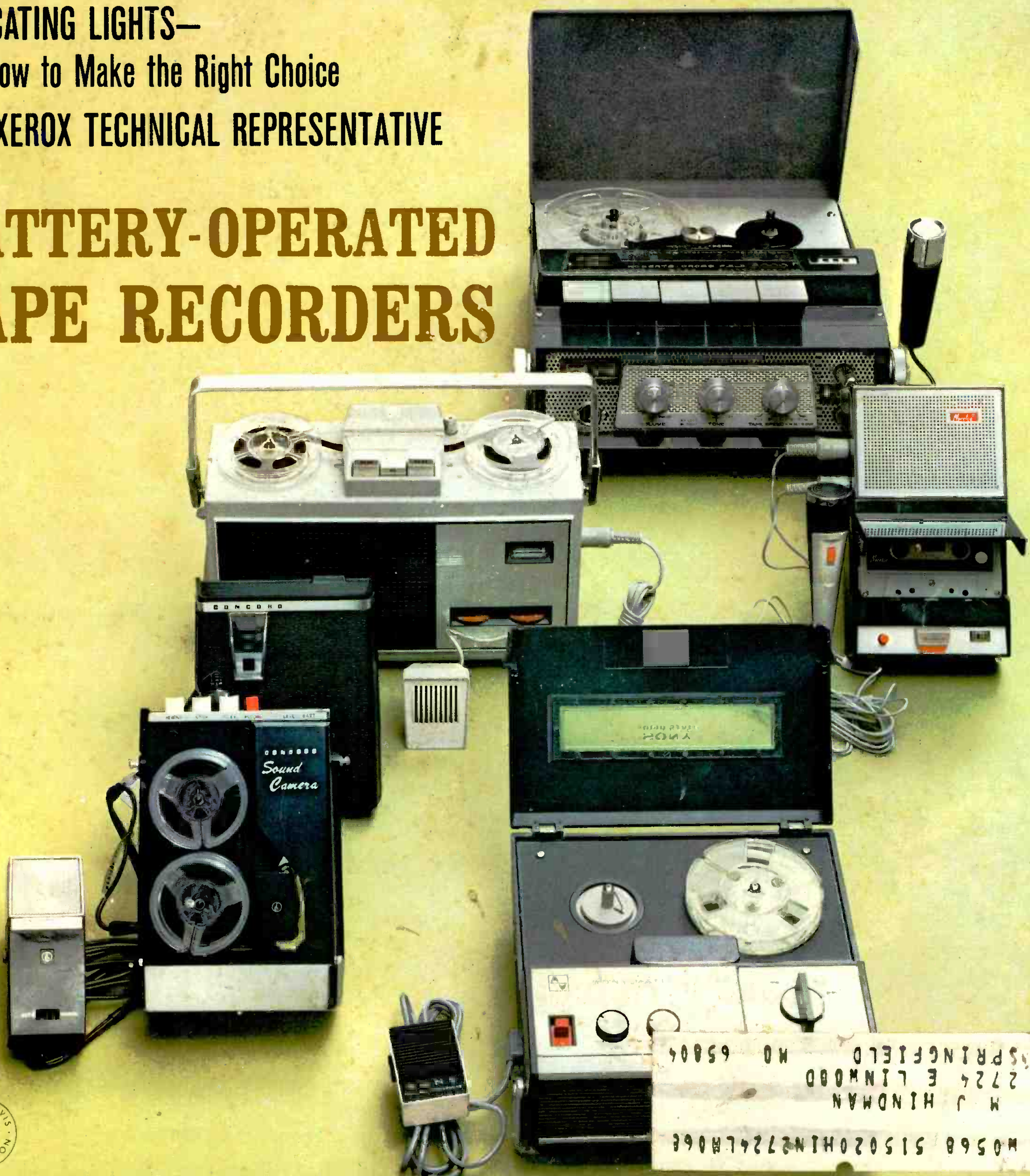
INDICATING LIGHTS—
How to Make the Right Choice

THE XEROX TECHNICAL REPRESENTATIVE

BATTERY-OPERATED TAPE RECORDERS



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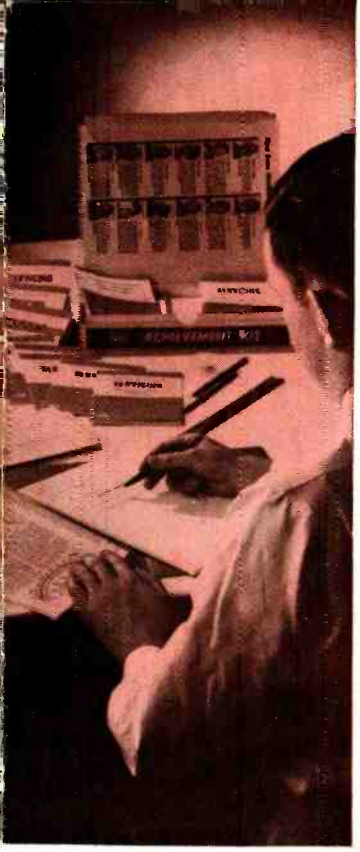

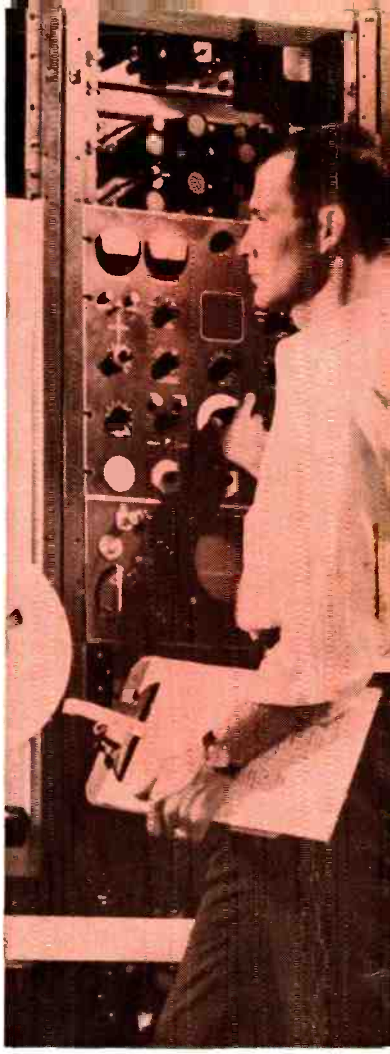

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At that rate, it's a multi-million dollar a year business... for burglars.

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Why? Because burglary can be stopped...with an effective alarm system.

In fact, police and insurance officials have proved that an alarm system reduces, and in many cases, eliminates losses—even helps police apprehend the criminal.

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Only a small percentage of the more than 100 million buildings—stores, offices, factories, schools, churches and homes are protected by an effective alarm system.

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In the past six years, thousands of RADAR SENTRY ALARM units have been sold in the Detroit, Michigan area alone—sold by men like yourself on a part-time and full-time basis.

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So take advantage of your profession! Put your technical knowledge and experience to work for you in a totally new area—an area that will make money for you!

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EW-8

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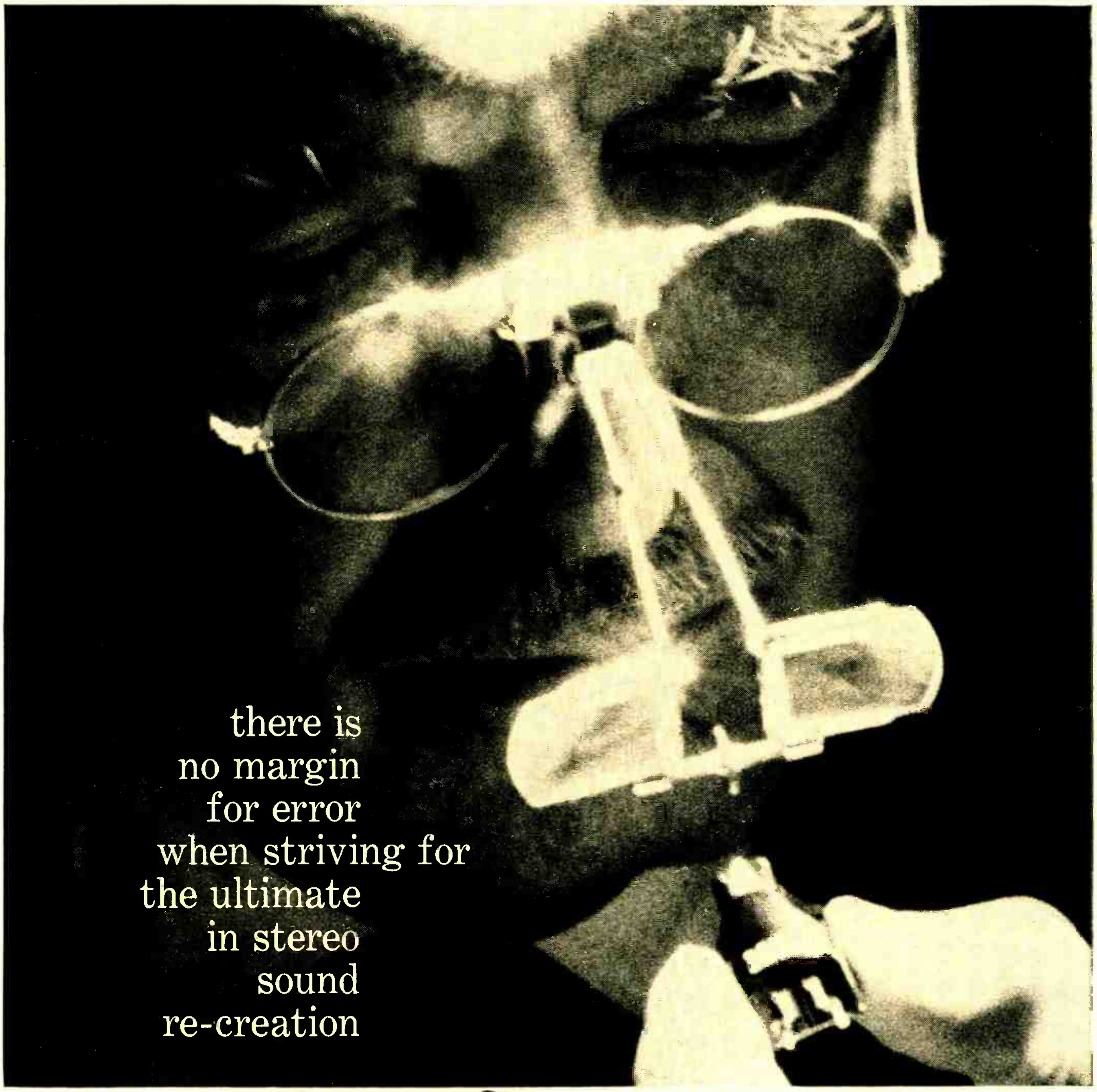
there is
no margin
for error
when striving for
the ultimate
in stereo
sound
re-creation

THIS MONTH'S COVER shows a selection of five battery-powered tape recorders currently available. Progressing clockwise starting at the lower left are: the Concord F-85 "Sound Camera"; the Norelco 101; the Roberts 6000; the Norelco 150; and the Sony 6000. These five are only a small sample of a number of better-quality battery-powered tape recorders whose characteristics are covered in directory form in this issue. These machines run the gamut from restricted-range voice recorders to high-quality units suitable for broadcast use. They come either as monophonic or stereo systems and each is complete within itself, carrying its own power source and microphones. Their light weight makes them ideal for field use. Photo: Bruce Pendleton

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CONTENTS

MONTHLY FEATURES

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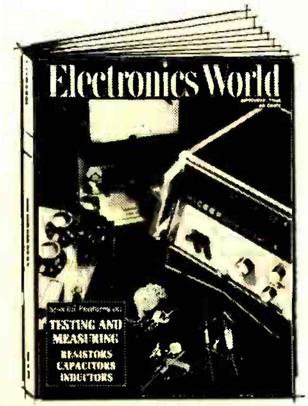
COMING NEXT MONTH



DESIGNING SILICON-TRANSISTOR HI-FI AMPLIFIERS
The first article of a three-part series by R. D. Gold and J. C. Sondermeyer of RCA covers the advantages of silicon power transistors in power output and driver stages. Subsequent articles will deal with design and performance parameters and practical circuits.

TESTING & MEASURING INDUCTORS
The methods and equipment used to measure inductance, self-resonance, distributed capacitance, and "Q" of air-core and iron-core coils are covered in this in-depth article by Sam Zwass of Triad.

SELECTING THE PROPER SWITCH
Switch materials and design are important factors in circuit performance. Bernard Golbeck of Oak outlines selection criteria and provides pertinent data on various materials used in switches.

TESTING & MEASURING CAPACITORS
R. C. Lynds and D. Quimby of Cornell-Dubilier discuss performance tests, instruments used to run such tests, and permissible tolerances for all types of capacitors in this comprehensive and informative article.

MEASURING INSTRUMENTS FOR ELECTRONIC COMPONENTS
A wide variety of general-purpose and special-purpose test equipment is available for measuring resistors, capacitors, and inductors. Fred Van Veen of General Radio sets forth guidelines for making a suitable choice for the job at hand.

TESTING & MEASURING RESISTORS
What the previously listed articles do for inductors and capacitors, this article by Fred Stern of IRC does for the resistor. In concise form, the author outlines various tests designed to insure performance within specifications.

TIME DOMAIN REFLECTOMETRY
John D. Lenk describes a useful laboratory technique for measuring transmission-line characteristics by means of a step generator and an oscilloscope.

*All these and many more interesting and informative articles will be yours in the **September** issue of ELECTRONICS WORLD . . . **on sale August 18th.***

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NEW YORK OFFICE 212 679-7200
James J. Sullivan
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MIDWESTERN OFFICE
307 North Michigan Avenue
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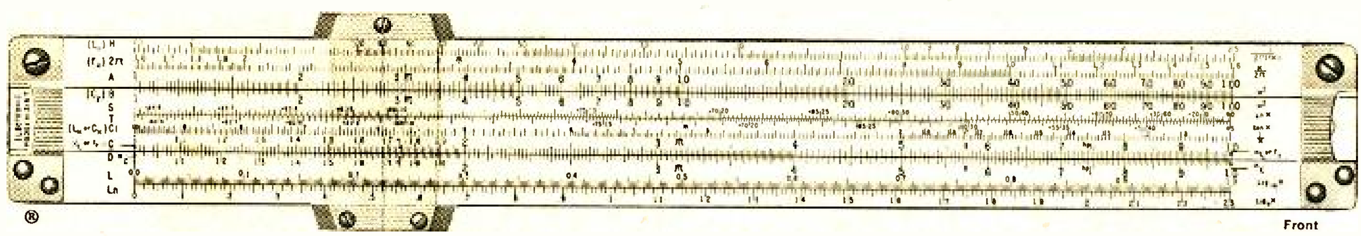
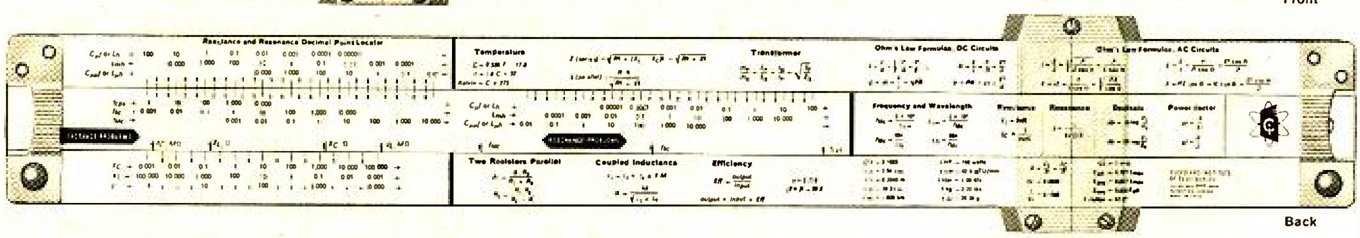


Front



Back

SOME DAY EVERYONE in electronics may have a slide rule like this. Till then, the man who uses one will seem like a wizard as he solves reactance and resonance problems in 12 to 20 seconds —*without pencil and paper*.

This is a professional slide rule in every detail, a full 10" long, made exclusively for Cleveland Institute of Electronics, to our rigid specifications, by Pickett, Inc. It can be used for conventional computation as well as special electronics calculations. All-metal construction assures smooth operation regardless of climate.

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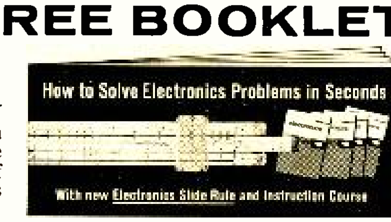

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For the record

WM. A. STOCKLIN, EDITOR

ELECTRONIC SALES SETTING RECORDS

IN our editorial of March 1960, we predicted that this decade would go down in history as "The Electronic Decade" and shortly thereafter, in October, we referred to "The Soaring Sixties."

It seemed obvious at that time that the electronics industry would continue to set records, but little did we realize the degree of growth that would be attained. Factory sales of electronic products are expected to reach a fantastic total of $19.3 billion this year. Thus, in only seven years, sales will have more than doubled the $9.2 billion total in 1959.

According to Dr. Harper Q. North, president of EIA, "Business in electronics is booming." This year's sales should exceed 1965's record by 11.5% and, if the present trend continues, EIA's 5-year forecast predicting a $21 billion level will be reached in 1967 instead of 1968.

All segments of our industry showed growth. However, the greatest increase is in the consumer products area, with $4.43 billion sales predicted in 1966 compared with $3.67 billion in 1965. This represents a 20.7% growth.

Color television, of course, is playing the major role in setting new all-time sales records. EIA's most recently revised forecast estimates that about 5.4 million color-TV sets will be sold this year. This will be double the 1965 record. For the first three months 942,000 color sets were sold compared with 481,000 for the same period in 1965. Even black-and-white TV sets have been holding their own with 1.9 million sold during the first three months of both 1965 and 1966.

The sale of color-TV sets has sparked the entire components industry. Total component sales will be up 9.6% over 1965, replacement components up 2.4%.

Industrial electronic sales will be up 14.2% this year over 1965 and sales of electronic equipment to the government is running at an increased rate of 7%.

Optimism persists throughout the entire industry. It was evident at the IEEE Show in New York in March; at the Hi-Fi Institute Show in Los Angeles in April; and, more recently, at the National Electronics Week (NEW) Show in San Francisco in June.

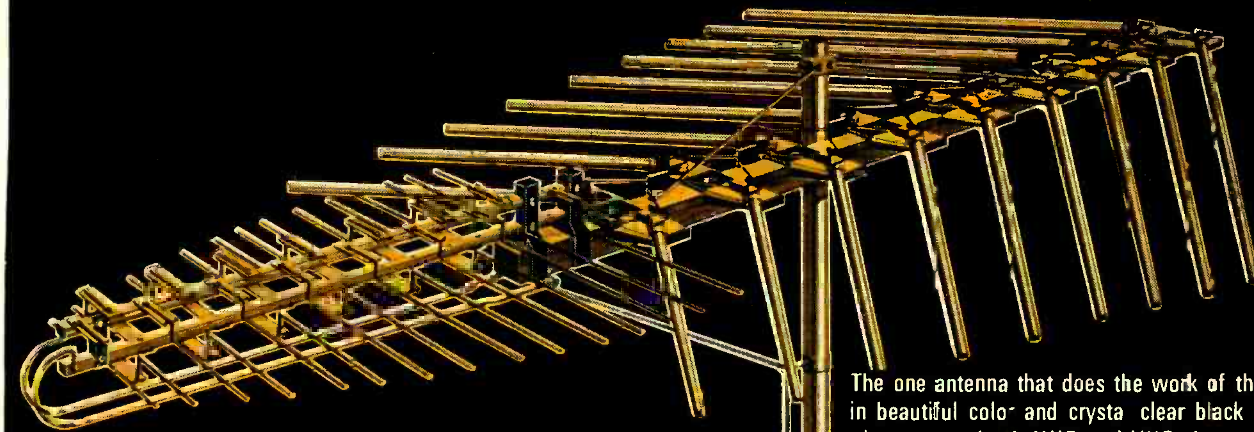
All three shows were extremely well attended, but those who had hoped to see developments of major importance or break-throughs were, for the most part, disappointed. Certainly there were changes but most of them were relatively insignificant. Of some importance was the realization of the potential markets for video-tape machines for the home and industry, and audio-tape cartridge machines for cars and boats. Most of the products themselves showed no major changes over last year, but the realization that these will add two new segments of tremendous potential to our industry is significant. It is inevitable that in any period where there is a sellers' market not much is done to redesign or develop new products.

The NEW Show, however, served a dual function. In addition to the normal exhibits, the show sponsored, under the direction of Gail Carter of NEDA, a "Profit Forum." Four simultaneous educational programs designed for electronic distributors, manufacturers, and their sales representatives took up a full day. Many of our industry's leading executives covered such subjects as modern information systems; descriptions of available business machines; explanation of a new data processing system for instant order handling; new concepts in merchandising; along with special sessions on selling. In addition, a panel of management consultants offered advice on such subjects as inventory and data processing; product control; business analysis and pre-planning; executive development and training.

This is the second year in which these Profit Forums have been presented and they were extremely well attended.

With any accelerated growth similar to what we have encountered in the past few years, problems do arise. Manufacturers are faced with expansion, automation, cost reduction, and employee training problems. Parts distributors are confronted with similar problems and also those unique to their type of operation. It is in this area that the NEW Show played a vital role.

In order for our industry to grow, it is necessary that all segments—management, sales, distribution, and manufacturing—progress simultaneously. All the help that we can get in these areas will be needed to make this decade "The Soaring Sixties." ▲



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75 OHM Model CX-UVF-24 $72.10 List

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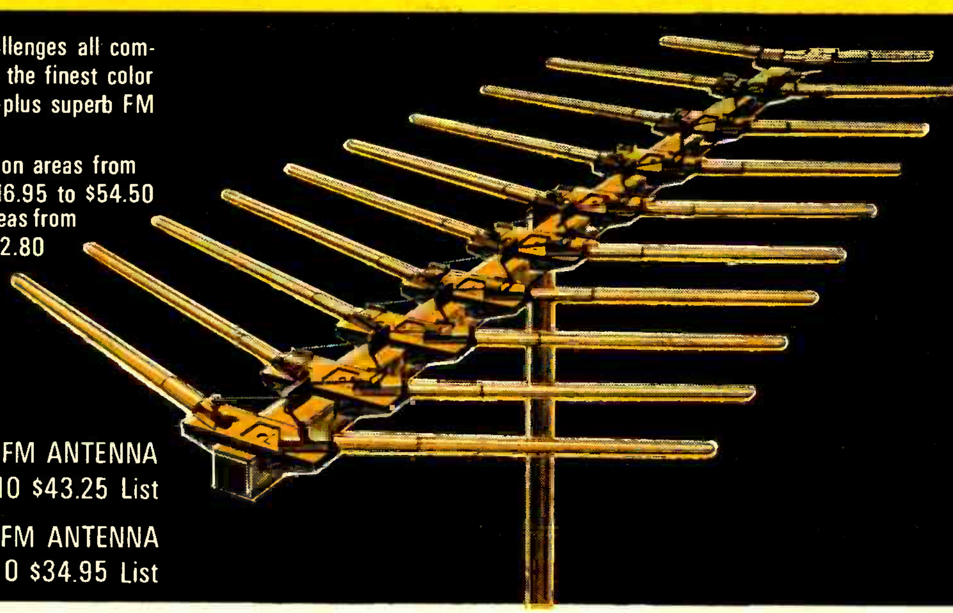

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FREE! ALL FINCO CX-VL, CX-UVF AND UVF ANTENNAS COME WITH A FREE INDOOR SET-MOUNTED TRANSFORMER, VHF-UHF TRANSFORMER SPLITTER OR VHF-UHF SPLITTER.

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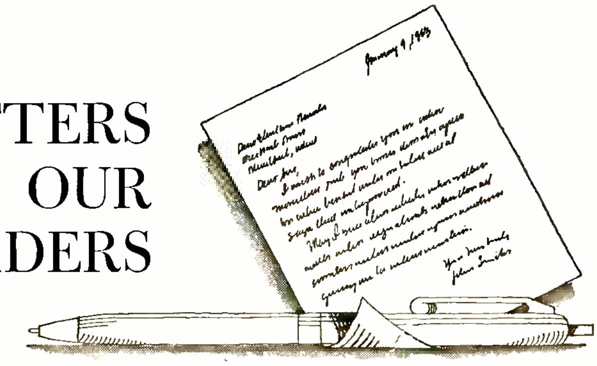
LETTERS FROM OUR READERS



TESTING DIODES

To the Editors:

I enjoyed reading the article "Testing Diodes" by Donald Ludwig (January, 1966, p. 95). Here on the Atlantic Missile Range, computers are an everyday working tool. These computers use millions of diodes of all types; therefore, a thorough knowledge of testing techniques is valuable to the technician who is required to maintain these complex devices. Don's article contributes to this knowledge with a direct, practical approach.

The subject of diode testing brings to mind an interesting experience that happened recently while a friend and I were building a limiting amplifier for a local radio station. Since the station had a fully equipped work area, we started construction with a blank chassis and a handful of components. For diodes, we selected (from the station's spare parts drawer) a number of 1N34's. Using an ohmmeter we checked forward resistance, reversed the diode to read backward resistance—and the meter needle deflected *backward*, against the peg! The same thing happened on *all* the diodes we checked: forward reading—OK; reverse reading—impossible.

At home that evening, I measured one of the diodes—forward resistance was less than 100 ohms; reverse resistance, 65,000 ohms. Obviously, our v.o.m. at the station was defective, I thought, so tomorrow I'll take my own with me.

The next day at the station, using my own meter, the same thing happened—forward resistance OK, although somewhat less than 100 ohms; reverse reading, needle pegged backwards.

Putting this resistance problem aside, we built the limiting amplifier, installed it, and checked it out. It worked perfectly (even though our 1N34 diodes measured strangely).

About two weeks later, while building an s.w.r. meter for my amateur radio station, the answer to the diode problem was found. We had neglected to consider the strong r.f. field at the radio station. Since the station's workshop was within 100 feet of its antenna, 1000 watts of power induced a considerable voltage into the v.o.m. leads. This induced voltage was rectified (by the diode under test) and effectively converted our ohmmeter into a field-strength meter, giving us the mysterious reverse-pegged meter indication.

On closing, I wish to comment on your selection of fine articles that appear every month. These articles, along with your over-all editorial policy, will keep your publication on my bookshelf for a long time to come.

FRANK J. LUTZ, JR.
Satellite Beach, Fla.

° ° °

R.M.S. POWER

To the Editors:

Why do you, along with so many other technical publications, persist in using the fictitious, non-existent term "r.m.s. power" when what you really mean is *average power?* When you measure the r.m.s. voltage across the loaded output of an audio amplifier, square it, and divide by the value of the load resistance, your result is *not* r.m.s. power at all: it is simply *average* power.

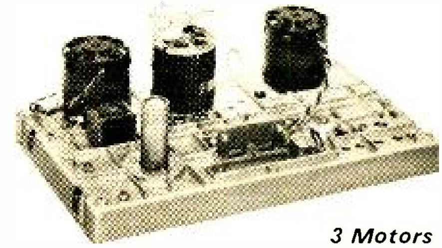
After all, the whole concept of r.m.s. voltage and current was developed in the first place to obtain effective values of voltage and current that would produce the same average heating effect or power as do similar values of d.c. voltage and current.

JOHN MURRAY
San Francisco, Calif.

Strictly speaking, Reader Murray is correct, and we prefer the more technically correct term "average power" or "continuous power." However, in a few cases, we have gone along with a good many hi-fi manufacturers in using the term "r.m.s. power" just to make sure that the reader understands that this is the power calculated from the value of r.m.s. rather than average voltage and current.

While we are on the subject, we would also like to point out that what many in the audio-recording industry call "peak power" or "power on peaks" is not instantaneous peak power (which is double the average power for sine-wave signals). A vu recording meter, for example, does not indicate and cannot follow instantaneous peaks but rather

How To Get A $570 Stereo Recorder For $400



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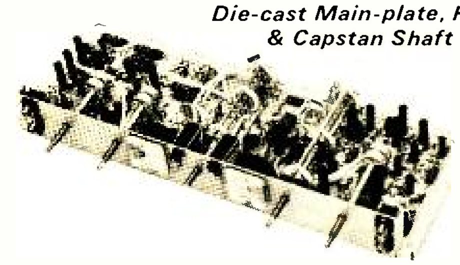

All Solid-State Electronics . . . Record 4-Track, Stereo-Mono, Sound-On-Sound, Sound-With-Sound & Echo!

Build The New Heathkit®/Magnecord® 1020!

You Save $170!

Thanks to Heath, you can now save $170 on the new Magnecord 1020 4-Track Transistor Stereo Tape Recorder by building it yourself. And the only difference between this Heathkit version and the original is the $170 you save (think of all the tape you can buy with that!).

All parts are made at the Magnecord factory . . . under a quality control system that meets the demanding requirements of the National Aeronautics & Space Administration (NASA).

Add to this Magnecord's years of pioneering and developing tape equipment for the broadcasting and recording industries, and you have a sophisticated recorder that will give you years of professional quality and reliability.

Professional Recording Facilities

With the 1020, you can record "live" from microphones, or from auxiliary sources like tuners, phonographs, TV's, etc., and playback . . . in 4-track stereo or mono at either 7½ or 3¾ ips. And you can make sound-on-sound, or sound-with-sound (mixing) recordings, or create interesting echo effects.

Professional Tape Transport

The tape transport is powered by 3 separate motors. The hysteresis synchronous capstan motor has a dynamically balanced flywheel and a ballbearing inertial stabilizer mount for constant, accurate speed. Two permanent split-capacitor type motors drive the reels. With the convenient push-button controls, you can change operational modes instantly and gently with the touch of a button. Compliance arms insure correct tape tension at all times.

The military-type differential band brakes are solenoid operated for instant, gentle stops. And when the tape runs out an automatic switch shuts off all motors and retracts the tape pressure roller eliminating unnecessary motor wear and prevents deformation of rollers. The tape gate and pressure roller also are solenoid-operated for positive action.

3 Professional Tape Heads

Selectable ¼ track erase, record and play. Engineered and lapped to a precise hyperbolic curve for smooth low frequency response . . . made with a deep gap, deposited quartz for high frequency response and long life. Removable shields afford double protection against external magnetic fields. Protective, snap-mounted head covers provide easy access for cleaning and de-magnetizing. And for quick, accurate editing, there are center-line marks.

Other Professional Features

All parts mount on a thick, die-cast main-plate that won't warp, reduces wear, provides rigid support and stable alignment. Two V.U. meters for visual monitoring of signal levels from either tape or source . . . allows quick comparision of source with recorded signal. Inputs for microphones and outputs for headphones are all front-panel mounted for easy access. Digital counter with push button reset. Low impedance emitter-follower outputs deliver 500 millivolts or more to amplifier inputs. Individual gain controls for each channel. And all solid-state circuitry . . . 21 transistors and 4 diodes . . . your assurance of cool, instant operation, long reliable life.

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Prices and specifications subject to change without notice. HF-194 *averages its readings during "peak" levels. Perhaps we should use the term "average power on peaks" to be more strictly correct.—Editors*

° ° °

LOW-COST INTEGRATED CIRCUITS

To the Editors:

Just a short note to express my appreciation for a fine magazine, at least during the seven years in which I have been supplementing my electronics background from it, and to point out an error in what to me was an extremely useful article in your March, 1966 issue by Donald E. Lancaster on "Using New Low-Cost Integrated Circuits." The error appears on p. 80, Fig. 7B, in the diagram for the frequency-to-voltage converter and was discovered when I was unable to make the circuit function as drawn. On referring back to the monostable circuit on p. 52, Fig. 4B, I was able to make the necessary correction to the one on p. 80, which I can best describe by renumbering the μL914 connections as follows: 1, 2, 3, 4, 7, 6, 5, 8.

Otherwise, the article has been very useful, especially the section on using the μL914 as a differential amplifier. I cascoded two of these to use as a low-level d.c. amplifier, differential input and output, and was surprised with its stability.

Thank you again for an excellent publication.

STEPHEN MCCORMICK
Univ. of Minn. Medical School
Dept. of Psychiatry & Neurology
Minneapolis, Minn.

° ° °

OSCILLOSCOPE PREAMP

To the Editors:

In the description of an oscilloscope preamp by E. N. Smith in your February, 1966 issue (p. 84), there seems to be an error in the input attenuator which does not hold to decade ratios throughout. Also, I cannot seem to locate the TI415 and TI416 transistors specified.

R. C. ANNEN
Coraopolis, Pa.

There was an error in the parts list involving the input attenuator of the circuit. Resistor R12 should be 15,000 ohms rather than 1000 ohms as shown. This resistor is effectively in parallel with R10 and R11 as well as with the input impedance of Q1, resulting in a total impedance of around 10,000 ohms. As mentioned in the text, this is not a precision decade attenuator but it does give excellent results with close-tolerance standard resistor values.

The Texas Instruments TI415 and TI416 transistors, since the article was first published, have been reregistered under the numbers 2N3707 and 2N3708, respectively. These are readily available from any TI distributor or from Allied Radio.*—Editors* ▲

HI-FI PRODUCT REPORT

TESTED BY HIRSCH-HOUCK LABS

"Knight-Kit" KG-415 "Superba" Tape Recorder
Electro-Voice Model 619 Microphone

"Knight-Kit" KG-415 "Superba" Tape Recorder

For copy of manufacturer's brochure, circle No. 26 on Reader Service Card.

THE "Knight-Kit" KG-415 is a highly flexible, attractively styled 4-track stereo tape recorder, sold in kit form by *Allied Radio Corp.* of Chicago. Although its price ($249.95) is higher than that of many factory-assembled tape recorders, it is much less expensive than any comparable recorder in assembled form.

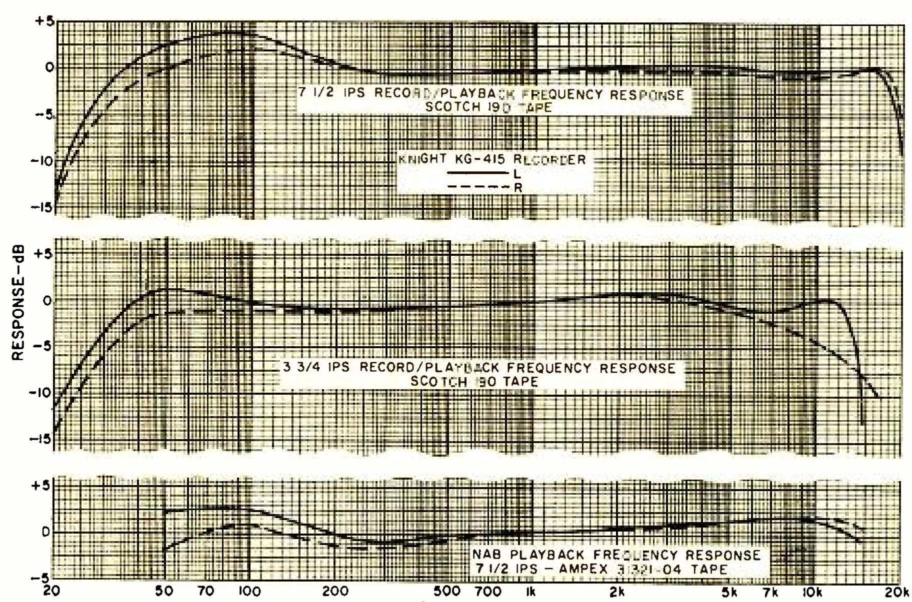
The deck of the KG-415 is a two-motor mechanism, manufactured by *Viking of Minneapolis, Inc.* It is supplied assembled and tested. The electronic portions of the recorder are fully solid-state, constructed in modular form on six plug-in printed boards. The kit builder mounts and solders the components on the boards and wires the main chassis with its various switches and controls.

The capstan is driven by a four-pole induction motor through a flutter-filter belt. A separate motor drives the two reels. The 2-pound capstan flywheel is dynamically balanced. The brakes, which operate on supply and take-up reels simultaneously, are mechanically controlled and can bring the tape up to speed or to a halt in 0.2 second.

The performance of the KG-415 can be credited, in a large measure, to its hyperbolic-contour, laminated quarter-track heads. Having three heads (erase, record, and playback), plus separate record and playback amplifiers, the recorder allows monitoring off the tape while recording. This highly desirable feature is not often found in moderate-priced recorders.

The tape speeds are 7½ and 3¾ ips. A separate amplifier-equalization switch must be set to agree with the tape speed. The unit will handle reels up to 7" in diameter. The transport mechanism is controlled by a pair of concentric knobs. The outer, circular knob is used for fast-forward and rewind functions. Normal play is initiated by the inner bar knob. When this knob is turned counterclockwise, the recorder is set up for cueing. The tape contacts the heads, but is not in motion. The reels can be turned by hand to locate any specific point on the tape for splicing, editing, or cueing purposes. A red push-button in the center of the transport control knob must be pressed in to record. A three-digit counter with push-button reset also assists in locating passages on a reel of tape.

The amplifiers have inputs for microphones and high-level lines. The line input impedance is 50,000 ohms and 100 millivolts is required for a "0-vu" recording level. The microphone inputs have a 3000-ohm impedance and require a 1.5-millivolt signal. Each channel has separate line and microphone recording level controls, permitting mixing of the two signal sources. The channel playback level controls are also separate.



There are two sets of outputs from the recorder. The "Output" jacks are permanently connected either to the record or playback amplifiers. The "Monitor" jacks are connected either to the record or playback amplifiers by a front-panel "Monitor" switch. A stereo headphone jack on the panel is also connected to the "Monitor" outputs. When properly interconnected with an amplifier or receiver having tape-monitoring facilities, this allows the user to instantly compare the signal coming out of the recorder with the input signal. In addition to insuring against inadvertent errors in recording (which would be immediately apparent in the "Monitor" outputs), this feature permits a very convincing evaluation of the quality of the recorder. The slightest degradation of the signal by noise, distortion, or alteration of frequency response is revealed by such a comparison. There are separate "Source" level adjustments to match the "Monitor" signal levels so that they do not change when the "Monitor" switch is operated from "Source" to "Playback."

The twin illuminated "vu-type" meters read the signal level in the monitor channel. With the front-panel switch set to "Source," they read recording levels; in "Playback" they read playback amplifier levels.

Special effects are possible without any patching through external cables. A front-panel switch allows sound-on-sound recording (mono only) in which one channel is recorded onto the other, with added program material. Another position of this switch adds echo to a recorded program, in easily controlled amounts.

The function selector switch has six positions: left and right playback through both outputs, stereo playback, left and right recording, stereo recording. A row of illuminated windows indicates the selected mode. To make recordings, the switch must be in one of the record positions and the red safety interlock button on the transport controls must be pressed after the tape is in motion. An indicator lamp glows when recording. Pressing the safety button while the recorder is in a playback mode will not erase the tape, nor will this occur if the switch is in a record mode as long as the button is not pressed.

A unique feature of the recorder is its built-in adjustment and test facilities. It has a 1000-Hz oscillator, controlled by a switch on the rear of the unit, which is used as a test signal for setting the correct bias and erase signal levels. The recorder's own "vu" meters are used when optimizing bias current for a particular type of tape. The instructions are simple, yet explicit—insuring realization of the full potential of the recorder.

Our laboratory measurements con-

(*Continued on page* 62)

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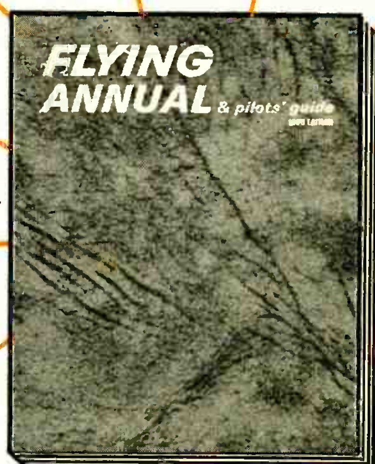

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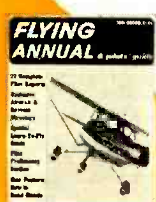

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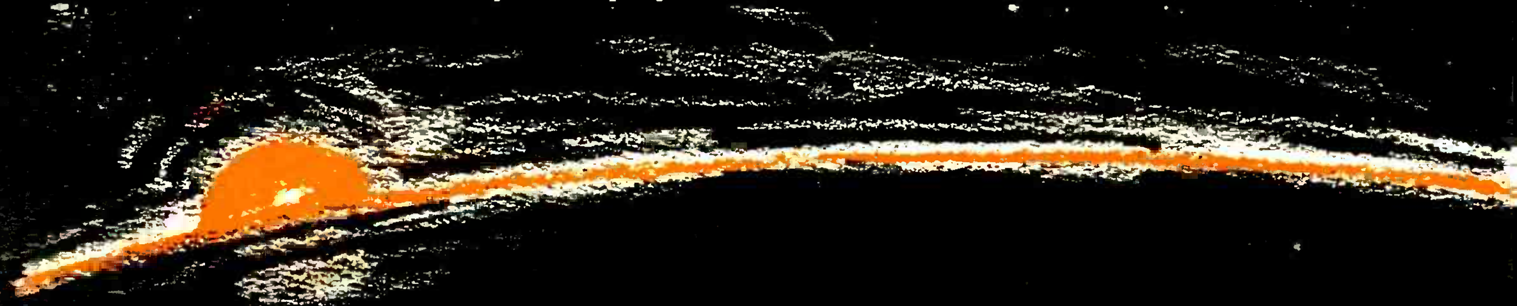
RADIATION MEASUREMENTS IN SPACE

By JOSEPH H. WUJEK, Jr.

Many types of radiation are encountered in space. Here is a description of the most commonly encountered along with the techniques employed in their detection and measurement.



IN 1896, the French physicist Henri Becquerel observed that certain substances emit radiations. A photographic plate which had been stored close to some uranium salts became fogged, as though partially exposed. From this observation Becquerel deduced that the uranium was radiating particles, or rays, which caused the photographic exposure. Two years later, the French scientists Pierre and Marie Curie succeeded in isolating a minute amount of radioactive radium from tons of pitchblende ore. Here, then, was the dawn of what writers have since called the Atomic Age.

Kinds of Radiation

Alpha (α) particles are ions of helium having a positive charge of +2. *Beta* (β) rays are free electrons, not bound to a nucleus, which have a charge of −1. *Gamma* (γ) rays may be thought of as high-energy x-rays and are uncharged. A proton is a particle of +1 charge having a mass approximately 1840 times greater than that of an electron.

Hydrogen is normally composed of atoms which have one proton and one electron as shown in Fig. 1A. An isotope of hydrogen is deuterium, which has a nucleus consisting of one proton and one neutron, and an electron outside the nucleus (see Fig. 1B). Isotopes are simply atoms of the same element which have a different nuclear mass due to the presence of more or less neutrons. Neutrons are uncharged particles which have a mass nearly the same as that of protons. An atom of deuterium which has had its electron removed is called a deuterium ion, or deuteron (see Fig. 1C). Ions of heavier elements are also found in space. One other particle also of interest in space research, the positron, has a mass equal to that of an electron but is of opposite charge, +1.

Space Radiation

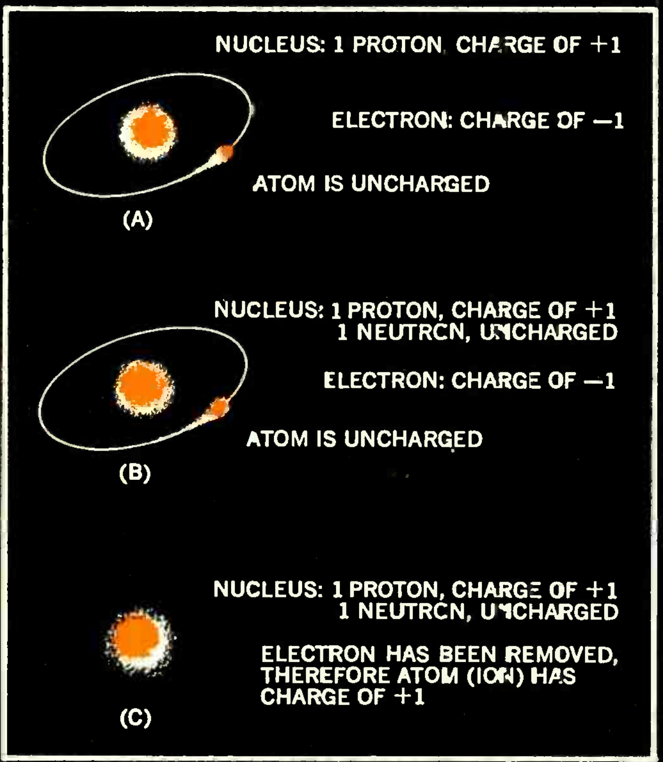
In broad terms, types of radiation may be classified as follows:

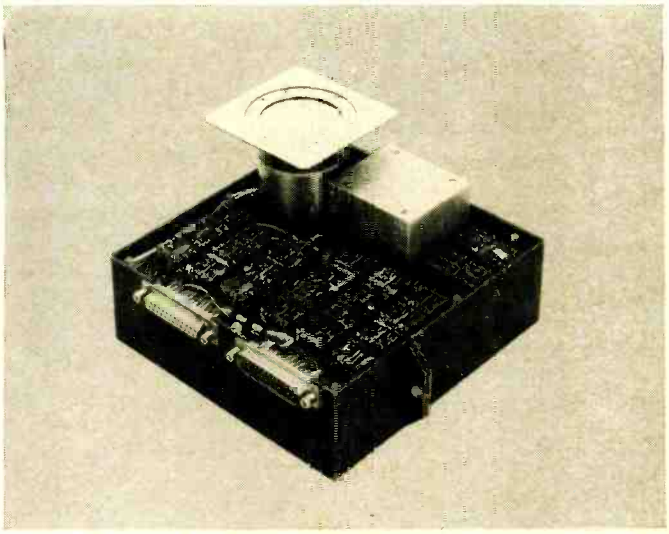
Primary Cosmics. These are particles and rays which bombard the earth from deep space. Fortunately, most of the cosmic showers are attenuated by the earth's atmosphere. Cosmic rays are a collection of protons, deuterons, *alphas*, electrons, *gammas*, positrons, and nuclei of atoms.

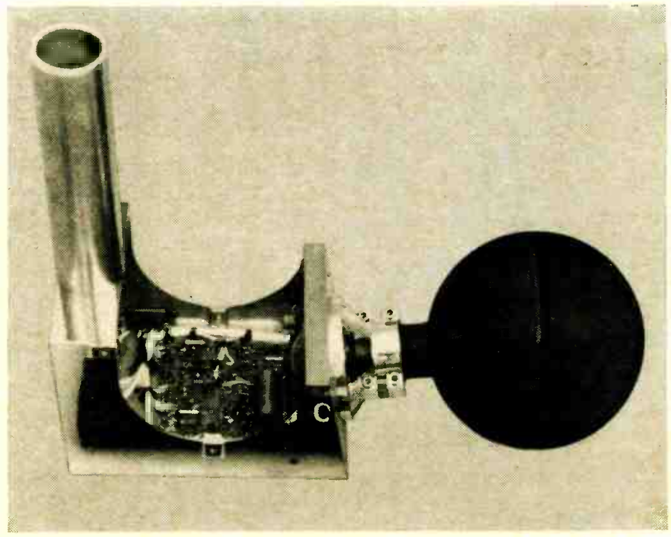
Solar Particles. These particles emanate from the sun and vary in quantity (flux) as the sun is "quiet" or "stormy." The composition is similar to primary cosmics but normally includes x-rays as well.

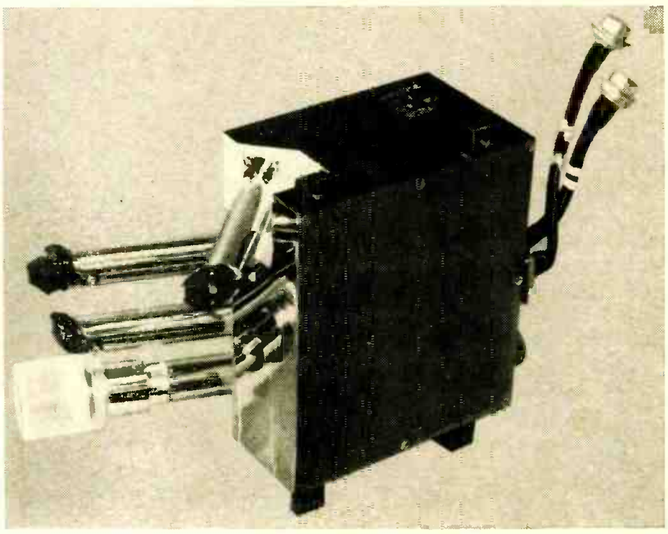
Trapped Radiation. This refers to the now-famous Van Allen belts, named for the State University of Iowa physicist who first propounded them. The belts are maintained by the action of the earth's magnetic field upon protons and electrons. Inner and outer belts are known to exist, and each is roughly doughnut-shaped, with weaker fluxes above the

Fig. 1. Variations of hydrogen. (A) Simple hydrogen atom. (B) The hydrogen isotope deuterium. (C) Deuterium ion or deuteron.









Radiation experiments carried in Mariner-IV (Mars) satellite. (Above left) Cosmic-ray telescope using solid-state detectors. (Above) Ionization chamber experiment using a five-inch stainless-steel sphere. (Bottom left) Trapped radiation experiment.

earth's poles. The belts were discovered by Explorer I in 1958.

Solar Wind. The solar wind is a swarm of protons, electrons, and possibly ions of heavy atoms which forms a lengthy plasma.

In measuring space radiation, the experimenter ideally seeks to determine what kind of particles are present, how many particles pass through a given area in a given time, from what direction in space the particles emanated and in what direction they are headed, and the energy and speed of the particles.

The energy unit most commonly used in nuclear physics is the electron-volt (eV). One electron-volt is the energy imparted to an electron when accelerated through one volt of potential. Thus, an electron which is accelerated from cathode to plate of a 15-kV electron tube has an energy of 15,000 eV, or 15 keV. An electron accelerated across one million volts has one million electron-volts (1 MeV) of energy. In space, particle energies of a few eV to about 10^{20} eV are present, but instruments are limited as to the energies which may be resolved.

The results of measurements are usually displayed as a spectrum, such as the hypothetical plot shown in Fig. 2 which illustrates electron flux. From Fig. 2, note that on the average, for a given direction, there are 1000 electrons of 1-MeV energy crossing an area of one square centimeter every second. From plots such as these, scientists can obtain some insight into what is happening in a given region of space.

Having thus discussed what it is we are trying to measure, let us see how these measurements are obtained. As is the case with magnetic measurements ("Magnetic Measurements in Space," January, 1966 ELECTRONICS WORLD), laboratory apparatus is often adaptable to space work after certain modifications aimed at reducing weight and power, and improving reliability. Since the equipment undergoes shock, vibration, and acceleration from the rocket (which, along with satellites and deep-space probes, is used to record radiation in space), experiment packages must be rugged. Temperatures may range from −50° to +160°F and may even go outside these limits. Thus, the demands placed upon space equipment are far in excess of those placed upon ordinary laboratory apparatus.

Measurement Techniques

A typical radiation-measuring experiment is illustrated by the block diagram of Fig. 3. Such an experiment may contain many similar channels and these may be interconnected to obtain a particular result. The transducer used for radiation detection converts the event of a particle striking the device into an electrical signal. Some means of signal amplification is usually required. If the signal is of the digital variety, *i.e.*, a series of discrete pulses, these pulses are counted and stored in a chain of flip-flops or magnetic-core memories. If the signal is an analog function, the pulses can be amplified and fed into the telemetry (TM) system directly. Some detectors put out a signal which is both analog and digital. The presence of a digital pulse indicates that a particle is striking the detector, while the amplitude of this pulse is proportional to the energy of the particle.

Detectors

Geiger-Mueller (GM) Tube. The Geiger-Mueller (GM) tube or "Geiger counter" is perhaps the simplest of all detectors. A GM tube consists of a cylinder or sphere of thin-walled conductor, with a thin wire passing through, and insulated from, the wall. Several hundred or a few thousand volts potential is maintained between the wire and wall, as shown in Fig. 4A, and the cylinder is filled with a gas, usually neon or argon. A high-energy particle passing through the wall creates a trail of positive ions and electrons. These ions and electrons are then accelerated to the negative and positive terminals, respectively. As they are accelerated, they produce more electrons and ions, or secondaries. An electrical discharge between wire and wall results, which appears as a voltage pulse. The GM tube requires little power and can be built for reliability and ruggedness. However, there are disadvantages. The GM tube does not distinguish among *alpha, beta,* or *gamma* particles, x-rays, or protons. The thin walls of the tube do not permit low-energy particles to penetrate into the tube interior, which limits the tube to high-energy applications. Also, the output pulse gives no information on the energy of an incident particle. Still another limitation is the relatively long duration of the output pulse. Even with the addition of so-called quenching agents to shorten the discharge time, a pulse duration is typically in the tens of microseconds. Hence, if two particles arrive up to tens of microseconds apart, they will not be resolved as two distinct events. The GM tube thus saturates at high counting rates (high flux levels).

Proportional Counter. By reducing the voltage bias of the arrangement shown in Fig. 4A, a proportional counter may be built. The voltage discharges are small and confined to a short distance along the central electrode. The pulse duration is also reduced so that particles arriving less than one microsecond apart may be resolved as two distinct events. Output pulse amplitude is proportional to the energy of an incident particle, and particle energies can be "sorted out" by the amplitudes of the pulses they produce. However, to take advantage of the proportional counter, a very stable power supply and very high gain amplifiers are required.

Ionization Chamber. Using the same mechanical arrangement of Fig. 4A but filling the tube with a gas at some higher pressure, say 50 pounds per square inch, results in an ionization chamber. Here, a few hundred volts bias the detector but not enough to produce secondary ion/electron pairs. The output current is then directly related to the total energy of the particles which arrive in a given time span. These currents are quite small, usually less than a tenth of a nanoampere, and no energy sorting of particle distinction is possible.

Scintillator. When radiation strikes certain kinds of materials, a flash of light results at the point of impact, and the material is said to fluoresce or scintillate. These flashes of light may be as long as a few milliseconds or as short as a few nanoseconds, depending upon the material. Common types of fluorescing material are cesium iodide, sodium iodide, anthracene, and polystyrene. The light flash is converted to an electrical pulse by a photomultiplier (PM) tube. The PM tube consists of a series of electrodes, called dynodes, with several hundred volts potential across each. The light energy striking the cathode causes electrons to be emitted by the photoelectric effect, as in the familiar photoelectric tube. The high potential causes the electrons to be accelerated to the first dynode, where their high velocity "kicks" out more electrons in an avalanching effect. The next pair of dynodes multiplies the process, and so on, until the final dynode collects more electrons than were emitted from the cathode.

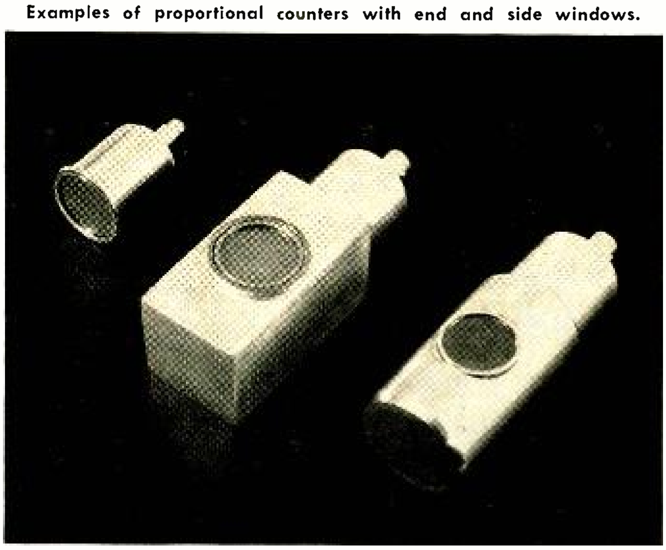
The output pulse amplitude of the PM tube is proportional to the energy of an incident particle. Hence, by sorting pulses according to their amplitudes, a spectrum may be obtained.

Cerenkov Detector. When a charged particle moves through a transparent material at a speed faster than the speed of light in the material, a cone of light follows the particle. This is known as the Cerenkov effect. Note that the speed of light in the material is, in general, slower than the speed of light in a vacuum. The pulse of light is nearly proportional to the energy of the incident particle, so when the pulse is detected by a PM tube, energy sorting may be accomplished. Common materials used for Cerenkov counters are Lucite, Plexiglass, and lead glass. Lead glass is used to detect *gamma* radiation. The incident *gamma* generates pairs of electrons and positrons, which, in turn, produce the light cone.

Solid-State Detector. Recent developments in the semiconductor art have led to the solid-state detector. This device is composed of *p-n* junctions which are sensitive to protons and electrons and which appear as solid-state ionization chambers. An incoming proton or electron generates hole/electron pairs at the junction which then move through the crystal as in an ordinary semiconductor diode. Several types of detectors are now manufactured, including the surface-barrier, diffused-junction, and lithium-drift devices. Such devices have the advantage of requiring lower voltage bias supplies than other common detectors. They require little power and can be expected to have long lifetimes in a space environment.

Other Detectors. In addition to the principal types of detectors described above, there are (*Continued on page* 72)

Examples of proportional counters with end and side windows.



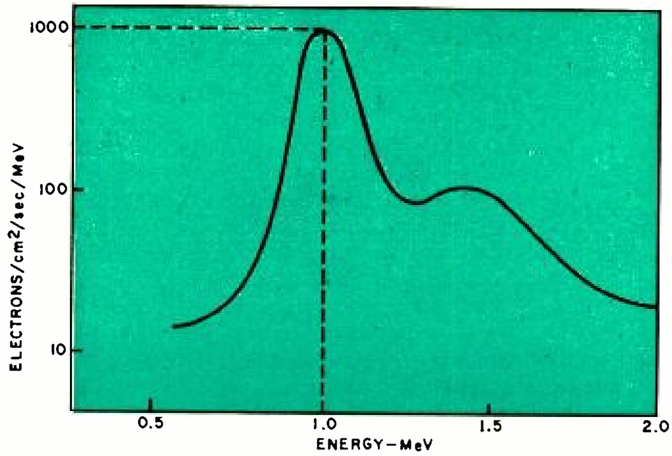


Fig. 2. Hypothetical spectrum shows that, on the average, 1000 electrons of 1-MeV cross one square centimeter every second.

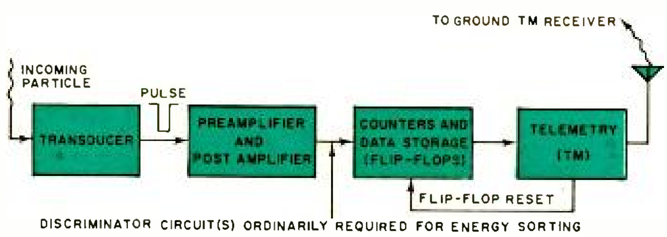
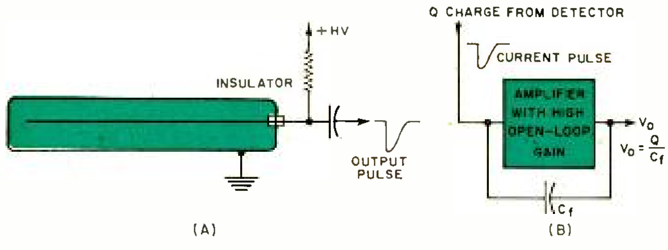
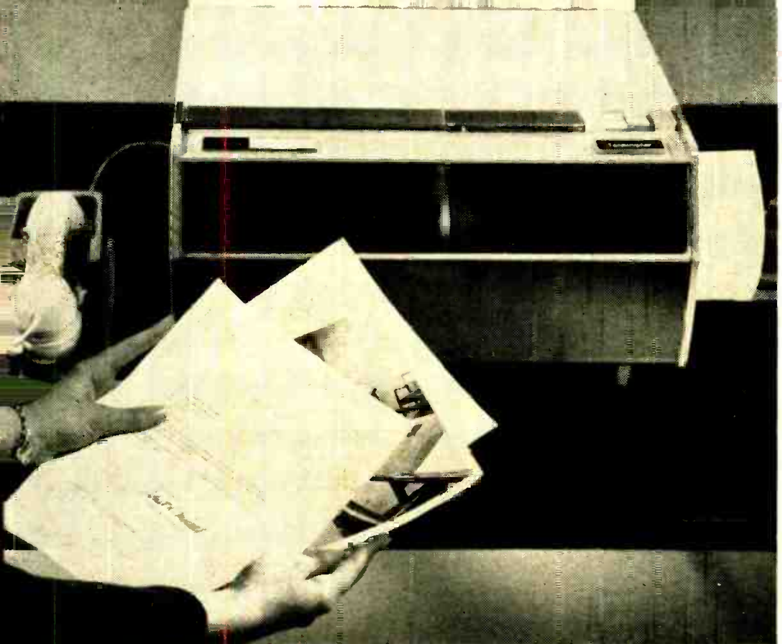
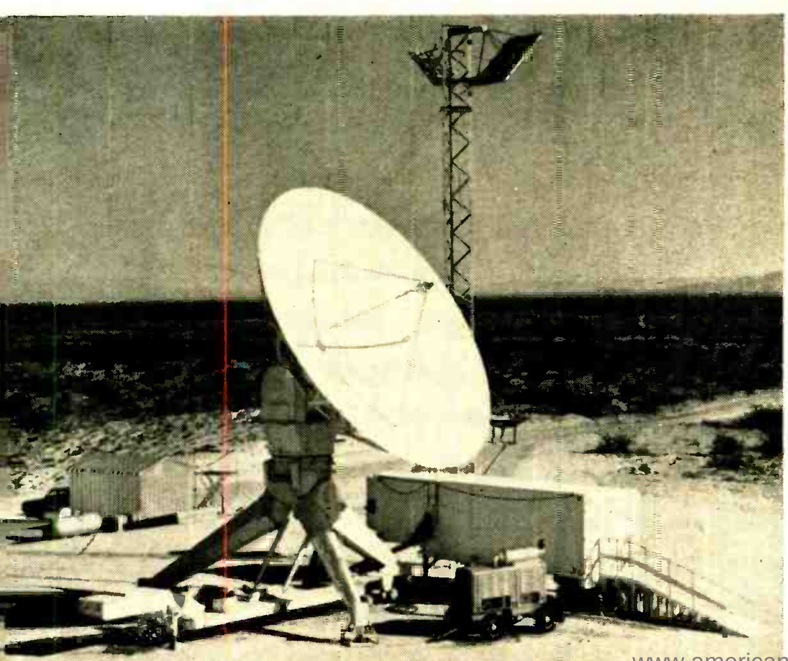


Fig. 3. Signal flow of typical radiation-measuring experiment.

Fig. 4. (A) A basic particle detector. (B) A charge amplifier.







RECENT DEVELOPMENTS IN ELECTRONICS

Facsimile by Telephone. (Top left) Letters, photos, business forms, and other documents can be transmitted and received with an ordinary telephone and a portable facsimile device recently introduced. The unit can transmit an 8½-in by 11-in document any distance—producing a copy on ordinary paper at the other end of the line in six minutes—just by placing a conventional telephone handset into the unit's acoustic cradle. The device, called the "Telecopier," weighs 50 pounds and is slightly larger than an office typewriter. The machine was developed and manufactured by Magnavox and is being marketed, installed, and serviced by Xerox. Initially, the unit will be leased to the user. The copier is a continuous-scanning facsimile transceiver in which a focused light source illuminates the document placed on a rotating drum. Reflected light passes through a chopper disc to a photocell. The resulting signals are converted into frequency-modulated audio that is transmitted over the phone lines. At the receiving end, two mechanical styli make contact with carbon-backed paper on which the picture is reproduced by pressure changes.

Automated Opera Stage. (Center) Stagehands at the new Metropolitan Opera House, opening this fall in New York, will use TV sets to tell how far the curtains are open on a dark stage. Feedback voltage from curtain-position potentiometers (connected to curtain-opening motors) produces a white horizontal line on the TV set which indicates the curtain opening. The positions of inner sets of curtains are also shown on the same display by means of other lines. The $45.7 million opera house will have one of the world's most automated stages. A winch system using 109 10-hp d.c. motors will be used to raise and lower scenery. The motors are driven by 30 SCR drive circuits. Large movable stages, weighing between 15 and 30 tons, are controlled by variable speed drives using adjustable frequencies. The stages can be set offstage, then wheeled on automatically. The entire system has been designed for the Met by Cutler-Hammer.

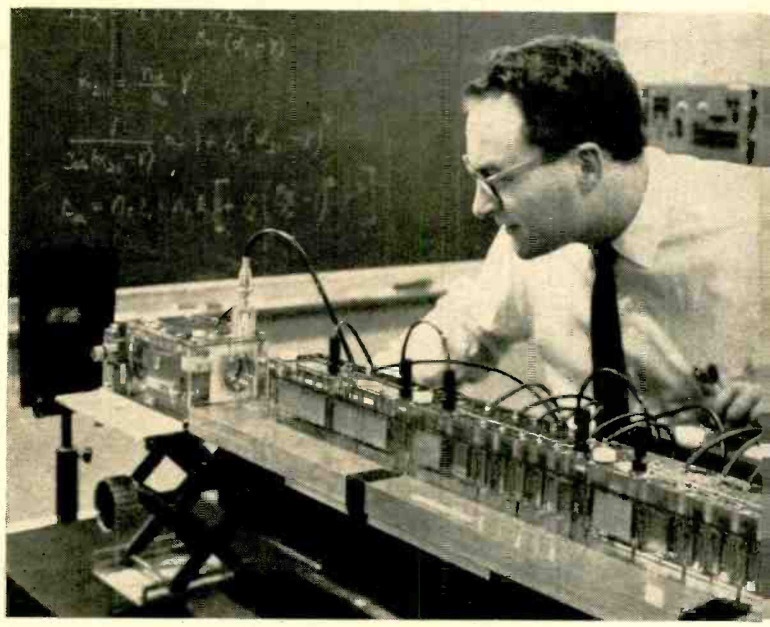
Mobile Radar System. (Bottom left) The mobile radar station shown here has been delivered to the U.S. Army by Sylvania recently. The station will be used as part of Project Defender, a program exploring defense against missiles and developing penetration aids for U.S. missiles. The system uses microwave and ultra-high frequency links to maintain communications between two sites. It consists of two 30-ft diameter dish antennas and vans with radar receivers and recorders.

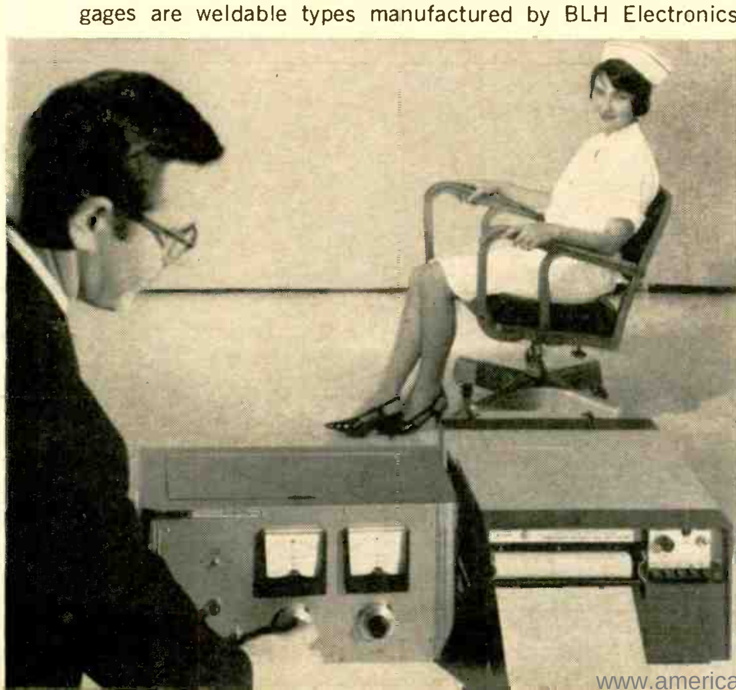
Ultrasonic Traffic Detectors. (Top right) The group of ultrasonic detectors shown are the first hardware to be delivered under a $5.4 million contract for New York's City's automated traffic control center. The radar-like devices use inaudible ultrasonic waves to detect the presence or motion of any type vehicle. Mounted above or to the side of a thoroughfare, each unit can cover one, two, or three traffic lanes. The aboveground location makes installation and maintenance less costly than devices located in the street. The compact detector uses solid-state circuits for high reliability. New York City has 1100 of the detectors on order from Sperry Gyroscope. Similar devices have been ordered for Pittsburgh, Houston, and Baltimore.

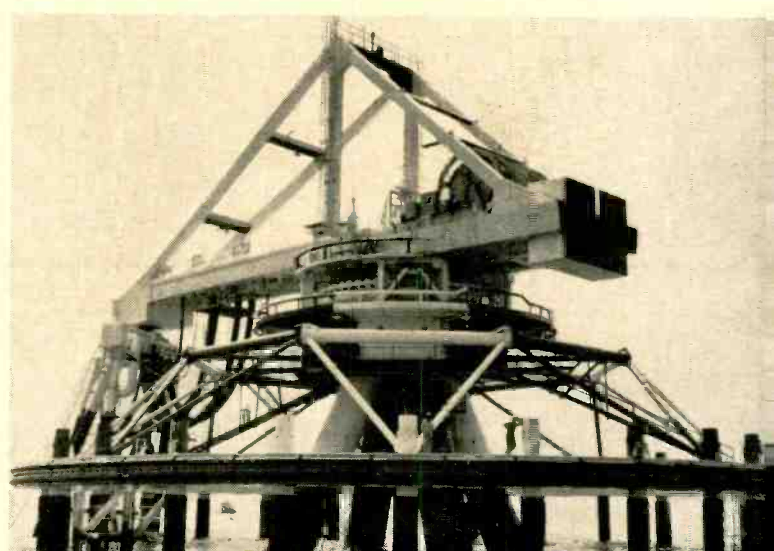
Digital Laser Light Deflector System. (Center) A new digital light deflector system that can position a laser light beam to any of 131,072 points at speeds exceeding 100,000 selections per second has been delivered to the U.S. Army Electronics Command, Fort Monmouth, by IBM. The equipment is experimental and is aimed toward use in automatic data systems for combat forces. The deflection technique permits the beam of light to be precisely focused on 131,072 distinct points within a space smaller than a match head. Deflection is accomplished by a series of electronically controlled crystals. Potential uses include print-out devices, display systems, and data handling.

Instrumented Medical Chair. (Below left) Physiological information can be obtained from a patient sitting in a new automatic medical monitor chair. No sensors are attached to the patient at all. Instead the upholstery of the chair contains a series of electrical pickups which serve the same purpose as the technician's paste and strapped-on electrodes. These pickups check pulse rate, respiration, heart sounds and impulses. The system includes a chart recorder on which all this data is displayed. The patient need only be seated comfortably in the chair, with his hands resting on conductive armrests. The monitor, designed by Philco scientists, would enable a busy doctor to have at his fingertips information that normally would require the services of a medical technician and the time-consuming use of a stethoscope, electrocardiograph, and other clinical instruments.

Strain Gages Check Offshore Oil Loader. (Below right) Semiconductor strain gages are attached to the various structural members of this offshore oil tanker loading tower in Libya. These gages are used with associated electronic equipment to determine actual stresses put on the tower by heavy seas and a moored tanker. The system is operated only during rough weather, during which time oscillographic recordings are made of the various stresses that occur. Analysis of the recordings showed that sea forces and inertial forces from a moored tanker were not enough to weaken or destroy the main tower components. The gages are weldable types manufactured by BLH Electronics.







RECEIVER NOISE MEASUREMENTS

By IRWIN MATH / Frequency Electronics Inc.

Basic approach to measurement of receiver and converter noise figures, along with some simple noise generators.

WHEN attempting to measure the sensitivity of a receiver or converter, especially one operating in the v.h.f. region, serious consideration must be given to the *noise figure*. It is this noise figure that is the true measure of the ability of the device to detect weak signals.

Normally, converters or receivers are aligned by simply adjusting them for maximum gain. This procedure is fine for the lower frequencies up to about 20 MHz or so, because here atmospheric noise and man-made noise are the primary limiting factors on sensitivity. Above 20 MHz, however, these sources of noise become minor and the over-all sensitivity of the receiver becomes dependent on the internal noise generated by the vacuum tubes, transistors, and other components. By measuring the noise figure of a device then, and by adjusting it for *maximum gain at the minimum noise point*, the best over-all sensitivity can be realized.

The two major sources of noise present in a v.h.f. receiving setup are *thermal* or Johnson noise, which is primarily generated by the antenna, and *shot* noise, which is generated by random electron motion in the vacuum tubes, transistors, and diodes of the receiver. Since all noise is produced by the random motion of free electrons, the greater this motion, the greater the noise. Thermal noise is generated by this random motion in a resistive element. Therefore, because an antenna is, and has, a definite radiation resistance, it will be a source of noise. Shot noise, on the other hand, is generated by the random motion of the electrons which leave the cathode and migrate to the plate in a vacuum tube and which flow through the semiconductor junctions in transistors and diodes.

When adjusting a receiver or converter, then, it is important to obtain the lowest additional noise (that is, the noise generated by the receiver itself). Let us now look at a method for determining the noise performance of a device.

The term "noise figure" refers to the ratio of actual output noise power available to that which would be available from an absolutely perfect device with a noise figure of 0. If we then measure the output noise of a receiver with the antenna terminals connected to a resistor equal to the input impedance, and then feed in a known amount of noise to double the output, we can then estimate the noise figure.

Noise Generators

Although there are many devices that can be used as noise sources, we will employ the diode because of its simplicity. By experimentation, it was found that the noise produced by a diode (especially tungsten filament vacuum ones) is almost directly proportional to the current flowing through it. This fact holds true up to about 300 GHz where components used in the noise generator become lossy and tend to reduce the accuracy of the device.

Fig. 1A shows a simple noise generator employing a 1N23 u.h.f. mixer diode. As there is no provision for monitoring current, the device is useful for comparisons only. One should first measure the output of the receiver with an audio v.t.v.m. connected across the (Continued on page 63)

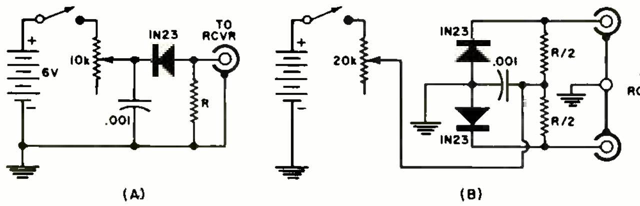


Fig. 1. Noise generators using 1N23 u.h.f. mixer diodes. R should be equal to the input impedance of the receiver or converter being checked. R/2 should be half the input impedance.

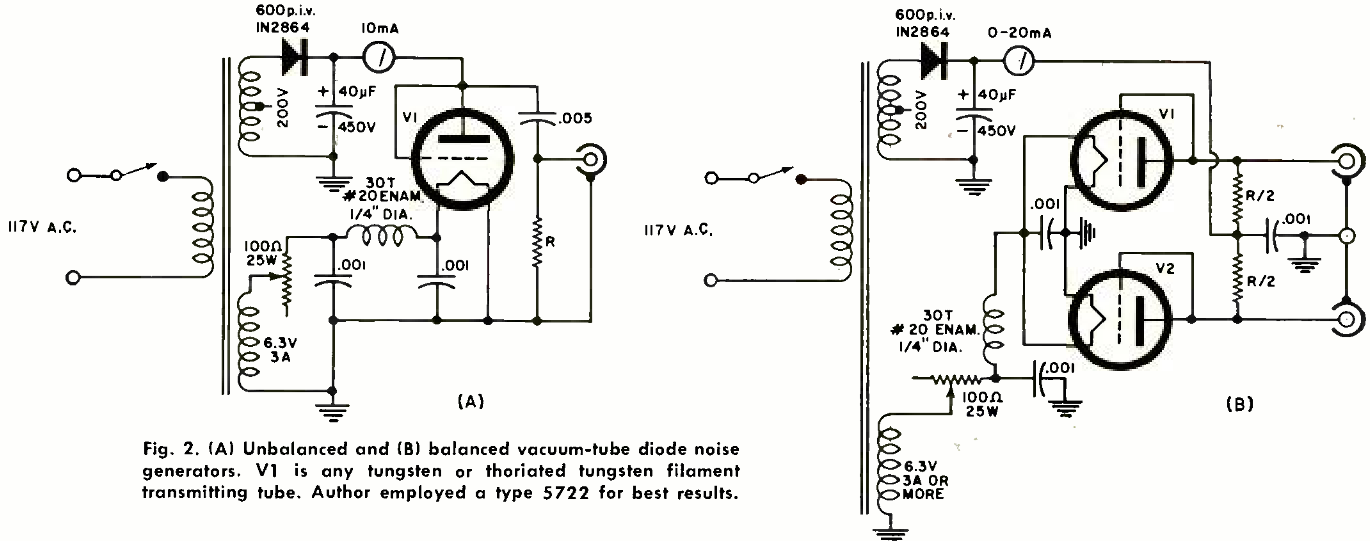
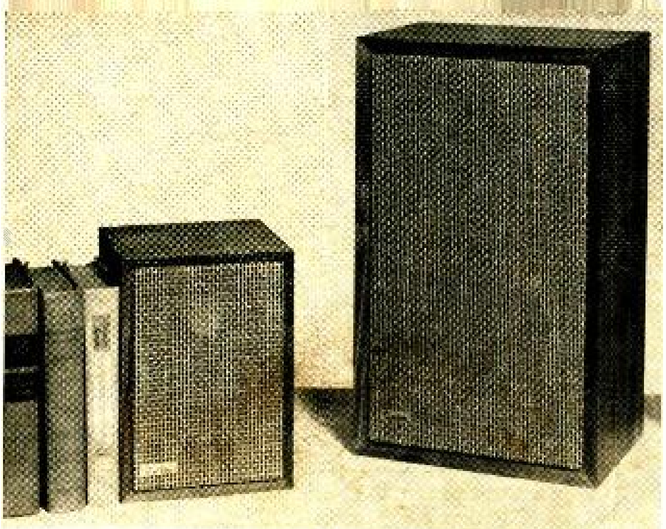


Fig. 2. (A) Unbalanced and (B) balanced vacuum-tube diode noise generators. V1 is any tungsten or thoriated tungsten filament transmitting tube. Author employed a type 5722 for best results.



Finished speaker systems using high-compliance drivers and completely sealed enclosures are quite compact. The smaller unit shown measures only 10½" x 7½" x 7" and includes a 4" woofer and 2" tweeter. The larger unit measures 19" x 11½" x 8½" and includes an 8" woofer along with a 3½" tweeter.

Enclosures for High-Compliance Loudspeakers

By ROGER H. RUSSELL / Sonotone Corp.

Design and construction of small, completely sealed hi-fi speaker enclosures. A number of practical graphs are included to determine speaker compliance and achieve best enclosure size.

DESIGN information on high-compliance speaker enclosures has been conspicuously lacking. As many manufacturers are now producing these small systems, the demand for more information has increased. This is especially true because it is now possible to purchase, separately, high-compliance drivers in all of the common speaker sizes from 4 inches on up to 15 inches.

This article describes how to design a high-compliance speaker system using one of these new speakers in a sealed cabinet. A few basic pieces of test equipment, as well as the charts to be shown later, are all that are necessary.

High Compliance

A definition of compliance will be helpful in understanding what makes these new speakers different. Compliance is the ease with which a material can be bent or stretched. In the case of a loudspeaker if the cone is easily pushed by a small force, the cone suspension is highly compliant.

A high-compliance speaker can perform well in a relatively small cabinet. To explain this we should first look at a few simple resonant circuits. Fig. 1A shows a simple *LC* series-resonant circuit. The inductor and capacitor resonate at frequency f_0 shown in Fig. 2A. A simplified electro-mechanical equivalent circuit for an unmounted loudspeaker is shown in Fig. 1B. Here, $M_{effective}$ is the effective mass of the speaker cone and voice coil and is represented by an inductor. $C_{effective}$ is the effective compliance of the cone suspension and is represented by a capacitor. $M_{effective}$ and $C_{effective}$ again resonate at f_0. If the speaker is placed in a small, sealed box, the enclosed air has a significant compliance. This is equivalent to adding a series capacitor as shown in Fig. 1C. As in an electrical circuit, the resonant frequency is raised to f_1.

For an ordinary 8" speaker (not high compliance) whose resonant frequency is 70 Hz, mounting in a small enclosure may raise the resonance to over 100 Hz. Below the resonant frequency, response begins to roll off. Placing this speaker in a small box, then, seriously reduces low-frequency response.

Other things being equal, an increase in compliance of the cone suspension (increasing $C_{effective}$) results in a lower unmounted or free-air resonant frequency. However, if the compliance is deliberately made very high, the speaker by itself will no longer be able to handle any power at low frequencies and the cone can be easily driven to maximum excursions.

The resulting free-air resonance can, in some cases, be

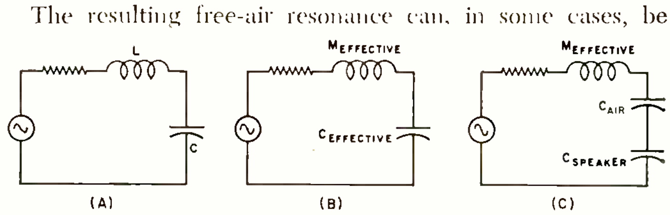
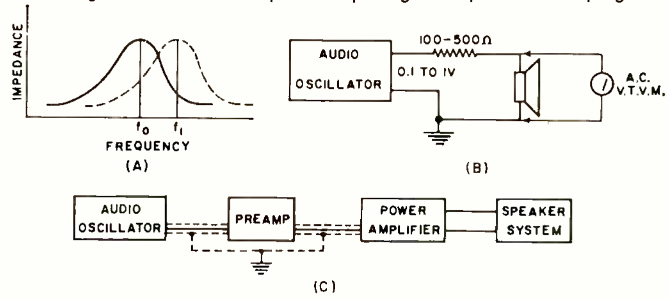
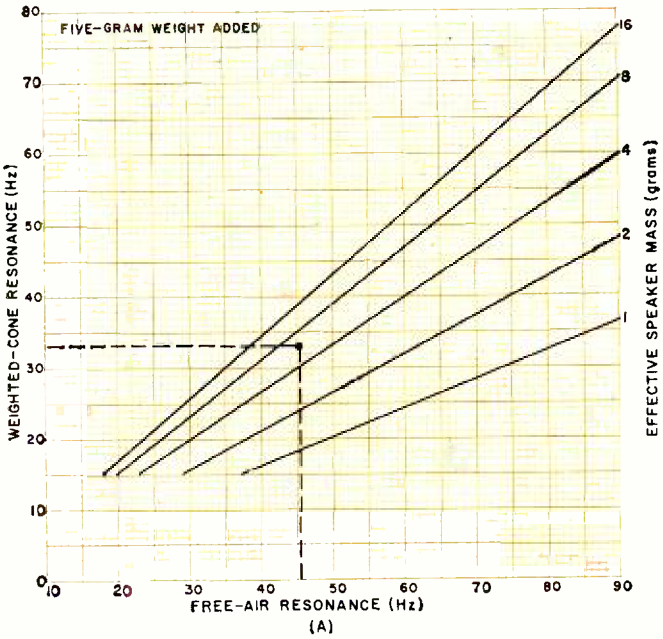


Fig. 1. (A) A series-resonant electrical circuit. (B) A simplified electro-mechanical equivalent circuit for loudspeaker in free air. (C) Simplified equivalent circuit of speaker in sealed box.

Fig. 2. (A) Shift to higher resonant frequency with added series capacitor. Note that the equivalent mechanical circuit is shown as being series-resonant, indicating maximum cone movement (minimum mechanical impedance) as resonance. Under these conditions, maximum counter-e.m.f. occurs which opposes the applied voltage. As a result, minimum current flows and the electrical impedance is at its maximum. (B) Measuring speaker resonance. In many cases, the series resistor can be omitted since the oscillator impedance is usually much higher than that of the speaker. The oscillator acts as a constant-current source (with high internal Z) and its voltage will therefore fluctuate in direct proportion to the impedance of the speaker being checked. (C) Setup for adjusting for optimum damping.





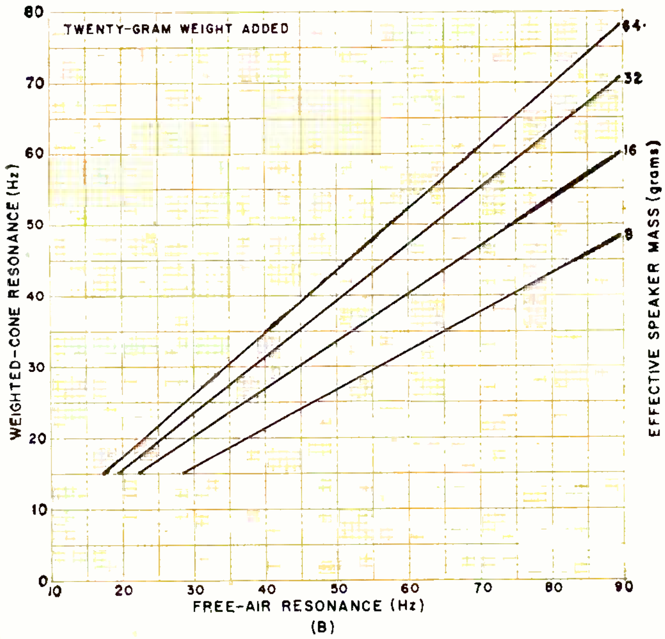


Fig. 3. Weighted-cone (free-air) resonance versus (unweighted-cone) free-air resonance for various effective speaker masses.

reduced to subsonic frequencies (below 20 Hz). Here is where a small, sealed box can be used successfully to restore some of the stiffness (reduced compliance) of the cone suspension. The stiffness is supplied by air trapped in the box and thus acts as a spring against the cone in much the same way as the original suspension. The original higher resonant frequency is also restored. This system resonance can be raised or lowered by varying the volume of the box, the smaller box producing the higher resonance. An 8" high-compliance speaker with a free-air resonance of 30 Hz may resonate at 50 or 60 Hz in a small, sealed enclosure.

Since low-frequency response rolls off below resonance, a lower resonance usually produces better low frequencies. Useful response is usually produced down to a frequency of about 30 percent below system resonance and it can sometimes be extended down to ½ octave below the system resonant frequency by using proper damping techniques. A system resonance of 50 Hz is considered to be more than adequate for the high-fidelity reproduction of orchestral music.

Cone Excursion

A second factor limiting low-frequency output is the amplitude of cone excursion. Most high-compliance speakers are made with a voice-coil length longer than the magnetic gap, allowing longer linear excursions of the cone and reducing low-frequency distortion. A four-inch woofer, unheard of a few years ago, now becomes a reality.

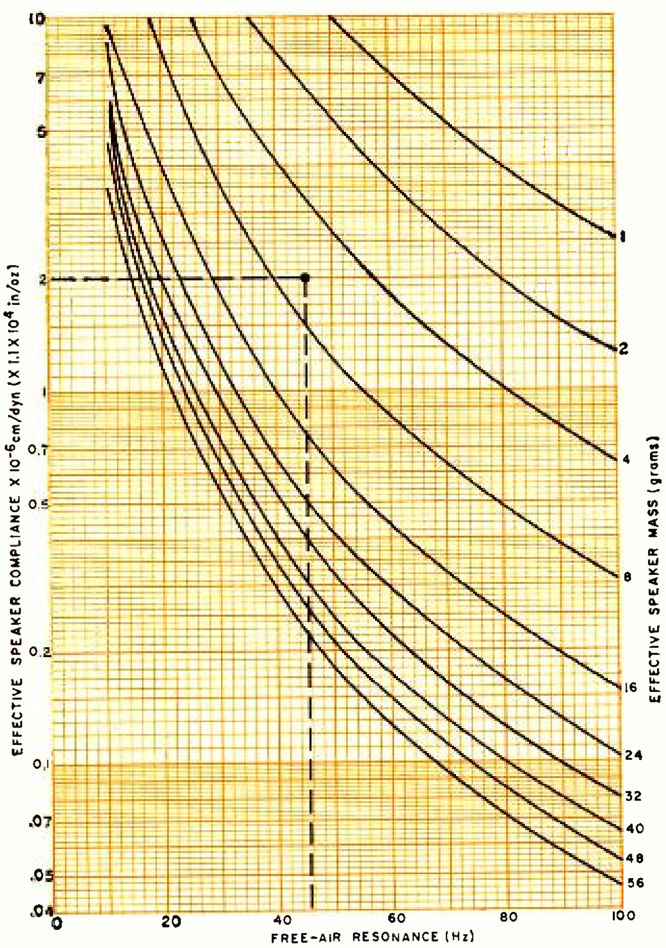
The smaller high-compliance speaker system can sound as good at low frequencies as a larger speaker system provided its power-handling capabilities are not exceeded. The larger speaker has a smaller cone excursion but a large cone area in contact with the surrounding air. For a certain excursion of the cone, this speaker moves a certain volume of air. In order for a smaller speaker to move an equal volume of air, the amplitude of its cone travel must be greater.

At high listening levels, any of the very small systems is limited to the amount of air they can move. Some low-frequency program material will drive the speaker cone to maximum excursions. In general, the smaller systems employing 4- to 5-inch woofers should be used in smaller rooms at lower listening levels. Larger speakers are required for higher listening levels as well as for larger rooms.

System Design

Design of the systems in this article is based on adjusting the cabinet compliance to be equal to the effective speaker compliance, provided the system resonance is above 50 Hz. A system resonance above this frequency is normally found for the smaller speakers (4" to 5") using this method. This high resonance is necessary to prevent the speaker cone from traveling beyond its excursion limits for normal listening levels. By maintaining a 50-Hz system resonance for the

Fig. 4. Effective speaker compliance vs free-air resonance for different values of effective speaker mass from Fig. 3.



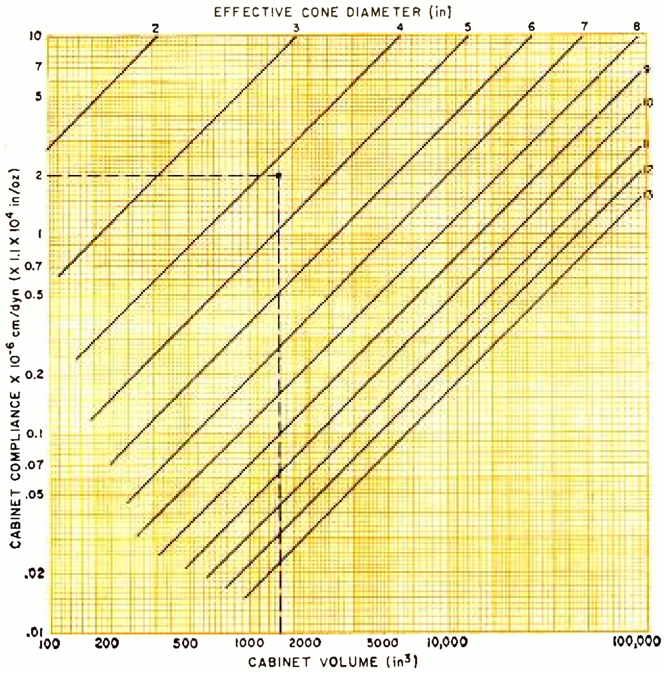


Fig. 5. Cabinet compliance versus cabinet volume for different values of effective cone diameter (excluding surround).

larger speakers (8″ and above), a relatively small cabinet can be used. In this case, the system compliance will be almost completely controlled by the enclosed air in the loudspeaker cabinet.

For either small or large speakers, a reduction in cabinet volume can be made beyond the design values in this article. The greater the reduction in volume, the more the low-frequency response will be reduced. The low-frequency power-handling capacity, however, will be increased.

If we can determine the actual value of effective mass of a high-compliance speaker in free air, we can find the effective compliance, $C_{effective}$, from the relation: $f = 1/2\pi\sqrt{M_{eff}C_{eff}}$. Knowing $C_{effective}$ of the speaker enables us to adjust the cabinet compliance (determined by its volume) for optimum system resonance.

The first step in measuring speaker mass is to connect the speaker as shown in Fig. 2B. The resistor value is not critical. Face the speaker cone upward and do not cover the cone. Tune the oscillator for a maximum reading on the a.c. voltmeter. This frequency setting is the free-air resonance of the speaker.

If the speaker is less than 8″ in diameter, temporarily attach one 5-gram weight to the speaker cone near the center. If the speaker is 8″ or greater in diameter, temporarily attach four 5-gram weights near the center of the cone. One U.S. nickel weighs exactly 5 grams and is convenient to use. The weights can be attached with a small piece of Mortite, caulking compound, or cellophane tape. When the weights are being attached to the cone, support the cone from the rear with the fingers in order to avoid moving the cone and damaging the speaker. Weights must not rattle against cone.

Again, tune the oscillator for a maximum reading on the a.c. voltmeter. This weighted-cone resonant frequency will always be lower than the free-air resonant frequency.

From the charts in Fig. 3, the effective mass of the speaker can be found. Draw a vertical line at the free-air resonant frequency (with unweighted cone) and a horizontal line at the weighted-cone resonant frequency. The intersection of these two lines will determine the value of effective cone mass. This value can be estimated from adjacent lines of known mass.

Knowing this value of effective cone mass, the effective speaker compliance can be found from Fig. 4. Draw a vertical line at the free-air resonant frequency. Place a point on this line at the corresponding value of $M_{effective}$ previously determined. Draw a horizontal line through this point to the compliance values at the left side. This is the value of the effective speaker compliance.

Knowing this value of $C_{effective}$ a cabinet volume can be found from Fig. 5. First, a value for the effective speaker diameter must be measured. The effective diameter of a speaker does not include the outside diameter of the frame or of the compliant surround, but only the diameter of the stiff paper cone. Draw a horizontal line at the compliance value found from Fig. 4. Place a point on this line at the value of the effective cone diameter. Draw a vertical line through this point to the bottom and read the corresponding inside volume for the cabinet.

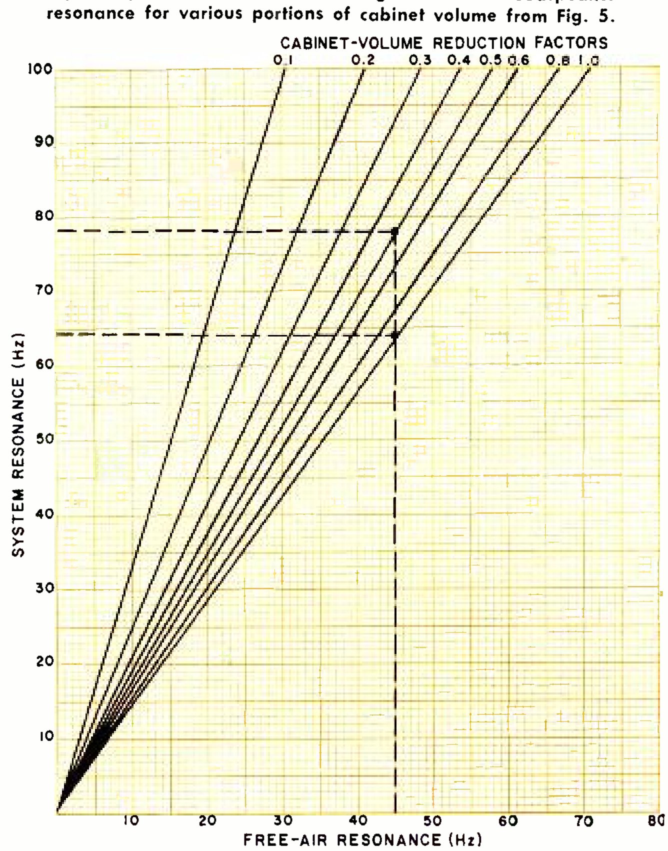
This volume may not be the best volume for the system, however, and a check using Fig. 6 should be made at this time to see if the volume can be reduced to maintain a 50-Hz resonance. Draw a vertical line at the free-air resonance frequency. Place a point at the intersection of the vertical line and the 1.0 cabinet-volume line. Draw a horizontal line from this point to the left side. This value is the system resonance when the effective speaker compliance equals the cabinet compliance.

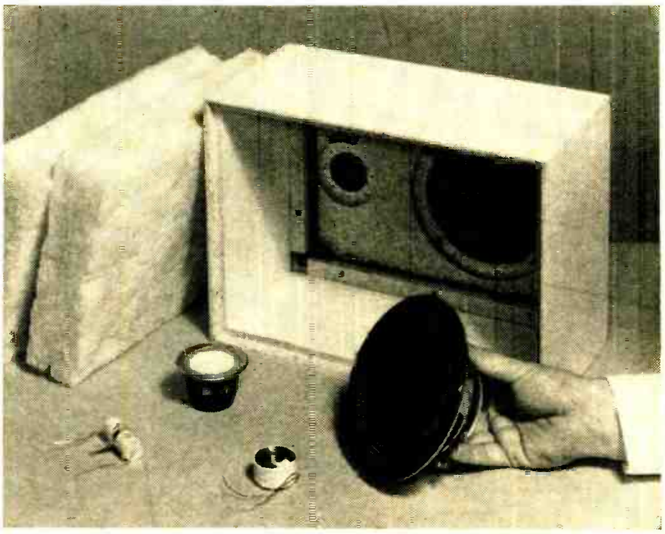
If this value of system resonance is higher than 50 Hz, the optimum volume found in Fig. 5 is satisfactory. If the value of system resonance is lower than 50 Hz, a reduction in cabinet volume can be made without a serious compromise in low-frequency performance. For example, if the free-air resonance of a speaker is 30 Hz and the vertical line on Fig. 6 intersects the 1.0 line at a corresponding system resonance of 42.5 Hz, a reduction in volume can be made to about 0.6 times the volume originally found on Fig. 5. In this case, a considerable reduction in size can be made without noticeably affecting the low-frequency performance.

Example of Design

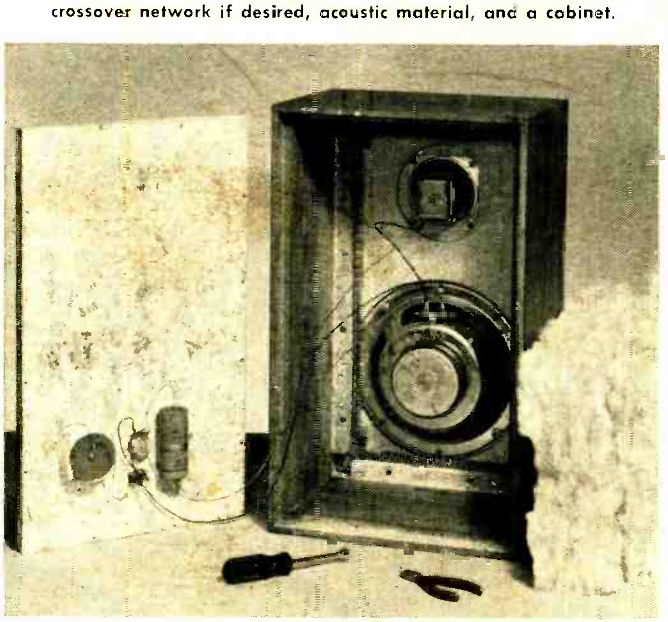
A high-compliance 6″ speaker is found to have a free-air resonance of 45 Hz. After adding a 5-gram weight, the reso-

Fig. 6. System resonance versus original free-air loudspeaker resonance for various portions of cabinet volume from Fig. 5.

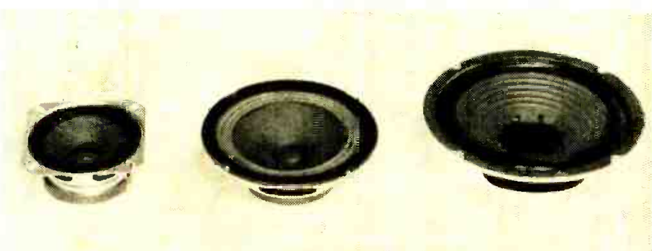




Essential parts include a high-compliance woofer, tweeter and crossover network if desired, acoustic material, and a cabinet.



After the fiberglass is put in the cabinet, back is screwed on.



Typical 4", 6", and 8" high-compliance speakers are shown. The free-air resonances are 60, 50, and 30 Hz, respectively. Speakers of this type are characterized by heavy magnets, very flexible cone surrounds, long-throw voice coils, and low cone resonance. Such speakers are readily available from most speaker manufacturers and as private-label brands from some of the larger electronics parts dealers. Speaker sizes range from approximately 4" all the way up to 15".

nance is lowered to 33 Hz. The effective cone diameter is 4¼ inches. On Fig. 3A, a vertical line is drawn at 45 Hz and a horizontal line is drawn at 33 Hz. The point of intersection is close to 6.5 grams. On Fig. 4, a vertical line is drawn at the free-air resonant frequency of 45 Hz. A point is made at 6.5 grams. A horizontal line is drawn through the point to a compliance of 2.0. On Fig. 5, a horizontal line is drawn at a compliance of 2.0. A point is made at the effective cone diameter of 4¼". A vertical line is drawn through the point to the bottom of the chart indicating a cabinet volume of 1500 cubic inches.

At this time a check for system resonance should be made on Fig. 6. A vertical line is drawn at the free-air resonance of 45 Hz. A point is made at the intersection of the vertical line and the 1.0 cabinet-volume line. A horizontal line is drawn through the point indicating a system resonance of 64 Hz. This system resonance is above 50 Hz and no reduction in cabinet volume need be made from the 1500 cubic inches found previously.

However, suppose a smaller cabinet is needed to fit in a small bookcase. Suppose if only half the volume is used it will fit. On Fig. 6 extend the vertical line to 0.5 or half the volume found in Fig. 5. A horizontal line is drawn to this intersection indicating a system resonance of 78 Hz. With this system resonance, a useful response may be extended down to around 55 Hz instead of around 45 Hz and the power handling is increased.

If the speaker used is not a wide-range unit, a complementary high-frequency tweeter is also necessary. We prefer cone tweeters for low distortion, wide dispersion, and low price. Tweeters should be completely isolated from the woofers either by having a closed frame (cone not exposed from rear) or by constructing a small, sealed box within the main enclosure. The smallest volume possible should be used to isolate the open-frame tweeter. After the tweeter is installed and wired, fill the remaining volume of this small box with fiberglass. Wear rubber or plastic gloves before handling fiberglass as it can cause irritation of the skin. In addition, an appropriate crossover network should be used.

Mechanical Considerations & Damping

In constructing the enclosure, shape is not critical providing no dimension is more than three times any other dimension. Where possible, especially with the smaller enclosures, a front dimension ratio should be about 1 to 1.41. For accuracy, the total enclosure volume should be increased over the volume determined from the charts by the volume occupied by the loudspeakers. Since the speakers are usually small and the enclosure volume is not highly critical, however, no great harm will result if the speaker volume is overlooked.

Enclosures should be completely sealed for best results. Use of caulking compound is satisfactory, especially when the back of the cabinet is put in place. ¾" plywood should be used to make the larger cabinets, but for speakers less than 6" in diameter, ½" plywood is satisfactory. The sides should be cross-braced parallel to the shorter dimension if they are greater than two square feet in area.

After the speaker has been installed in the cabinet, some amount of acoustical damping will be required for optimum performance of the system. In a tuned-port (bass-reflex) system, double impedance peaks are adjusted for equal amplitudes. For the sealed system, however, only one main resonance peak occurs in the impedance. The amplitude of this peak can be adjusted to control the damping of this resonance. Fiberglass acoustic material is excellent for this purpose and it also helps to damp out reflected waves in the enclosure at higher frequencies. Addition of fiberglass will also reduce the system resonance slightly, depending on the quantity added.

A good rule for speakers smaller than 8" in diameter is to completely fill the entire enclosure with layers of fiberglass. They should be placed loosely in the enclosure, not squeezed together. For speakers 8" in diameter or larger, a layer of 2 or 3 inches of fiberglass should be used on all inside walls except the front speaker board.

An additional test can be used to determine the optimum damping for the system for best low-frequency performance. The oscillator previously used should be connected to the hi-fi amplifier (auxiliary or tuner input) as in Fig. 2C.

Set the tone controls to the (*Continued on page* 56)

SELECTING THE PROPER INDICATING LIGHT

By WARREN WALKER / Manager of Research & Development, Dialight Corp.

A comprehensive guide for specifying lamps and lamp housings used for all types of electronic equipment.

It is the purpose of this article to suggest a logical approach to the choice of pilot lights. The first step must be a decision on the light source to be used. Every device is designed to accommodate lamps of a particular bulb size and base type and so many lamps are available for indicator service that the choice may appear difficult. Following a brief review of general data and lamp descriptions, some specific recommendations will be offered to assist the designer.

Lamps for Indicator Service

It is useful to understand some of the terminology used in the lamp industry. A lamp consists of a bulb and its base. Bulb size and shape are designated by a letter and a number; for example, S-6 or T-3¼. The letter indicates the bulb shape; S is for pear shaped and T is for tubular. The digits following give the maximum bulb diameter in eighths of an inch, thus S-6 is ¾" and T-3¼ is 13/32".

The bases used on S-6 bulbs are usually candelabra screw but may be double-contact bayonet. Only the single-contact miniature bayonet base is used on the T-3¼ bulbs discussed here. The smallest lamps of practical nature for pilot lights are T-1¾ and T-2. Both are provided with midget flanged bases. There is also in extensive use a product described as a lamp cartridge which employs T-1¾ or T-2 bulbs. They are enclosed in a close fitting tubular housing with a two-pin header at one end and a light transmitting plastic cap at the other. Internally, the bulb wires are welded to the inner ends of the pins. The device may be regarded as a plug-in lamp and the fitting as a very special base.

Ordering designations are not easy to understand because all lamps suited to pilot-light service are not treated in the same way. Miniature lamps such as the T-1¾ and T-3¼ of particular base types are assigned arbitrary numbers of 2, 3, or 4 digits by the A.S.A. (American Standards Association) and their full description and characteristics are filed under that number.

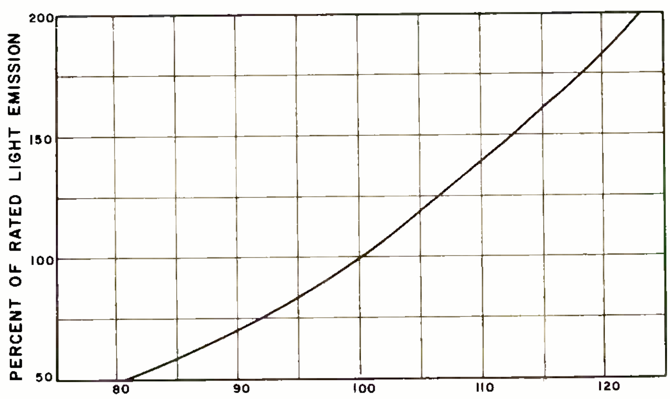
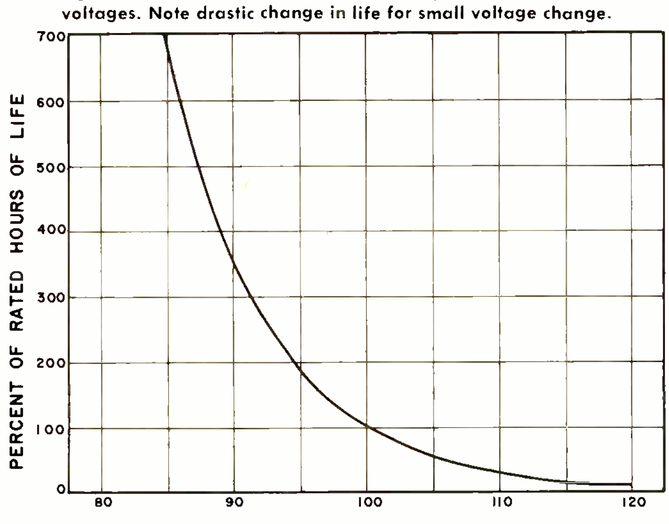


Fig. 2. Variations in light output for various voltages.

Fig. 1. Variation in life when lamp is operated at different voltages. Note drastic change in life for small voltage change.



The S-6 lamps have a descriptive designation such as 6S6DC-120. The first six indicates 6 watts; the S-6 has the shape and size significance just described; DC is for double-contact base; and 120 is the rated voltage. If the base is not described, as in the number 6S6-120, it indicates that the base is candelabra screw which is the most commonly used or "standard" base.

Any discussion of indicators must include the 110- to 125-volt neon lamps. Those most often used are the T-2 and the T-3¼. The latter is always equipped with miniature bayonet base and there are two numbers, NE-51H and NE-51. The T-2 lamps are used in lamp cartridges or equipped with midget flanged bases. The NE-2J and NE-2D are the based lamps that are most often used. A changeover in designations to A.S.A.-assigned letter/number combinations is now underway. It is worth noting these equivalents although they are not in general use as yet:

Old NE No.	NE51-H	NE-51	NE-2J	NE-2D
A.S.A. Designation	B2A	B1A	C9A	C7A

Incandescent lamps provide rated hours of life at exactly rated volts. Lamp ampere limits are not closely held but filament temperature must be uniform, lamp to lamp, if life is to be satisfactory. Variations in applied voltage have a drastic effect on life; only 5% overvoltage will reduce the lamp life by half. The relation of life and candlepower to the applied voltage are shown in Figs. 1 and 2.

Incandescent indicator lamps have their greatest filament strength in the lower voltage and higher current ratings. When filaments are long, they are strung over supports, but even then strength is low in the higher voltage lamps. Current must be kept low and filaments are, of necessity, thin. It is obvious that the rule should be: always use a low-voltage lamp if an appropriate power supply is available.

Neon Lamps

These lamps are usually called neon cold-cathode glow lamps. Light is produced by a glow surrounding the unheated negative electrode. In their most common application, in 117-volt a.c. circuits, both electrodes glow. Neon lamps are always small and light output is low. Light of limited color range is emitted, but such lamps are used extensively because they are very rugged and effective and have a very long life. Reliability is high in the sense that early failures are practically unknown. When indication is needed on high-voltage circuits from pilot lights of small size, only neon lamps will do.

The recent introduction of a family of "high-brightness" neon lamps has largely obsoleted the older types now described as "standard brightness." The standard lamps should be specified only for d.c. applications in the 105- to 125-volt range.

It should be recognized that neon lamps are unlike other lamps in their electrical characteristics. They require some minimum circuit voltage to initiate any current flow and then adequate resistance to limit the current to a value that will give the desired life. The necessary starting voltage is provided by 110-125-volt a.c. (not d.c.) supplies. Pilot lights which incorporate the current-limiting resistor as an integral feature are available.

Supply Voltages

The first consideration in selecting a lamp should be the supply voltage that will light it. For all voltages below 105 volts d.c., incandescent lamps should be used. There is a "gray area" between 28 and 105 volts where there is very limited lamp availability but power supplies rarely fall into this range. A range of voltage from 1.35 volts (for a single mercury cell) to 28 volts is found in the T-1¾ (midget flanged base) series and in the two-pin, plug-in lamp cartridge line. In the somewhat larger T-3¼ (miniature bayonet base) category, the range is extended to 55 volts. The 6-watt and 10-watt S-6 lamps are made for 6 to 250 volt operation.

All of these lamps have tungsten filaments and emit "white light." They can be used with colored lenses and most of them will produce enough light for bright indication with the lenses supplied with such pilot lights.

Neon lamps of the T-3¼ and T-2 sizes, or in lamp cartridges, should be considered for all applications at 117 volts a.c. and are the only suitable choice for applications involving operation at 220 volts and over.

Selecting the Right Lamp

Before listing the specific lamps that will handle 90% of all applications, these general principles are offered to assist in making your selection. When space permits, use a large lamp rather than a tiny one. The cost of the lamp and device will be lower and life and reliability higher. Effectiveness can also be greater since the larger bulb can enclose a more powerful filament.

Select a 6-volt lamp rather than a 12 volt, and a 12 volt rather than a 28- (or higher) voltage lamp if power is available at the lower voltage. For given volt-amperes, the lower voltage filament will be stronger.

Avoid incandescent lamps of the S-6 group for voltages over 125, such as 220 to 250 volts. Wattage goes up to 10, making a hot lamp and filaments are fragile. At 440 volts, it is essential to use a stepdown transformer and a 6-volt T-3¼ lamp. Use a neon lamp if it will provide enough light of a satisfactory color.

A neon lamp is the only solution to the problem of operating under severe conditions of shock or vibration. If the necessary 117 volts is not available, the only incandescent filaments capable of surviving are those of 6 volts, with higher current ratings, in the T-3¼ size.

Select the lamp and pilot light early in the designing stage before all the space has been allotted to other components and very little left for the indicator.

When space is at a premium, use a lamp cartridge. Such cartridges may contain T-1¾ incandescent lamps and T-2 neon lamps so that the voltage range from 1.35 to 125 volts is covered. No other pilot lights require smaller panel areas.

Recommended Lamp Usage

Table 1 gives a partial listing of available lamps. First choices are shown in each case, with alternatives given, for the most common supply voltages. In each lamp series there are numerous other voltage ratings for special conditions. The approximate light output, in lumens, is given for comparison of effectiveness.

Lamps Whose Use is Discouraged

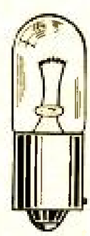
We would be remiss if we failed to mention other lamps of which the reader may be aware and which might appear to be overlooked, which are *not recommended*.

For example, the T-3¼ bulb was once used extensively with a miniature screw base. There are no electrical ratings in the

Table 1. Listing of recommended and readily available lamps.

T-3¼ MIDGET FLANGED-BASE SERIES—INCANDESCENT

Voltage Range: 6.3 to 55 volts
Useful in Group I Lights



RECOMMENDED FOR HIGH RELIABILITY

Lamp No.	Volts	Milliamps	Lumens	Rated Hours
755	6.3	150	4.1	50,000
756	14.0	80	3.9	50,000
757	28.0	80	7.7	50,000
1828	37.5	50	8.1	50,000
1835	55.0	50	13.7	50,000

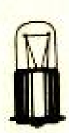
Because of their long life design these lamps tolerate some overvoltage operation.

RECOMMENDED FOR HIGHER LUMENS

Lamp No.	Volts	Milliamps	Lumens	Rated Hours
44	6.3	250	11.1	3000
1815	14.0	200	17.5	3000
1820	28.0	100	20.0	1000

T-1¾ MIDGET FLANGED-BASE SERIES—INCANDESCENT

Voltage Range: 1.35 to 28 volts
Useful in Group III Lights and Some of Group V



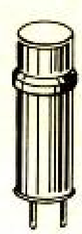
RECOMMENDED FOR HIGH RELIABILITY

Lamp No.	Volts	Milliamps	Lumens	Rated Hours
380	6.3	40	.25	50,000
381	6.3	200	5.0	50,000
344	10.0	14	.025	100,000
367X	10.0	40	1.0	10,000
382	14.0	80	3.8	50,000
387	28.0	40	3.8	25,000

RECOMMENDED FOR HIGHER LUMENS
(and two low voltages)

Lamp No.	Volts	Milliamps	Lumens	Rated Hours
331	1.3	60	.075	500
338	2.7	60	.50	500
328	6.0	200	7.9	1000
349	6.3	200	6.9	3000
330	14.0	80	6.3	750

T-1¾ LAMP CARTRIDGE SERIES #39 —INCANDESCENT



Voltage Range: 1.3 to 28 volts
Useful in Group II Lights

There is no standard system of numbers for lamp cartridges containing these small bulbs. They are best described as #39 cartridges with lamps of the same rating as lamps of the above numbers. All of the ratings shown above for lamps with midget flanged-bases are available.

T-3¼ bulb series that are not available in bayonet-based lamps. The screw-in lamp is not really secure in its socket and is easily jarred loose. Its use should be avoided. Even less satisfactory is the T-1¾ with midget screw base whose sockets rarely have satisfactory spring contact to the solder ball. They do not stay in place.

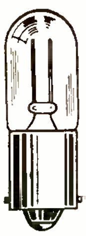
Despite their extensive use in the communications field, no new applications of the T-2 telephone slide-base lamps can be justified. The lamps are long and, while the bulb is of small diameter, all available lights require at least 9/16" mounting holes. This spacing will accommodate the much superior T-3¼ (miniature bayonet) lamps. Also, the flat end of the T-2 bulb is the area through which all of the useful light must be emitted. But this clear area is a much smaller circle than the bulb diameter. The junction of the flat end and the side wall cylinder is substantially opaque because of refraction. Lamps of higher voltage ratings emit little of the light the filament produces. Finally, there is nothing but friction to secure these lamps in their sockets. They are likely to be pushed in too far for maximum effectiveness and they require an extractor tool to remove them.

Failure to recommend any "sub-subminiature" lamps is deliberate. The tremendous accomplishments of the semiconductor industry in miniaturization and microminiaturization have made it appear that the lamp industry is lagging. Everything seems possible, so why not small lamps? The industry has provided very small lamps for medical use, but they are lamps with very short filaments, operating on 1.2 volts from a single battery cell. Thermal efficiency of filament lamps is low but these are the lowest.

Industry demands small lamps in voltages as high as 28 V, and in bulb sizes of ⅛" diameter and smaller. Some companies have offered such lamps but these do not usually work out. A 28-volt filament cannot be short and it cannot be thick if the volt-amperes are to be kept within the ability of the bulb to dissipate the heat. A 28-volt coiled filament put into a T-1 bulb is crowded even though the turns of the coil are closely spaced. A tungsten coil is not a stable thing when it is heated, even if the filament temperature is kept low. It squirms and turns become shorted and then the temperature is not low any more. The 60,000- and 100,000-hour ratings that are predicated on the slow evaporation rate of a low-temperature filament are not realized. Sometimes two such lamps are put into one base on the theory, apparently, that two poor lamps are better than one good one. The same base can accommodate a T-1¾ bulb of good design. Hence, all sizes smaller than the T-1¾ should be avoided.

All illustrations of lamps are shown full size in the table.

T-3¼ MINIATURE BAYONET-BASE SERIES—NEON



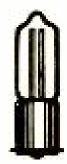
Voltage Ranges: 110 to 125 volts and 220 to 250 volts
Useful in Group I Lights with Integral Resistors
RECOMMENDED FOR VERY HIGH RELIABILITY
Lamp No. NE-51H

Selection of resistor from information below provides operation at either of two levels of performance and at two ranges of supply voltage.

	110-125V	220-250V
Most light and 5000 hours	22 k	56 k
Less light and 20,000 hours	33 k	100 k

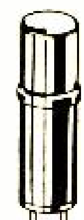
Hours of life above are minimum and are not to be compared with average hours given for incandescent lamps.

T-2 MIDGET FLANGED-BASE LAMP—NEON



Voltage Range: 110 to 125 volts, a.c. only
Useful in Group III Lights with Integral Resistors
RECOMMENDED FOR VERY HIGH RELIABILITY
Lamp No. NE-2J

The use of this lamp is limited to only the lower voltage range and in lights provided with 22k resistor. Performance exceeds most needs in minimum life, and best light output is obtained.

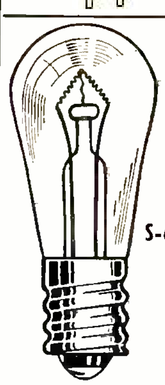


T-2 LAMP CARTRIDGE SERIES #45—NEON

Voltage Range: 110 to 125 volts, a.c. only
Useful in Group II Lights

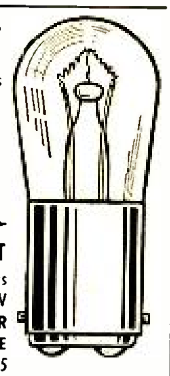
RECOMMENDED FOR VERY HIGH RELIABILITY

#45 Cartridge with unbased NE-2J and integral resistor of 33k.



◄ **S-6 CANDELABRA SCREW-BASE SERIES—INCANDESCENT**

Voltage Ratings: 125 volts and 250 volts
Useful in Lights of Group IV
RECOMMENDED FOR GENERAL SERVICE
At 90 to 125 volts Lamp No. 6S6-125
At 180 to 250 volts Lamp No. 10S6-250



S-6 DOUBLE-CONTACT BAYONET-BASE SERIES—INCANDESCENT ►

Voltage Ratings: 125 volts
Useful in Lights of Group IV
RECOMMENDED FOR GENERAL SERVICE
At 9 to 125 volts—Lamp No. 6S6DC-125

Selecting the Pilot Light

When the lamp has been chosen, it is possible to proceed to the pilot light. The several optional features of the light are dominated by the choice of the lens cap details; the nature, shape, and color of the lens, and how it is secured to the body of the light.

Lenses are generally made of plastic, although on larger lights for the hot 6-watt S-6 lamps they are sometimes made of glass. The availability of heat-resisting polycarbonate material has made it possible to replace glass in most cases. Often the lens is mounted in a metal holder which screws into the body or is a precise friction fit that is secure against vibration. The friction fitted lens caps are rotatable. This is an important feature for erecting markings on the lenses. In many screw caps, the lens is spring mounted to produce friction and is rotatable independent of its metal holder which may be tightened securely.

In the area of identifying indicators by lens color, there is the greatest possibility of error. The automatic choice of red for danger and green to indicate that all is well is a mistake too many designers make. It is time that some real thought be given to the specification of color. There are just a few fundamentals that should be kept in mind.

1. Light sources do not emit uniformly in all the colors from violet to red.
2. The eye is not equally affected by the same amount of energy in each color region.
3. The materials that change the color of light sources are subtractive. They reduce the light which is effective in stimulating the eye.
4. Color really does not provide any specific information.

How does the viewer respond to the showing of a red light? What emergency is indicated? Or to the extinguishing of a green light? If all is no longer well, how bad are things and what is to be done? Evidently, a study should be made of when color is really useful and how it can be used to convey some definite meaning. Consideration should also be given to the possibility that the observer may be color blind.

The most effective color is that to which the eye is most sensitive, *i.e.*, yellow to yellow-green. The natural color of neon lamps is nearly ideal. Incandescent lamps emit most strongly in the red region. When filtered to appear green, much light is lost and luminosity is low. The loss is so great when only blue is transmitted that it is quite ineffective.

In the seeing process, human characteristics modify any purely theoretical conclusions. Only this can account for the fact that yellow with a reddish tinge (amber) appears to many as brighter than the unfiltered light. This is the reason why yellow auto headlights are used in some European countries.

Extensive specification of amber color is recommended. Its use will assure maximum visibility. Red can be next in effectiveness but its use should be discouraged except for real emergency indication which should also be explained by an associated legend.

Since color, as such, cannot provide specific information, each indicator—especially when more than one is displayed—should have an associated legend. Assuming that there will be adequate general lighting in the operating area, the legend could be a reflective marking in light letters on a dark panel or the reverse, or a marking on a plate attached to the panel in the mounting of the pilot light. A legend lighted by the pilot-light lens is best. The legend could be applied to the face of the lens as black characters against an amber lens. In larger lenses, the usual practice is to provide a photographically reproduced transparency. The legend may appear as lighted characters against a black background or the reverse.

Stamped markings in black against light-translucent amber plastic lenses provide the most practical marking where many lights will bear different identifications. If neon lamps are used, the translucency should be lightly diffusing, which is another way of saying of low absorption, since neon lamps produce little light and none can be wasted.

Other Pilot Light Features

While occasionally other types of terminals are available, soldering terminals are preferred. Screw terminals should not be used unless the connecting wire has a closed eyelet terminal. Sometimes an optional male spade for a "quick-connection" wire terminal is offered. Their use is desirable only for high-production applications where prepared wiring harnesses are employed.

The parts of the pilot light which show on the face of the panel should be either black or polished metal. The nature of the panel usually dictates the choice.

Frequently, pilot lights are provided with a fixed flange which will rest on the face of the panel with fastenings applied from the rear. Optionally, but not in all cases, the light may be inserted from the rear of the panel and secured with a round knurled nut on the face. The user's special requirements will dictate this choice.

It may be noted that all lights are cylindrical, enclosed, and are intended for one-hole mounting on fairly thin panels.

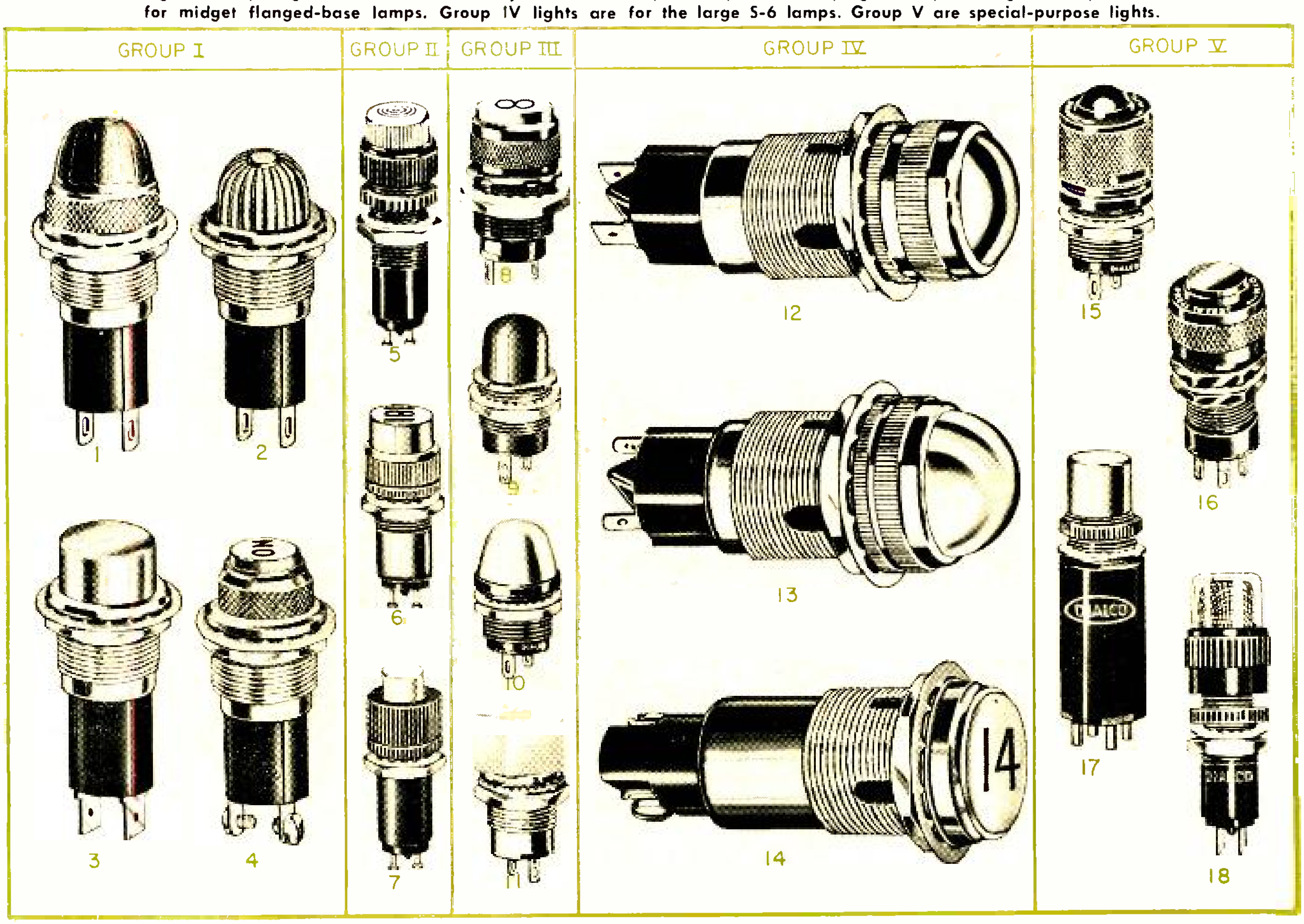
Typical Pilot Lights

Lights for miniature bayonet-based lamps, $1\frac{1}{16}$" mounting. Lights that accommodate T-3¼, miniature bayonet-base lamps are shown in Group I (Fig. 3). All of the voltages from 6.3 to 55 volts, recommended in the incandescent series, and the NE-51H neon lamp may be used in these four lights. The dome-shaped lenses of #1 and #2 are desirable with NE-51H. No. 2 is a simple all-plastic screw-in cap, useful with neon. No. 1 provides for a lens mounted in a metal holder which screws on. The lens may be of heat-resisting material recommended for use with incandescent lamps of high volt-amperes. No. 3 has an all-plastic cap and permits stamped marking. The lens is not rotatable, requiring the body to be secured to the panel with the lens in place for erect reading. No. 4 has a flat lens suitable for marking and is rotatable so that marking is readily adjusted to be erect.

The terminals shown are soldering, screw, and quick-connecting. Any terminal type may be specified for any light.

Special note: Any of the four lights may be specified with any of four recommended values of resistors built in for the NE-51H lamp. All have (*Continued on page* 52)

Fig. 3. Group I lights are for miniature bayonet-based lamps. Group II are for plug-in lamp cartridges. Group III are for midget flanged-base lamps. Group IV lights are for the large S-6 lamps. Group V are special-purpose lights.



New Low-Loss Coax for TV

Description of a coaxial lead-in for color-TV and u.h.f. that has less loss than ordinary twin-lead in many cases.

By LON CANTOR
Jerrold Electronics Corp.

THE twin-lead *vs* coax controversy has resulted in improvements in both types of transmission lines. Recently, for example, *Belden Manufacturing Company* showed a new shielded twin-lead (ELECTRONICS WORLD, October, 1965). And, now, *Jerrold Electronics* is introducing an improved coaxial cable for use in home TV antenna systems.

It is generally conceded that shielded coaxial cable causes less deterioration of signal quality than ordinary twin-lead. Coax tends to keep out interference and local pickup ghosts and to reduce standing waves, which result in line ghosts. That is why coax is used exclusively in professional installations such as TV studios and master TV systems.

But coax has usually been thought to cause more signal loss than twin-lead, at least in theory. At v.h.f. frequencies, this increased loss is generally tolerable. On u.h.f. channels, however, increased loss might easily mean the difference between good pictures and snow on the TV screen.

Called "82-Channel Coloraxial Cable," the new coax causes only slightly more than half as much loss as ordinary RG-59/U. In fact, it causes even less loss than twin-lead in most home TV installations. And twin-lead losses are known to increase considerably with age, moisture, smog, etc., while coax line losses remain virtually constant.

A Practical Example

Loss, of course, is not the most important characteristic of TV transmission lines. It is generally important only in a fringe area. Let us examine a practical system to see why this is so. Consider two similar antenna systems. Both start with 10,000 microvolts of u.h.f. TV channel-83 signal at the antenna. However, if the signal is carried through 100 feet of RG-59/U, only about 2250 microvolts will reach the TV set. On the other hand, almost 4000 microvolts reach the TV set through the low-loss coaxial cable.

On the surface, this seems like a significant difference. But both signals would look the same on most color-TV screens. This is because all modern TV sets include a.g.c. circuits. As long as enough signal is supplied to take the picture out of the snow and activate the a.g.c., no amount of additional signal results in any better picture quality.

Let us suppose, on the other hand, that the antenna picked up only 1000 microvolts of signal. In this case, the set connected to the RG-59/U would see only 225 microvolts while the other set would be fed 390 microvolts. At this level, there can be a considerable difference in picture quality.

How is the lower loss achieved? Loss in transmission line is dependent upon conductor resistance and dielectric heating—primarily the former. Therefore, the larger the center conductor of the cable, the lower its loss.

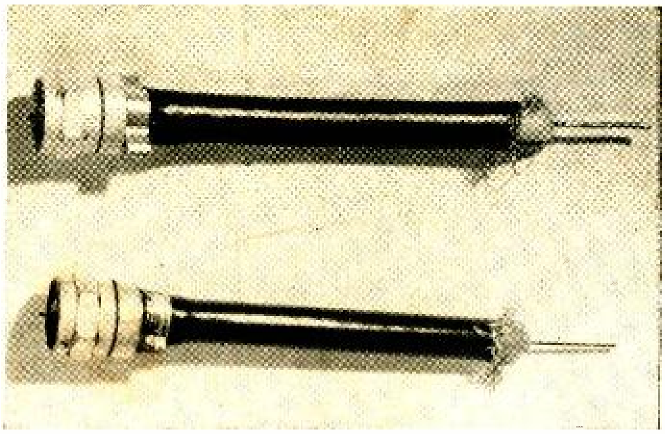
But the center conductor cannot simply be made larger and the rest of the cable left alone. This would change the characteristic impedance of the cable. Characteristic impedance is a term that describes the behavior of the cable in passing signals and the way it cooperates with the source and load. It includes both resistance and reactance, comprising both capacitive and inductive elements. The value of the characteristic impedance is determined by the following factors:

1. The ratio between the diameter of the inner conductor and the diameter of the outer conductor.
2. The dielectric constant of the dielectric.

Thus, if the diameter of the center conductor is increased, the same impedance can be maintained only by increasing the diameter of the outer-conductor shield. Obviously, this would make the cable thicker and harder to handle.

The solution was to change the dielectric, using a foam-type polyethylene (which also contributes somewhat to the reduced attenuation). The new 82-channel cable is only slightly thicker than RG-59/U (see photograph). Cost of the new cable is about 25% higher than conventional coax, and it is available in 50-, 75-, and 100-foot lengths, with fittings and weatherboot attached.

While many technicians will continue to prefer twin-lead, it seems quite likely that coax will be used more extensively in home TV antenna systems now that the loss barrier has been broken. ▲



The new coax cable is shown at the top compared to conventional RG-59/U below. The new cable is just a little thicker, it uses a larger center conductor and foam-type dielectric.

Table 1. Attenuation per 100 feet for twin-lead and coax. The figures for encapsulated and shielded twin-lead are from Electronics World, October 1965, page 29, Fig. 4. According to this figure, flat ribbon and tubular twin-lead losses are over 20 dB at channel 83 in a typical installation. Note that the losses of the new coax are about the same as those for shielded twin-lead. Note also the use of one or two matching transformers required with a coaxial installation may increase the attenuation by approximately 1 or 2 dB.

	Channel 2	Channel 13	Channel 14	Channel 83
Encapsulated twin-lead (300 ohm)	3.2 dB	5.8 dB	7.8 dB	9.8 dB
Shielded twin-lead (300 ohm)	2.1	4.1	6.0	7.8
RG-59/U coax (75 ohm)	2.8	5.8	9.0	13.0
Low-loss coax (75 ohm)	1.75	3.15	5.5	8.2

Battery-Powered Tape Recorders

Here are the technical specifications for 41 models of battery powered tape recorders made available by 19 different companies.

THE battery-operated portable tape recorders shown on these pages run the gamut from restricted-range devices used only for voice communications to portable units whose performance rivals those of quality a.c.-operated units.

Because of their light weight and slow speed that permits storing a considerable amount of information, the smaller units are finding increasing favor as "electronic notebooks," for interview purposes and for information interchange between engineers and their offices. The higher quality units are finding use as mechanical engineering aids by recording sounds made by mechanical parts making faulty contact, so that designers at remote locations will have a better idea of the problem. In some companies, the portable tape recorder is considered as useful an engineering tool as is an oscilloscope.

Most of these portable devices can be run for long hours on their internal batteries. In most cases, replacement batteries are available at the corner store. In some cases, the batteries can be recharged. Some units can also operate off the a.c. line, where it is available, while others can use a conventional car battery.

Prices of these units range from less than $25 to more

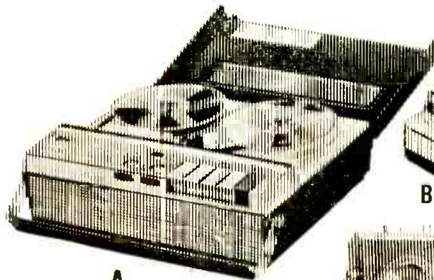
Photo	Model	Tape speed (ips)	Reel size (inches)	Playing time	Tracks: number; stereo or mono	Frequency response	Type of bias	Type of erase	Level indicator	Battery indicator
CHANNEL MASTER CORP., Ellenville, N.Y. 12428										
A	6464	1⅞, 3¾	5	N.S.	2 M	100-7000 Hz—3¾ 100-4000 Hz—1⅞	N.S.	d.c.	meter	meter[q]
B	6545	1⅞, 3¾	3¼	N.S.	2 M	N.S.	a.c.	d.c.	meter	meter[q]
C	6549	1⅞, 3¾	3¼	2 hrs.	2 M	N.S.	a.c.	d.c.	N.S.	N.S.
CONCERTONE DIV., ASTRO-SCIENCE CORP., 9731 Factorial Way, South El Monte, Calif.										
	727	15/16, 1⅞ 3¾, 7½	5	N.S.	4 S	50-3000 Hz—15/16 30-7000 Hz—1⅞ 30-10,000 Hz—3¾ 30-15,000 Hz—7½	N.S.	N.S.	meter	N.S.
CONCORD ELECTRONICS CORP., 1935 Armacost Ave., Los Angeles, California 90025										
D	F-20	Variable	2½	1 hr.	2 M	60 Hz-6 kHz	d.c.	d.c.	none	none
E	F-85	1⅞	2½	2 hrs.	2 M	60 Hz-7 kHz	a.c.	d.c.	none	none
F	300	1⅞, 3¾	4	1⅞—6 hrs. 3¾—3 hrs.	2 M	60 Hz-10 kHz	a.c.	d.c.	meter[k]	meter[q]
G	350	1⅞, 3¾	5	1⅞—6 hrs. 3¾—3 hrs.	2 M	50 Hz-10 kHz	a.c.	d.c.	meter	meter[q]
CRAIG-PANORAMA INC., 2302 E. 15th Street, Los Angeles, California 90021										
H	212	1⅞, 3¾	3¼	2 hrs.	2 M	150 Hz-7 kHz—3¾ 150 Hz-3.5 kHz—1⅞	a.c.	d.c.	[k]	none
I	490	Variable	Cartridge	32 min.	2 M	N.S.	d.c.	d.c.	meter	meter[q]
J	520	1⅞, 3¾	5	N.S.	2 M	N.S.	d.c.	d.c.	meter	meter[q]
GENERAL ELECTRIC CO., 2200 N. 22nd Street, Decatur, Illinois 62525										
K	M8000	1⅞, 3¾	3	1⅞—1 hr. 3¾—30 min.	2 M	N.S.	d.c.	d.c.	[l]	none
L	M8010	1⅞, 3¾	3	1⅞—1 hr. 3¾—30 min.	2 M	N.S.	d.c.	d.c.	meter	meter[q]
M	M8020	Variable	3⅜	60 min.	2 M	N.S.	d.c.	d.c.	[l]	none
MARTEL, 2339 S. Cotner Ave., West Los Angeles, California 90064										
N	201	1⅞, 3¾	5	N.S.	2 M	N.S.	N.S.	N.S.	meter	meter
MAYFAIR-ARCTIC IMPORT CO., 1024 West Randolph St., Chicago, Illinois										
O	JV-1	3¾, 7½	5	3¾—1 hr. 7½—30 min.	2 M	200 Hz-7 kHz	d.c.	perm. mag.	none	none
P	600	3¾, 7½	5	3¾—1 hr. 7½—30 min.	2 M	200 Hz-7 kHz	d.c.	perm. mag.	meter	meter[q]
Q	1802	1⅞, 3¾	3¼	1⅞—2 hrs. 3¾—1 hr.	2 M	200 Hz-6 kHz	d.c.	d.c.	meter	meter[q]
MIRANDA-ALLIED IMPEX CORP., 300 Park Ave. South, New York, N.Y. 10010										
	MIRANDETTE	1⅞, 3¾	3	1 hr.	2 M	200 Hz-6 kHz	a.c.	d.c.	meter	meter[q]
NAGRA-MAGNA TECH ELECTRONIC CO. INC., 630 Ninth Ave., New York, N.Y. 10036										
	NTPH	3¾, 7½, 15	7	N.S.	Full M track	30 Hz-18 kHz	d.c.	d.c.	meter	meter[q]

Footnotes: a—remote control b—a.c. line cord c—splicer d—carrying case e—also a.c. powered f—telephone pickup g—spare reel h—earphone i—voice operation j—tape counter k—automatic level l—neon light m—recharger n—motion picture/slide sync o—auxiliary input p—indicator light q—same as level meter N.S.—not specified than $1000. The prices shown are advertised list or selling price. Check your dealer for the latest prices. Machines selling for less than $25 are not listed as we consider them "toys" rather than serious tape recorders.

The bulk of these devices are not restricted to use with just a microphone. Note that a considerable number of different types of "outboard" devices are available to cover almost any recording situation. These range from telephone pickups to external power supplies.

A number of these machines are foreign-made. This should not deter the purchaser since service for these relatively high-quality devices is available in almost every major city.

The photos illustrating the directory are keyed to each model, where pictures were made available to us. ▲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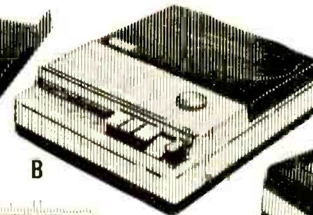
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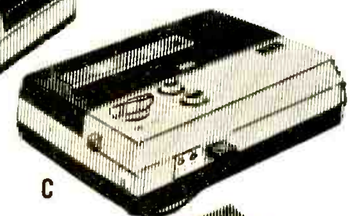
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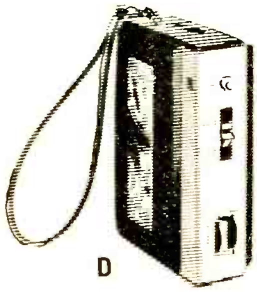
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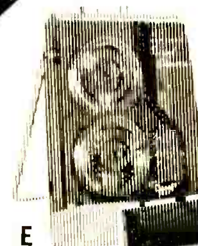
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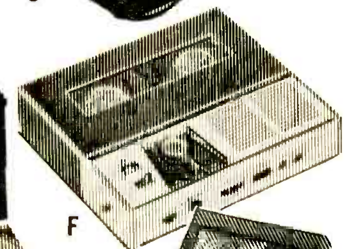
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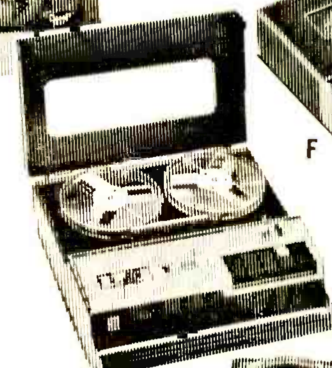
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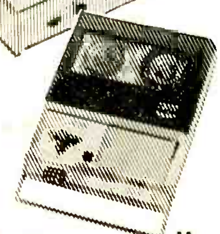
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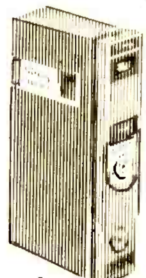
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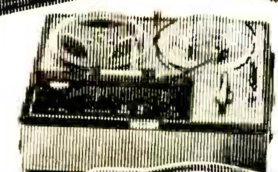
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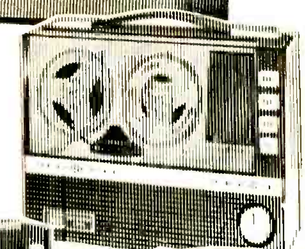
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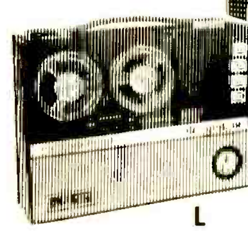
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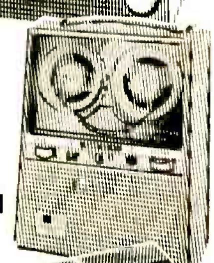
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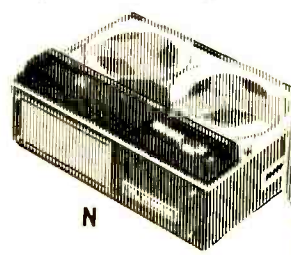
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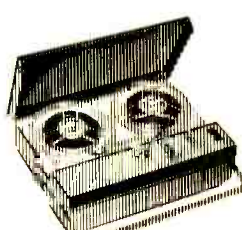
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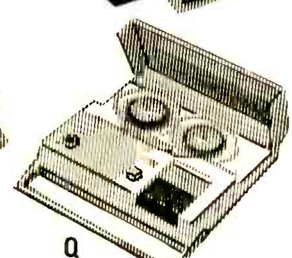
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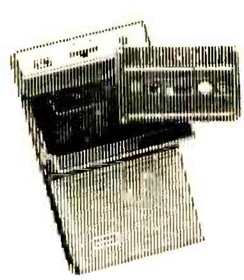
Batteries: number and type	Size (inches) h.	w.	d.	Weight (lbs)	Price	Accessories (See footnotes)
6 "D"	3½	11¼	10	8½	N.S.	a,b,c,d,e,g
6 "C"	2¾	8	10	5¾	N.S.	a,c,e,f,g
6 "D"	3	10½	8½	5	N.S.	a,c,d,e,g,h
6 "D"	13½	11⅝	5⅝	16	N.S.	e
4 "AA"	6½	4½	2½	2	24.95	a,f,g,h,i
4 "C"	7	5	3	2	49.95	a,f,g,h,i
6 "D"	3	10	9	6½	129.95	a,f,g,h,i
6 "D"	4	11½	11	10	199.95	a,f,g,h,i
6 "C"	3⅛	7⅞	9¾	4½	39.95	a,e,f,g,h
4 "AA"	3¾	1⅜	6½	2	79.95	a,d,e,f,g,h
4 "D"	4½	11¼	9½	10	59.95	a,e,f,g,h
4 "D"	8	11 1/16	3⅛	4¼	39.95	e,h
4 "D"	8	11 1/16	3⅛	4¼	49.95	a,e,h
4 "D"	9¾	8	2¾	N.S.	24.95	a,d,e,h
N.S.		N.S.		7	100.00	f,j
3 "D"	4¾	12½	9½	11½	N.S.	d,h,m
6 "D"	4¾	11	8½	6	N.S.	d,h,m
4 "C"	2½	9⅜	8⅜	4	N.S.	d,h,m
4 "D"	2 15/16	9⅝	8 5/16	7¼	169.95	h,j,m
12 "D"	4⅓	14	9½	13.3	1186.00	h,m

Photo	Model	Tape speed (ips)	Reel size (inches)	Playing time	Tracks: number; stereo or mono	Frequency response	Type of bias	Type of erase	Level indicator	Battery indicator
NORELCO, 100 E. 42nd Street, New York, N.Y. 10017										
A	101	1⅞	4	2 hrs.	2 M	80 Hz-8 kHz	a.c.	a.c.	meter	meter[q]
B	150	1⅞	Cartridge	1 hr.	2 M	100 Hz-7 kHz	a.c.	a.c.	meter	meter[q]
PANASONIC, 200 Park Ave., New York, N.Y.										
	RQ-102	1⅞, 3¾	3	N.S.	2 M	100 Hz-4 kHz—1⅞ 100 Hz-7 kHz—3¾	a.c.	N.S.	meter	meter
	RQ-105	1⅞, 3¾	3	N.S.	2 M	100 Hz-4 kHz—1⅞ 100 Hz-7 kHz—3¾	a.c.	N.S.	meter	meter
	RQ-116	1⅞, 3¾	3	N.S.	4 M	100 Hz-4 kHz—1⅞ 100 Hz-7 kHz—3¾	a.c.	N.S.	meter	meter
	RQ-152	1⅞, 3¾	5	N.S.	2 M	100 Hz-4 kHz—1⅞ 100 Hz-7 kHz—3¾	a.c.	N.S.	meter	meter
RCA SALES CORP., 600 N. Sherman Drive, Indianapolis, Indiana 46201										
C	YGS 11	1⅞, 3¾	3	1⅞—1 hr. 3¾—30 min.	2 M	600 Hz-4 kHz	d.c.	d.c.	meter	meter[q]
D	YGS 21	1⅞, 3¾	3	1⅞—1 hr. 3¾—30 min.	2 M	90 Hz-3.5 kHz	a.c.	a.c.	p	none
ROBERTS ELECTRONICS, DIV. OF RHEEM MFG. CO., 5922 Bowcroft St., Los Angeles, Calif. 90016										
E	6000 M and S	15/16, 1⅞, 3¾, 7½	5	15/16—6 hrs., 24 min. 1⅞—3 hrs., 12 min. 3¾—1 hr., 36 min. 7½—48 min.	4 both	30 Hz-10 kHz	a.c.	a.c.	meter(2)	none
SONY-SUPERSCOPE, INC., 8150 Vineland Ave., Sun Valley, Calif.										
F	800	1⅞, 3¾, 7½	5	4 hrs.	2 M	50 Hz-6 kHz—1⅞ 50 Hz-9 kHz—3¾ 50 Hz-12 kHz—7½	a.c.	N.S.	meter	meter
G	900	1⅞, 3¾	3¼	1⅞—2 hrs. 3¾—1 hr.	2 M	90 Hz-9.5 kHz	a.c.	perm. mag.	k	none
STUART, MATTHEW & CO. INC., 3650 Dyre Ave., Bronx 6, N.Y., N.Y.										
H	88B	1⅞	2½	70 min.	2 M	100 Hz-6 kHz	a.c.	d.c.	none	none
I	216	2.20	3.4	70 min.	2 M	250 Hz-5 kHz	a.c.	d.c.	none	l
TANDBERG OF AMERICA INC., 8 Third Ave., Pelham, N.Y. 10803										
	11	15/16, 1⅞, 3¾, 7½	7	N.S.	N.S. M	40 Hz-16 kHz—7½ 60 Hz-9 kHz—3¾ 80 Hz-5 kHz—1⅞ 100 Hz-2.5 kHz—15/16	a.c.	a.c.	meter	none
TELEFUNKEN-AMERICAN ELITE INC., 48-50 34th St., Long Island City, N.Y.										
J	MAGNET-OPHON 300	3¾	5	3 hrs.	2 M	40 Hz-14 kHz	a.c.	a.c.	meter	meter
K	MAGNET-OPHON 301	3¾	5	3 hrs.	4 M	40 Hz-14 kHz	a.c.	a.c.	meter	meter
UHER-MARTEL, 2339 S. Cotner Ave., West Los Angeles, California 90064										
	4000-L	15/16, 1⅞, 3¾, 7½	5	N.S.	2 M	50 Hz-22 kHz—7½ 70 Hz-5 kHz—15/16	a.c.	a.c.	meter	meter
V-M CORP., 305 Territorial St., Benton Harbor, Michigan 49023										
L	760	1⅞, 3¾	3¼	1⅞—1 hr. 3¾—32 min.	N.S. M	200 Hz-6 kHz	a.c.	d.c.	meter	meter
WESTINGHOUSE ELECTRIC CORP., TV-RADIO DIV., Metuchen, New Jersey										
M	27R1	Variable	3	20 min.	2 M	N.S.	d.c.	d.c.	none	none
N	28R1	Variable	3	N.S.	2 M	N.S.	d.c.	d.c.	meter	meter[q]
	29R1	Variable	Cartridge	35 min.	2 M	N.S.	d.c.	d.c.	meter	meter[q]
O	32R1	1⅞, 3¾	3¾	1⅞—80 min. 3¾—40 min.	2 M	N.S.	d.c.	d.c.	meter	meter[q]

A



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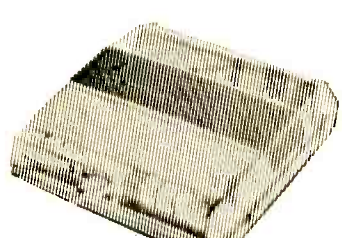

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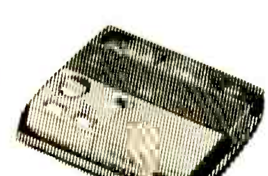

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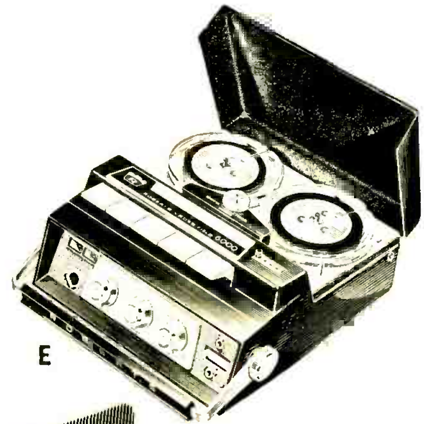
Batteries: number and type	Size (inches) h.	w.	d.	Weight (lbs)	Price	Accessories (See footnotes)
5 "D"	8	11	3¾	7	79.50	h,m,o
5 "C"	7¾	4½	2¼	3	89.50	h,m,o
6 "C"	3	9⅝	8½	4½	59.95	a,e,g,i,m
4 "C"	2½	10¼	7¾	4½	49.95	a,g,i,m
12 "AA"	2½	7¾	7¼	4⅛	129.95	a,e,f,i,m
6 "D"	3⅓	11⅗	10¼	7½	99.95	a,g,h,i,m
4 "C"	2¾	9¾	9¼	4.9	49.95	e,h,o
6 "D"	3½	10⅜	8½	6.5	N.S.	d,e,h,o
4 "D"	4	9⅜	10	11	M-299.95 S-359.95	j,m
8 "D"	4¼	12¼	10½	13	199.95	a,e,j,k
4 "D"	3¾	8¾	8¾	5.5	67.50	d,i
3 "C" 3 penlight	1⅞	4¼	7¾	2¾	69.95	a,d,f,h,o
2 recharge.	3½	7½	13	6¼	179.95	a,f,h,i,o
10 N.S.	10	13	4	7	595.00	e,k,o
5 "D"	3	10¾	10⅞	7½	139.95	e,d,m
5 "D"	3	10¾	10⅞	7½	169.95	e,d,m
N.S.	3¼	10½	8½	7	440.00	a,d,e,i,j,m,n
rechargeable	2¾	10⅝	6	5	129.95	a,d,f,h,m
2C 4AA		N.S.		N.S.	N.S.	N.S.
3C 6AA		N.S.		N.S.	N.S.	N.S.
4 "AA"		N.S.		N.S.	N.S.	N.S.
4 "D"		N.S.		N.S.	N.S.	N.S.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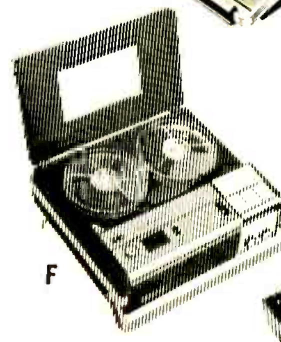
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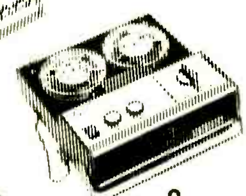
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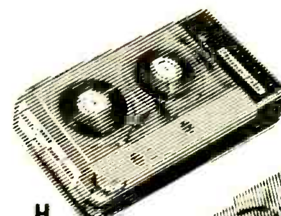
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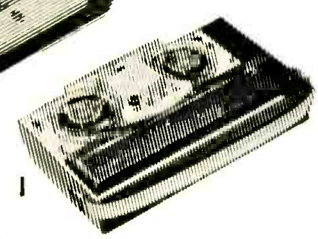
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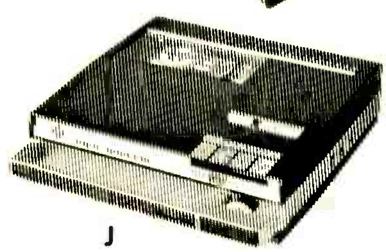
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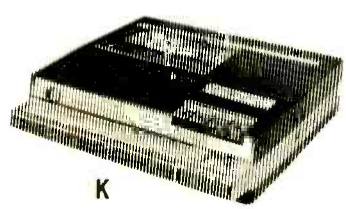
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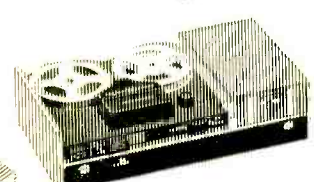
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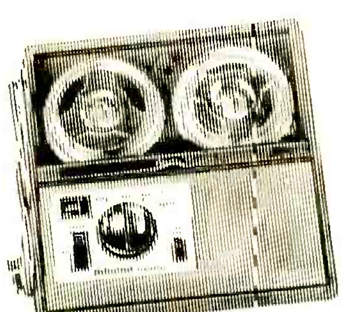
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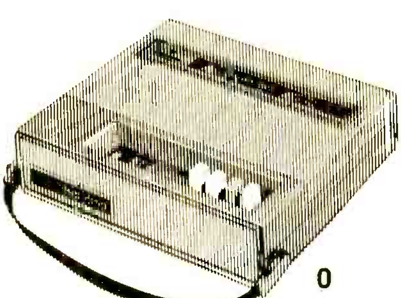
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Convergence Circuits of Color Sets: RCA

By WALTER H. BUCHSBAUM

Special circuitry is necessary for shadow-mask color CRT's to assure that the three electron beams will correctly converge at the shadow-mask holes to strike their respective phosphor dots.

IN addition to the deflection coils, several other factors determine the path of the three electron beams in a conventional three-gun, shadow-mask color CRT. The first of these factors is the purity adjustment, a constant magnetic field which affects all three electron beams. The second adjustment, known as static convergence, controls the coincidence of the three electron beams near the center of the picture-tube active-screen area This static convergence is achieved by adjusting the fields of three permanent magnets, each controlling one electron beam as illustrated in Fig. 1. The final convergence of the three beams, however, requires a fourth motion, and this is produced by the blue lateral magnet which permits static adjustment of the blue beam in the horizontal direction. This allows all three beams to converge exactly.

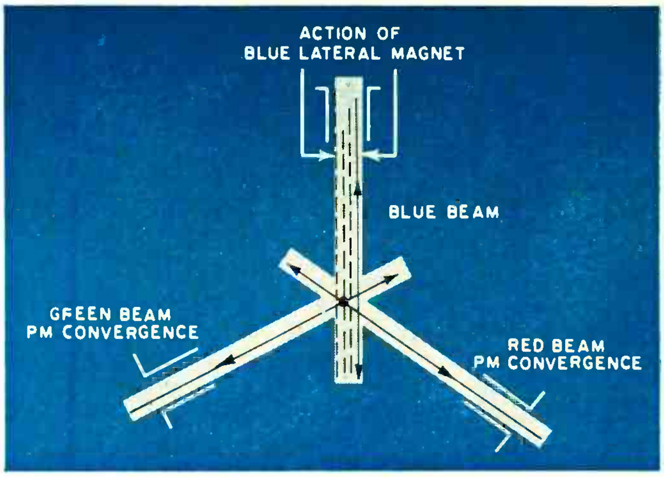
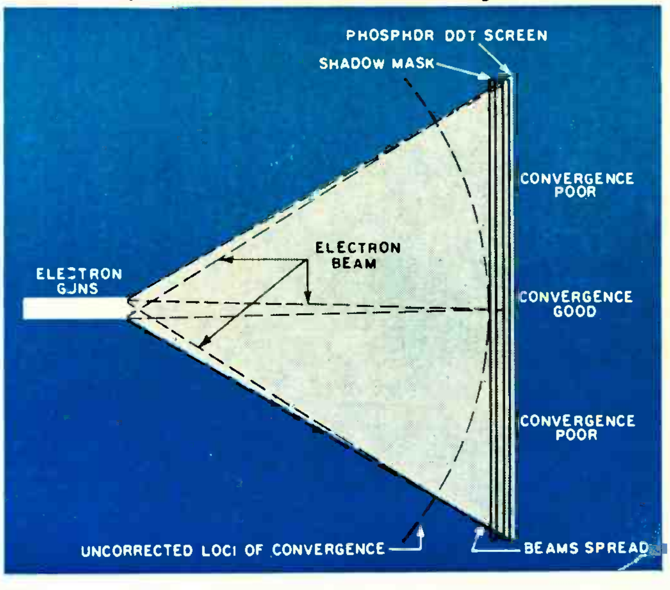


Fig. 1. Permanent magnet convergence and the blue lateral magnet adjustment is used to set purity of the color CRT screen.

Fig. 2. The electron beam convergence (and focus) point describes an arc about the deflection center. As the shadow mask is relatively flat, some form of correction signal is needed.



The third, and by far the most complicated, convergence requirement, is that the three electron beams converge at the top, bottom, and sides of the screen area as the electron beams scan across the face of the screen. The electron-beam convergence, or focus point, moves through an arc as shown in Fig. 2, and since it is intended to strike an almost flat area, the phosphor dot screen, corrections must be made for the focus point so that it changes as the three beams are deflected across the screen. This is called dynamic convergence.

Without proper static and dynamic convergence, good black-and-white and color pictures are impossible. Poor convergence is most easily visible on black-and-white reception when the areas appear to overlap with red, green, and blue borders, similar to misregistration on a color print. Many service calls are due to poor convergence, and it is no wonder that color-TV manufacturers pay special attention to the design of reliable and stable convergence circuits which are also easy to adjust. In the *RCA* CTC19 and CTC17 series of color models, new and improved convergence circuits are used, and adjustments are simplified by reference to specific areas of the screen which each adjustment is designed to control. This article will not go into the details of the convergence adjustment procedure but will concentrate instead on the new features of the dynamic convergence circuitry and on understanding the principles used in their operation.

Purity

The new *RCA* receivers use the same purity magnet assembly that has been employed for the past few years. Two permanent-magnet rings are rotated against each other, or as an assembly. The purity magnet rings are adjusted until a reasonably pure red screen is displayed. *RCA* points out that the static convergence must be set before any purity adjustments should be attempted. The company also advises that no purity or convergence adjustments should be made until after the set has been operating for at least 15 to 25 minutes.

Each of the three convergence magnets in the purity ring assembly contains a permanent magnet which is adjusted to converge the red, green, and blue electron beams

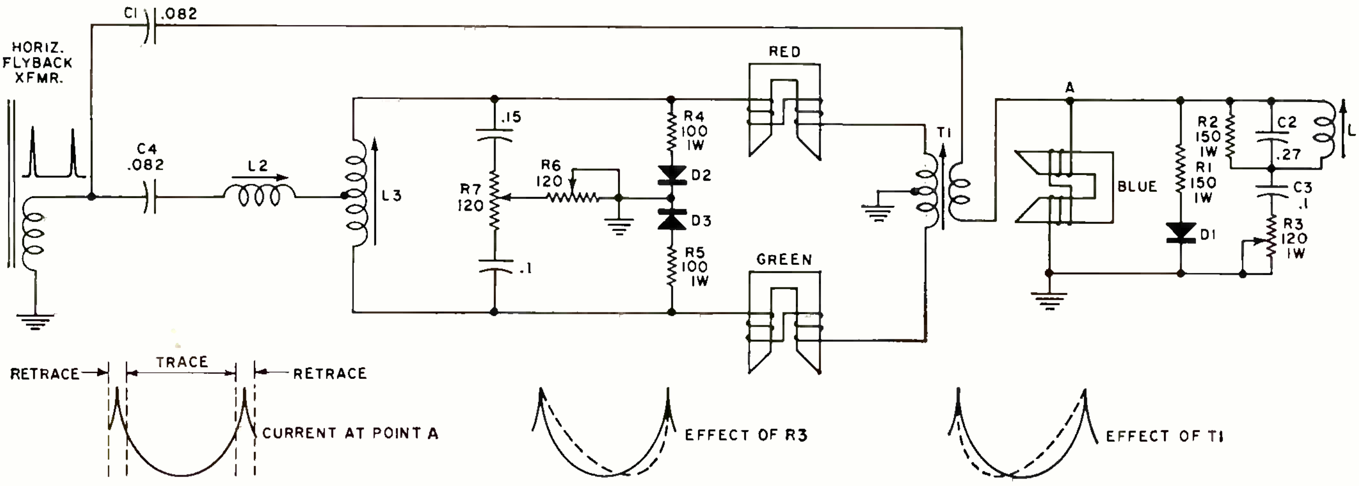


Fig. 3. The waveshapes show how the blue convergence current is affected by adjustment of certain controls. The other two currents (red and green) are affected by adjustment of controls that determine only their particular current flow. The circuit shown is a simplified schematic of the dynamic horizontal circuits used in the RCA CTC17 and -19.

at the center of the screen. The blue lateral magnet is set separately to bring the blue beam into convergence. These are mechanical adjustments, and since no circuitry is involved, they will not be described any further.

Dynamic Horizontal Convergence

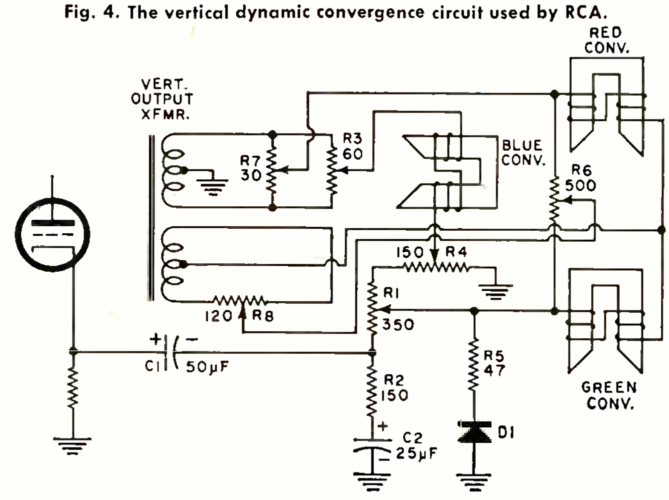
As the red, green, and blue electron beams are deflected across the screen, the point at which they converge changes. If the static convergence is adjusted correctly, the electron beams will converge properly in an area around the center of the screen but, as they move away from the center, some correction is necessary at either side (see Fig. 2). As in all shadow-mask picture tubes, this correction is provided by a shaped current passing through a coil wound over the convergence magnet. This changes the magnetic field as a function of current flow. In many early color sets, a single coil carried both vertical and horizontal dynamic convergence signals; however, new models use separate horizontal and vertical convergence coils. To provide convergence correction, a current which corresponds in frequency to the horizontal deflection signal is passed through the horizontal coils. The current waveshape is parabolic, as shown in the Fig. 3 waveforms, and provides the correction between the flat phosphor dot screen and the radius which the convergence point would describe without these corrections. The amplitude of this correction current will determine the extent of correction that will be present at both sides. As long as this current waveshape is symmetrical as shown in the lefthand waveform of Fig. 3, it will provide equal correction at the left and right. If more correction is required on one side than on the other, tilting or unbalance is achieved, causing the current to appear as shown in the other two waveforms.

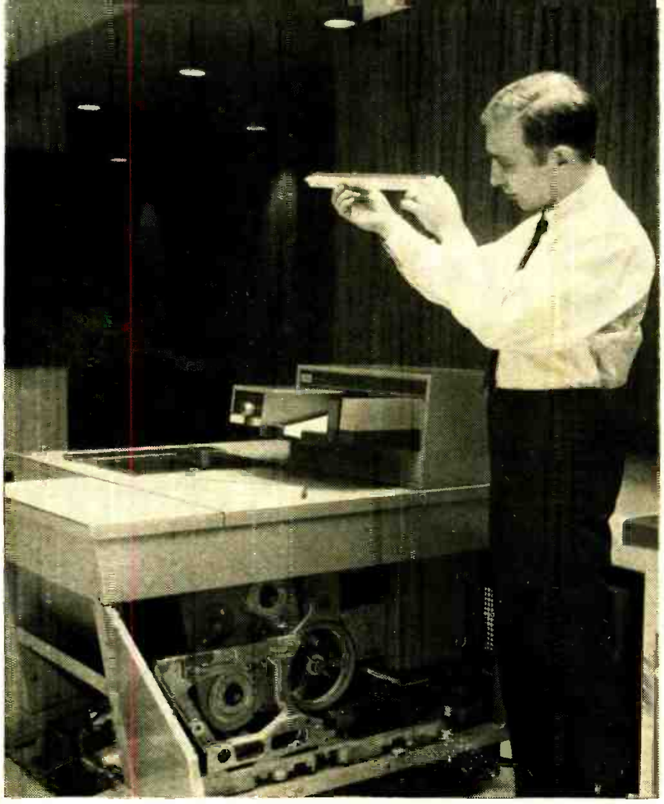
One of the inherent problems in convergence circuitry is the interaction among the three convergence signals, their magnetic fields, and the three electron beams. It is difficult to provide adjustment for the red electron beam without also affecting the green and the blue. What makes this matter even more complex is the problem of determining, in the case of misconvergence, which of the three is really wrong. In the *RCA* models, this has been solved to some extent by using one set of circuitry and controls for the blue electron beam and another set of controls for both red and green.

All horizontal convergence signals are obtained from the same source, but to analyze the circuit functions in detail, examine the blue horizontal convergence circuit as shown in Fig. 3. A 235-volt (approximately) peak positive pulse (the same signal which is used for gating the burst amplifier, the color killer, and the keyed a.g.c.) from the horizontal flyback transformer is the source of the horizontal convergence signal. This pulse passes through capacitor *C*1 and the primary of *T*1. Then the current is divided, at point "A," into the coils of the blue convergence magnet assembly, the tuned circuit of *L*1 and associated components, and the combination of *R*1 and diode *D*1. This latter is a selenium diode, part of a four-section selenium-diode assembly. It should be remembered that the waveform shown as a series of positive pulses is a voltage waveform and that this is different from the actual current passing through the coils of the convergence magnet. It is the current, not the voltage, that determines the convergence action because the electron beam is affected by magnetic flux. Diode *D*1 limits the peaks and prevents ringing. Also across the horizontal convergence coils is an *RLC* circuit (*R*2, *L*1, and *C*2) which acts as a broadly tuned resonant network. Inductor *L*1 is adjustable and its function is to shape the signal. In effect, *L*1 determines the load that the convergence circuits reflect back to the flyback transformer. The adjustment of *L*1 is not part of the convergence procedure but affects the linearity and efficiency of the flyback section. It should be changed only when major repairs have been made, and the detailed procedure described in the service manual should be followed. Both *C*3 and *R*3 determine the amount of amplitude at the left side of the screen, while adjustment of *T*1 determines the amplitude at the right side of the screen. Fig. 3 shows the effect of these two adjustments. (We have assumed here that the left side of the page facing the reader corresponds to the left side of the picture-tube screen.)

The red/green horizontal convergence circuit shown in Fig. 3 is recognizable as some kind of balanced arrangement. It is this balanced circuit that makes adjustment of the red and green horizontal (*Continued on page* 74)

Fig. 4. The vertical dynamic convergence circuit used by RCA.





Looking for flaws in the corotron assembly used in a copier This assembly gives the selenium drum a positive charge that prepares it to receive t. e electronic image.

The Xerox Corp. Tech Rep is a trouble preventer, troubleshooter, customer educator, goodwill ambassador, and engineering consultant whose reports and suggestions lead to important design changes.

By GENE SMITH

The Technical Representative

STEPHEN Levit is a technical representative for *Xerox Corporation,* and he is proud of being one. If he worked for *International Business Machines,* he would be known as a customer engineer. And if he and his *IBM* counterpart had been working in the immediate post-World War II years, they would have been called servicemen.

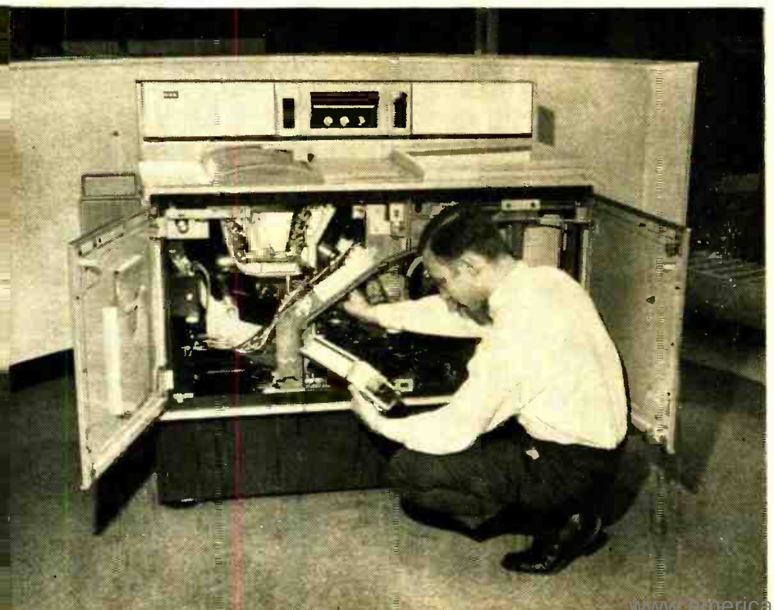
But Levit really is much more than that. His very appearance points that up. He makes his calls in a business suit; there are no coveralls for him with the company name embroidered on the back. He carries the tools that he needs in two sleek-looking attaché cases. He is clean-cut, neat, well-spoken, for when he calls on a client he *is* the company.

The tech rep is actually a vital member of the company's marketing team. The work he does, the service he renders, the contacts he establishes, go hand in glove with the efforts of company salesmen. It is up to the TR to maintain customer satisfaction and to help promote the other machines and services offered by his company.

Levit is typical of this new breed that has sprung up to service the complicated business machines that are today leased all over the country in ever-increasing numbers. Company revenues depend on all the Stephen Levits it employs, since the leased machines are metered, with the customer paying only for the copy that is actually produced. Downtime, when a machine is out of action, is thus an important item in the balance sheets. How well the TR's do their work is reflected in the all-important earnings of the company.

So, an accurate description of what Levit does proves the importance of his position. He is at one and the same time a trouble preventer, a troubleshooter, a customer educator, a

Using a pyrometer to check the temperature of the fuser heat pressure roller. This roller fuses the toner into the paper.



Steve Levit (center, front row) joins other tech reps in an after-hours class in electronics conducted by the company.

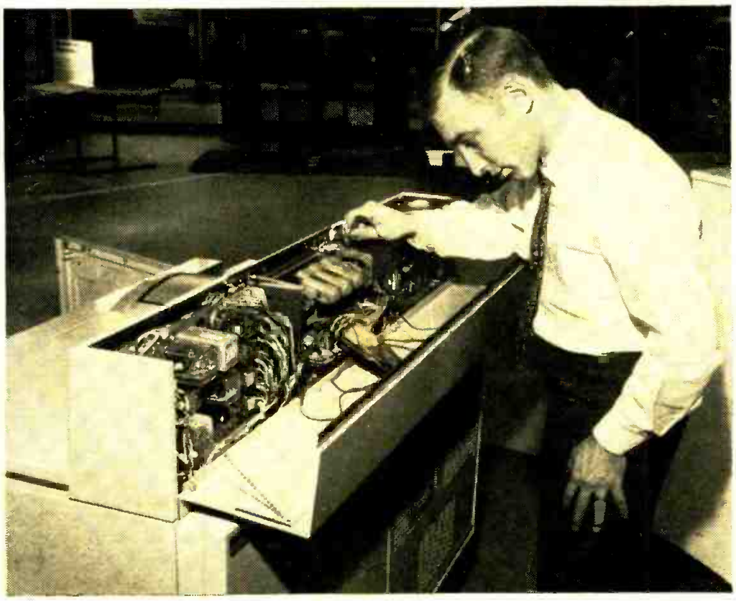
goodwill ambassador, and an engineering consultant, whose reports and suggestions lead to design changes incorporated in new machines or retrofitted into earlier models.

Background and Training

He joined the company five years ago upon his release from the United States Navy, in which he had been an Electronics Technician Second Class. It was only natural that a young veteran should seek work in a field in which he was best qualified, so he tried to locate a job in the radar field. There was little available. So he went to an agency and they told him about *Xerox*.

His electronics training fitted him neatly for the job, and he went to work as one of about 20 TR's whose territory then covered the entire uptown area of New York's Borough of Manhattan, above 42nd Street. Their responsibility: to maintain customer installations of copiers and equipment for producing offset printing masters.

Levit spent his first two weeks in intensive training on the fundamentals of xerography and the machines. He learned all about corona discharge of positive ions and the corotron units that produce it to put an electrostatic charge on a selenium drum or plate. He learned about photoconductivity, the property that enables a material like selenium to act as an insulator and store an electrical charge in darkness and then become a conductor, surrendering the charge in the presence of light. He was thoroughly indoctrinated in the electrical, mechanical, and optical complexities of the devices for which he was to be responsible.



Employing a v.o.m. to check programmer assembly on copier. This assembly sets up a relay switching sequence in the copy cycle.

The next two weeks saw him in the field, actually working with an experienced tech rep on machines at customer installations.

So well did he take to his job that he was subsequently the first TR selected to attend a new company school at Garden City, Long Island, for instruction in the then-new desk-top copy machine. After two weeks there, he was placed in charge of maintaining the first such machines that were installed in New York City.

Today he is also qualified on a number of other machines. These include the highly sophisticated electronic facsimile communications system known as LDX (long-distance xerography). Levit is as much at home troubleshooting the circuitry of an LDX scanner (transmitter) or an LDX printer (receiver) as he is checking out the bias voltage adjustment on a more conventional copier.

Preparing to tune up a long-distance xerography scanner, Levit traces a supervisory signal through the computer logic schematic.

Typical of many TR's, he has shown that he wants to advance himself. He is working hard to earn promotion and to prepare himself for it now by acquiring extra skills. Twenty-six-years old and married, he is an evening student at City College of New York. His company foots half the bill for such outside courses if they are job-related, and more than half the company's TR's take advantage of the opportunity.

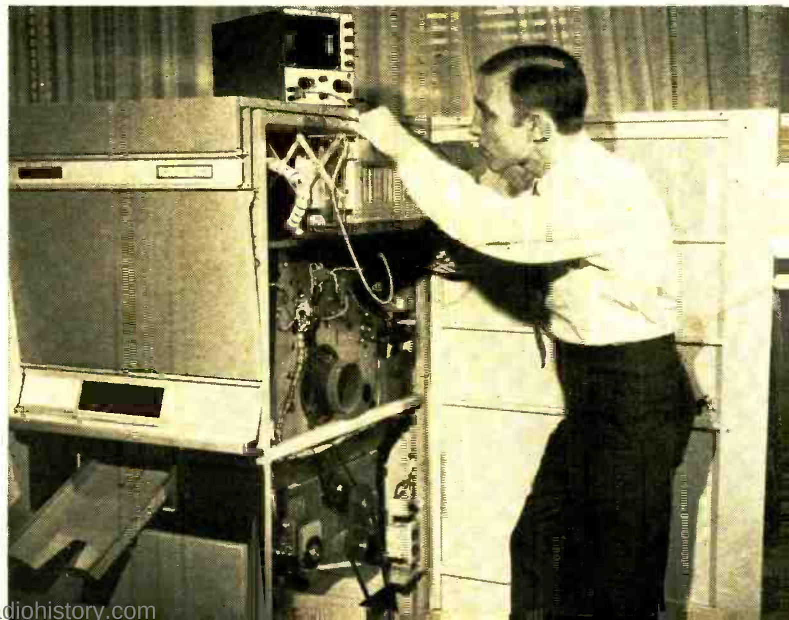
While Levit at first aimed at a major in engineering, he has switched to psychology. "I changed because it fits in with the possibilities of getting into management work," Stephen explains. "I have found that a great part of my job is really customer relations. I feel that I have the proper technical background, and this new field teaches me how to deal correctly with people problems."

He points out that this was a personal decision. Other tech reps might prefer to go ever deeper into the technical side, perhaps with an engineering position as a goal.

Even to him, "the most important thing is to have a good background in electronics."

This is truer than ever today for tech reps. The company recently announced that it will (*Continued on page* 73)

Using an oscilloscope to check the width of video blanking pulses that are employed in long-distance xerography unit.



Electromechanical Choppers

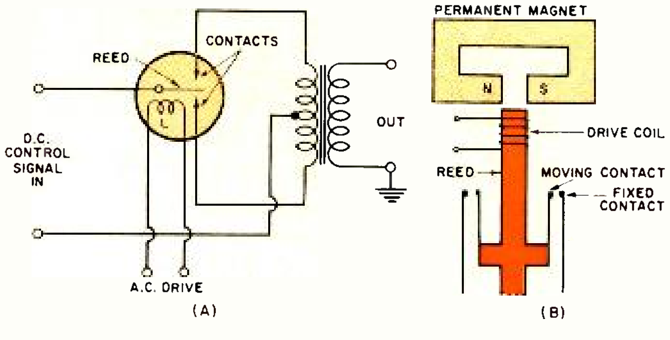
By SIDNEY L. SILVER / B. Eichwald & Co.

Widely used in industrial electronic instrumentation, these contact modulators convert slowly varying signals or changes in d.c. levels into a.c. square waves that can be handled more easily by amplifiers.

IN the field of electronic instrumentation, it is frequently necessary to convert low-level d.c. or very-low-frequency signals to a.c. pulses that bear a definite relationship to a driving sine wave. The driving signal serves as a carrier which is modulated or "chopped" by the original d.c. or slowly varying signal. This function is performed by a switching device, or chopper, which produces an output square wave whose level corresponds to the d.c. signal. The resultant square wave may then be amplified by a conventional a.c.-coupled amplifier, and reconverted to d.c. at a higher level by means of a demodulator and filter.

The use of the chopping technique in the amplification of low-level d.c. signals arises from the fact that d.c. amplifiers, while permitting response down to 0 Hz, introduce drift. This undesirable characteristic is caused by random fluctuations in tube and transistor parameters due to the aging of components and also by the gradual shift of the operating point due to temperature changes. As a result, an output error signal is produced which cannot be distinguished from normal changes in the output caused by the input signal. In control applications where zero reference must be maintained, it is essential that the output of an amplifier be zero when no input signal is present.

Fig. 1. (A) Simple chopper circuit in which the switching action performs function of modulation. (B) Resonant chopper mechanism.



The d.c.-to-a.c. conversion process overcomes these limitations by utilizing simple a.c. amplifiers (*RC* coupling between stages) which can easily be designed for high-gain stability and freedom from drift. After synchronous rectification and filtering, further amplification in d.c. form may be provided by high-level d.c. amplifiers to obtain the desired output voltage.

Modern choppers may be classified as electromechanical, semiconductor, magnetic, or photoelectric—all of which serve useful purposes for specific applications. This article deals exclusively with the electromechanical type, also referred to as the contact modulator. The mechanical chopper has been developed to a high degree of perfection which enables it to perform efficiently under conditions of shock, acceleration, and vibration. Its use is essential in low-level circuitry where electrical noise must be minimized and positive switching action is required.

In industrial electronics, mechanical choppers have found application in feedback control systems, analog computers (differential analyzers), chopper-stabilized amplifiers, precision test equipment (level recording devices), data reduction systems, and medical instrumentation (electrocardiographs).

Mode of Operation

The basic elements of a mechanical chopper consist of a contact-bearing metal reed, positioned between fixed contacts, and a polarized drive coil. In the simple chopper circuit shown in Fig. 1A, an a.c. excitation signal is applied to the drive coil (L) which gives rise to an alternating magnetic field, thus causing the reed to vibrate at the frequency of the applied voltage. The vibrating reed alternately deflects toward each fixed contact in synchronism with the drive frequency, so that contact motion is determined by the polarity of the coil.

When the d.c. control signal is applied to the contacts, the switching action of the reed periodically interrupts or chops the d.c. so that induction occurs in the transformer. Thus a rectangular a.c. pulse is developed across the second-

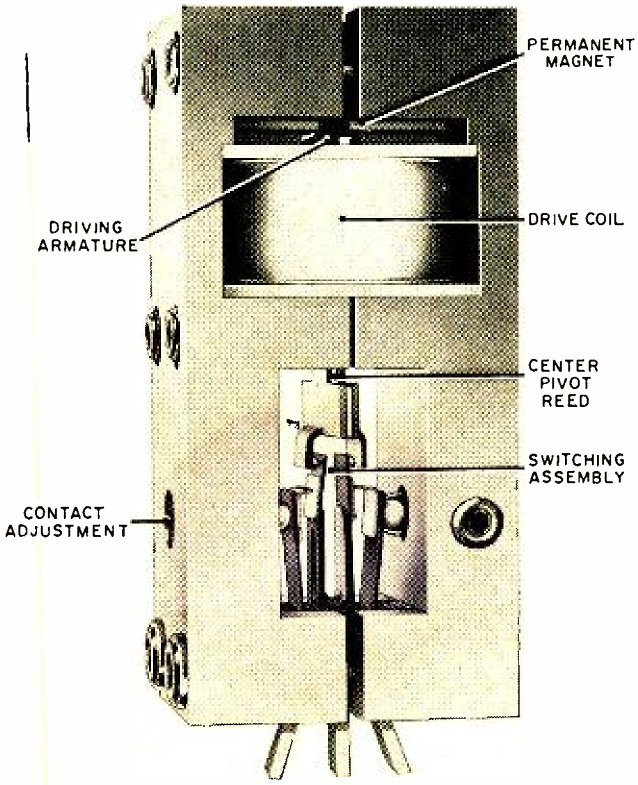


Fig. 2. Basic mechanism of a miniature non-resonant chopper.

ary, the amplitude of which is dependent upon the amplitude of the d.c. input and the step-up ratio of the transformer. The frequency of the output pulse is equal to the driving sine-wave frequency and may be reversed in phase by changing the polarity of the d.c. input signal. Since the transformer cannot pass the d.c. component of the waveform, the a.c. output is effectively isolated from the d.c. input.

Basic Types

In the mechanism of a mechanical chopper, a weight and spring relationship exists in the moving structure of the device to form a mass-compliant system If the natural frequency of the metal reed is used to achieve contact motion, the device is referred to as a "resonant chopper." To make the chopper operate at the same fundamental frequency as the excitation, a d.c. polarizing field is provided by a permanent magnet.

Fig. 1B shows the basic elements of a resonant-type chopper in which the drive coil current polarizes the end of the reed north or south, depending on the direction of the coil current. When the end of the reed is polarized north, it is deflected toward the south pole of the permanent magnet. A reversal of coil current causes the reed to reverse polarity and deflect toward the north pole. In this manner, the coil excitation alternately increases and reduces the magnetic field of the polarizing magnet so that the vibrating reed causes the contacts to make and break once for each oscillation of the drive voltage. The reed vibrates at the coil excitation if this frequency is near the natural resonant frequency of the reed.

Since the "Q" of the mass-compliant system is high at resonance, any variation in temperature, drive frequency, or drive voltage may produce large phase shifts between the reed oscillation and the reed drive. To stabilize these operating characteristics, the resonant chopper is designed to operate with a drive frequency which is near, but not equal to, the natural resonant frequency of the reed. In a typical 60-Hz chopper, for example, the reed frequency is frequently on the order of 80 Hz.

Most resonant choppers are designed to operate at either 60 Hz or 400 Hz with a nominal drive coil rating of 6.3 volts r.m.s. High voltages, up to 100 volts, may be switched intermittently across the contacts, since the resonant-reed principle permits adjustment for large contact motion. When adjusted for large contact motion, the resonant chopper produces high contact pressures which contribute to positive switching action.

A variation in chopper design is the non-resonant type or "driven chopper." In this configuration, the mechanical resonance of the moving contact assembly is considerably higher than the operating frequency range of the chopper. Switching action is achieved by a stiff armature which is deflected solely by the energy derived from the magnetic fields of the permanent magnet and the drive coil. The stiffness of the armature requires that a high driving force be exerted on the moving contacts to obtain contact motion. This high-force-to-mass ratio enables the chopper to operate efficiently under extreme conditions of shock and vibration. Driving waveforms for non-resonant choppers may be sinusoidal, square, step function, or even irregular pulses of a repetitive nature. The use of drive voltages with steep wavefronts, however, is generally undesirable since they contain high-frequency components which may cause contact chatter.

Fig. 2 shows the internal construction of a commercial chopper with a non-resonant driving system, which can accommodate a span of drive frequencies above or below its nominal frequency. In this design, the driving armature is separated from the switching circuit by a center pivot reed which permits extensive shielding between the driving system and the low-level switching circuit. This mode of construction also balances the armature and minimizes the effects of external mechanical forces. Since the frame mass is made high in relation to the driving system, there is a low vibration transmission to adjacent components so that no shock mounting is required.

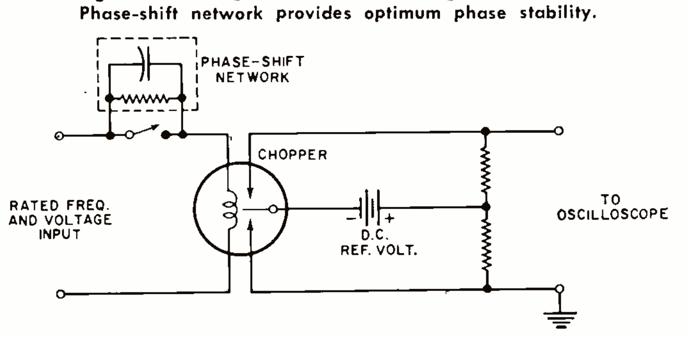
To eliminate a possible source of noise generated by electrochemical action, all component parts are gold plated. The contacts are made with a special gold alloy in order to avoid erratic contact resistance when switching very-low-level signals. Adjustment is made by glass-tipped screws which fix the position of the stationary contact arms.

Electrical Characteristics

An important factor which determines the useful life of a chopper is its ability to function within specified limits. In general, choppers remain within their ratings for at least 5000 hours of continuous operation. Since the circuitry used has a considerable bearing on performance, it is difficult to specify precisely the life of a chopper. In order to evaluate electrical performance a measuring circuit, as shown in Fig. 3, may be used, in which the driving voltage is a perfect sine wave and the output signal is developed across a resistive load. Fig. 4 illustrates the important parameters which can be determined by this method.

One of the operating characteristics of a chopper is the time in electrical degrees that each contact is closed, in relation to the sinusoidal reference wave. This factor is called

Fig. 3. Measuring circuit for determining contact action. Phase-shift network provides optimum phase stability.



the *dwell time* and it occurs twice each cycle. Any difference in closure time of two contacts opposite each other results in a different dwell time (asymmetry) of the two halves of the square wave.

Dwell time changes when the chopper approaches the end of its life so that the device fails to function within certain tolerances. For example, a decrease in dwell time caused by changes in the time interval between the initial engagement of the movable contact and the fixed contacts is equivalent in many chopper circuits to an effective loss in gain. This limitation may be overcome by using circuits with a substantial margin of gain so that the chopper may deliver useful performance for several times its rated life.

The interval of time during which neither contact of an opposing pair is closed is referred to as the *transit time*, or "off" time." This interval of no electrical contact occurs twice each cycle and is a characteristic of a break-before-make chopper. During transit time the presence of undesirable pickup currents may permit inductive spikes to appear in the output signal.

Another parameter of interest is the precise timing relation between the opening and closing action of the contacts and the driving sine wave. This relation is called the *phase lag* and is defined as the displacement in electrical degrees between the peak of the sine wave and the midpoint of the corresponding dwell time. Phase angle is measured between the 90° (or 270°) point of the sine wave and the square-wave center. The inherent phase lag is caused by the drive coil inductance and the mechanical mass of the moving armature assembly. An increase in the driving frequency increases the phase angle, while a rise in driving voltage reduces the angle. Effective phase may be changed by external circuitry. To adjust a chopper for a phase angle of 0°, for example, a phase-shifting network may be connected in series with the drive coil, which introduces a leading current and provides optimum phase stability.

An important chopper characteristic is the presence of unwanted signal, or residual noise, which is generated within the chopper. Chopper noise is the voltage appearing between each contact and ground which is measured across a resistive load, with the driving signal applied to the coil and no control signal at the contacts. The noise component in phase with the drive voltage, termed "offset," is rectified and appears as d.c. at the output of the synchronous rectifier. This noise element can be measured by applying a d.c. input and chopping the signal both in the plus and minus direction, the difference being the offset.

A major source of noise inherent to a mechanical chopper, especially in high-impedance circuits, is electrostatic noise caused by capacitive coupling between the drive coil and the switching assembly. The value of the coupling impedance is much higher than the load impedances employed in chopper circuits, so that electrostatic noise is directly proportional to the external load.

Another type of spurious signal is magnetic noise caused by stray leakage currents originating in the drive coil and induced into the switching circuit. Magnetic noise has a source impedance much lower than the external load impedances generally used in chopper circuits, and is nearly constant and independent of circuit loading. Noise can also take the form of thermal e.m.f.'s produced at the junction of dissimilar metals due to a temperature gradient. These bimetallic junctions exist in the switching circuit connections and also at the chopper base terminals.

Low residual noise levels are obtained by electrostatic and electromagnetic shielding between the drive coil and the contact assembly. Further isolation is maintained by feeding the drive coil leads out through the top of the chopper enclosure and bringing the contact leads out through the base. To resist the effects of moisture and dust contamination, most choppers are hermetically sealed in metal enclosures (brass or Mumetal). Some choppers, however, are designed with removable covers to permit cleaning and adjustment of the contacts in order to extend its useful life.

In modern chopper design, noise has been reduced to a negligible value, with noise figures obtainable under one microvolt when operating into a high-impedance load.

Chopper Applications

The primary function of a chopper in most circuits is to modulate and demodulate a signal in conjunction with a

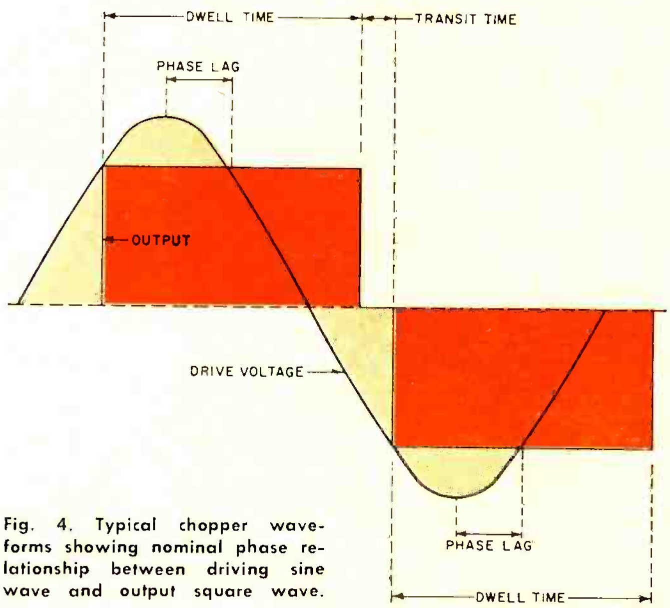


Fig. 4. Typical chopper waveforms showing nominal phase relationship between driving sine wave and output square wave.

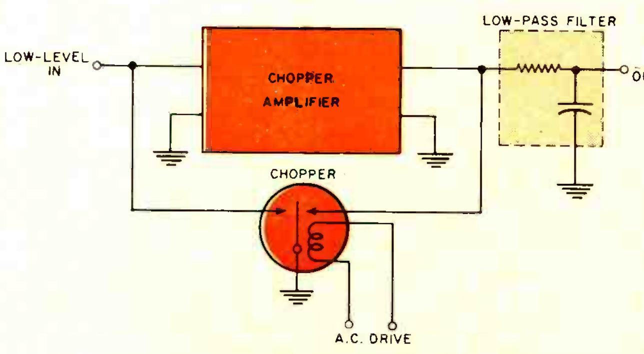


Fig. 5. Block diagram of chopper amplifier with s.p.d.t. chopper.

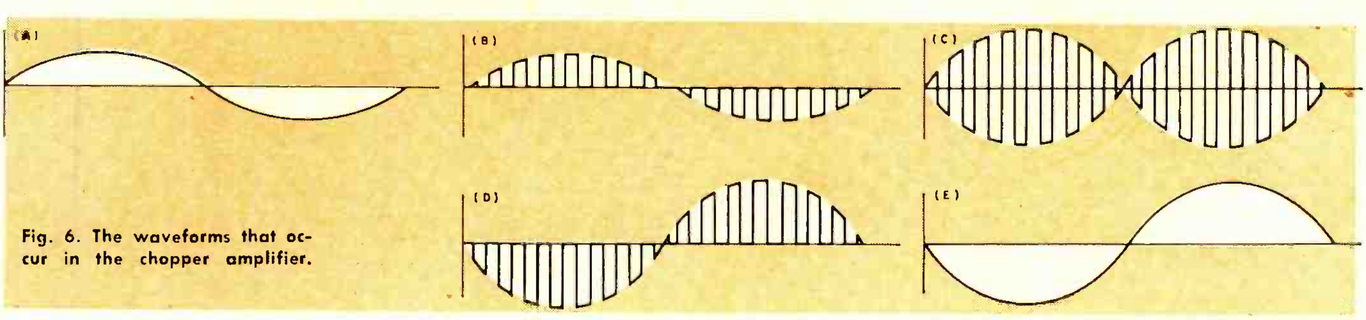


Fig. 6. The waveforms that occur in the chopper amplifier.

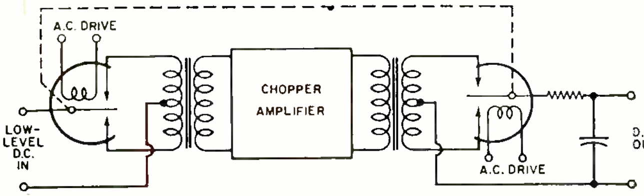


Fig. 7. Amplifier with d.p.d.t. chopper for full-wave demodulation.

high-gain a.c. amplifier. In the chopper amplifier shown in Fig. 5, a single chopper acts as a s.p.d.t. switch to perform the function of both the modulator and demodulator. The operation of the circuit may be analyzed by assuming the input control signal to be a very-low-frequency sine wave, as shown in Fig. 6A. When the signal is applied to the input contacts, the amplifier is modulated at the drive frequency by being alternately shorted to ground to produce the waveform shown in Fig. 6B. Assuming that the low-frequency signal does not lie within the passband of the a.c. amplifier, the amplified voltage output will have the form shown in Fig. 6C. The output is half-wave rectified (Fig. 6D) and fed to the low-pass filter during the interval of time that the output contacts are open. Thus, either the input or the output of the amplifier is always grounded. The filter serves to reduce the chopper frequency ripple to a negligible value so that the final output voltage in Fig. 6E is an amplified reproduction of the input. A 180-degree phase reversal exists between the input and output voltage due to the fact that the chopper applies the input signal to the amplifier at the same time that it shorts the output, and *vice versa.*

To obtain an output voltage free from harmonics introduced by the modulator, the cut-off frequency of the filter must be low compared to the modulation frequency. This limits the frequency response of the system to a few cycles, in the case of a 60-Hz chopper, which is sufficient for small bandwidth requirements. Where a wider bandwidth and faster response time is required, a 400-Hz chopper may be employed.

The use of a single chopper to modulate and demodulate a signal may introduce a source of undesirable feedback since the input and output terminals are in close proximity. To avoid oscillation, it is necessary to employ a make-before-break type of chopper so that at least one end of the amplifier is grounded at any instant. In this way, capacitive coupling between input and output contacts is avoided.

For high gains, it may be feasible to employ a d.p.d.t. chopper with one section used for modulation and the other for demodulation. Fig. 7 shows a chopper amplifier in which a full-wave demodulator rectifies the output signal in synchronism with the modulator contacts at the input. The split-reed construction of this type of chopper isolates the two sets of contacts from each other, thereby avoiding a possible source of feedback. Since both sets of contacts are in the same case, any phase angle variations caused by changes in temperature affect both sections alike, so that the two sets of contacts remain closely synchronized with each other. The tracking between the moving contacts and the fixed contacts must be closely matched in order to hold the chopper dwell time and phase relationships precisely constant. Any major differences in these operating characteristics will affect the d.c. gain of the chopper amplifier.

To overcome the disadvantages of restricted upper frequency limit of the chopper amplifier, a chopper-stabilized system is used in circuits that require a very high gain over a wide frequency range. As shown in Fig. 8, this technique consists of a two-channel arrangement in which the low-frequency components of the input signal are fed to a chopper amplifier through a low-pass filter (*R*1, *C*1) and appear at one input of a d.c. differential amplifier. The high-frequency components of the signal bypass the chopper section through a high-pass filter (*R*2,*C*2) and are fed to the other input of the d.c. amplifier, where they are reunited with the low frequencies. By adjusting the crossover frequency of the filter networks to a sufficiently low value, negligible energy at the chopper frequency enters the modulator. Over-all negative feedback is employed to stabilize the gain and provide a flat, uniform response ranging from d.c. to the upper frequency limit of the d.c. amplifier.

The reduction of drift, which may be regarded as a very-low-frequency noise component, is made possible by the large amount of negative feedback used in the low-frequency channel. Any drift component which is developed across the output of the d.c. amplifier is fed back through the feedback resistor (R_f) and passed through the chopper amplifier to the input of the d.c. amplifier. Since the drift is inversely proportional to the chopper amplifier gain, the effective drift level becomes exceedingly small compared to the enormous amount of stable low-frequency amplification available from the chopper amplifier. In effect, the chopper amplifier serves as a high-gain, (*Continued on page* 56)

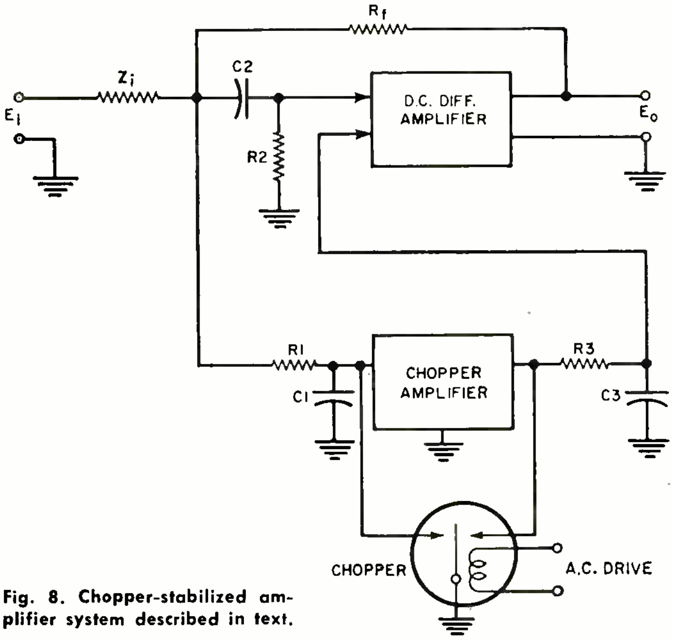


Fig. 8. Chopper-stabilized amplifier system described in text.

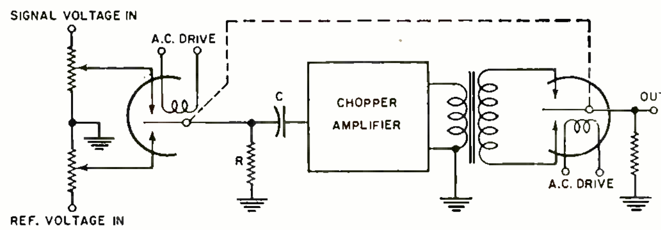


Fig. 9. Comparison circuit measures difference in d.c. values.

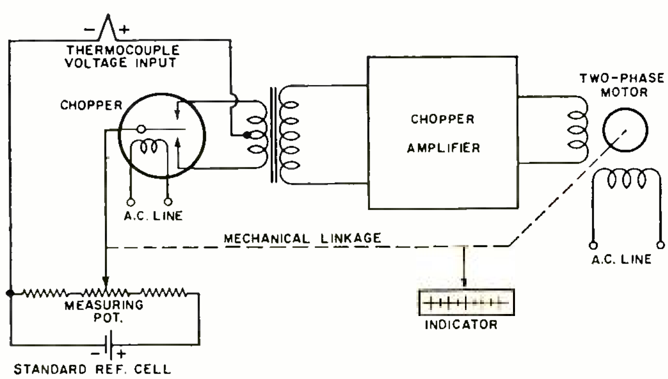
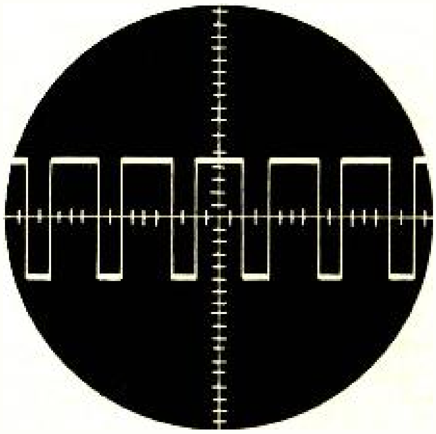


Fig. 10. Electronic null-balance temperature recorder circuit.



Oscilloscope Probes

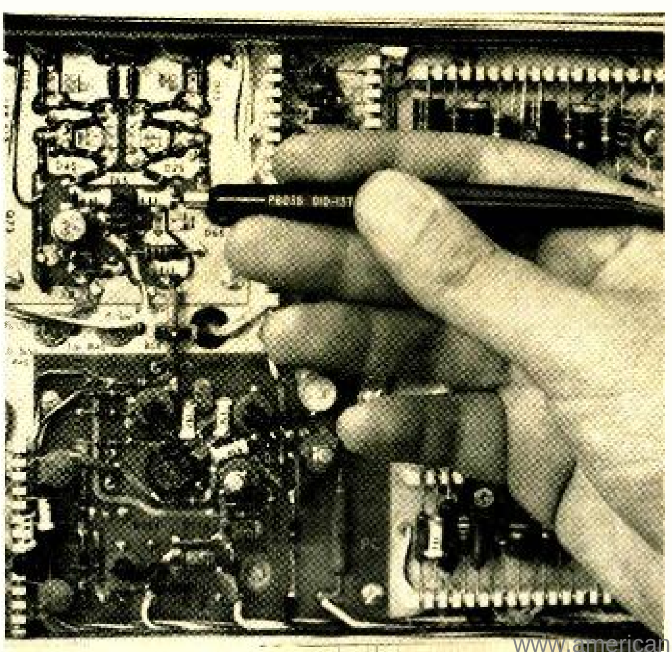
By WALTER H. BUCHSBAUM

While probes are only an accessory to the scope, they have a strong influence on the accuracy of any measurements. Choosing the correct probe, and knowing its characteristics, then becomes very important.

ONE of the basic principles in electronics is that every measurement somehow always affects the measured quantity. When a particular voltage is measured, for example, some of the energy must be diverted to the voltmeter itself, thereby lowering the actual voltage. In practical testing and measurement, this amount is so small that it can be neglected. There are many instances, however, where the amount of energy drained off by the measuring device is great enough to cause trouble. Voltmeter resistances are given as 1000 or 20,000 ohms per volt, which is the resistance represented by the meter circuit when it is shunted across the point at which the voltage is measured. Knowing the circuit, we can calculate the error due to meter loading, but for most practical purposes, even a 3% loading effect can be neglected, especially since it is always present and repeated measurements with the same instrument will always produce the same results.

When an oscilloscope is used to measure a.c. signals, the loading effects of capacitance, resistance, or inductance can seriously distort the shape of the signal. This distortion can be especially severe at the higher frequencies, with complex waveshapes, or with very high voltages. For this reason, practically all manufacturers of oscilloscopes provide special test probes to assure that the measurement of the signal does not cause any distortion in itself. This article deals with the various types of oscilloscope probes, their circuitry, and their proper use in making measurements.

Fig. 1. Oscilloscope probes enable convenient circuit testing. The probe should be selected to fit the desired measurement.



Mechanical Probes

Probes provide convenient mechanical methods of reaching various test points without danger of accidental shorts. Fig. 1 shows a typical probe in use and illustrates the convenience of a particular type of tip. When tracing through a circuit, where quick connections to one point after another must be made, a simple needle-point probe is usually best. When the oscilloscope probe is to be attached to a terminal or a piece of wire, alligator clips, hooks, or springs are more convenient. Fig. 2 shows some of the different tips which can be used with a particular *Tektronix* probe. The popular "Klipzon" probe tips combine a needle point with a spring-loaded hook for clipping the probe to a terminal or bare wire lead. Another probe tip consists of two parallel springs which come apart to form a clip when the insulating sleeve is pulled back. Still other inexpensive probes have tips over which a small alligator clip can be fitted to provide attachment to a terminal or wire.

The coaxial cable that is connected to the probe is, of course, grounded at the oscilloscope chassis, and it is usually best to bring a short lead from the cable or probe ground directly to the chassis ground nearest the point under test. This grounding arrangement will prevent undesired pickup by the probe cable but requires shifting the ground lead as the probe is moved around. In testing lower frequency circuits, a common ground between the oscilloscope and the chassis under test may be sufficient. This makes it easier to move the probe around but can cause pickup trouble.

D.C. Probes

If the shielded test cable were connected directly to the point being measured, this would shunt the capacitance of the cable and the scope input circuit directly across the circuit under test. To avoid this, an isolating resistor can be connected in series with the test cable. This is usually a one-megohm, ½-watt resistor mounted inside the probe case. Because most oscilloscope input circuits have a very high impedance input, this isolating resistor has the effect of attenuating the signal amplitude. The shunt capacitance of the cable and the scope input circuit increase the attenuation at the higher frequencies. A simple isolation probe can only be used on signals below 10 kHz and does not permit really accurate measurements.

For accurate amplitude measurements, the probe attenuation must be known precisely, and the effects of cable and scope input capacitance should be at a minimum. The amount of attenuation depends upon the circuit of the particular oscilloscope probe and will vary from 10× to 1000×. A typical probe circuit, such as shown in Fig. 3, provides 100× attenuation as determined by the ratio of $R1$ to $R2$. The probe itself, the cable, and the input to the oscilloscope all have capacitance which means that at higher frequencies, $R2$ is shunted by the capacitance of the coaxial cable, $C2$.

To appreciate the importance of this shunt capacitance, assume that the combined capacitance of the probe handle, the coaxial cable, and the scope input circuit all add up to 50 pF. When a 10-kHz square-wave signal is applied to the probe, the reactance of $C2$ will be about 300,000 ohms at the 10-kHz fundamental. A rise time of 10 microseconds equals a frequency of 100 kHz at which the reactance of $C2$ will be about 30,000 ohms. The wavefront of the square wave will therefore be attenuated almost ten times as much as the 10-kHz fundamental, resulting in a much-rounded-off square-wave display on the oscilloscope screen. Neglecting the small resistance of $R3$, the basic attenuator consists of $R1$ and $R2$. Since $R2$ is shunted by $C2$, $R1$ can be shunted by a capacitor to compensate for the effect of $C2$. Using the same ratio of capacitor reactance to resistance, $C1$ turns out to be approximately .5 pF. When a 100-kHz signal appears at the probe input, $C1$ will shunt $R1$ with a reactance of approximately 3 megohms, while $C2$ will shunt $R2$ with 30,000 ohms. The attenuation then remains a constant 100×, regardless of frequency. Capacitor $C1$ is made adjustable because the capacitance of the oscilloscope input and the length of the cable will vary slightly.

During the calibration process (of $C1$), the square wave viewed on the oscilloscope should be capable of being adjusted from insufficient compensation as shown in Fig. 4 (left), to the over-compensation of Fig. 4 (center), to the correct adjustment of Fig. 4 (right).

As previously pointed out, it is important that the signal power taken by the oscilloscope probe be relatively small compared to the power available in the circuit under test. This means that the impedance presented by the oscilloscope probe must be at least ten times greater than the impedance level of the circuit. If the input impedance of a typical vacuum-tube circuit being tested is on the order of one megohm, the oscilloscope probe, in order not to present appreciable loading, should have an impedance of at least ten megohms. Oscilloscope probes using special electrometer tubes or subminiature triodes in cathode-follower circuits provide very high impedances without having the great attenuation of resistance probes. Separate power-supply subassemblies and compensating boxes are usually furnished with these vacuum-tube probes. They are intended for precision, laboratory-type measurements, particularly at the higher frequencies, rather than general test and troubleshooting work.

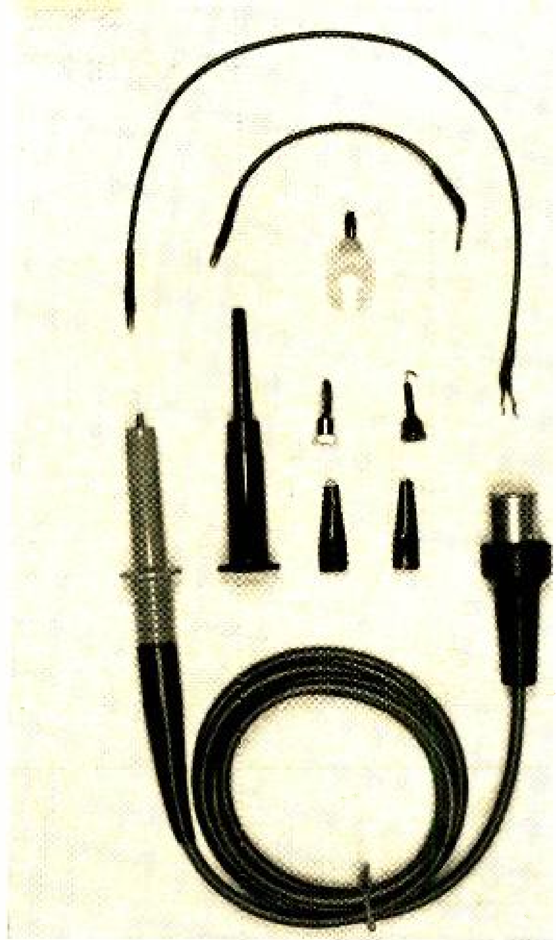


Fig. 2. Some probes come with a variety of interchangeable tips.

In transistor circuits, the impedance between stages is much lower, generally on the order of 100 to 10,000 ohms. It is therefore possible for transistor circuits to use oscilloscope probes which have only a one-megohm input impedance; in many instances, no isolating probes are required because the input impedance of the oscilloscope is so high. The capacitance due to the coaxial cable and the scope input may, however, be high enough to load certain high-frequency transistor circuits so that some isolation probe is still needed.

High-Voltage Probes

TV technicians have often observed the "caution" on sche-

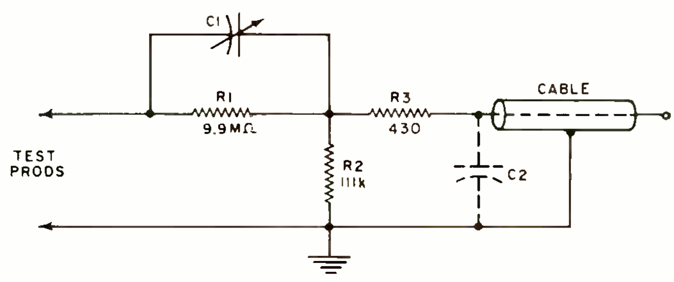
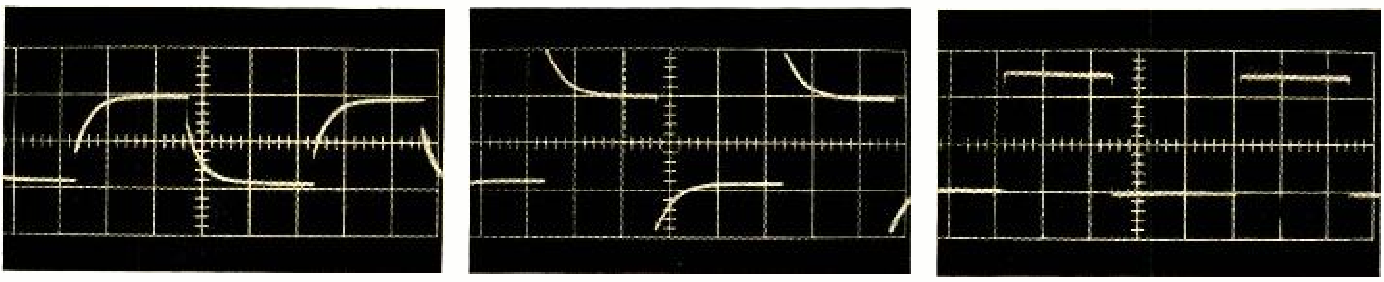


Fig. 3. A typical 100× attenuator probe uses a small variable capacitor to compensate for coaxial cable capacitance present.

Fig. 4 (Left) Insufficient compensation of the probe. (Center) Overcompensation of the probe. (Right) Correct probe compensation.



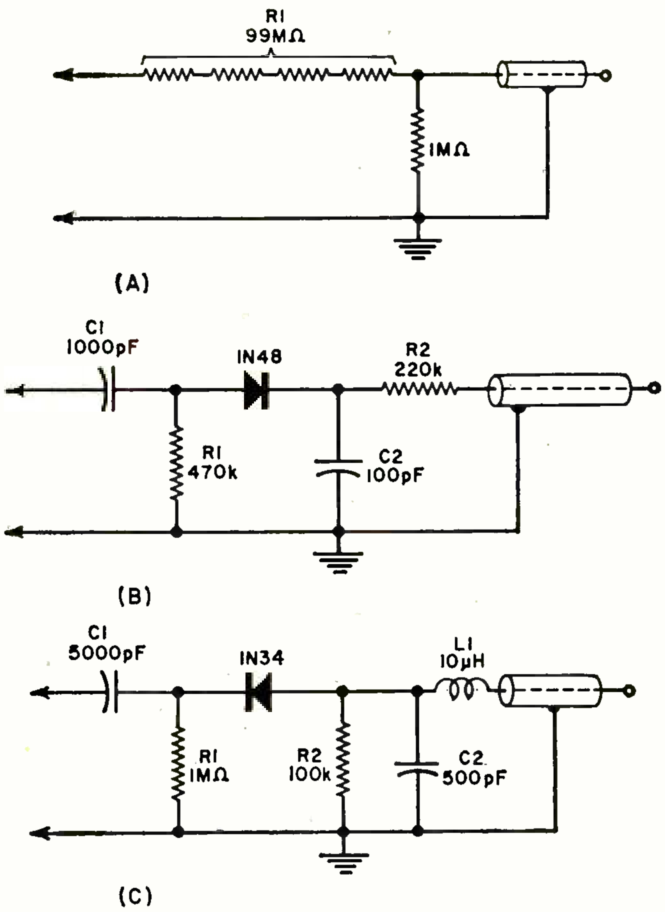
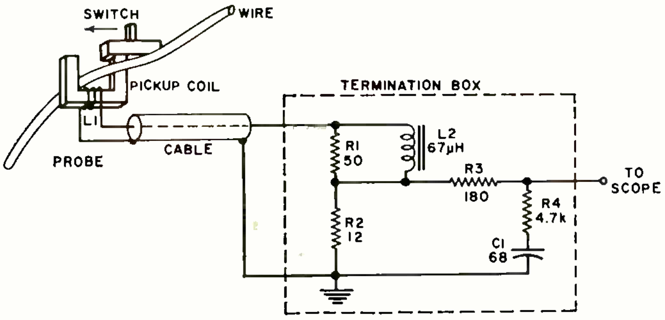


Fig. 5. (A) High-voltage (100 ×) probe. (B) Typical demodulator probe. (C) One variation of the demodulator probe.

matic diagrams not to measure the pulse at the plate of the horizontal output tube. The reason for this is that the high voltage at that point would break down an ordinary probe or else damage the oscilloscope input circuits. High-voltage pulses are also found in radar, telemetry, and many other fields so that a high-voltage probe, specially designed for oscilloscopes, has become important. The circuit of a simple high-voltage probe having an attenuation of 100× appears in Fig. 5A. This probe could be used with a v.t.v.m. as well. Note that *R*1, the series resistor, does not contain a means for compensating for the shunt capacitance. A compact and adjustable capacitor, capable of withstanding the high voltage, would be difficult to construct. When this high-voltage probe is used with an oscilloscope, a separate compensating box connected at the cable end will contain the adjustable features. High-voltage probes are available in attenuations of 100× and 1000×, and in operating voltages up to 40 kilovolts. With such probes, it is possible to make oscilloscope observations and measurements of high-voltage pulses at the output tube of the horizontal output transformer in a television set, or at the output modulator stage of a radar transmitter. If it is desired to observe the output of the transmitter or look at the r.f. circuits of a receiver, it is necessary to rectify the r.f. signal to observe the modulation envelope.

Fig. 6. An a.c. current probe senses current flow through wire, enabling measurement without direct circuit contact.



Demodulator-Type Probes

Wherever the signal to be observed is amplitude-modulated on another (usually r.f.) signal, a special demodulator-type probe must be used. Such probes are commonly used with vacuum-tube voltmeters when it is desired to measure r.f. voltages. In tracing audio or video signals through the r.f. and i.f. stages of a receiver, it is particularly useful to use a detector between the circuit under test and the oscilloscope because the modulated signal (audio or video) can then be observed directly. Demodulator probes are either part of the oscilloscope probe package or can be obtained separately.

The circuit of the *Eico* demodulator probe, shown in Fig. 5B, appears similar to the detector circuit in a superhet AM receiver. Because of the relative values of *R*1 and *R*2, some attenuation of the detected signal occurs which must be compensated by the scope amplifier. The circuit of Fig. 5C shows another version of a demodulator probe that uses a small r.f. choke (*L*1) to help filter the i.f. or r.f. while providing very little attenuation to the demodulated signal. This is helpful when signal tracing i.f. sections where millivolt or even microvolt signals must be demodulated. Almost any diode can be used equally well in these circuits. The polarity of the diode affects only the polarity of the demodulated signal.

The demodulator probe input impedance is determined largely by a shunt resistor (*R*1 in Figs. 5B and 5C) and the forward impedance of the diode during conduction. In general, detector probes are used in r.f. or i.f. circuits where the circuit impedances are much lower than the probe impedance. The capacitor at the output of the probe (*C*2) affects the frequency response of the detected signal. To get sufficient filtering and yet keep this capacitor small, the circuit of Fig. 5B uses a series resistor (*R*2), while a small r.f. choke (*L*1) is shown in Fig. 5C. Most demodulator probes are designed to have an output impedance which is reasonably flat up to frequencies of about 1 megacycle.

A.C. Current Probes

Many professional oscilloscopes make a.c. current probes available to permit picking up signals without direct electrical contact. A small ferrite-core coil is placed over the wire that carries the signal and coupled to the oscilloscope. To get maximum coupling, the ferrite core must enclose the wire, and this is accomplished, as illustrated in Fig. 6, by making a portion of the ferrite core movable so that the wire can be enclosed. The probe contains only the pickup coil, *L*1, and the movable ferrite switch for closing the magnetic loop. Between the cable and the scope a termination box must be used to get the required flat frequency response. The termination-box circuit shown in Fig. 6 is designed for current of 10 mA per millivolt of signal to the scope. A different termination box is available for smaller currents and, for very weak signals, a special transistor amplifier box can be used.

The great advantage of the a.c. current probe is that no direct electrical connections are required and individual wires can be monitored in situations where there is no access to the signals inside the chassis. Because the size of the wire carrying the signal and the position of the wire within the pickup loop may vary, exact signal-amplitude calibration is usually difficult with this method. The efficiency of the pickup coil also depends upon the magnetic path within the over-all ferrite core. If dirt gets into the gap between the U-shaped piece and the movable piece, or for some reason the gap is not entirely closed, the resistance in the magnetic path may be increased sufficiently to reduce the picked-up signal below usable strength. To assure correct measurements with the a.c. current probe, some comparison measurements with a wire carrying a signal of known amplitude can be used. ▲

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JOHN FRYE

First- or second-semester performance in college has proven to be the best indicator of a student's final achievement.

PREDICTING ACADEMIC SUCCESS

BARNEY and Matilda were taking a Coke break with Mac, their employer, on this hot and humid August afternoon. The office girl traced a wavy line on the frosty bottle with a finger tip and spoke above the whirring of the air conditioner: "The boy next door is getting ready to go to college. He's going to take up mechanical engineering, and I'll bet he's a whiz at it. Every spare minute he has is spent fooling around with lawn mowers, old cars, and other mechanical things."

"I hate to disagree, especially with a lady on such a hot day," Mac drawled; "but I doubt your neighbor's incessant tinkering with things mechanical is a very reliable indication of how he will do in college. About a month ago I read an article in *Backgrounder*, a publication of Purdue University's Schools of Engineering, that knocked a big hole in this hallowed theory—which, incidentally, I had always held right along with you, Matilda.

"The article discussed findings made by Professor William K. LeBold, Professor of Engineering and Assistant to the Dean of Engineering at Purdue. Prof. LeBold has a Ph.D. in psychology, so he is well equipped to evaluate the ten-year study he made of the characteristics of engineering and science students and graduates. In a nutshell, Prof. LeBold found the most reliable indicators of what a youth can be expected to do in college are not the grades he made in high school, are not the scores he racked up on College Entrance Examinations Board tests, and are not interests he may have that are similar to those of people in the profession he intends to take up. The fact that he likes math or fools around with cars means little in forecasting how he will do in engineering."

"If none of these things are reliable indicators, what are?" Barney demanded.

"What a boy does in his first year, or even his first semester of college, is a far, far better sign of what you can expect of him during the remainder of his college years. Let me quote you some facts and figures from the article to back this up. When combined high school grades and CEEB scores are compared with actual college achievement, a correlation coefficient of .5 or lower turns up repeatedly, not only at Purdue but at other universities and colleges. You square the correlation coefficient to translate it into percentages; so that means that high school rankings and CEEB scores have only 25% in common with actual college achievement. In other words, if you used high school grades and College Entrance Exam Board scores to guide you in 'guessing' how a youngster would do in his college career, you would be right only one-fourth of the time.

"But when you compare what he does in his first semester with his final cumulative index (final grades), you come up with a correlation coefficient of .7. The percentage of right guesses has increased to 49%. And when you compare the correlation between second semester achievement and the final index, the correlation coefficient goes to .9. This should enable you to predict success or failure with 81% accuracy.

"Several theories have been advanced to try to explain the poor correlation between high-school-grades-plus-CEEB-scores and actual achievement in which various 'non-cognitive' factors—motivation, home influences, study habits, personality, interests, etc.—are credited with causing the discrepancy. In one Purdue study, students were assessed on the basis of 150 of these non-cognitive variables to see if personality, attitudes, interests, or some other factor could be used as a key to future academic performance. All attempts to measure and make use of such factors proved largely fruitless. There was little relationship found between any of them and actual performance.

"One rather bizarre result turned up in the testing. In the well-known Strong Vocational Interest Test, a student's score on the Mortician Scale portion was found to be the best indicator of engineering performance—in reverse! The more the student's interests approach those of a practicing mortician, the more likely he is to be an engineering dropout. But his performance on the Engineering Scale portion has no more value. It has zero correlation with first-year academic performance in engineering. Prof. LeBold carefully points out that failure to find some reliable non-cognitive indicator does not necessarily mean no such indicator exists. But if it does exist, it has not yet been found.

"The professor is a positive thinker. He believes a student who wants to go into engineering should not be too easily discouraged because of mediocre high school grades or CEEB scores. He says, 'It's clear that if you . . . exclude from college those who have less than a B average in high school and who fall below 450 on the CEEB, you inevitably are going to exclude many who might be able to perform satisfactorily if given the chance.'

"If, because of increasing college enrollments, they cannot get this chance in a four-year school, they should have it in a junior college or some similar institution, according to LeBold. Students starting there, he says, will not be handicapped when they transfer later. Repeated checks at Purdue and other institutions show that students entering after two years of junior college work usually require only one semester of adjustment before it becomes difficult to tell they haven't spent their whole careers in the university.

"He doesn't discount the stiff competition the youngster will encounter in an engineering course in a university such as Purdue. For example, one-half of all high school seniors score below 430 on the CEEB quantitative examination, but only two percent of Purdue freshmen engineers score below 430. This is especially significant when you remember Purdue is a state university open to most Hoosier students wishing to go to college.

"On the other hand, he points out there is less attrition in college than is generally believed. Many people believe more than half the students who enter college never finish. A recent University of Illinois study of male students shows that three out of four eventually graduate, although not necessarily from the institution where they began or even in the field in which they started. At Purdue, 60% of beginning engineering students go on to graduate from Purdue, and another 20% graduate elsewhere.

"One thing you must keep in mind is that college education is no longer the classical four-year process. An increasing number of students take more than four years to get that bachelor's degree. In cities where there is opportunity for part-time work, it is not unusual for half of all students to take six years to graduate. Obviously, if you list all students who have not graduated in four years as dropouts, you get a misleading attrition figure. Prof. LeBold thinks attrition figures should be based on six, seven, or even ten years instead of four."

"Well, you have certainly made some quick changes in my thinking," Matilda admitted. "As I get it, about the only way to tell if a student can handle an engineering course is to give him a chance to try it. At the end of the first year, you'll pretty well know if he can cut the mustard."

"Yeah," Barney chimed in, "and it certainly will behoove him to give that first year all he's got. But I hate to give up the idea that I can't make a good guess about who will make an engineer and who will not, even before he completes the first semester. I've always believed that one type of radio amateur is a 'natural' to become a good electronics engineer. This is not just a hunch. I've watched many hams go through college and on into good jobs in electronics."

"You speak of 'one type of ham' as being good engineer material," Mac observed. "I take it from this that a person's having a ham ticket is not enough to make your crystal ball light up optimistically."

"You take it right. The rag-chewing, traffic-handling, plug-in appliance operator—one who buys his equipment ready-built and knows just enough about it to plug it in—may or may not make an engineer; but his ham activity is useless as an indicator. By the same token, the fanatic who eats, drinks, and sleeps amateur radio is quite likely to flunk out. His brain is too obsessed with hamming to permit the entry of anything else. He is the sort who takes a transmitter along to college so that he can 'keep in touch' with the folks at home—or so he says. Actually he will be hamming when he should be studying. Providing him with a telephone credit card for 'keeping in touch' would be an excellent investment on the part of his parents who are paying for his college education.

"The kind of ham I have in mind is the one who is continually probing into the 'why' and the 'how' of the apparatus he uses. He is constantly experimenting and building new equipment—not just to use it, but to find out if it works and how it works. He doesn't get his technical information by chatting on the air with other hams—I don't know a better way to become misinformed—instead, he ferrets out the answers he wants by studying technical journals, magazines, and books. He takes pleasure in operating his gear, maintained in top-notch condition, and in keeping records of its performance, but hamming to him is not an end in itself. Instead, it is just an early stepping stone in his quest for knowledge about the field of electricity and electronics that is so fascinating to him.

"When this ham enters college and finds himself surrounded by knowledgable instructors, excellent laboratory equipment, a wonderful technical library, and bright stimulating fellow students, he no longer needs ham radio any more than a 'swinger' at a party needs the hostess after she has introduced him around. He may continue amateur radio as a fine relaxing hobby, but he doesn't insist on making it a major part of his life's work."

"Okay, but I doubt you've found a non-cognitive indicator Prof. LeBold overlooked," Mac said. "Actually your non-typical ham is a self-taught budding engineer before he ever enters college. Already he is well-grounded in the experimental approach, in technical research, and in record-keeping."

"Well, you guys and Prof. LeBold can fool around with your variation coefficients and other mumbo-jumbo all you want," Matilda said as she started collecting the empty Coke bottles, "but I'm still sure Tommy next door is going to make a fine engineer. My woman's intuition tells me so."

"And *that* is *that*!" Mac murmured with a broad grin. ▲

SOLDER INACCESSIBLE JOINTS

By A. A. MANGIERI

REPLACEMENT of components deeply buried within a TV tuner or compact assemblies can often be handled without disconnecting interfering wires and parts which would otherwise be burned or damaged by heat. First, try bending the wire tip of the soldering gun to one side or the other in a radius to clear and avoid contact with nearby wires and parts. Of course, parts replaced in TV tuners must be placed and dressed in the same position as the part removed.

In some cases, the soldering gun tip may be too short to reach the soldered joint. In this case, fashion a longer tip of #12 or #14 gauge solid copper wire. Shape and bend it as required. Tin the tip. Sufficient heat will be developed to handle all but the heavier junctions. Wire gauges as small as #18 were used with success for delicate soldering operations although such wires lack the rigidity of the heavier gauges.

All tips should be no shorter nor heavier than the original. Many seemingly impossible soldering jobs were handled easily by these substitute tips, thereby avoiding unnecessary disassembly or complete replacement of an assembly. ▲

Selecting Indicating Lights

(Continued from page 32)

Underwriters Listing for 125 volts or 250 volts.

Lights for plug-in lamp cartridges, 3/8" mounting. The Group II lights accept plug-in lamp cartridges containing T-1¾ lamps of the incandescent series, rated from 1.35 volts to 28 volts, and T-2 neon lamps with 110 to 125 volts a.c. to the terminals of the light. The lights illustrated accept #39 series with incandescent lamps. The lights for #45 series with high-brightness neon lamps and resistors enclosed are longer and the lights have somewhat more back projection but identical front-of-panel features. Nos. 5 and 6 are preferred types with screw-on cap over the lens of the cartridge. No. 7 is an older type with the lens of the cartridge displayed as it projects through the knurled nut which secures it. The newer lights with caps are recommended for almost all applications.

The lens of #5 is always transparent with lenticular inner surface to control the light and to obscure bright filaments or neon electrodes without light loss. This cap makes low-powered incandescent lamps and neon lamps very effective. For cases where the light needs identification, the rotatable lens of #6 is recommended. It is effective with amber translucent lenses and black stamped marking except with low-lumen incandescent ratings and neon with long-life resistor. Identification should be on the panel for those lamps and #5 should be used.

All of these lights are shown with turret terminals for soldered wiring and no other type connection is recommended.

Attention is called to the fact that these lights cover almost the complete voltage range and permit closer spacing than any of the other lights shown or generally available.

Lights for midget flanged-base lamps, mounting 15/32". Group III lights accommodate T-1¾ incandescent lamps with midget-flanged bases. Some models, with somewhat longer lenses and greater front projection, employ the NE-2J neon lamps. They are available with integral resistors for application of 110 to 125 volts to the terminals of the light.

Lights of this group are ruggedly made and have military and aeronautical applications. No. 10 is waterproof and oil-proof at the front of the panel. The metal mechanical parts are of aluminum and the usual finish is black anodized. The exception is #11 which has a square plastic cap which is friction fitted to the body so as to be rotatable. Nos. 9 and 10, dome shaped, provide wide visibility and good effectiveness. No. 8 has rotatable lens and is the recommended choice in the group for identification by stamped marking. No. 11 may be similarly used for non-military applications on panels where the square style presents a more desirable appearance. Round caps may also be chosen.

Large lights for S-6 lamps, 1" mounting. The lights for large lamps of the 6S6 series, with either candelabra screw sockets (or double-contact bayonet) provide brightly lighted lenses of about 1-inch diameter. These are shown in Group IV.

A selection may be made among three types of terminals for combination with any other option.

Nos. 12 and 13 lenses provide very bright concentrated light with plano-convex len or for wide spread with the dome. It is recommended that a diffusing surface be specified for these lenses, which are mounted in screw-on holders.

No. 14 is friction fitted to the body to permit rotation for erection of the legend. This light well is adapted to very crisp display of bright legends presented as negative or positive by the use of photo-transparencies under the flat lens.

All members of this group have Underwriters Listing.

Special-Purpose Features

No discussion would be complete without mention of some lights with special features, shown in Group V.

No. 15 is typical of mechanically operated dimming devices that reduce the emitted light by rotating the front part of the cap. Some have shutter action and some have superimposed polarizing disks which display the full aperture in changing intensity. Their use has been almost exclusively aeronautical or military and is declining.

No. 16 answers the question, "Will it light if an emergency arises?" It is a press-to-test light (combined with a dimmer) that contains two paths for current to the lamp. The circuit, through the actuating device to the supply, is normally closed. Pressure on the lens cap moves the whole lamp and socket and cylinder to complete connection directly to the supply and the lighting of the lamp gives the assurance.

No. 17 is a pilot light with transistor drive. When available voltage or current, or both, are very low and a source of power is available for lamp operation, this combination is useful. Indication is possible on small "signals."

No. 18 answers the problem of how to reduce emission of electrical and r.f. interference. More and more tight limits are being applied to reduce the "noise" that is causing interference with communications. The pilot light shown is designed to house a plug-in cartridge. The cap is equipped with fine mesh screen, well grounded to the cap and with provision for good contacts to a knurled nut and, in turn, to the grounded panel. Quite satisfactory attenuation is obtained in this light and others operating on the same principle.

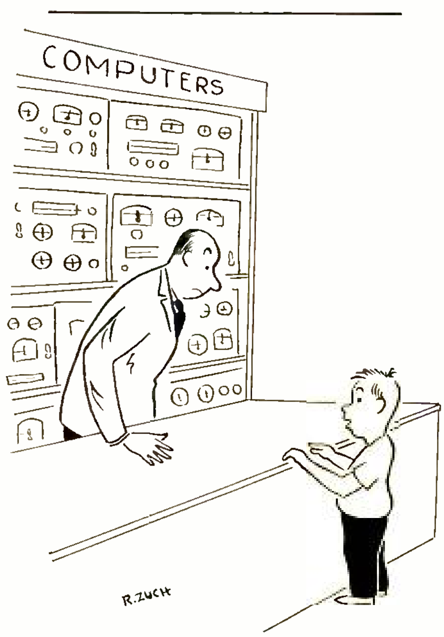
Military Specifications

The broadest specification affecting applications of indicator lights is MIL-L-3661A entitled: "Lampholders; Lights, Indicator; Indicator-Light Housings; and Lenses, Indicator Light." This specification treats the panel-mounting base portion of the device separately from the lens cap. It is in error in many instances and is under revision. It is the current spec but exceptions are necessary to make parts operate together and to permit use of more up-to-date components.

Two other specs of the vintage of the forties are applicable. They are MIL-L-7961B entitled: "Light, Indicator, Press-To-Test" and MIL-L-6723B: "Lights, Aircraft." These are applicable. There has been little need to change these but usage has declined as new aircraft replace older designs.

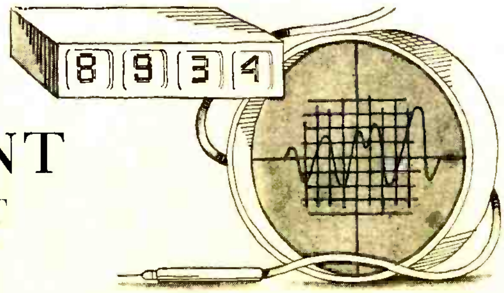
In general, the MIL Specs have lagged behind modern practice and insistence on following old specs can only lead to obsolescence.

There have been a few cases where specifications and MIL-Spec drawings have been issued to cover light sources. In general, these have described lamps with A.S.A. status that are included in the rather adequate and complete Federal Specifications used for purchases by the General Services Administration. There is much duplication and it is being eliminated only gradually. Cooperative action by lamp manufacturers through the American Standards Association has kept the situation in order as far as designations and descriptions of miniature lamps is concerned. Military drawings usually refer to these designations. ▲



"Do you have a fourth-grade computer?"

TEST EQUIPMENT
PRODUCT REPORT



Eico Model 715 "Trans/Match" Ham-CB Tester

For copy of manufacturer's brochure, circle No. 28 on Reader Service Card.

THE Model 715 is a flexible, multi-purpose instrument that can be used to check CB transmitters and low-power ham rigs. Requiring no batteries or other power sources, the compact, portable tester performs all its functions using the transmitted signal only. (See diagram.)

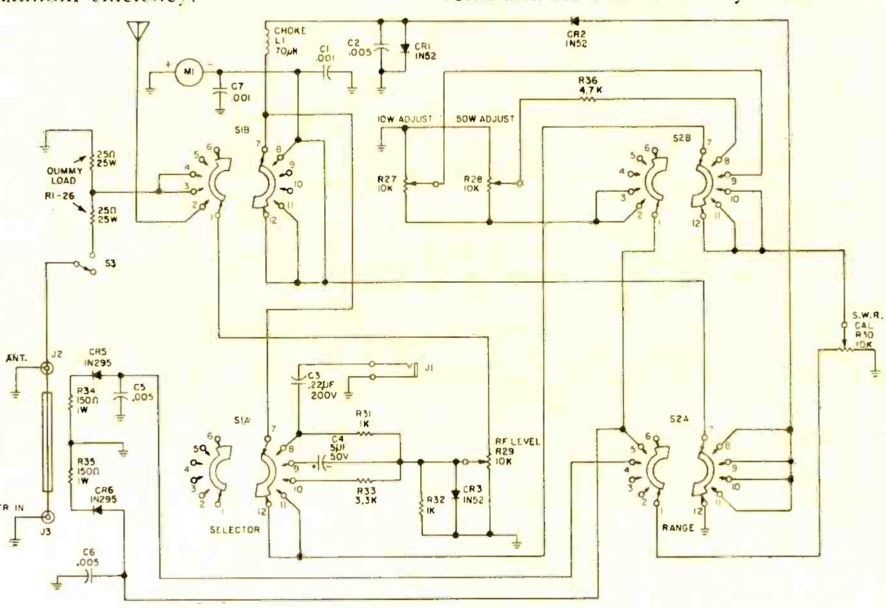
When inserted into a 50-ohm coax feeder between the transmitter output and the antenna, the tester will check the standing-wave ratio of the antenna and transmission line. This is done by comparing the incident power with the reflected power using a simple r.f. directional coupler circuit. The s.w.r. should be as close to 1 as possible for maximum efficiency.

The second function the tester will perform is measurement of the r.f. power output. Two scales are provided: 10 watts and 50 watts. During this test, a built-in resistor load is used which will handle up to 50 watts intermittently and 25 watts continuously. The power output is read directly on the three-inch meter.

A third function provided is a measure of modulation percentage. This also employs the built-in load and takes advantage of the power increase that occurs during modulation to produce a direct meter indication of percent modulation. A set of phones can be plugged in to check the audible quality of the modulation.

A fourth function, which is particularly useful in comparing different antennas or different rigs, is taking field-strength measurements. Now the unit is used a short distance from the transmitting antenna and its collapsible, 2½-foot antenna is extended. A simple crystal detector and meter (100 μA) circuit is used to show relative field strengths. Antenna radiation patterns along with the locations of lobes or nulls can be readily checked.

The tester measures only about 5x8x3½ inches. It sells for $34.95 in kit form and for $44.95 factory-wired. ▲



Pace Communications Model 5803 Power Supply

For copy of manufacturer's brochure, circle No. 29 on Reader Service Card.

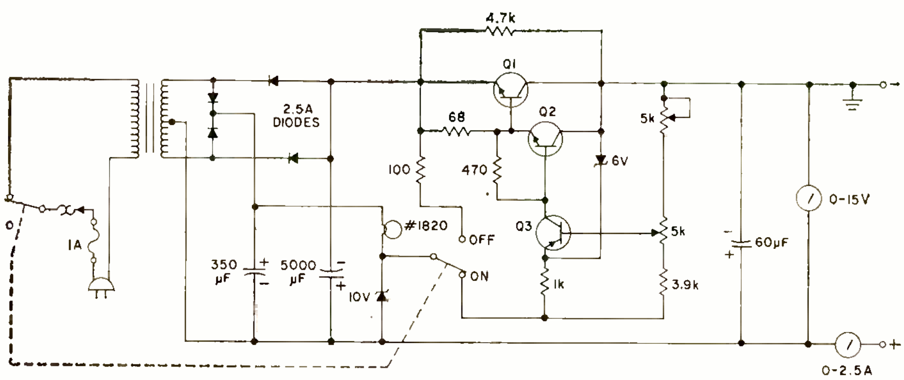
THIS power supply was developed to fill the need for precisely regulated d.c. power as required on the service bench, in the radio or electrical laboratory, or for any application where excellent regulation is necessary at load currents up to 2.5 amperes and voltages from zero to 15 volts. The supply is immune to damage from short circuit, overload, high temperature, or almost any other abuse that may be encountered on the service bench or in a school or industrial lab. Its compact size enables it to be readily moved or placed anywhere on a crowded bench. All silicon transistors ensure long-term reliability.

The circuit (see diagram) consists of the familiar series or passing transistor driven by amplifiers using a zener diode reference. The six-volt zener diode is connected between the regulated output and the emitter of Q3. Therefore, the emitter of Q3 will "follow" any change in output with a constant difference of six volts. Assume that a sudden increase in load current causes the output voltage

to decrease. This decrease occurs both at the base and emitter of Q3, but because of the six-volt zener diode, a much greater change occurs at the emitter. As a result, Q3 is turned on more and increased current flows in both Q2 and Q1. This reduces the resistance of Q1 and increases the output voltage until the difference between the base and emitter of Q3 is restored to its original value.

Under short-circuit conditions, both ends of the output-adjusting potentiometer are effectively grounded. As the voltage drops below the zener voltage, the zener diode opens and the emitter of Q3 is grounded through its emitter resistor. Because its base and emitter are grounded, Q3 does not conduct, with the result that no base current flows in Q2 and Q1, turning them off. This feature provides instant automatic short-circuit protection.

A disadvantage of this basic regulator is its inability to operate at output voltages lower than the zener voltage. To overcome this difficulty, Q3 emitter resistor can be returned to a positive voltage point. This voltage is supplied from an auxiliary ten-volt zener-regulated



supply. Because the auxiliary supply is of opposite polarity to the main supply, a change in its zener voltage due to temperature effects tends to offset temperature effects in the main supply.

A #1820 lamp bulb is used as a ballast to supply relatively constant current to the ten-volt zener diode over a wide range of input voltages. This prevents excessive dissipation in the diode and provides a zener voltage that is more stable.

Because the 5000-μF filter capacitor is much larger than the 350-μF filter, turning the supply off under low-current load conditions could result in a momentary increase in output voltage. To prevent this, when the power switch is turned to "Off" position, a 100-ohm resistor is switched in to discharge the larger capacitor immediately.

A thermal protector is bolted to the chassis next to Q1. This protector will open at 100°C and protect the supply from any possibility of thermal runaway or other damage due to the effects of the temperature.

This supply will be very useful to the shop or lab working with such transistorized equipment as CB transceivers or auto radios and is very useful for hi-fi and general audio work. It will also charge batteries, operate plating tanks, and perform a multitude of other tasks wherever it is necessary to use very low ripple, precisely regulated d.c. power.

The 5803 lab power supply measures 6½x8½x2⅞ inches, weighs 4½ pounds, and rests on four plastic legs that provide an attractive "tilt-up" appearance. The price is $59.95. ▲

Data Instruments SSVM-1 FET Voltmeter

For copy of manufacturer's brochure, circle No. 156 on Reader Service Card.

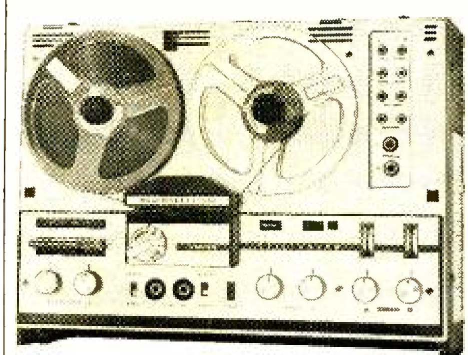
THE industry's first broadband FET voltmeter is the Model SSVM-1 by *Data Instruments.* The new device has extremely high input impedance and can make measurements over a very wide frequency range. Input impedance on d.c. is greater than 100 megohms, and on a.c. it is about 15 megohms shunted by 2 pF.

Design of a solid-state a.c. probe was a major factor in the development. The probe has a bandwidth of 20 Hz to 700 MHz ±1 dB, and 50 Hz to 100 MHz at ±2%. Since the probe does not have a sharp cut-off, usable indications can be obtained that are much higher than 100 MHz. For example, useful comparative readings have been obtained at 1200 MHz with the use of a special coax T adapter.

The d.c. measuring circuit consists of a pair of "n"-channel silicon field-effect transistors arranged as a differential amplifier. The power supply is two 6.75-volt mercury batteries. The drain on these batteries is so small (750 μA) that the operating life is essentially the shelf life of the batteries. The accuracy of the instrument is unaffected by battery aging up to the point where the meter indication on the battery-check position shows that replacement is necessary. A single 1.35-volt mercury cell powers the ohmmeter circuits.

An important feature of the design is that the circuit ground is insulated from the case and brought out to a "common" binding post. The metal case and chassis are connected to a ground terminal. Because of this and because the instrument is not connected to the a.c. power line, it is possible to take measurements of voltages where neither side is grounded.

Price of the meter is $215 including probe. ▲



Choppers

(*Continued from page 45*)

drift-free preamplifier ahead of the main d.c. amplifier which reduces the drift arising in the d.c. amplifier to a negligible value.

In a chopper-stablized amplifier, the internal loop gain at d.c. and very-low frequencies is equal to the product of the chopper amplifier gain and the d.c. amplifier gain. For high frequencies, the internal loop gain is equal to that of the d.c. amplifier alone. Since the d.c. amplifier delivers very high gain, however, the over-all gain characteristic is independent of the open-loop gain and is determined by the ratio of the feedback resistance (R_f) to the input impedance (Z_i).

Electromechanical choppers are frequently used in precision measurement where a difference is observed between a standard and an unknown quantity. Fig. 9 shows a typical comparison circuit of a d.c. voltmeter in which the unknown voltage to be measured is compared to a standard reference voltage. When the two signals are adjusted for equal values, the input capacitor (C) becomes charged to the common potential so that the difference signal applied to the input of the a.c. amplifier is zero. The input signal and reference voltage are alternately sampled by one section of a d.p.d.t. chopper to produce the characteristic chopper square wave. In addition to its modulating function, the chopper prevents interaction between input signal and reference circuit, especially when they are at greatly different impedance levels.

The input capacitor should have a high insulation resistance compared to the input resistance (R) in order to block stray leakage currents in the amplifier input, which may be modulated by the chopper along with the desired signal. To produce a reconstructed d.c. voltage at the amplifier output, the second section of the d.p.d.t. chopper acts as a balanced demodulator to synchronously rectify the signal.

Although a demodulator is necessary to extract the information from the carrier, it need not have an electrical output, but may be an a.c. servomotor whose output is angular motion. This principle is employed in the design of electronic null-balance recorders to provide an accurate record of changing temperature.

Fig. 10 shows a temperature recorder which responds to tiny voltage changes (less than 1/10 mV) produced by a thermocouple. These d.c. voltage changes are converted to a.c. by the chopper at the chopper's driving frequency and at a phase which indicates the polarity of the d.c. signal. The amplified output signal excites the control winding of a two-phase servomotor, while the other winding continuously draws power from the a.c. line. Since the shaft of the motor is mechanically linked to the slider arm of a potentiometer in a bridge divider, the balancing motor turns in a direction that will balance the measuring circuit. When the measuring circuit is in balance, no d.c. current is fed to the chopper and hence no a.c. current flows through the control winding. Under these conditions, the motor stops and the system is at rest, so that the slider indicates correct temperature.

Potential applications of electromechanical choppers are so varied that constructional designs call for special choppers to fit specific applications. There is a current trend for more and more miniaturization of chopper units in sophisticated instrumentation, in which extremely low noise characteristic and high stability are combined with ruggedness and a resistance to extreme environmental conditions. ▲

Speaker Enclosures

(*Continued from page 28*)

flat position and switch out the loudness control and any rumble filter. Place the speaker system where it will normally be used in the room. With 1 or 2 volts at the terminals of the speaker system at 400 Hz, gradually reduce the frequency of the oscillator. The loudness of the tone should remain reasonably constant as the frequency decreases. Pay particular attention when passing through the vicinity of system resonance. If the loudness suddenly increases in this area, more fiberglass should be added to the system. If the loudness decreases noticeably before reaching the resonant frequency, some fiberglass should be removed from the system. Some fiberglass should always remain in the enclosure to absorb reflected waves at higher frequencies. The tone should retain a constant loudness down to or slightly below system resonance.

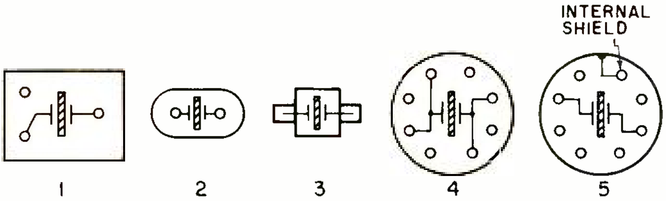
If th low-frequency power handling ability of the system is still considered inadequate for the use intended, reduce the volume of the enclosure. The volume can be experimentally reduced by adding a stack of books or magazines in the enclosure and resealing the back. When the power handling is satisfactory, the volume of the enclosure should be permanently reduced by this amount. The damping should be readjusted for best low-frequency performance from the speaker system.

Several different sealed speaker systems have been constructed using the data in this article and their performance has been excellent. ▲

IDENTIFYING SURPLUS CRYSTALS

By IRWIN MATH

AT the present time, there are still a large number of surplus military crystals available. While frequencies are occasionally marked on these crystals, there is little other information given. The table was compiled to provide a reference for most crystals used by the military from 1940 to the present. Electrical characteristics and basing are provided. ▲



Type (CR—/U)	Holder (HC—/U)	Base	Freq. Range	Tol. (%)	Load Cap. (pF)	Overtone[a]	Drive (mW)
15	5	1	80-200 kHz	.01	32	1	2
16	5	1	80-200 kHz	.01	b	1	2
18	6	2	.8-1.6 MHz	.005	32	1	7
19	6	2	.8-20 MHz	.005	7	1	7
23	6	2	10-70 MHz	.005	b	3[c] 5[d]	3
24	10	3	15-50 MHz	.005	b	3[e] 5[c]	2
25	6	2	200-500 kHz	.01	b	1	2
26	6	2	200-500 kHz	.002	b	1	2
27	6	2	.8-15 MHz	.002	32	1	3
28	6	2	.8-20 MHz	.002	b	1	3
29	5	1	80-200 kHz	.002	32	1	2
30	5	1	80-200 kHz	.002	b	1	2
32	6	2	10-75 MHz	.002	b	3[f] 5[g]	1
33	6	2	10-25 MHz	.005	3	3	2.5
35	6	2	.8-20 MHz	.002	b	1	3
36	6	2	.8-15 MHz	.002	32	1	3
37	13	2	90-250 kHz	.02	20	1	2
38	13	2	16-100 kHz	.012	20	1	.1
39	15	4	160-330 kHz	.003	b	1	.1
40	15	4	160-330 kHz	.003	b	1	.1
42	13	2	90-250 kHz	.003	32	1	2
43	16	5	70-100 kHz	.01	45	1	2
44	6	2	15-20 MHz	.002	32	1	1
45	6	2	455 kHz	.02	b	1	2
46	6	2	200-500 kHz	.01	20	1	2
47	6	2	200-500 kHz	.002	20	1	2
48	6	2	.8-3 MHz	.0075	32	1	10
49	6	2	.8-3 MHz	.0075	32	1	10
50	13	2	16-100 kHz	.012	b	1	.1
51	6	2	10-61 MHz	.005	b	3	20
52	6	2	10-61 MHz	.005	b	3	3
53	6	2	50-87 MHz	.005	b	5	20
54	6	2	50-87 MHz	.005	b	5	2
55	6	2	17-61 MHz	.005	b	3	2

Notes: [a]An overtone of 1 indicates a fundamental crystal. [b]Series resonant operation. [c]To 50 MHz. [d]To 70 MHz. [e]To 25 MHz. [f]To 52 MHz. [g]To 75 MHz.

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DATE AND TIME OF EXPIRATION: SEPTEMBER 11, 1968 AT THREE O'CLOCK A. M., EASTERN STANDARD TIME.

SPECIAL ENDORSEMENT: SHIP RADAR ENDORSEMENT - SEPTEMBER 11, 1963 - BUFFALO, NEW YORK

SPECIMEN

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VETERANS

If you had active duty in any branch of the Armed Forces after January 31, 1955, you may be entitled to Government-paid tuition for any CIE course.

EW Lab Tested

(*Continued from page* 16)

firmed the impressive specifications of the KG-415. Its record/playback frequency response was ±0.5 dB between 200 and 18,000 Hz and over-all was within ±4 dB from 27 to 19,000 Hz at 7½ ips. Even at 3¾ ips, the frequency response was ±1 dB from 37 to 13,000 Hz. The playback response at 7½ ips, with the *Ampex* 31321-04 alignment tape, was ±1.5 dB from 50 to 15,000 Hz.

The wow and flutter at 7½ ips were, respectively, 0.02% and 0.09%, well below the rated 0.2%. The tape speeds were slightly fast—by about 30 seconds in 30 minutes. In fast-forward, 1200 feet of tape was handled in 55 seconds, while rewind required 80 seconds. The signal-to-noise ratio was 44 dB at both speeds. The noise was all in the form of a soft hiss—no hum was detectable.

The mechanical and electrical operation was flawless. At 7½ ips, we were unable to detect any audible differences between the incoming and outgoing signals. At 3¾ ips, a slight increase in hiss level could be heard, but the frequency response was adequate for full-fidelity recording of most FM broadcasts.

We did not have dynamic microphones designed for a 3000-ohm load impedance on hand for our tests. However, we were pleasantly surprised to find that a 50,000-ohm high-impedance dynamic microphone performed very well with the unit. The echo and sound-on-sound effects were obtained without undue complexity and with excellent quality (many recorders introduce excessive distortion when making sound-on-sound recordings).

We do have two minor criticisms of the operation of the recorder. The first is the need for three operations when going from playback to recording: setting the function switch, the monitor switch, and the record safety button. This sequence becomes virtually automatic when one has been using the recorder for a while, but we did, on occasion, find ourselves forgetting to change the monitor switch and wondering why the meters did not indicate a recording level.

The second difficulty was in placing the tape in the correct path over the heads. Even with the hinged head cover lifted, the tape does not fall very easily into place and requires a little dexterity on the part of the operator.

Judged solely by its sonic performance, the "Knight-Kit" KG-415 is easily the equal of most recorders selling for $400 to $700. It is surpassed in a few operating conveniences by only a few of the most expensive recorders. We know of nothing near its price which is comparable to it, from the standpoints of flatness of frequency response, operating flexibility, or speed uniformity. At $249.95, it offers a truly high-fidelity tape recorder at a reasonable price.

The same unit is now available factory-wired and tested as the Model KN-4450, for $299.50. Like the kit, it is an excellent value for the price. A portable carrying case ($29.95) or a handsome walnut enclosure ($19.95) can be had for either model. ▲

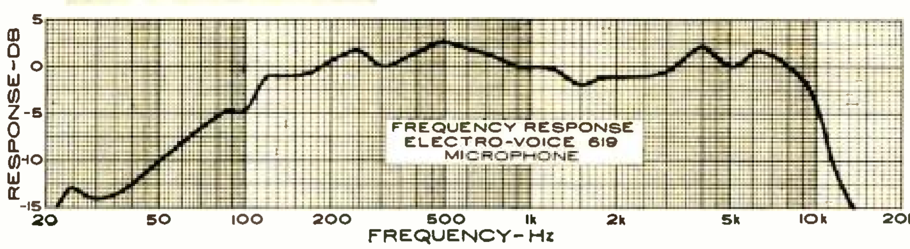
Electro-Voice Model 619 Microphone

For copy of manufacturer's brochure, circle No. 27 on Reader Service Card.

THE *Electro-Voice* Model 619 dynamic microphone is an omnidirectional type, with integral stand, intended for a variety of communications and paging applications. It is available in either low- or high-impedance models, having similar response characteristics.

The microphone has a non-metallic "Acoustalloy" diaphragm, resistant to the effects of humidity, salt air, and extreme temperatures. It is housed in attractive satin-finished case, permanently fastened to a die-cast zinc desk stand. The stand is contoured for comfortable hand-held operation and, with a total weight of about 2¾ pounds, the 619 is easy to use in either hand-held or table-mounted installations.

A plastic push-to-talk switch button



is located on the base of the microphone. It may be operated as a s.p.d.t. switch in the "Hi-Z" model, or as a s.p.s.t. (normally open) switch in the "Lo-Z" model. The switch may be locked in the "on" position by sliding it to one side. The microphone element is shorted in the "off" position of the switch. For hand-held operation, the switch may be relocated in the handle of the base, which is convenient for many push-to-talk applications.

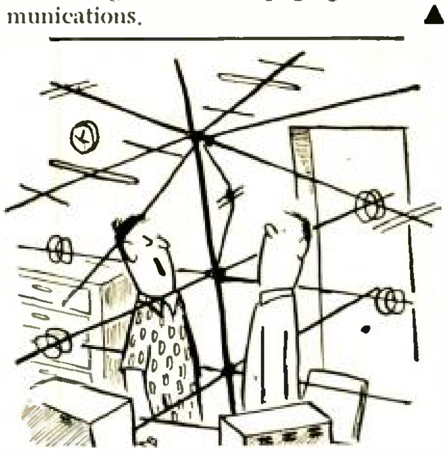
The integral shielded cable is 16 feet long in the low-impedance model and 6½ feet long in the high-impedance model.

We tested the Model 619 ("Lo-Z") by direct comparison with a calibrated wide-range capacitor microphone, using a loudspeaker as the sound source. The two microphones were located in the same position relative to the speaker and automatic response curves were made with each microphone. The difference between the two curves was plotted as the response of the *E-V* 619, since the other microphone was essentially flat in the frequency range of interest.

Our measurements confirmed the manufacturer's claim of 70 to 10,000 Hz response. The response was very smooth from about 110 to 10,000 Hz, within ±2.5 dB. It fell off gradually at lower frequencies, being down 6.5 dB at 70 Hz and 10 dB at 50 Hz. Above 10,000 Hz the response also fell off, −10 dB at 11,500 Hz.

The sound produced by using the microphone was very smooth and natural. The reduced bass response is highly desirable for a voice microphone, preventing the boomy sound which often characterizes close-talking microphones. We used the microphone in our amateur radio station, receiving uniformly complimentary reports on the quality. With the push-to-talk switch relocated to the handle, we found the balance of the microphone conducive to long hours of comfortable operating.

The *Electro-Voice* 619 sells for less than $30 and is admirably suited to any of its designated uses in paging and communications. ▲



"It's one of those spring-loaded jobs. I can't get it together again."

Receiver Noise Measurements

(Continued from page 24)

speaker, and with the potentiometer of the generator set to give some convenient reading on one of the lower ranges. The r.f. and mixer tuned circuits should then be "touched up" for lowest reading on the v.t.v.m. A signal generator should also be used to make sure that the circuits are not detuned to the point where sensitivity suffers greatly.

Fig. 1B is a schematic of a similar type of noise generator, but expressly designed for use with balanced inputs. For best results, both of these circuits should be constructed with the shortest possible leads and connected to the input of the receiver or converter being tested with short lengths of coaxial cable of the proper impedance.

Tube-Type Generators

Fig. 2A is a schematic of a noise generator designed for more accurate measurements of receiver noise. In this circuit the current through the diode-connected triode is measured and used to determine the noise figure. To use this generator, first turn on the receiver and, with the generator connected but turned off, adjust the receiver for some convenient reading on an audio v.t.v.m. connected to the audio output of the receiver. Now turn on the noise generator and, using the reading just taken as a reference, adjust the 100-ohm filament potentiometer until the v.t.v.m. indicates a 3 dB rise (about 40%) in output voltage. Do not touch any receiver controls. The diode current can now be read on the 0-10 mA meter. Once this reading is obtained, substitute it into the equation: $F = 20\,IR$, for noise figure directly, or $F_{dB} = 10 \log_{10} 20IR$, for noise figure in decibels. In both cases, I is the diode current in amperes, and R the value of the resistance used in the generator output circuit (in ohms).

Fig. 2B shows the circuit of a noise generator that would be used for balanced inputs. All is as in the previous case except that the equations are now $F = 5IR$ and $F_{dB} = 10 \log_{10} 5IR$. R is the total resistance across the output terminals $(R/2 + R/2)$.

Hence, by careful measurement of the noise figure and consequent adjustment of receivers, optimum performance can be obtained, and those weak signals which were previously "in the noise" can often be brought up to a readable level. In fact, on a commercial communications receiver which had been factory-aligned, an improvement of 2 dB was noticed after re-aligning the front-end with a diode noise generator like the one shown in Fig. 1A. Signals which could not previously be understood were now clearly readable. ▲

SCR AUTO BURGLAR ALARM

By EDWIN R. DeLOACH

A transistor-SCR circuit that actuates horn for 30 seconds when car door, hood, or trunk are opened.

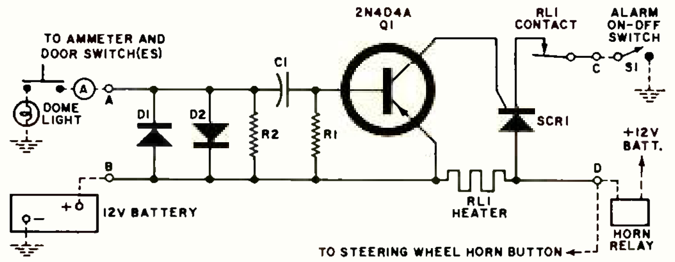
THIS circuit offers a new approach to a vehicle burglar alarm. It uses to advantage the already installed "sensors" found in most cars—the dome, trunk, and hood lights. Only four connections are required to install the circuit. The horn is the alarm and no battery power is drawn except when the circuit is triggered on. It is timed to cut off after a half minute to prevent discharging the battery. Then it will reset itself ready to be triggered on again if a second attempt is made to break into the car.

Note that this unit uses the dome, hood, or trunk lights as sensors. Your car must be equipped with these features or something to draw current from the battery otherwise the alarm would be without sensors and, of course, be inoperative. This was the author's problem at first—no hood light. Since such an installation was contemplated, the author purchased the type which operates off a mercury switch. Now, not only is there a hood light but also a burglar alarm sensor under the hood so if an attempt is made to tow the car away, this would tilt the switch and trigger the alarm. To make the alarm inoperative, the hood must be raised to get at the unit. This, of course, would trigger the alarm so it is practically impossible to disable it.

The operation is as follows. As a door light is switched on, current from the battery flows through the diode *D1* to the light (Fig. 1). The voltage dropped across the diode is coupled through C1 into the base of the transistor. The transistor is switched on momentarily, applying current to the gate of the SCR. The SCR turns on, applying power to the horn relay and heater of the time-delay relay. When the time-delay relay breaks the circuit, the SCR switches to the "off" state as before. The circuit may be manually reset with the "on-off" switch. D2 passes current back into the battery when the battery is charging. R2 shunts small leakage current around D1.

The alarm was built in a small aluminum box 3"x2½"x2". The photos show the approximate layout of parts. All parts are insulated from the chassis and the unit was wired on a printed-circuit board and potted. Of course the PC board and potting are not necessary, but the same wiring plan and rigid mounting are.

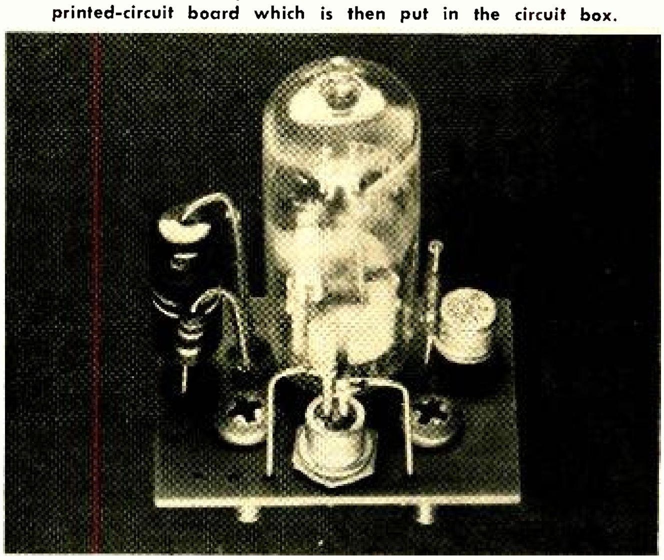
From the schematic you will notice the terminals are labeled "A" "B", "C" and "D." Mark the terminals on your unit to correspond. The alarm terminals "A" and "B" must be in series with the battery circuit to the ammeter and dome light.



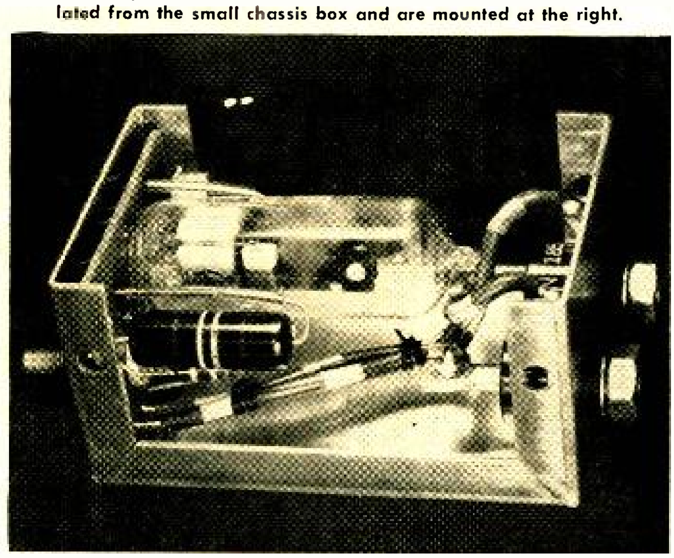
R1—1100 ohm, ¼ W res. ± 10%
R2—47 ohm, ¼ W. res. ± 10%
C1—0.1 μF paper capacitor
D1, D2—1N1184A silicon rectifier
RL1—Relay (Amperite 12C30T)
SCR1—Silicon controlled rectifier (IR 2N1600 or Westinghouse 207B)
S1—S.p.s.t switch (lock type, if preferred)
Q1—2N404A transistor
Note: For 6-volt automobile systems, change RL1 to 6C30T.

Fig. 1. Current drawn by dome light produces voltage that turns on transistor. This, in turn, switches on the SCR and operates horn. After 30 seconds, time-delay relay contacts open circuit and horn stops. Circuit can be retriggered. Alarm switch is off at all times except when driver leaves car.

All components except the two diodes are mounted on a small printed-circuit board which is then put in the circuit box.



The component board is at left and the two diodes are insulated from the small chassis box and are mounted at the right.



Connect the battery side of the circuit to the "B" terminal and the ammeter side of the circuit to the "A" terminal. If there is any doubt that you have found the right conductor, turn on a light (the door or dome light will do), then break or open the circuit. The light should extinguish.

Now connect terminal "D" to the horn-relay wire. This conductor runs from the horn relay to the steering wheel horn button switch. To check if you have the correct wire, quickly touch it to ground. The horn should blow. Next run a wire from terminal "C" to an "on-off" switch as shown. This may be a toggle switch in a concealed place or a lock switch on the fender or door.

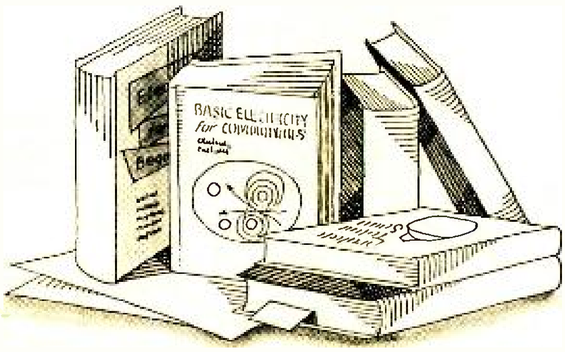
If the unit doesn't trigger upon opening the door but works fine upon closing the door, then you have mislabeled terminals "A" and "B." Reverse the wires to these terminals and the unit will operate correctly. If the unit does not operate at all, chances are your car has unusually high leakage currents. First, be sure that everything is off in the car—ignition switch, radio, lights, etc.—exactly the way you leave the car overnight. Then check to see that the alarm "on-off" switch is on and makes good continuity from terminal "C" to ground. Now, momentarily short a piece of wire across terminals "A" and "B." If this triggers the alarm, then you do have high leakage currents. Resistor *R2* (47 ohms) shunts these currents around the diode so there is no voltage dropped across the diode until, of course, the light or something is switched on. If this is the case, change the resistor to a lower value, say, 22 ohms.

This circuit can be used with any 12-volt system. If you have a 6-volt system, just change the relay from 12C30T to 6C30T. If you have an electric clock, its electric power must be supplied from terminal "B" on the battery side of the circuit. Failing to do so will result in the alarm actuating each time the clock rewinds.

Total cost of parts should be less than $20.00. This, you will have to admit, is a fair price for permanent insurance against theft, burglary, or vandalism. In addition, this device will warn of fire and flood. Electrical shorts resulting in or caused by fire and water would trigger the unit. One of the most unusual uses of all is that of acting as a "baby sitter." The author often leaves his kids in the car with instructions not to get out. With the alarm set, if they should open a door to get out or if someone attempted to take them out, the alarm sounds.

Editor's Note: This device is available in kit form for $18 or already assembled for $23 from General Electronics Sales & Service Co., *Box 52362, New Orleans, Louisiana 70150.* ▲

BOOK REVIEWS



"RCA TRANSISTOR MANUAL" compiled and published by Electronic Components and Devices, *Radio Corporation of America,* Harrison, N.J. 476 pages. Price $1.50. Soft cover.

This is a completely revised edition which will be useful to engineers, students, hams, hobbyists, and others technically interested in transistors, silicon rectifiers, silicon controlled rectifiers, varactor diodes, and tunnel diodes.

It contains extensive text material on semiconductor devices and, of special interest to those who work with transistors, an expanded data section with more extensive information on active transistors, up-to-date transistor selection charts, military-specification types, and mounting hardware than ever before.

Of particular note is the expanded circuit section with the operation of each circuit explained in considerable detail. Thus the builder not only constructs a piece of equipment but *learns* how and why the circuit works. In this section are more than 40 circuits with complete schematic and parts listing for each. A varied assortment of circuits is covered.

° ° °

"FUNDAMENTALS OF AUTOMATION AND REMOTE CONTROLS" by S. A. Ginzburg, I. Ya. Lekhtman, and V. S. Malov. Published by *Pergamon Press Inc.,* 44-01 21st Street, Long Island City, New York, 11101. 486 pages. Price $15.00.

This is the first English translation of the second edition of a Russian text which has been revised and up-dated to reflect recent developments in the field. The text now includes information on semiconductor and radioactive components and has been expanded with new material on ferromagnetic and electronic components.

The text has been slanted to the undergraduate engineer, as a reference source, and as a training aid in engineering firms. The treatment is somewhat mathematical. The authors have dealt only with the electrical components and systems and have omitted mechanical, hydraulic, and pneumatic systems used in automation.

At first the reader may encounter a little difficulty in converting the Russian method of designating various circuit components and parameters into American terminology, but after that is mastered, the text should offer no problems to those with the requisite technical background.

° ° °

"THIN FILM MICROELECTRONICS" edited by L. Holland. Published by *John Wiley & Sons, Inc.,* New York. 280 pages. Price $9.00.

This volume represents contributions by six experts (four English and two American) on thin-film technology—specifically as it applies to present-day electronics. The six chapters cover the properties of passive circuit elements, the properties of thin-film active elements, semiconductor integrated circuits, vacuum deposition apparatus and techniques, thin-film monitoring techniques, and the layout of microcircuits, masking, and etching techniques.

The text is written at the engineering level and the authors have assumed that their readers will have the requisite technical background. The book is well illustrated by photographs, micrographs, charts, graphs, line drawings, tables, and perspective drawings. An extensive bibliography accompanies each chapter making it easy for the engineering reader to continue his investigation.

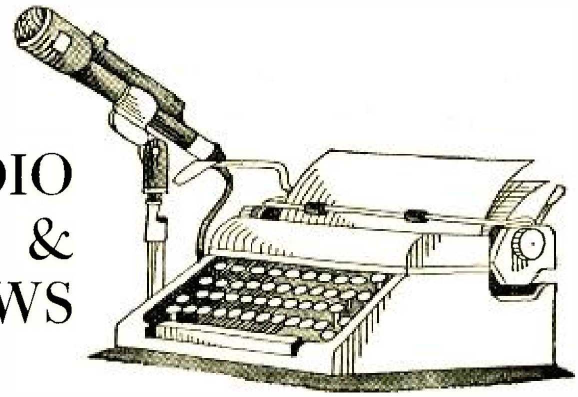
° ° °

"ANALYSIS AND DESIGN OF TRANSISTOR CIRCUITS" by Laurence G. Cowles. Published *D. Van Nostrand Company, Inc.,* Princeton, N.J. 304 pages. Price $9.75.

This is a thoroughly practical text written by and for electronics design engineers. By assuming that his reader is familiar with transistor electronics and is actually working with transistor circuits, the author has been able to eliminate much of the elementary material normally included in such texts. By treating the transistor as a circuit element with special emphasis on temperature effects and feedback, the text offers a new approach to circuit design.

The text is divided into 21 chapters and 10 appendices of value in working with the text. Diagrams, graphs, a listing of symbols, and individual chapter references for further reading are also included, thus enhancing the self-contained aspect of this excellent text. ▲

RADIO & TV NEWS



WITH the introduction of low-cost integrated circuits (see our June issue) into consumer-type equipment, more attention is now being focused on them. Because these solid-state devices have no moving parts to wear out, and because they do not employ physical phenomena that use up material, in theory they should last forever.

Engineers at the *Fairchild Semiconductor* labs have rigged up a set of 3626 digital IC's so that they can trigger each other into operation. Every so often the engineers "look in" on the pulsing circuit to see how the devices are doing. At the last count (Feb. 28, 1966), these IC's had been operating for a total of some 60,252,144 device-hours without a single failure. If this number looks large, it is. A single device would have to operate 24 hours a day for 6878 years to reach this figure.

One of the major roadblocks in the path of using IC's has been the unit price. Many companies are reducing the cost of these tiny circuits, with some digital types being reduced (by *Motorola*) as much as 70% in some cases to about 48% in others for an average price reduction of 57%. Although this price drop has been for digital IC's, as the demand for linear circuits goes up, the chances are that prices of these units will drop.

Laser Recorder

A new type of photographic recorder that uses a laser beam to generate images has produced its first pictures on film, according to scientists at *North American Aviation Autonetics Division.*

The light beam from a helium-neon laser, focused to a spot 0.0004 inch in diameter, "writes" lines on a fine-grained, high-resolution photographic film. The closely spaced lines form an image on the film in a manner similar to a TV-type picture. Only one ten-thousandth of a watt of light power is necessary to form the pictures. The device is capable of recording all the image detail of a normal television picture on one-tenth square inch of film.

Included in the device is a laser flying-spot scanner, believed to be the first of its kind that "reads" previously developed photographs and generates electrical signals as it scans the film line by line.

These signals are fed into a light modulator which acts as a high-speed valve to vary the intensity of the recording laser beam.

Studies performed at *Autonetics* show that, with modification, the device could read out and record information from 20 TV stations simultaneously.

Educasting

A new approach to education by radio called "Educasting" has been tested over a pair of New York City FM stations and is now FCC-approved as a subsidiary communications service on two Pennsylvania FM stations.

The source of the program is a four-track teaching tape, supplying signals to a four-channel subcarrier generator that, in turn, multiplex-modulates the FM transmitter.

The special receivers, manufactured by *Sylvania,* are equipped with four push-buttons that can select any of the four subcarrier channels.

The program material is presented in a step-by-step logical sequence. After each step the student is asked to respond to what he has heard. He can choose from four possible responses, each having a separate push-button. If the student selects the correct answer, he receives reinforcement of the concept. If he selects the wrong answer, he is given an explanation of why he was incorrect.

Ceramic CRT

Outside of a momentary excursion into the area of metal CRT's for use in some TV sets of several years ago, CRT's have always been made from glass. To meet the problem of operating under high stresses and severe vibration conditions that may damage conventional glass types, an English company is now fabricating a CRT whose outer shell is made from ceramic (alumina). The electron gun is brazed onto the ceramic and a glass faceplate is used. If necessary, the faceplate can be made from sapphire, a translucent form of alumina. At present, only 2-inch tubes are in production, but the company expects to market a 5-inch version soon. ▲

Calibration chart is taped to side of the 3" x 4" x 5" case. The output frequency of this particular unit is about 750 Hz.

Audio Calibrator for Transistor Amplifiers

By RYDER WILSON

Two-transistor circuit provides accurately calibrated signal, from 0.5 to 100 mV at low impedance, for checking gain and distortion of sensitive transistor amplifiers.

SENSITIVE transistor amplifiers are being used more and more in every type of electronic equipment from pocket radios to high-fidelity amplifiers, to portable TV sets. Finding a suitable test signal for these circuits is frequently a problem for the electronics technician. Few commercially available audio oscillators can produce stable, accurate, low-level signals that are completely free from noise.

Here is a simple, easily constructed oscillator that can be used to measure the gain and distortion of sensitive amplifiers and one which also provides a signal for checking speakers, earphones, or anything that responds to an audio signal.

Q1 is connected as a phase-shift oscillator. The *RC* network consisting of *R1-C1*, *R2-C2*, and *R3-C3*, determines the frequency and provides the regenerative feedback necessary to sustain oscillation. The frequency may be raised by decreasing the size of *C1*, *C2*, and *C3* or lowered by increasing the value of these capacitors. *R5* provides degenerative feedback to improve the stability and waveform of the oscillator. It should be adjusted with a scope across the output terminals to make sure that a good sine wave is obtained; otherwise the oscillator will be useless for distortion tests. *R4* controls the base bias of *Q1* and may also be critical. Select a value which insures oscillation every time the unit is turned on.

The output of *Q1* is transformer-coupled to the emitter-follower stage, *Q2*, which provides a low output impedance. *R6* is a calibrating pot used to set the voltage level at the output. *R8* and *R9* are precision 1% resistors, switch-selected to give the two voltage ranges. *R10*, a wirewound pot, is used for fine adjustment of the output voltage.

The completed unit, shown in the photo, is housed in a 3" x 4" x 5" metal utility box, finished off with decals and clear plastic spray. The 5-way binding posts used for the output terminals can be seen on the right, with the "off-on" toggle switch located on the left. The range selector slide switch is placed just below the dial scale. The two small batteries are mounted at the bottom of the case in a battery holder. *R6*, the calibration pot, is available for adjustment when the back cover is removed.

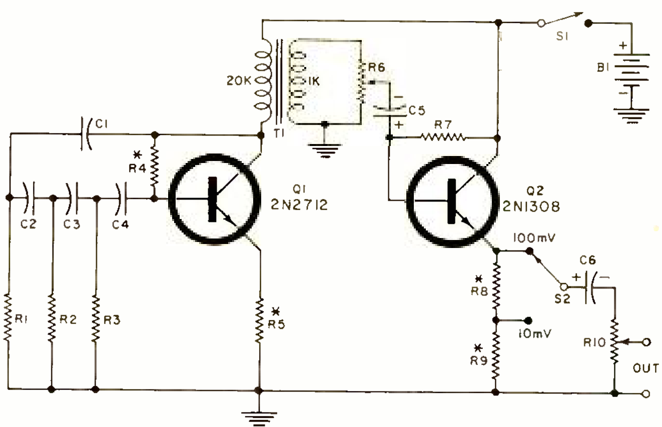
Most of the components were wired on a perforated circuit board using flea clips for terminals. The board was then mounted on a pot mounting bracket so that the output control, *R10*, holds the circuit board to the front panel. Parts layout is not critical since there is plenty of room.

Calibration

To get the most out of this instrument, it should be calibrated as accurately as possible. For this purpose, a *Ballantine* Model 300 a.c. v.t.v.m. was used. With the v.t.v.m. connected to the output terminals of the audio calibrator, the unit is turned on with the back cover removed so that the calibration pot, *R6*, is accessible. With the v.t.v.m. set on its 100-mV scale, rotate *R10* fully clockwise until it reads exactly 100 on the dial scale. Then adjust *R6* until a reading of 100 mV is obtained with S2 set on 100 mV. Slowly rotate *R10* counterclockwise until a reading of 90 mV is obtained on the v.t.v.m., going down in 10-mV increments each time until a 10-mV output is obtained. The exact reading of the dial scale should be noted for each setting. Repeat this process for the 10-mV scale. The result will be a calibration chart like the one shown in the photo on the side of the calibrator. The frequency of the author's model was measured and noted on the calibration chart; however, it is not necessary to know the exact frequency to use the oscillator.

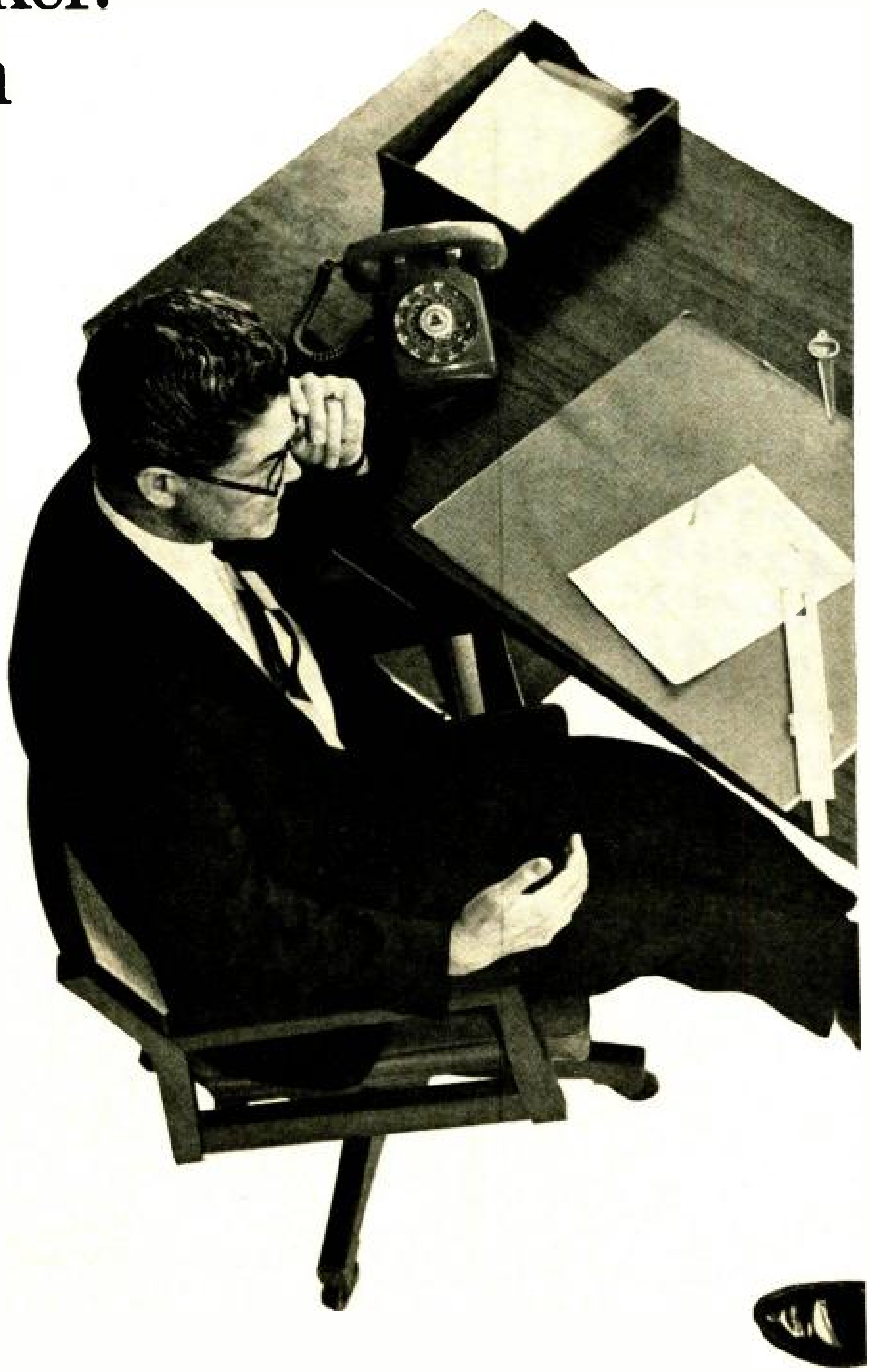
Once calibrated, the oscillator may be used as an audio voltage standard to calibrate an oscilloscope or as a test signal in checking low-level amplifiers of either the tube or transistor type. If your scope has a built-in calibrating voltage, the stage-by-stage gain of an amplifier can be measured by injecting a known signal with the oscillator at the input of the amplifier and looking at the output of each stage. Since the oscillator produces a good sine wave, distortion and clipping can be observed with your scope while making gain measurements.

The author has used his calibrator to measure the relative sensitivities of earphones, and to check speakers for open voice coils. Any place where an accurately known audio test signal is needed, this little device will find a use. ▲



R1, R2, R3—2200 ohm, 1/4 W res. ±5%
R4—270,000 ohm, 1/4 W res.
R5—180 ohm, 1/4 W res.
R6—100,000 ohm subminiature 1/4 W pot
R7—220,000 ohm, 1/4 W res.
R8—900 ohm, 1/2 W res. ±1%
R9—100 ohm, 1/2 W res. ±1%
R10—1000 ohm linear-taper, wire-wound pot
C1, C2, C3, C4—0.04 μF, 200 V paper capacitor
C5—10 μF, 6 V elec. capacitor
C6—50 μF, 6 V elec. capacitor
S1—S.p.s.t. toggle sw.
S2—S.p.d.t. slide sw.
T1—Transistor interstage trans. 20,000/1000 ohms
B1—3 V battery (two 1.5-volt "AAA" cells in series)
Q1—2N2712 transistor
Q2—2N1308 transistor
* See text

"He's a good worker. I'd promote him right now if he had more education in electronics."



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Convergence Circuits

(*Continued from page* 39)

convergence relatively simple. Again, the signal is taken from the flyback transformer through *C*4 and series coil *L*2. The signal is divided by center-tapped coil *L*3, and one portion is applied to the red horizontal convergence coils while the opposite polarity goes to the green horizontal convergence coils. Both convergence coils return to ground through the center-tapped secondary of *T*1.

Because the magnetic fields generated by the red and green convergence coils must be "in step," the windings on one of the two coils are reversed to compensate for the opposite polarity of the signals. One advantage of using currents of opposite polarity in the convergence circuits is that a minimum of interference can be expected. As in the case of the blue horizontal convergence signal, a resistor and diode (*R*4 and *D*2 for red and *R*5 and *D*3 for green) limit the positive peaks and the possibility of ringing in each coil. Of the four controls in this circuit, two control *both* the red and green convergence. Variable inductor *L*2 affects both the red and green current and determines the convergence at the right side of the screen, while *R*6, which is part of the common return to ground, determines the convergence at the left side of the screen for both red and green. Both *L*3 and *R*6 control the current going to either set of coils, with *R*7 determining the convergence between the red and green electron beams at the left of the screen, and *L*3 controlling the convergence between red and green at the right of the screen.

It is apparent from this description that coils *L*2 and *L*3 have their greatest effect at the right of the screen while the resistors have their greatest effect at the left of the screen. This was also observed for the blue horizontal convergence circuit in which the resistor had its greatest effect at the left and the coil at the right of the screen. The reason for this is that in a circuit with a series inductance and shunt *RC*, variation of the coil will have its greatest effect on the phase shift in one direction, while the *RC* portion will have its greatest effect on the phase shift in the opposite direction. By distorting the current waveforms of Fig. 3, the results of this phase shift can be clearly seen. Whether these directions are left or right depends, of course, upon the polarity of the winding and on the location of the U-shaped pole pieces over the neck of the picture tube. In the actual circuit, center-tapped transformer *T*1 provides a small amount of feedback, or bucking signal, to the low end of the red and green signals. Adjustment of *T*1 also affects this bucking signal and therefore, to a very small extent, the red and green convergence. This electrical interaction, however, helps to overcome some of the magnetic interaction which is inevitable among the three convergence fields in the neck of the picture tube.

Vertical Convergence

As shown in Fig. 4, dynamic vertical convergence signals are obtained from the cathode of the vertical output amplifier through *C*1 and are applied to the blue convergence circuit through *R*1. Components *R*2, *C*1, and *C*2 determine the correct current waveshape. The upper center-tapped secondary winding on the vertical output transformer is the ground return for the convergence signal, and the amount and polarity of any feedback is determined by *R*3 which controls the blue convergence at the top of the picture. Potentiometer *R*4 controls the blue convergence at the bottom of the picture. Both *R*5 and diode *D*1 perform the same functions as the similar circuit in the horizontal convergence sections; they limit peaks and prevent ringing.

The red/green vertical convergence has four controls. The red/green convergence signal is obtained, as with the blue convergence signal, through *C*1 and *R*1 and is supplied to the red and green convergence coils. Both *R*6 and *R*7 affect the convergence at the bottom of the screen, while *R*6 and *R*8 both affect the red/green convergence at the top of the screen. Similar to the arrangement of the horizontal red/green convergence, *R*6 and *R*8 have their primary effect on both red and green beams, while *R*1 and *R*7 tend to differentiate between the two.

The vertical convergence circuits are much simpler than the horizontal ones. One reason for this is that the aspect ratio of the screen means that there is less vertical deflection than horizontal and therefore less correction is needed. Another reason is the lower frequency of the vertical sweep signal which makes it somewhat easier to shape and control.

Most 1966 color-TV models, including *Admiral*, *Philco*, *Motorola*, *Sylvania*, and *Zenith*, use a very similar approach in their convergence systems. The few existing differences are minor and do not affect convergence circuit operation as described in this article. ▲

MARINER IV STILL ALIVE

THE Mariner IV, which took close-up pictures of Mars last year, has been contacted at a distance of 197.5 million miles. Among the information gleaned was that all systems are operating normally, the solar panel is at full strength, and all temperatures and voltages are normal. NASA hopes to command more exercises in 1967. During its life, Mariner has travelled 750 million miles. ▲

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

TWO-CHANNEL SAMPLING RECORDER

A two-channel sampling recorder with a sampling rate of 3 kHz per channel is now offered as the Type 1520-A. The new unit achieves its high speed through a bank of 101 fixed styli which, when energized, produce plots on electrosensitive chart paper.

The maximum recordable frequency is determined by the sampling rate and the paper speed

which can be set as fast as 10 inches per second. A vertical rise time as short as 300 μsec can be determined from the chart.

Calibrated voltage ranges are 1 V to 500 V (linear) and 20 to 50 dB (log) full-scale. The recorder prints its own coordinates as well as voltage and time scales. Over-all accuracy of the recorder is the same as its accuracy: ±1%. General Radio

Circle No. 126 on Reader Service Card

PRECISION DECADE BOXES

Two new "Resist-O-Stat" decade boxes are now being marketed as the Models RDS 67A and RDS 67B. These units feature accuracies of 0.01% and 0.025%, respectively. Allowance for zero resistance is not required. These six-decade units have a decade-ohms-per-step range from 100 ohms to 10 megohms.

Utilizing positive in-line readout, these numeric dial decade resistors permit rapid selection of resistance settings accurate to 0.01%. They are used in test, checkout, and ground-support equipment.

Stability is 25 ppm per year, switch life is better than 100,000 operations, temperature coefficient is 5 ppm per °C, redundant switching, and weight is 5¼ lbs. General Resistance

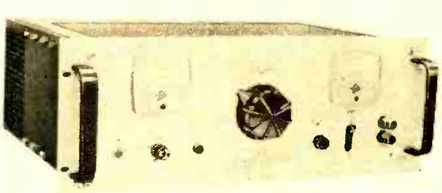
Circle No. 127 on Reader Service Card

REGULATED POWER SUPPLIES

A new series of highly regulated, continuously variable power supplies, suitable for both laboratory use or for rack mounting, is being offered as the H Series.

All thirteen models in the new series are free from overshoot; are short-circuit-proof; and are supplied with large, accurate meters; front and rear terminals; and coarse and fine controls. All units include 0.01% line and load regulation.

Ratings from 0-20 to 0-100 d.c. volts at from 2 to 100 amperes are included in the line. Bulletin 108A giving complete specifications is available on request. Deltron



Circle No. 128 on Reader Service Card

WIREWOUND POWER RESISTORS

The development of a new dielectric material has made possible a new series of power resistors wound on a solid aluminum core. The new dielectric is a high-temperature, high-emissivity insulation which withstands continuous operation at 350°C, intermittent temperatures in excess of 500°C, and BCM high-voltage tests between leads and core without flashover—under high temperature and high altitude conditions.

The new resistors require only a fifth the volume of a resistor with beryllium oxide core and 1/18th the volume of a resistor with aluminum oxide core—with the same power rating.

Complete specifications on this new series of resistors are contained in Data Sheet R366 which will be supplied on request. Ultronix

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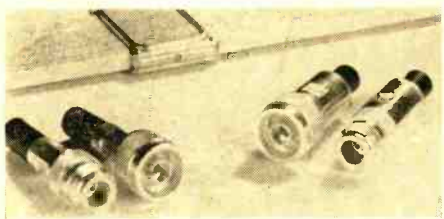
"N"-TYPE COAX CONNECTORS

A new Type "N" coaxial connector, electrically identical in both field-serviceable and crimp versions, enables design engineers to use the field-serviceable type for prototype equipment and for field replacement and the crimp unit for production.

Impedance of the connectors is 50 ohms; voltage rating is 1000 V r.m.s.; and specified frequency range extends up to 10 GHz. Maximum v.s.w.r. is 1.12:1, exceeding the MIL-C-39012 "N" specification. Cable retention exceeds the specification requirement of 75 pounds. Operating temperature is 200°C maximum.

The connectors are available in a number of



configurations, details of which will be supplied on request. Amphenol

Circle No. 130 on Reader Service Card

FLAT-CONSTRUCTION FILTER

The FLH-600 flat-construction low-pass filter is especially suited for 400-Hz applications. Designed, manufactured, and tested to complete MIL-F-18327B specification, the new unit has a source and load of 10,000 ohms. It is within 1 dB from d.c. to 450 Hz, 3 dB ± 1 dB at 600 Hz, and then sharply attenuates to at least 40 dB at frequencies above 800 Hz.

The filter is housed in a case measuring 2" square by ½" high. It weighs 2.5 ounces. UTC

Circle No. 131 on Reader Service Card

DUAL-WAVEFORM GENERATOR

The new Model 636 provides a complete source of sine- and square-wave signals from 20 to 200,000 Hz for a wide range of audio and video testing, servicing, and experimental work. The instrument is designed with one scale-frequency dial to simplify readings for both sine- and square-wave outputs, and a dual-function control.

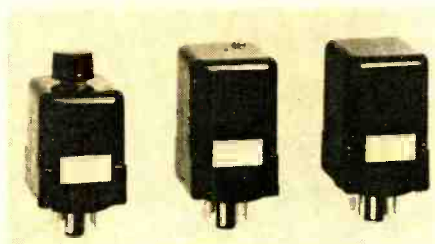
Other features include negligible distortion and high stability of sine-wave output; a Schmitt trigger multivibrator and buffer to provide isolated optimum waveform square-wave output; negligible square-wave tilt and fast risetime at all square-wave frequencies; and extensive shielding for minimum radiation pickup.

The instrument measures 8¼" x 11¼" x 7" and weighs 15 pounds. Precise Electronics

Circle No. 1 on Reader Service Card

SOLID-STATE TIMER

A new solid-state timer which can be combined with the firm's advanced-design line of wide application relays has been announced. The time range is from 100 msec to 300 seconds, with reset time less than 20 msec, repeatability of ±2%,



and temperature range from −10°C to +85°C.

The units are mounted on standard 8- and 11-pin octal plugs, enclosed in a hermetically sealed rectangular dust cover, and offered as knob adjustable, screwdriver adjustable, and fixed time or remote resistor adjustable models. Cornell-Dubilier

Circle No. 132 on Reader Service Card

LOW-COST WIRE TIE

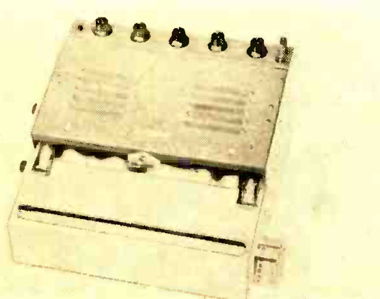
A new low-cost plastic wire tie has been introduced as the "Purse-Lock." Suited to the job of bundling several loose wires in a wide variety of applications where a number of electrical wires run along the same path, the new unit consists of a plastic tie which is looped around the wires and the spherical ends then twisted to snap the tie into a locking position.

The wire tie is being offered in a variety of sizes to accommodate wire bundles from 0.200 to 0.499 inch in diameter. Other sizes are available on custom order. Fastex

Circle No. 133 on Reader Service Card

SERVO-CHART RECORDER

The Model EUW-20M servo-chart recorder features 21 switch-selected chart speeds. In its internal mode of operation, the available chart speeds range from 0.5 inch per hour to 12 inches per minute with selection of any desired speed made by means of a single knob. The 21-position switch is calibrated with five rate scales—seconds per inch, minutes per inch, hours per inch, inches per minute, and inches per hour. With the mode



switch in the external position, the unit may be operated from an external source of sine waves, square waves, or pulses. The sine-wave frequency or pulse repetition rate and the position of the selector switch determines the chart speed in this mode.

The recorder is offered with or without the 21-speed drive feature. The 21-speed drive accessory is available separately for installation in earlier models. Full specifications on the EUW-20M are available on request. Heath

Circle No. 2 on Reader Service Card

VIDEO TAPE RECORDER

A new video tape recorder featuring instant play, ease of operation, and a new long-life recording head has been put on the market as the Wollensak VTR-150. The unit has been designed primarily for educational, industrial, and military markets.

The unit will be offered in two package concepts: as a recording and playback device or installed in a mobile console. Tape for the unit is priced at $39.95 per 2400-foot roll which will yield one hour of recording time.

The unit contains all-transistor, solid-state circuitry which, coupled with a two-motor driver, produces an almost instantaneous runup time of 8 seconds. Recording and playback speed is 7½ ips. The VTR-150 uses ½" video tape and will record and replay up to one hour on a 7" reel. Maximum reel size is 8".

The VTR-150 will not be available on the commercial market until later in the year but information regarding the recorder is available on request. 3M

Circle No. 3 on Reader Service Card

PRECISION A.C. POTS

A new line of precision a.c. potentiometers is now being marketed as the Series 7 "Vernistats." These high-accuracy, 20-turn units in size 11 offer very low output impedance. For example, Model 7B1 provides an output impedance of 20 ohms and an absolute linearity of ±0.01 percent. Extended slope is 180° at each end.

These new pots meet applicable requirements of MIL-E-005272, MIL-R-12934, and others. They are designed to be used in servo and control systems such as missile guidance systems, automatic checkout equipment, navigation systems, simulators, computers, and specialized industrial equipment.

Electrical and mechanical specifications on this new Series-7 line will be supplied on request. Perkin-Elmer

Circle No. 134 on Reader Service Card

ENCAPSULATED TRANSISTORS

A new line of microminiature, high-performance, plastic-encapsulated transistors is now available at what are believed to be the lowest prices for their type. Included in this new silicon "microtab" line is a high-gain, low-noise amplifier which is designed for use in hearing aids, instrumentation, hybrid circuits, linear and analog circuits, miniature operational amplifiers, and any other application where small size is important.

These amplifiers, designated Types D26E-1 through E-7, are similar to conventional 2N930 or 2N2484 types. Betas range from 40 to 300. The high-frequency amplifier, D26G-1, is similar to the 2N918. It has a beta at 100 MHz of greater than six.

The amplifiers are color coded for type number and lead configuration. Package size is 0.07" x 0.07" x 0.085". General Electric

Circle No. 135 on Reader Service Card

MAGNETIC-REED ROTARY SWITCHES

A complete line of magnetic-reed rotary switches, consisting of eight models, is currently available. They are available with either Form A or Form C contacts, or in combination of both, and have isolated contacts, making it possible for each stack to handle up to 12 individual circuits.

The units are light in weight—as little as 3 ounces for a 12-position switch—and have an improved ball and sprocket detenting mechanism and no sliding contacts, which greatly reduces operating force and eliminates contact wear. Rhodium contacts hermetically sealed in pure nitrogen make these units suitable for use in hazardous locations, dry-circuit applications, and assures reliable operation with low contact resistance under all environmental conditions. Hart

Circle No. 136 on Reader Service Card

METAL-FILM TRIMMERS

A new line of low-ohm, metal-film trimmers which provide the temperature coefficients and noise characteristics of wirewounds is now available. The new units are housed in humidity-vibration-shock-proof cases while a silicon "O" ring shuts out dust and humidity. A precious metal contact assures low contact resistance. Resistances available in the new line range from 50 to 100,000 ohms. Amphenol

Circle No. 137 on Reader Service Card

U.H.F./V.H.F./FM ANTENNA

A log-periodic antenna designed especially for urban use has been introduced as the LPV-VU5. The new "Metro-Color" antenna is designed for v.h.f./u.h.f. black-and-white or color and FM or FM-stereo. This single-downlead log-periodic unit is 45 inches long and has three driven V dipoles to cover both v.h.f. bands. Three active dipoles plus three directors provide the stepped up gain needed for u.h.f. Frequency response is flat within ±½ dB on any channel. A sharp forward lobe in the polar pattern assures unidirectional pickup and high front-to-back ratio on all the designated channels. JFD

Circle No. 4 on Reader Service Card

NEW CABINET LINE

Designed to accommodate various sizes of electronics systems, the new "Classic" cabinet line is being offered in 15 different sizes to house standard 19" panels. The finish is vinyl textured charcoal gray or sand. Doors are available as auxiliary items. The cabinets have welded frames of aluminum extrusions while patterned aluminum panels complete the enclosures. Bud

Circle No. 5 on Reader Service Card

EXACT-REPLACEMENT TV PEC's

Ten new exact-replacement PEC's for television receivers are now available for use in retrace suppression, sound i.f., and sync circuitry. Nos. PC-491, PC-492, PC-493, and PC-494 are three-terminal retrace suppression networks consisting of two resistors and two capacitors of various values and manner of combination.

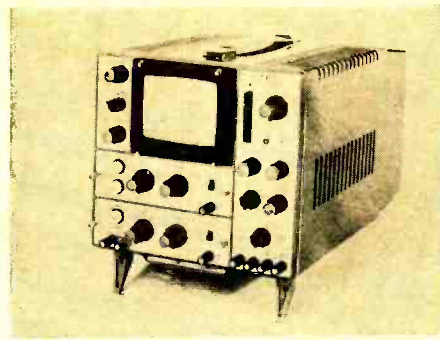
PC-495 is a four-terminal sound i.f. network consisting of three resistors and two capacitors. PC-496 through PC-500 are two- to five-terminal networks for sync coupling and take-off. Centralab

Circle No. 6 on Reader Service Card

DUAL-BEAM SCOPE

The high-performance, dual-beam oscilloscope, D53, is a laboratory-type instrument designed for wide-band, multiple-trace applications including differential measurements and high-d.c.-sensitivity applications.

The main frame contains the CRT, power supplies, and the delays; the time base and horizontal amplification are provided by a plug-in module; vertical amplifiers are available in six models for use with the D53.



Full specifications on this 25-MHz range scope will be forwarded on request. Data Instruments

Circle No. 138 on Reader Service Card

BROADBAND MEASURING SET

A general-purpose voltmeter featuring ruggedness, compactness, and a frequency response of 50 Hz to 800 MHz is now being offered as the Type 74832. This all-transistor level-measuring set is a portable, general-purpose 75-ohm-input voltmeter. It is housed in a strong diecast metal case, making the unit suitable for field use. It combines small size, light weight, and long operation from its internal dry cells.

Three r.m.s. measuring ranges are provided: 0-60 and 0-600 millivolts and 0-3 volts. The scale on the 60-mV range is also graduated from −10 to 0 dB. The response is flat within 0.3 dB between 1 and 30 MHz and 0.6 dB between 30 and 500 MHz.

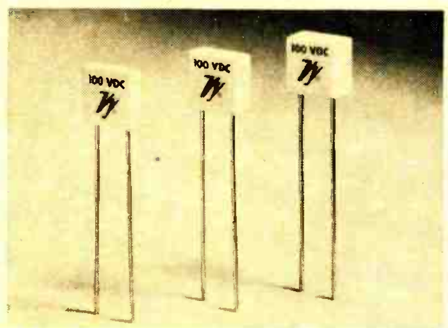
The instrument measures 7⅜" x 5¾" x 3" and weighs 4 pounds. ITT Industrial

Circle No. 139 on Reader Service Card

PORCELAIN CAPACITOR LINE

A new line of radial porcelain capacitors with a 0 ± 25 ppm/°C temperature coefficient as standard, 0.200" lead spacing, and voltage ratings up to 200 V d.c. is now on the market. These new monolithic capacitors have a high volumetric efficiency in a small case size and incorporate new electrode and terminal designs.

The new line is available in 13 standard values within the capacitance range of 5.1 to 1000 pF. They have low dissipation factors of 0.001 (@ 25°C) and 0.002 (@ 125°C) and operate within the temperature range of −55°C to +125°C without voltage derating. Based on extensive life tests, they are rated at 200 V d.c. from −55°C to +85°C; 100 V d.c. from −55°C to +125°C; and 50 V d.c. from −55°C to 150°C. Vitramon



Circle No. 140 on Reader Service Card

SINGLE-SCALE CIRCULAR SLIDE RULE

A radical new slide rule, created by John Tyler, professor emeritus of mathematics at the U.S. Naval Academy, uses only a single numbered scale for calculations in trigonometry, geometry, multiplication, division, and log functions.

One advantage of the new design is the elimination of multiple sets of numbered scales. The new rule presents a clean and uncluttered face with a single, easy-to-read, spiraled scale carrying all numbers necessary to perform the computations of the older type rule.

The new rule has a transparent cursor arm and a rotating disc mounting on a flat plastic base, 8½" square. The spiral-shaped C scale is the only working scale and is imprinted on the rotatable disc. All other scales found on the conventional rule are replaced by curved hairline indexes which are inscribed on the base. Weems & Plath

Circle No. 7 on Reader Service Card

PRECISION ROTARY SWITCH

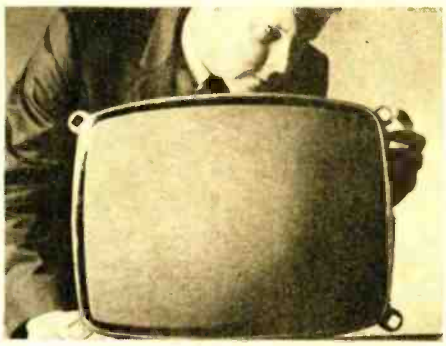
The Model SW200 precision rotary switch can be supplied with various conducting angle switch segments and tolerances held within ±1°. Conducting current is 100 mA and the conducting material, nominal zero resistance, is precious metal.

The case is machined anodized aluminum, with a one-piece diallyl phthalate molded interior and external terminal board. This technique provides a complete insulating envelope inside the housing and eliminates all possible leakage paths. The unit is supplied as a sleeve-bearing panel mount, ball-bearing servo mount, or with a coupling device wherein it can be coupled to precision pots. Samarius

Circle No. 141 on Reader Service Card

25" IMPLOSION-PROTECTED TUBE

A new 25-inch, 110-degree black-and-white TV picture tube recently introduced features its own integral implosion protection system. It features a viewing area of over 327 square inches, has special tinted glass that improves picture contrast, four integral mounting brackets, as well as the implosion protection system. This latter is



composed of a metal rim band and a steel tension strap. The metal rim band, suitably curved to fit snugly around the periphery of the tube face, is epoxy bonded to the glass. A steel tension strap is then prestressed tightly over the rim band and mechanically clinched in place to maintain a residual tension in the system. Westinghouse

Circle No. 142 on Reader Service Card

MULTI-PURPOSE PROBE

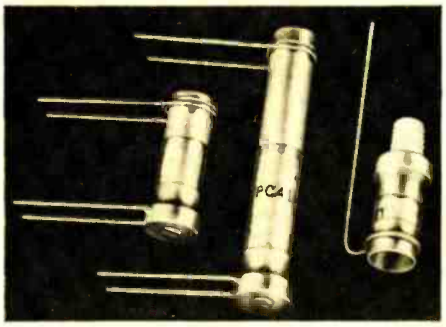
A multi-purpose probe, the Model MP-1, can function as a d.c. probe, a.c./ohms probe, r.f. probe, and a low-capacitance probe. The new four-in-one design saves the cost of four probes and eliminates the need for switching probes during servicing. The unit will extend the operating range of a v.t.v.m., scope, or signal tracer.

As a d.c. probe, the MP-1 provides isolation for all d.c. measurements. As an a.c./ohms probe, it can be used for all low-impedance, low-frequency voltages and waveforms. As an r.f. probe it is a demodulator for checking r.f. voltages, waveforms, and signals in TV-radio r.f. and i.f. stages. As a low-capacitance probe, it can be used for high-impedance sync circuits where regular probes would overload the circuit. Mercury

Circle No. 8 on Reader Service Card

NEW TRIMMER CAPACITORS

A new series of miniature trimmer capacitors, to meet styles PC40 and PC41 of MIL-C-14409, is now on the market. Ten models of these new higher capacitance trimmers are available, five each in panel-mount and printed-circuit styles. Models are available with both H and J characteristics and capacitance ranges meet values



specified in MIL-C-14409 for all values from 0.8 to 4.5 pF and 1.0 to 30 pF.

Quality factor is guaranteed at 650 maximum. d.c. working voltage is 750 volts. LRC Electronics

Circle No. 143 on Reader Service Card

TERMINAL/WIRE-WRAPPING TOOL

A new terminal design and a new wire-wrapping tool combine to reduce the wiring time on the firm's line of low-cost connectors. A stripped lead is quickly ready for soldering after being fed into the terminal hole and wrapped around the terminal with a single stroke of the tool.

The improved connector meets requirements for 14-milliohm contact resistance, 50-gram individual contact retention, 2000-volt breakdown, and 2-ampere current-carrying capacity. North Electric

Circle No. 144 on Reader Service Card

SUBMINIATURE TOGGLE SWITCH

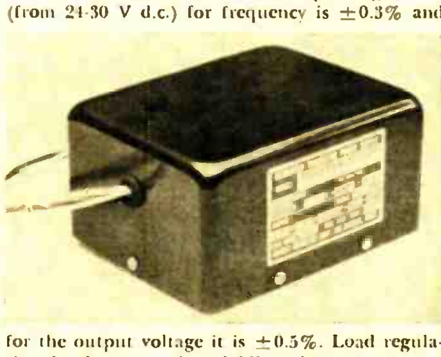
The Model 7205 d.p.d.t. subminiature toggle switch features minimum life of 100,000 cycles, solid-coin-silver contacts and terminals, and molded phenolic bases. Bat-handle operating levers are standard, but color-coded plastic caps in many color choices are available on request.

Contact rating is 5 amperes resistance load at 117-volts a.c., insulation resistance is 1000 megohms minimum, dielectric strength is 1000 volts r.m.s. at sea level, and initial contact resistance is 20 milliohms at 2-4 volts d.c., 1 amp. Weight is 5.5 grams. C&K Components

Circle No. 145 on Reader Service Card

400-Hz SINE-WAVE INVERTER

A 110-volt, 400-Hz sine-wave inverter rated at 100 watts is now on the market. The unit operates from an input voltage of from 24 to 30 volts d.c. and the output is 110 volts r.m.s., adjustable ±5%. Output frequency is 400 Hz, with a tolerance of ±0.5%. Output power is rated at 100 VA at 50°C or 80 VA at 71°C. The waveshape is sinusoidal with 4% maximum harmonic distortion at full load. Input regulation (from 24-30 V d.c.) for frequency is ±0.3% and



for the output voltage it is ±0.5%. Load regulation for frequency is ±0.3% and for the output voltage it is ±2%.

The unit measures 4" x 5" x 2½" and weighs approximately 56 ounces. Arnold Magnetics

Circle No. 146 on Reader Service Card

A.C. VOLTMETERS

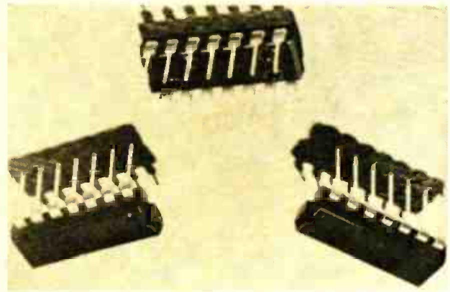
Two new models have been added to the 400 Series of a.c. voltmeters as the 400F and 400FL. Both have 100-μV full-scale ranges and 10-megohm input impedance. An a.c. output produces one volt r.m.s. for full-scale meter deflection, regardless of range and use; on the 100-μV range, the amplifier has 80-dB gain with less than 5 μV noise. Frequency range is 20 Hz to 4 MHz. Accuracy, in the range from 100 Hz to 1MHz, is ±0.5% of full scale ±0.5% of reading for the 400F and 1% of reading for the 400FL. The Model 400F presents the linear voltage scale uppermost, while the Model 400FL presents a linear dB scale uppermost. Hewlett-Packard

Circle No. 147 on Reader Service Card

PLASTIC-PACKAGED INTEGRATEDS

A new line of resistor-transistor-logic circuits is now being offered in a solid, void-free, pressure-molded case providing a high degree of environmental protection. The lead arrangement is a dual in-line configuration with leads on 100-mil centers and with 300-mil spacing between parallel rows of leads. The circuits feature central power supply connections; specifically, the ground connection is on pin 4 and V_{CC} is on pin 11.

The new "Unibloc" packaged units are available in quad 2-input, triple 3-input, and dual



4-input gates as well as dual buffers and dual J-K flip-flops. The initial series has an operating temperature range of +15°C to +55°C. Motorola

Circle No. 148 on Reader Service Card

DRY-TRANSFER SYMBOLS

A line of dry-transfer alphabets and numerals and electronic symbols is now being offered in various sizes and in black or white type. Size ranges are ⅛", ¼", ⅜", ½", 21/32", and 25/32". The electronic symbol sheets, 7" x 13", cover the entire gamut of electronic components for drafting of circuits. Russell Industries

Circle No. 149 on Reader Service Card

HI-FI—AUDIO PRODUCTS

AUTO REVERB SYSTEM

A deluxe car "Vibrasonic" sound system, designed to add reverberation to music for greater depth and realism has been put on the market as the Model KM201R. The new unit employs three transistors and can be added to any car radio where the car has a 12-volt negative ignition system and the radio has either an 8-10 or 40 ohm speaker.

The unit has a die-cast control housing which fits under and dash; one control knob with three positions for reverberation, regular listening without reverb, or front-speaker only; and a second knob which acts as a balance or fader control that permits speakers, front or back, to be adjusted to the listener's personal preference, with or without reverberation. Motorola

Circle No. 9 on Reader Service Card

SOLID-STATE TAPE/PHONO PREAMP

A new solid-state tape/phono preamplifier featuring an extremely low noise figure of 6 dB below inherent noise generated by unrecorded tape is now available as the Model ATP-24.

The unit is designed for use with conventional magnetic tape heads or phono cartridges. Proper equalization is provided for playback compensation of tapes recorded at 7½ and 15 ips. Also, by simply strapping a terminal on the board, proper equalization is obtained for the playback compensation of discs recorded using the RIAA curve.

In addition, the unit features compact size, controls for gain and high-frequency tape response, output impedance of less than 10%

of nominal load, 20 to 20,000-Hz power bandwidth, and high-sensitivity tape and phono input. Melcor

Circle No. 10 on Reader Service Card

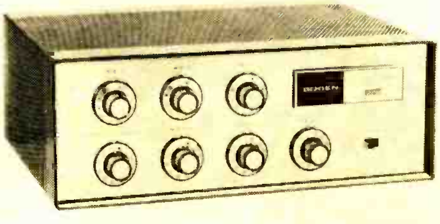
SOLID-STATE P.A. AMPLIFIERS

A new line of public-address amplifiers, the MTA series, includes six units featuring solid-state circuitry for ultra reliability yet at moderate cost.

The series, with a complete accessory line available, delivers 10 to 100 watts and features silicon transistors, low-impedance microphone inputs requiring no transformer, and built-in protection against short-circuited or open speaker lines.

Plug-in circuit boards provide high quality control and servicing ease. Chimney-type heat sinks and heat-sensing "thermoguards" permit safe and continuous operation up to 158° F.

Available accessories include manual phono



tops, carrying cases, plug-in transformers and magnetic cartridge module, rack panel kits, control guard locking plate, standby controllers, remote volume controllers, and a plug-in component for microphone precedence. Bogen

Circle No. 11 on Reader Service Card

12" COMPONENT LOUDSPEAKERS

Two new twelve-inch component loudspeakers, the MC12 and the MT12, have recently been added to the "Michigan" speaker line.

The MC12 features the "Radax" dual cone while the MT12 features the same dual cone but adds a ring diaphragm tweeter and annular horn for increased efficiency in the higher frequencies. The MT12 has a continuously variable level control for adjusting brilliance to suit varying personal tastes and environmental acoustics. Its frequency response is 40 to 14,000 Hz. The MT12 covers 40 to 18,000 Hz. Electro-Voice

Circle No. 12 on Reader Service Card

30-WATT P.A. DRIVER

A built-in transformer and watts/impedance selector switch are features of the new 30-watt public-address driver unit being marketed as the PD-30T. The weatherproof unit is designed to be used as a replacement driver on any industry-standard horn having 1⅜"-18 threads. Special corrosion-proofing and melamine enamel finish maintains weather protection.

The unit's screw-to-line terminals, cable strain-relief clamp, watt/impedance switch, and built-in transformer save installation time, costs of wiring, and speeds balancing of power levels in multiple speaker systems.

Power output is a continuous 30 watts, power equalized to frequencies above horn cut-off is 40 watts, and frequency response is 120 to 14,000 Hz. The sound level is 126 dB measured 4 feet on-axis with a DR-42 horn at 30 watts input. The unit is 4¾" in diameter and 4⅞" deep. Atlas Sound

Circle No. 13 on Reader Service Card

MICROPHONE MIXER

Four low-impedance microphones can be fed into the new microphone mixer currently being offered. Each channel has its own volume control and built-in preamplifier. A master output volume control and "on-off" switch are provided.

The unit will operate on either batteries (six 1.5-volt penlight type) or on 110-240-volt a.c., with automatic switching. Other features include an output jack for connection to a rever-

beration unit, separate "on-off" switch, a.c. power-indicating light, and a scratch-resistant vinyl case which measures 9" x 8" x 6". Weight is 5½ lbs. American Geloso

Circle No. 14 on Reader Service Card

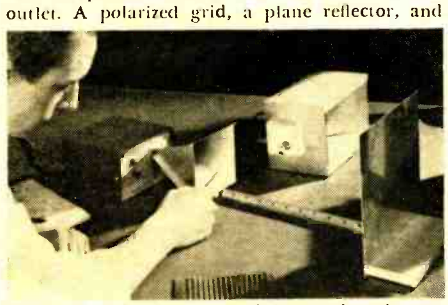
CB-HAM-COMMUNICATIONS

MICROWAVE OSCILLATOR KIT

The theory and behavior of microwaves can be demonstrated by means of the new Andrews microwave oscillator kit. Designed for use by teams of four students, the apparatus employs microwave frequencies to introduce students to the basic laws of light waves. Standing waves, interference in thin films, Young's experiment, Lloyd's mirror, polarization, and Doppler effects can be explored and measured in laboratory experiments.

A clean, polarized electromagnetic wave with a frequency of 6.6 GHz and a 4.6 cm wavelength is generated by a small 7486 triode. The tube's metal cap is employed to form an inexpensive grid-anode coaxial resonant cavity. This is positioned at the throat of a flared microwave antenna horn attached to a small, specially designed power supply.

The unit comes factory tuned and ready for use. It operates from a three-wire 117-volt, a.c. outlet. A polarized grid, a plane reflector, and



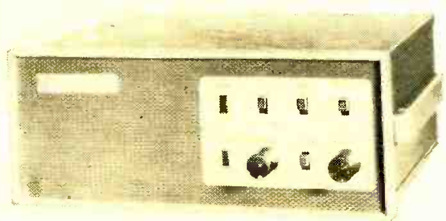
a plastic rule for measuring wavelengths are supplied, along with a copy of Dr. C. L. Andrews' book "Optics of the Electromagnetic Spectrum." Macalester Scientific

Circle No. 15 on Reader Service Card

FM ALERTING/MONITORING UNITS

Three new FM radio alerting and monitoring receivers, especially designed for use by fire departments, Civil Defense units, police departments, Industrial and Business Radio Services licensees, emergency crews, etc., are now on the market.

In use the alerting receiver remains on silent standby until activated by a tone signal transmitted from headquarters. The receiver, now operating at full sensitivity, produces a voice message advising the listener the exact nature of the alert and the action to be taken.



The three basic models are the "Polaris," a 24-transistor FM tone-voice alerting unit; the "Mercury," a 31-transistor monitor receiver; and the "Gemini" (photo), a 36-transistor combination tone alerting and monitoring receiver. They are available in the low (30-50 MHz) or high (150-174 MHz) bands with other frequencies available on special order. Viking Instruments

Circle No. 16 on Reader Service Card

450-MHz MOBILE RADIO

To provide effective and economical communications in the u.h.f. band, a new 450-MHz two-way FM mobile radio has been introduced as the "Dispatcher."

The unit features completely transistorized exciter, receiver, and power supply. The only tubes in the unit are three in the transmitter, which provides 15 watts r.f. power output.

The new 450-570-MHz unit has ultra-stable solid-state channel elements to maintain precise frequency control at wide operating temperatures—without using crystal heaters or ovens. A battery-saver circuit switches off the transmitter filaments when the vehicle ignition is turned off.

Five watts of audio output with less than 5 percent distortion is provided in the unit. This permits hearing calls even when the operator is away from his vehicle.

Complete technical specs on the "Dispatcher" are contained in Bulletin E-746 which will be forwarded on request. Motorola

Circle No. 17 on Reader Service Card

SSB/AM MOBILE UNIT

The CH25M has been specifically designed to meet the growing demand for both land and marine mobile SSB, has an output of 100 watts SSB or compatible AM—all in a package weighing less than 22 pounds and measuring 10¾" x 7" x 13¾".

The unit will mount under the dashboard of most vehicles, eliminating the necessity of a separate control head and connecting cables. Transistorization has reduced the current requirement to less than 0.16 ampere on receive, permitting constant monitoring without excessive battery drain. Plug-in power modules, either a universal 12, 24, 32 volt d.c. or a 115/230 volt a.c. unit, permit instant conversion from mobile to base-station use.

The CM25M is a six-channel unit with plug-in tuning coils to facilitate rapid change of operating frequency in the field. A matching antenna tuner, which may be installed on the back of the set or remote controlled up to 100 feet away, permits the unit to be used with a variety of antenna types without excessive signal loss. Kaar

Circle No. 18 on Reader Service Card

MANUFACTURERS' LITERATURE

AUDIO EQUIPMENT

A wide range of microphones and accessories for professional sound applications is presented in a new 31-page fully illustrated catalogue (No. 566). Wide-range, hand-held, and lavalier types of omnidirectional microphones are included, as well as stand- and boom-mounted cardioid and "Cardiline" devices.

Wall-mount and free-standing studio monitors are also covered, and a 4-page section on selecting the proper professional microphone is provided. Electro-Voice

Circle No. 19 on Reader Service Card

INSULATION RESISTANCE

A new 12-page pocket-size manual (P-16124) which discusses the fundamentals of insulation resistance testing is now available. The booklet shows test hook-ups for performing insulation resistance evaluations on wiring, meters, appliances, d.c. motors and generators, and a.c. motors with the Model 2000 "Meg-Chek" instrument. Associated Research

Circle No. 20 on Reader Service Card

BATTERY WALL CHART

Information on the chemistry and physical structure of advanced battery systems is presented on a new illustrated wall chart. Suitable for schools and colleges, the chart is printed in four colors and contains data on the performance, power, and applications of primary batteries. Mallory Battery

Circle No. 21 on Reader Service Card

EDUCATIONAL TV

The basic types of educational TV systems, including broadcasting stations, 2500-MHz instructional TV systems, inter-school cable, and conventional microwave link, are outlined and evaluated in a new 36-page reference: "1966 Schoolman's Guide to ETV Communications."

Master antenna TV (MATV) and closed-circuit TV (CCTV) systems are also covered, along with financing information and sources of ETV advice and counsel. Jerrold

Circle No. 22 on Reader Service Card

COLOR-TV COMPACTRONS

A new 12-page guide to the selection of multi-function compactrons for color and black-and-white TV is now available. Approximately 150 devices are listed in the booklet, which contains easy-to-use charts giving condensed specifications.

Also included in bulletin ETD-4359 is a page of basing diagrams. General Electric

Circle No. 150 on Reader Service Card

BROADBAND ANTENNAS

A new 20-page illustrated booklet describing a complete line of stock and custom broadband antennas has been published. Included are log-periodic types, cavity-backed devices, conical spiral and helical units, horn antennas, and a variety of special-purpose antennas.

Information on antenna characteristics and terminology is also provided. American Electronic Laboratories

Circle No. 23 on Reader Service Card

SOUND COLUMNS

A new 10-page manual which describes and illustrates the advantages and applications of sound columns in p.a. systems has recently been published. Methods of installation and arrangement of sound-column speakers are fully explained.

In addition, the booklet contains a table of technical data and specifications. American Geloso

Circle No. 24 on Reader Service Card

PILOT LIGHT/SWITCH

Information on the new "Slidelite" unit which combines a pilot-light indicator with a switch in one compact, snap-in installation is contained in a new catalogue sheet (No. SL66).

The device is designed to operate with either neon or incandescent lamps, and a variety of lens colors is available. Messages, trademarks, or other legends may be stamped on the pilot-light lens. Leecraft

Circle No. 151 on Reader Service Card

WIRE DESIGN BOOKLET

Information on advantages and applications of precision wire forms and welded assemblies of wire, strip, and tubing is contained in a new 20-page handbook entitled "New Concepts in Wire Design."

The brochure includes a discussion of the types of steel wire as well as a table of steel wire sizes. In addition, a section on the elements of wire design lists design tips and describes various methods of forming and welding wire. Titchener

Circle No. 152 on Reader Service Card

TEST EQUIPMENT

A new 16-page brochure covering a complete line of test equipment has been published. Included in booklet No. 2072 are v.o.m.'s, v.t.v.m.'s, scopes, microtesters, and temperature indicators.

The company is also offering a catalogue which gives full specifications and applications data on its "Lab-Line" group of precision electrical measuring instruments. Simpson

Circle No. 25 on Reader Service Card

R.F. POWER MEASUREMENT

Absorption wattmeters, coaxial load resistors, directional wattmeters, and coaxial switches are among the instruments for r.f. power measurement that are listed in a new 4-page illustrated short-form catalog (SF-66).

In addition, the brochure describes related custom-built accessories such as coaxial filters and power monitors. Bird

Circle No. 153 on Reader Service Card

MEASURING EQUIPMENT

A comprehensive 50-page 1966-1967 index of electronic measuring instruments has been published. Covering a wide range of devices, including waveform and distortion analyzers, oscilloscopes, amplifiers, and attenuators, as well as equipment for measuring voltage, current, resistance, impedance, frequency, microwave noise figure, and temperature, the index is illustrated and contains complete specifications for all devices listed. Hewlett-Packard

Circle No. 154 on Reader Service Card

FREQUENCY STANDARD

Complete technical specifications for the Model JKTO-66 5-MHz laboratory frequency standard are contained in a new illustrated catalogue sheet. CTS Knights

Circle No. 155 on Reader Service Card

CATV FINANCING

The National Community Television Association (NCTA) has announced publication of the proceedings of its "CATV Financial Seminar" which was held in New York City in January, 1966.

Contained in the 172-page volume are the complete texts, charts, and illustrations of 16 papers on the financial aspects of CATV which were presented by prominent spokesmen from the industry itself, government, broadcasting, and allied fields.

Copies of the publication are available from the National Community Television Association, 535 Transportation Building, Washington, D.C. 20006 at $15.00 per copy.

CABLE INSTALLATION

A new cable installation handbook which provides guidelines for the construction of CATV transmission lines has been published. The manual includes tips on selection of materials and lists specifications for conforming to utility-company practices and the National Electrical Safety Code.

Two sections dealing with pole line and aerial construction are already contained in a soft-cover, loose-leaf binder, and a third section on buried cable construction is forthcoming.

The handbook is available from Ameco, 2949 West Osborn Road, Phoenix, Arizona 85017. List price is $5.00 including all future additions and revisions.

USING THE V.O.M.

Simpson Electric Company, 5200 West Kinzie Street, Chicago, Illinois 60644 is currently offering a 90-page paperback entitled "1001 Uses for the '260' Volt-Ohm-Milliammeter."

Fully illustrated, the book is a comprehensive compilation of all known test applications for the device and covers voltage, current, resistance, and power measurements as well as receiver, transmitter, and industrial measurements and automotive tests.

The manual is available from electronic distributors for 75¢ or directly from the company for $1.00 (to cover postage and handling). ▲

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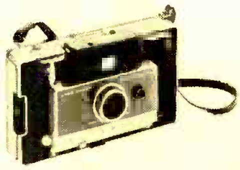

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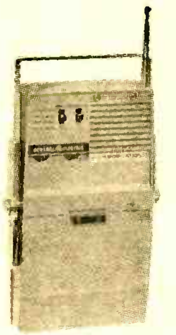

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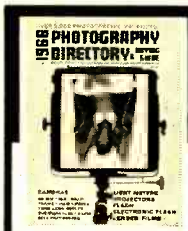

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