Electronics World

JULY, 1964
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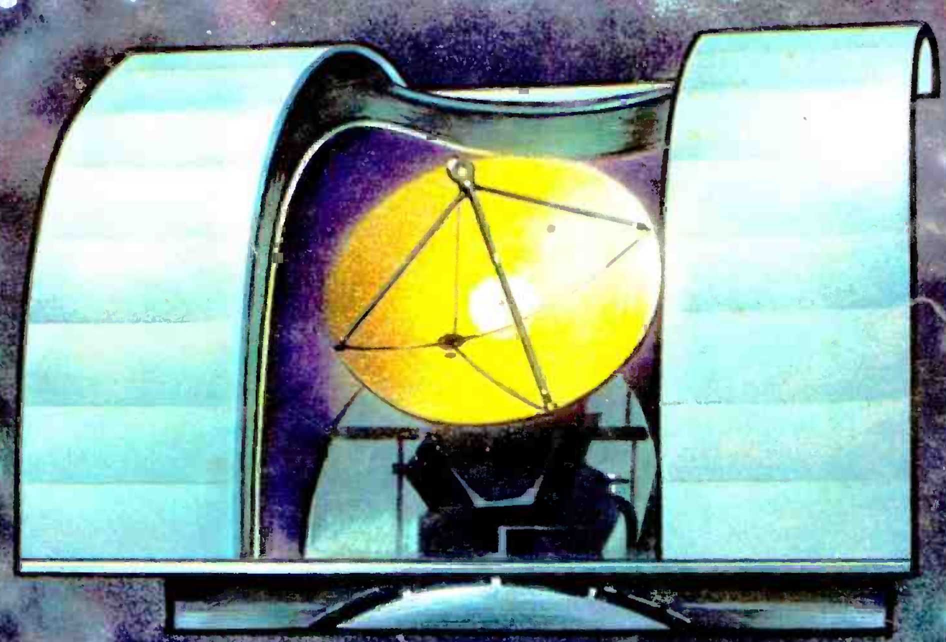

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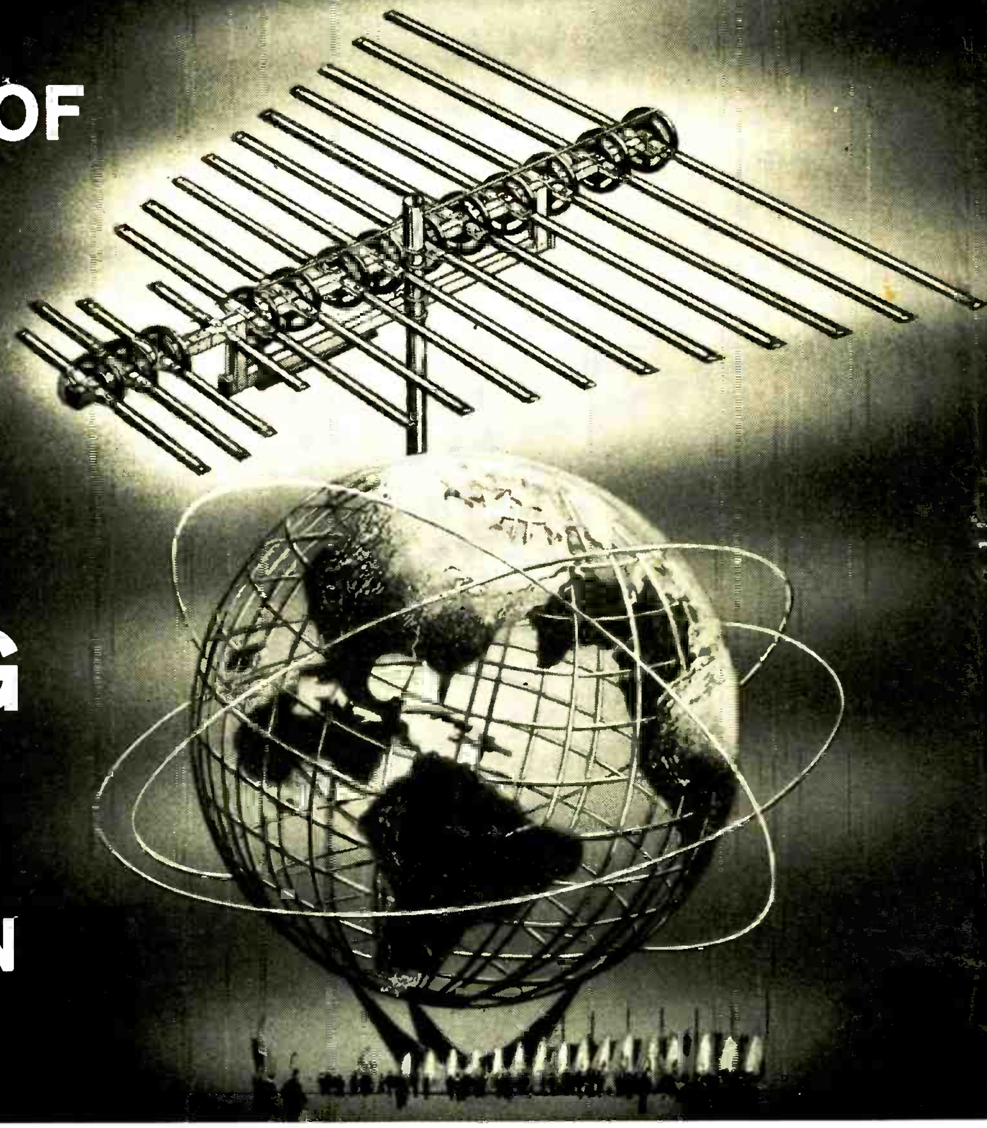

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Electronics World

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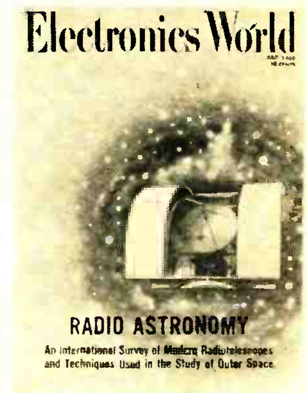
JULY 1964
VOL. 72, No. 1

MONTHLY FEATURES



THIS MONTH'S COVER illustrates the University of Texas' 16-foot radio telescope. This is probably the most accurate radio telescope made having its surface finished to an accuracy of .0025 inch, less than the thickness of a human hair. It is gold plated with a film of 14K gold, 40 millionths of an inch thick. This is only one of the many radio telescopes scattered over the world that are being used to advance man's knowledge of the physical universe that surrounds him. For more information, see the article "Radio Telescopes: Past, Present & Future." .... (Illustration: Geo. Samerjan.)

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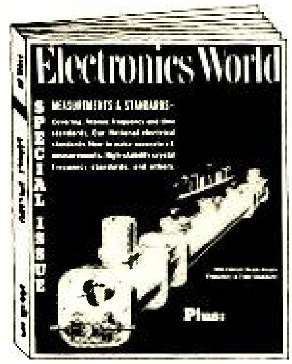

SPECIAL ISSUE:

Measurements & Standards

FREQUENCY & TIME STANDARDS
National Bureau of Standards' work on atomic frequency standards is described by G. E. Hudson, Assistant Chief of the Radio Standards Physics Div. of NBS. He discusses the U.S. Frequency Standard which can control clocks that would run 3000 years without gaining or losing over a second.

HIGH-FIDELITY MEASUREMENTS—SCIENCE OR CHAOS?
Is objective testing possible in the audio field? Do some of our present tests have reliability but no validity? Can a device that measures well still sound bad? Ed Villchur, speaker designer and president of Acoustic Research, has some interesting ideas on the subject backed up by his own years of designing experience.

DATA FLOW IN DIGITAL COMPUTERS
Ed Bukstein provides a step-by-step description of how a computer is programmed in order to perform a deliberately simplified (for this article) calculation automatically.

NEW APPROACH TO HIGH-FREQUENCY MEASUREMENTS
In a variation of the microwave slotted-line measurement technique, Robert Jones explains how v.s.w.r., R, C, L, and "Q" can be determined at TV frequencies using ordinary shop or lab equipment. Method can be used on TV tuners, FM receivers, field-strength meters, antennas, attenuators, r.f. amplifiers, signal splitters, coaxial traps and stubs, and other r.f. devices.

CRYSTAL-FREQUENCY STANDARD
Irwin Math of Manson Laboratories tells how crystal oscillators can be designed to have frequency stabilities approaching those provided by atomic standards.

PRECISE R.F. MEASUREMENTS
It isn't necessary to have elaborate lab equipment in order to measure transmitter or r.f. generator frequencies. J. Richard Johnson explains how a secondary frequency standard, checked against WWV, can be used to obtain accuracies far exceeding present FCC requirements.

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ELECTRONICS WORLD is published monthly by Ziff-Davis Publishing Company at 434 South Wabash Avenue, Chicago, Ill. 60605. (Ziff-Davis also publishes Popular Photography, Popular Electronics, HiFi/Stereo Review, Popular Boating, Car and Driver, Flying, Modern Bride, Amazing, and Fantastic.) Subscription rates: one year United States and possessions $5.00; Canada and Pan American Union countries $5.50; all other foreign countries $6.00. Second class postage paid at Chicago, Illinois and at additional mailing offices. Authorized as second class mail by the Post Office Department, Ottawa, Canada and for payment of postage in cash. July, 1964. Vol. 72, No. 1.

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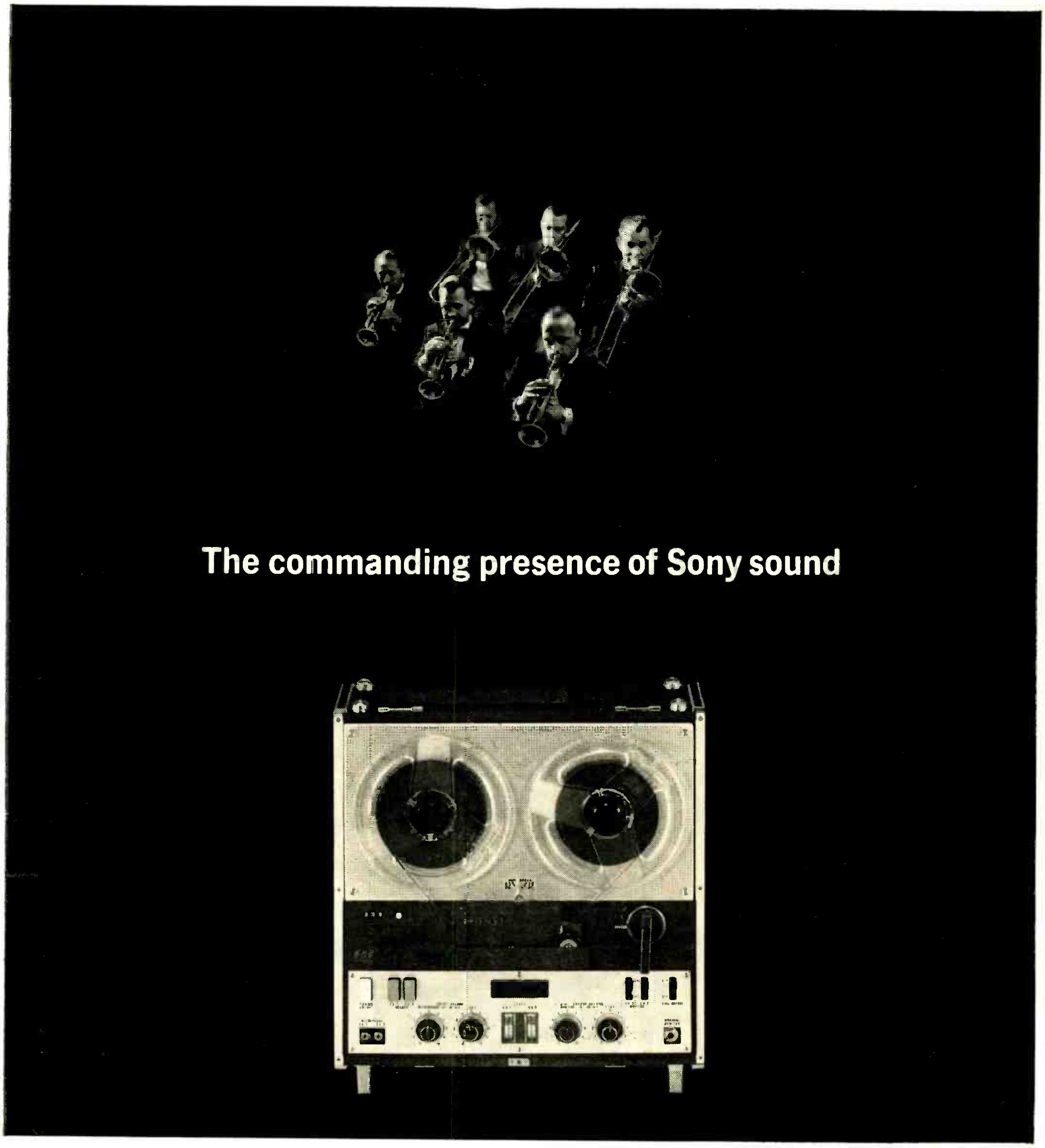

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CIRCLE NO. 135 ON READER SERVICE PAGE

For the record

WM. A. STOCKLIN, EDITOR

MEASUREMENTS AND STANDARDS

ONE of our most important tasks, as technicians and engineers, is to take measurements. Seldom does a day go by that some of us have not been measuring voltages or resistance, taking responses, checking output power, looking at waveforms, measuring frequency, determining currents or impedances, reading distortion, counting pulses, measuring resolution, checking for flutter, compliance, or any of hundreds of others. Whether the measurements are done in an advanced laboratory, at a plant, on a service bench, or in the private or home laboratory, we seem to always be interested in knowing how much and what kind. Hence, measurements are important to *all* our readers, whether they are working on a radar system for our space program, on a new computer, on a television set, or on a transistor audio amplifier.

Measurements have always been important in technology. One of the early workers in the field was British physicist Lord Kelvin, who might be called one of our earliest communications engineers for his work in submarine telegraphy. Over a hundred years ago, he calculated the absolute voltage of a Daniell cell and determined the absolute resistance of a wire from the heat produced by a known current. The first famous committee of the British Association to determine electrical standards was set up because of his urging. Present-day engineers and technicians agree with Kelvin's famous pronouncement:

"I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it."

In order to take all the measurements we must have, a wide variety of test equipment is used. Some of this test equipment is simple, fairly generalized in its applications, inexpensive, and with only enough accuracy to do its job adequately. Other test equipment is complex, highly specialized, expensive, and with extremely high accuracy. We recently talked to a military instrumentation specialist who told us about some of his field equipment that is so accurate that he does not have equipment that is accurate enough to check it against.

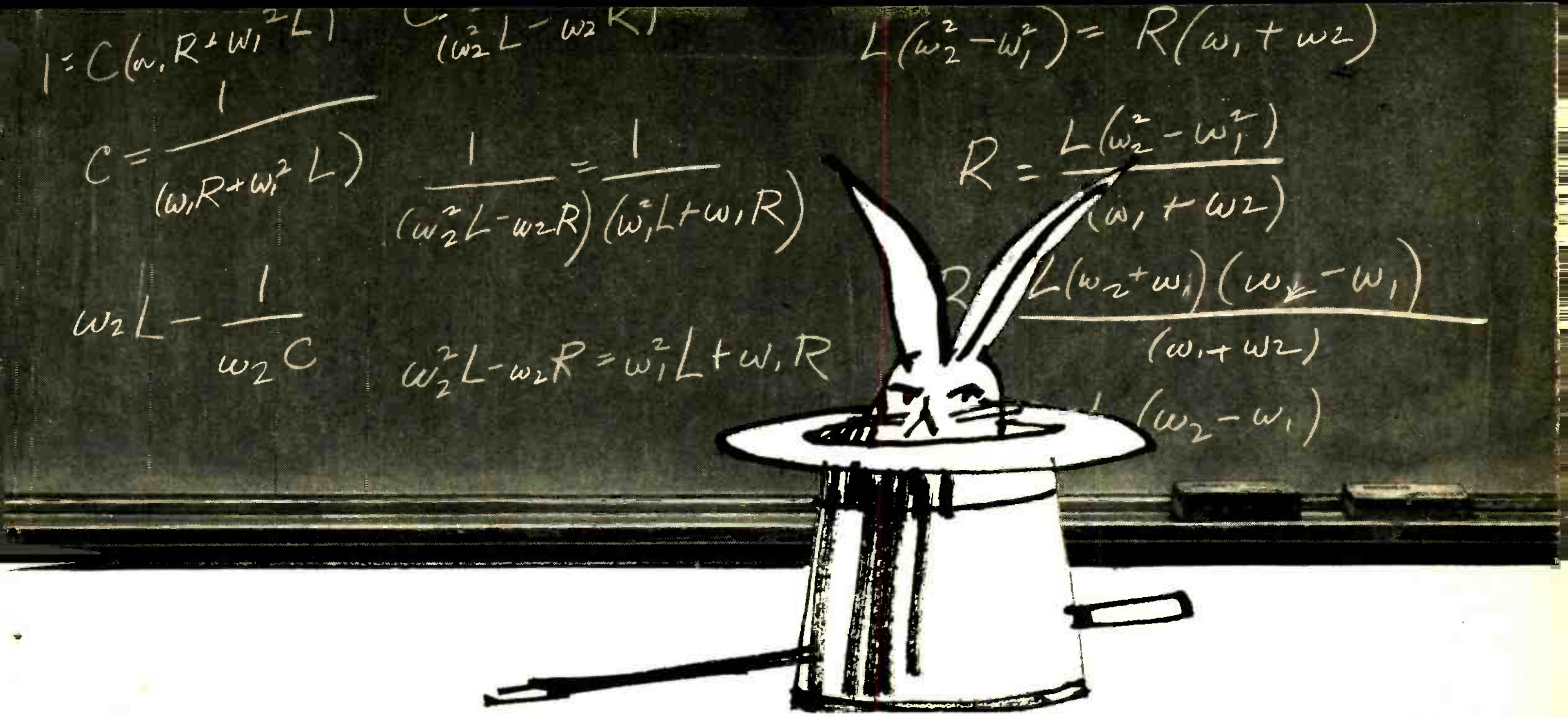
This leads us to the thought that just about all the measurements we take are actually comparisons, and these comparisons always go back to some standard of reference. When we measure voltage or resistance, for example, our meter is comparing these quantities with the standard volt or standard ohm maintained by our National Bureau of Standards. When we check the frequency of a transmitter, we are comparing it to a standard of frequency that ultimately goes back to the period of rotation of the earth. Even this rotation is not an accurate enough standard however, since the earth has slowed down by almost 3 seconds since 1957. Flights into space and highly accurate long-distance radio wave measurements require even greater accuracy. Therefore, the Bureau of Standards has gone to even more accurate time and frequency generators involving the natural vibrating period of certain elements, such as cesium.

An electronic device based on this idea is now being used to check the earth's rotation and to operate as our primary standard of frequency. This cesium-beam "atomic clock" is so accurate that a clock, controlled by this instrument, might lose or gain no more than one second after running continuously for 3000 years. Or, put another way, its accuracy is equivalent to measuring the width of the United States with less error than the thickness of the paper on which this editorial is written. This "clock" is not the ultimate, however. Scientists are currently working on devices that may prove to have even higher accuracies.

Because of the importance of test equipment, measurements, and standards to all our readers, we have planned a special issue next month dealing with these subjects. We will have articles, written for us by eminent authorities from the National Bureau of Standards, on the basic electrical standards and on frequency and time standards; what they are, their accuracy, stability, and what is being planned for the future. Also, articles on making precise r.f. measurements and some unusual measuring techniques will be included. Just to show that "atomic clocks" are not the only way to obtain high accuracies, we will cover some unusual crystal oscillators for which extremely high accuracies are possible.

Finally, to make sure that we do not get overwhelmed by our measurements, we will feature a provocative article on high-fidelity measurements. The author will take to task those engineers and technicians who make highly accurate measurements but in such a way that there is little or no significance to what they have measured. The important distinction between the *reliability* of a test *versus* its *validity* will be covered.

All in all, we are finding next month's issue interesting to work on and we believe you will find it interesting and useful too. ▲



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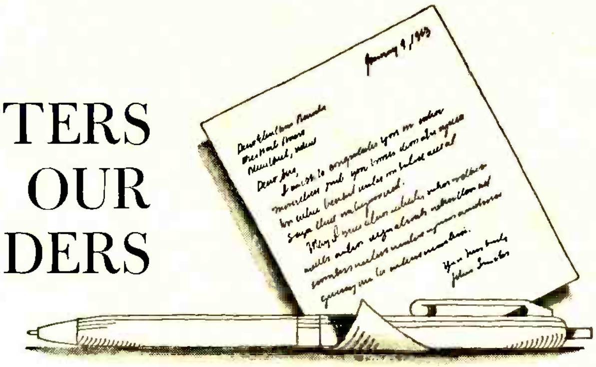
LETTERS FROM OUR READERS



TRANSISTORS FOR MUSIC

To the Editors:

Three cheers for Messrs. Furst and Zide ("Transistors for Music," March 1964 ELECTRONICS WORLD). At last the acoustic air is being cleared in terms that are easy to understand.

It would be a shame if our ears were nothing more than stretched diaphragms incapable of detecting the total information contained in complex music; however, nothing could be further from the truth. It is possible to completely miss important facts such as these by improper measurement techniques and misinterpretation of the test data taken, as evident in past articles.

Most hi-fi addicts that I know agree on the cleanness of transistor sound, the something that makes it sound just plain "different." What is it? Furst and Zide seem to know. Could it be among other things a lack of phase shift at frequencies well above 10-20 kc.?

DONALD J. BROWN
Alexandria, Va.

° ° °

SOLID-STATE COLOR ORGAN

To the Editors:

Some readers have written and informed me of some difficulties they were having in getting their "Simplified Solid-State Color Organ" (January '64 issue) to perform properly. Most of the troubles seem to stem from parts substitutions and a not-too-clear understanding of just how the circuit operates.

In answer to inquiries, the circuit is correct as it appeared in the article. All parts values are correct. Several readers have successfully completed working models, and are quite pleased with the results.

The load SCR's are pulsed on when the control neon bulb discharges timing capacitors *C5*, *C6*, or *C7*. This is a 10-volt pulse only a few microseconds long. It is this pulse that turns on the SCR once each half-cycle. If too much current is fed to the timing capacitors, the neon bulb will lock on and operate continuously, thus providing no gate pulses for the SCR and no load power.

A change in neon bulb, SCR, capacitor, output transformer, or *R4*, *R5*, or *R6* could conceivably prevent the neon circuit from oscillating properly. If diodes *D9*, *D10*, or *D11* were slightly leaky, this could also cause the neon bulbs to remain on constantly and not oscillate.

I would suggest the following modifications to anyone unable to get the circuit to function properly: (a) raise *R4*, *R5*, and *R6* to 220,000 ohms; (b) omit *R1*, *R2*, and *R3*. This should allow the circuit to operate properly with reasonable parts substitutions. In addition, *C5*, *C6*, and *C7* could be raised to .033 μf.

If an oscilloscope can be used, the circuit is functioning properly when there is a 10-volt saw-tooth waveform across *C5*, *C6*, and *C7*.

If a reader is still having difficulty at this point, it is best to replace the neon lamps with 30-volt *p-n-p-n* trigger diodes (*Texas Instruments* TI-43, *Transitron* ER-900, *G-E* "Diac," etc.). *R9*, *R11*, and *R13* may then be changed to 10,000 ohms. This will add about $7 to the unit cost, but perhaps could save a bit of time.

DONALD E. LANCASTER
Phoenix, Ariz.

° ° °

MAGNETIC-CORE COMPUTER MEMORIES

To the Editors:

This is in reference to Richard B. Rusch's article on "Magnetic Core Memories" in the April, 1964 issue of ELECTRONICS WORLD. He wrote: "As computers come into greater use, and more use is made of them, memory systems will have to be greatly enlarged. In the not-too-distant future, computers with multi-million word random-access memories will be called upon to perform the necessary storage . . ."

Not-too-distant future? The *Univac* 1107 thin-film computer was delivered to the field over 18 months ago with random-access memory. This computer uses magnetic drums for memory with read-write heads riding on a cushion of air. Each drum's storage is 786,432 (36-bit) words. The average access time is 17.5 milliseconds, and once it is accessed the transfer rate is a word every 16 microseconds. Up to 8 of these drums can be put on one input/output channel. The 1107 computer has up to 16 of these channels, or 100,663,296 words of drum storage.

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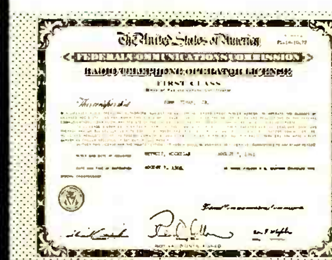

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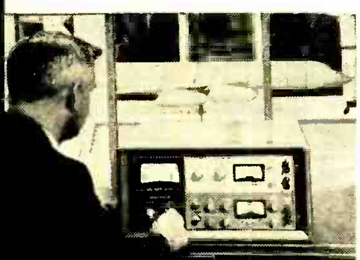

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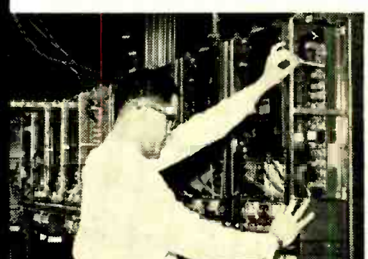

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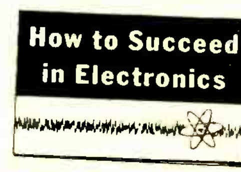

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ALVIN D. BEHRENS
Univac Senior Systems Engineer
Los Angeles, Calif.

* * *

"ELEKTRONIKA WERELD"

To the Editors:

You might be interested in seeing the Dutch version of ELECTRONICS WORLD

which I picked up in Amsterdam. The cover features some microelectronic circuitry and refers to articles on transistor ignition systems and the construction of an FM generator.

JOHN CARLIN
Amsterdam, Netherlands

Thanks for sending along a copy of the magazine. Although it has the same title as ours, there is no connection between the two publications.—Editors.

* * *

MIRROR FOR TURNTABLE

To the Editors:

Those of us who prefer a turntable to a record changer are plagued with the necessity of having to change records at the appropriate times. Frequently I have rushed over to do this, only to find that a considerable amount of the disc remained to be played.

This problem no longer exists, for I have mounted an inexpensive mirror above the center of the turntable at about a 45° angle. From my easy chair across the room, a quick glance tells me where the arm is on the record.

C. L. HATHAWAY
Coronado, Calif.

* * *

POWER FORMULAS

To the Editors:

Here I was admiringly looking over some back issues of what I thought was probably the finest electronics periodical on the newsstand—when it happened. Yes, right there on page 54 of the October, 1963 issue—in the caption of Fig. 2 where it says, "Power is computed from $P = I^2/R^2$"! Egad!

J. ZINTER
Logistics Field Engineering
Autonetics
Downey, Calif.

Sorry. $P = I^2R$, $P = I^2R$, $P = I^2R$, . . . —*Editors.*

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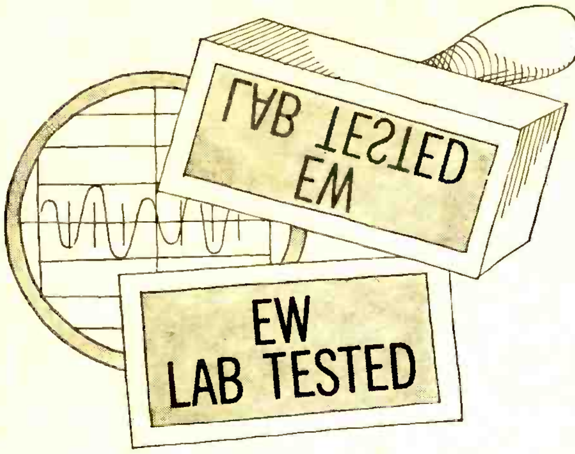


HI-FI PRODUCT REPORT

TESTED BY HIRSCH-HOUCK LABS

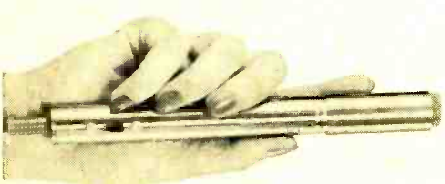
Shure Model 578 Microphone
"Knight" KN-990 Record Changer

Shure Model 578 Microphone

For copy of manufacturer's brochure, circle No. 38 on coupon (page 12).

THE *Shure* Model 578 "Omnidyne" is a slender, omni-directional dynamic microphone designed for high-quality public-address or recording applications. It is about 7⅜ inches long and ¾ inch in diameter, finished in satin chrome with a stainless steel grille. An "on-off" switch is built in and a locking plate is provided to clamp the switch in either position.

The microphone is finished with an integral 18-foot, three-conductor shielded cable. An impedance transformer, built into the microphone case, provides a low-impedance output for 50- to 250-ohm loads, and a high-impedance output for loads of 100,000 ohms or higher. Impedance is selected at the free end of the cable by picking the proper pair of output wires. A swivel stand, supplied with the microphone, mounts on any stand



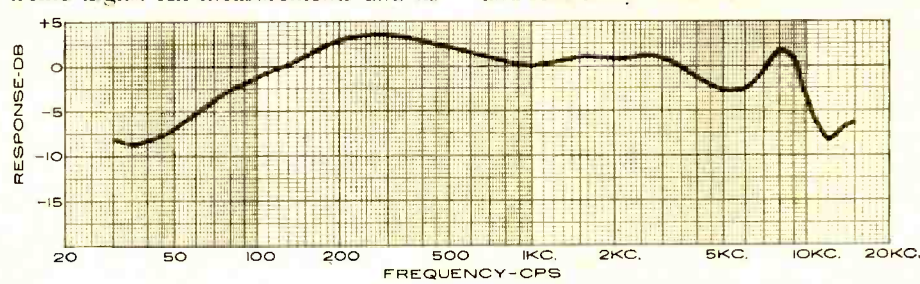
with ⅝"-27 threads and allows the Model 578 to be tilted through a 90-degree arc. Its slim shape makes it especially convenient for hand-held operation.

We measured the frequency response of the Model 578 by comparing it to our calibrated laboratory microphone, with each one mounted in the same position relative to a speaker some 18 inches away. The reference microphone is flat within ±1 db from 20 to 15,000 cps, so that no correction was made for its response.

The frequency response of the mike was within ±3.5 db from 70 to 10,000 cps. The mid-range was smooth and the low-frequency response began a gradual descent below 150 cps. Over the rated 50- to 15,000-cps range of the microphone, the variation was under ±5 db.

Performance of the unit was also checked by tape recording voice and musical selections with it and listening critically to the playback. Its quality was very natural, balanced, and pleasing on voice. Music also reproduced well, although with a perceptible loss of extreme highs. All measurements and listening tests were made with the high-impedance connection, which may have had some effect on the treble response.

The *Shure* Model 578 microphone sells for $49.50. It is also available in matched pairs for stereo recording, with frequency response matched to ±1.5 db and sensitivity matched to ±1 db. ▲



"Knight" KN-990 Record Changer

For copy of manufacturer's brochure, circle No. 39 on coupon (page 12).

THE "Knight" KN-990 record changer has several interesting features not often found in low-priced units. Basically, it is a four-speed intermix changer which can handle a stack of up to twelve 10" or 12" records (of the same speed), or up to fourteen 7" records. Its 11" weighted aluminum turntable is driven by a four-pole motor.

The changer has two operating controls—a speed selector (with a neutral position which disengages the idler wheel), and a knob which turns on the changer, rejects a record, or shuts it off.

Most record changers which offer "manual" operation do this only partially since their trip mechanisms remain operative and shut off the changer after playing a record manually. This often prevents the user from manually placing the pickup near the end of a record without actuating the trip mechanism. The KN-990 offers true manual operation in which the trip and change mechanisms are completely disabled. This is accomplished by moving the overhead leveling arm to one side and holding the arm against the center post while the change

cycle is underway. The trip and change mechanism remain disabled until a new change cycle is manually initiated. The player can be shut off and turned on at will without leaving the manual mode if the control knob is not moved to its "Reject" position.

The arm of the changer is a balanced, tubular design with a plug-in cartridge shell. It has a sliding tracking-force indicator and adjustment which controls the tension in a spring that sets the tracking force. The arm tube is calibrated in one-gram intervals from 0 to 5 grams. Although the balanced arm is not particularly critical as to leveling, the three mounting springs can be adjusted to level the changer. This is made especially convenient by a built-in spirit level on the motorboard.

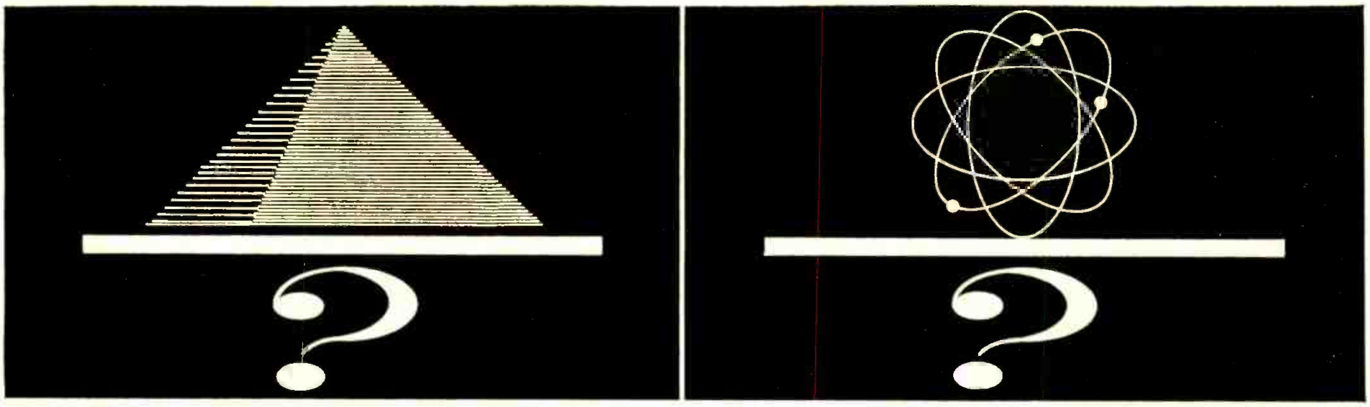
Measuring the rumble of the turntable in accordance with NAB standards, we found it to be −30.5 db in the lateral plane and −19.5 db in the vertical plane. These figures, while not as low as we have measured on some more expensive record players, are comparable to others in its price class. Rumble is not particularly audible unless speakers with substantial output in the 30-cps region are used.

The wow and flutter were very low, 0.07% and 0.035% respectively at 33⅓ and 45 rpm, and 0.05% and 0.025% at 78 rpm. At 16⅔ rpm the wow and flutter were each 0.1%, which is quite satisfactory for music and completely negligible for the talking books and speech recordings which make up the bulk of 16⅔ rpm recordings. The four speeds were very slightly fast when playing one record with a 4-gram tracking force. The stylus force calibration was accurate to within ±0.5 gram. Tracking force increased by about 1 gram from beginning to end of a ¾" stack of records. The change cycle required 8.5 seconds.

The arm appeared to be slightly too short for optimum tracking-angle error. The error was as great as 2 degrees/inch of record radius at the inner grooves of a record. This is not a serious fault from a listening standpoint, but could be easily cured with a slight change of cartridge shell dimensions.

We found the operation of the changer to be smooth, quiet, and reliable. The manual operation was especially convenient for some of our test records where we have to select bands near the inside of the record. The finger lift on the cartridge shell was much too short and almost impossible to use in the intended manner.

The KN-990, which is manufactured in the U.S., is currently listed in *Allied Radio* catalogues for $49.95 and can be had with any of several makes of cartridges already installed in its head for only one cent additional. Our test unit was fitted with a *Shure* M3D. A walnut mounting base is available for $4.00. ▲



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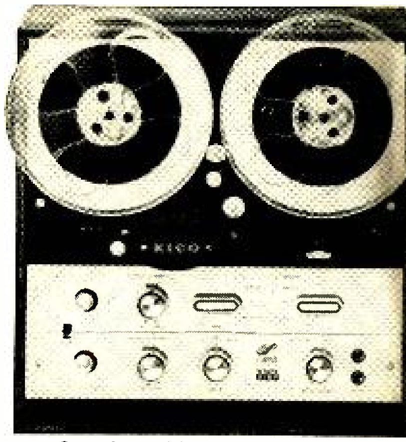

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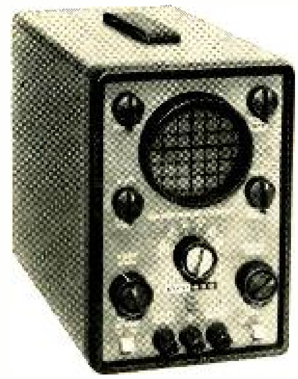

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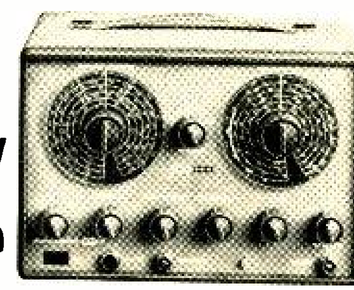

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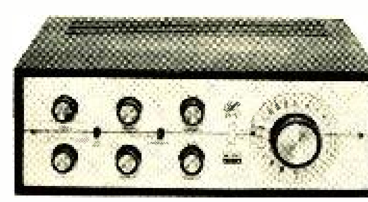

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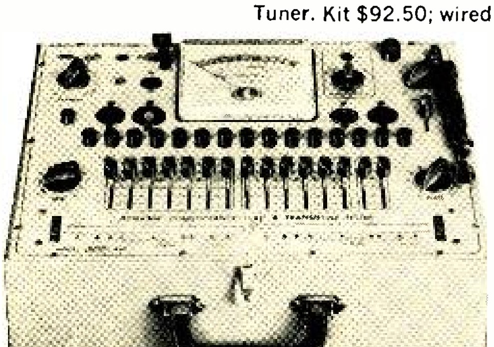

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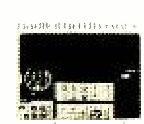


RADIO TELESCOPES: PAST, PRESENT & FUTURE

By ALBERT GIDDIS & LOUIS MAGGI / Philco Corporation

An international roundup of radio telescopes showing how they work, some of the new looks in antennas, and a look into the possible future of these new devices.

RADIO telescopes are opening new windows in the sky by letting astronomers "see" vast regions of the heavens hitherto denied to them by optically opaque clouds of interstellar dust and gas. Radio signals emanating from celestial objects that are invisible to optical telescopes constantly penetrate this curtain, and supersensitive radio telescopes now enable radio astronomers to detect these signals and to use them to further advance man's knowledge of his universe.

The first signals from outer space were detected—by accident—in 1931 when Karl Guthe

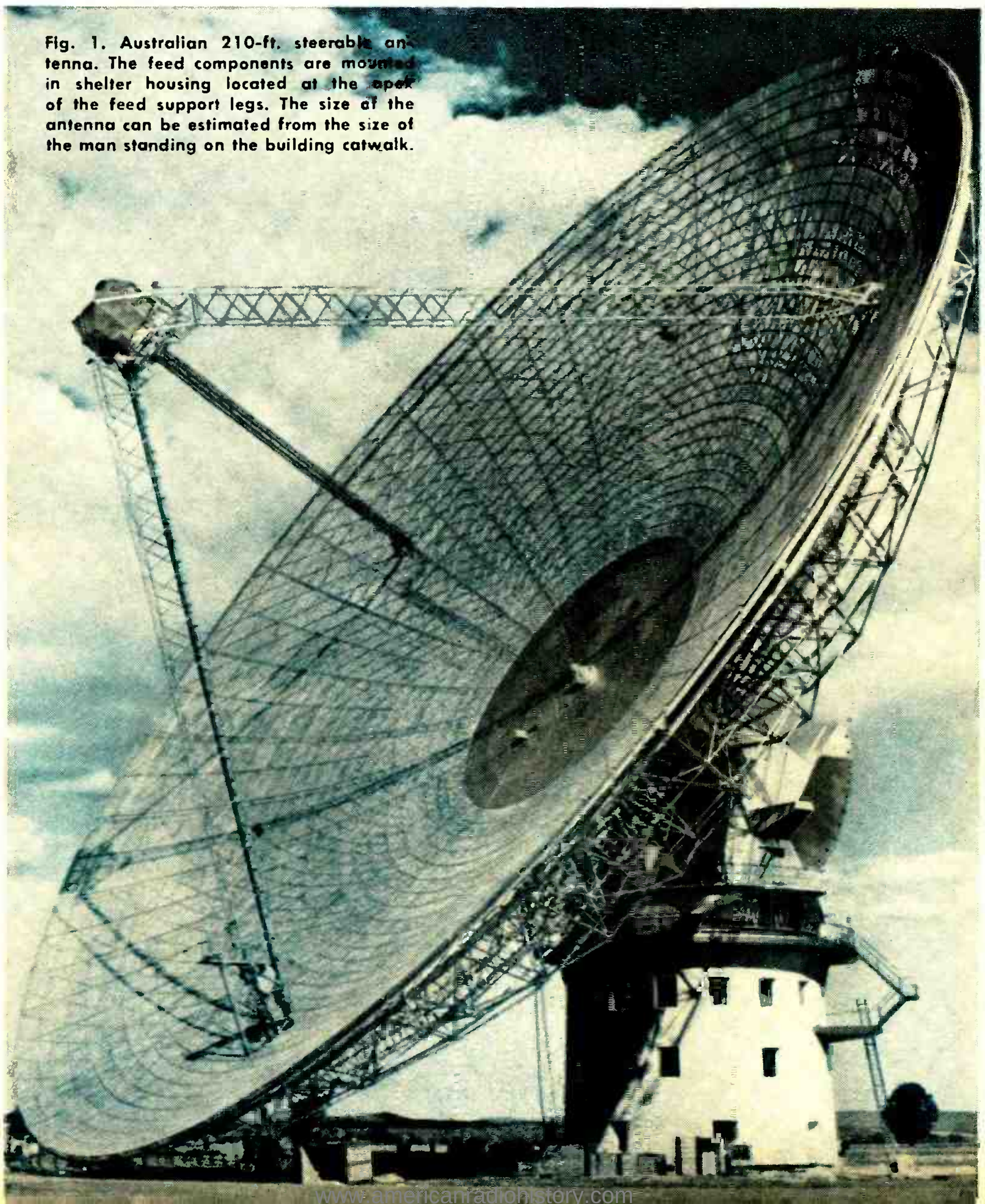


Fig. 1. Australian 210-ft. steerable antenna. The feed components are mounted in shelter housing located at the apex of the feed support legs. The size of the antenna can be estimated from the size of the man standing on the building catwalk.

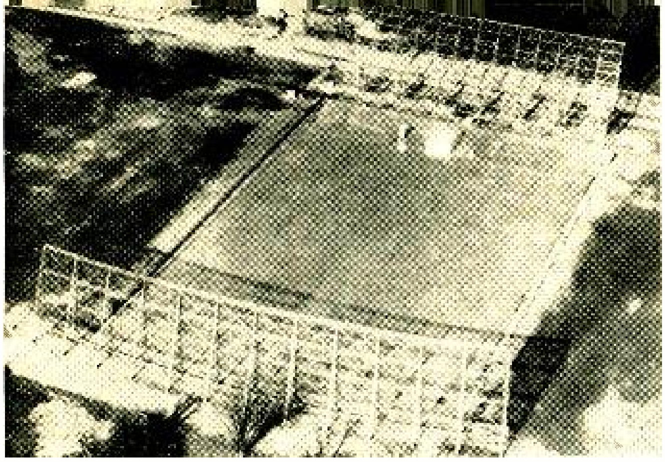


Fig. 2. Ohio State University parabola. The flat, tiltable portion is at the top. The small structure located on the ground plane is the housing for the feed line for this unique system.

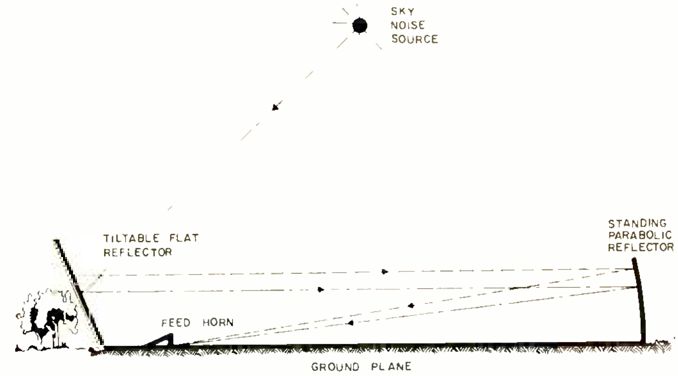


Fig. 3. Operation of the Ohio State University parabola. The flat reflector is tilted to scan the skies for radio signals. The parabolic section focuses the signal to the feed horn.

Jansky, then a 23-year-old research engineer with *Bell Laboratories*, was investigating the causes of static at 20 mc. in transatlantic radio communications. During his long periods of listening he heard some strange hissing noises coming from his receiver. After carefully checking his log book he noted that the times these noises occurred coincided with the passage of certain stars in the sky. Further investigation proved, indeed, that these strange signals were being generated by the constellation Saggitarius in the heart of the Milky Way. After the initial excitement of his discovery had died down, however, Jansky was given other work to do, and the scientific world soon lost interest in this remarkable phenomenon. During the next few years only one man, a United States scientist named Grote Reber, carried Jansky's work forward. Reber (who became interested in these celestial radio waves through his avid preoccupation with DX as a ham) designed and constructed his own radio telescope, a crude wooden and tin parabolic reflector 30 feet in diameter and operating at a frequency of 160 mc. With this apparatus he not only confirmed Jansky's initial findings, but he also discovered a new source of radio signals coming from the constellation Cygnus.

In 1942, at the height of the German bombardment of England during World War II, a number of British radars tracking the invading aircraft experienced severe interference when the antennas were pointed toward the sun. Mr. J. S. Hey, then a physicist with the Royal Radar Establishment, investigated this unusual phenomenon. In secret reports made public after the war, he announced that this interference was, without question, caused by electromagnetic radiation from the sun in association with sunspot activity.

Except for these isolated instances of sky probing, it was not until a decade after Jansky's discovery that the scientific world began to take active interest in radio emission from outer space. Although the original discovery of celestial radiation was made and subsequently confirmed by two American scientists, further advances in radio astronomy were carried out principally in England and Australia. After it became apparent that this new science could unlock secrets of the universe forever closed to optical astronomers, other countries, including the United States, began actively experimenting in radio astronomy.

Today, more than 350 radio telescopes are either in operation, in construction, or on drawing boards throughout the world. Let's take a look at a few of those currently in use and at some planned for the not-too-distant future.

Single-Aperture Types

The most popular radio telescopes in use today are the "single-aperture" devices, such as parabolic reflectors (or "dishes"), that collect the fantastically weak signals from outer space and focus them onto feed systems connected to sensitive receivers. The term "aperture" in radio astronomy refers to the signal-collecting area of a radio telescope. It is synonymous with the same term used in optics to denote a light- or image-collecting device. The outputs of these receivers are usually connected to recording apparatus that provide continuous, permanent records of the celestial signals received.

Naval Research Laboratory Radio Telescope: One of the first modern radio telescopes to be placed in operation in the United States was the Naval Research Laboratory's 50-foot parabolic antenna located on the roof of the Laboratory at Washington, D.C. In continuous operation since the early 1950's, the NRL radio telescope has been (and is now being) used as an astronomical workhorse for observing the Sun, Moon, Jupiter, Venus, and Mars as well as a number of radio stars. Because of its 0.032-inch surface accuracy, the solid-aluminum dish is useful for detecting extraterrestrial radio signals in frequencies up to 15 gc. (15,000 mc.). Recent introduction of a maser receiver has greatly improved the sensitivity of this antenna.

Australia's 210-Foot Dish: One of the most recent single-aperture radio telescopes placed in operation is the Commonwealth Scientific and Industrial Research Organization's (CSIRO) 210-foot steerable dish located near Sydney, Australia. See Fig. 1. This huge structure, mounted on an azimuth-elevation (az-el) pedestal is designed to detect the 21-cm. radiation emitted by hydrogen atoms in the galaxies. Detecting this hydrogen radiation will give astronomers and scientists a detailed picture of the structure of our own Milky Way, enabling them to further probe the mysteries of our neighboring galaxies and to answer the question, "What fills the space between the stars?"

Although smaller than the well-known 250-foot radio telescope located at Jodrell Bank, England, the ability of the Australian antenna to detect the hydrogen-line radiation, plus the closer mesh of its reflector surface, allows it to outperform its big brother in England and makes it one of the most effective instruments in use today. The beamwidth of the CSIRO antenna is an extremely narrow 0.25 degree; thus, giving it a good resolution capability. In spite of its huge size, this radio telescope can be pointed to an accuracy of 0.02 degree by means of a unique drive system.

University of Texas' 16-Foot Midget: In addition to the highly publicized giant radio telescopes, numerous smaller instruments are in use today, scanning the skies and adding to man's storehouse of knowledge. One such antenna is the 16-foot parabola (cover) recently placed in operation at the University of Texas in Austin, Texas. This antenna is worthy of mention since it is by far the most accurate radio telescope ever constructed. The surface of the reflector is finished to an accuracy of 0.0025 inch (less than the thickness of a human hair) and is gold-plated with a film of 14K gold, 40-millionths of an inch thick. The final polishing operation was performed by hand in much the same way that mirrors of optical telescopes are polished. The beamwidth of this remarkable antenna is only 0.03 degree. The chief role of this telescope is to measure the levels of planetary and lunar emission at wave-

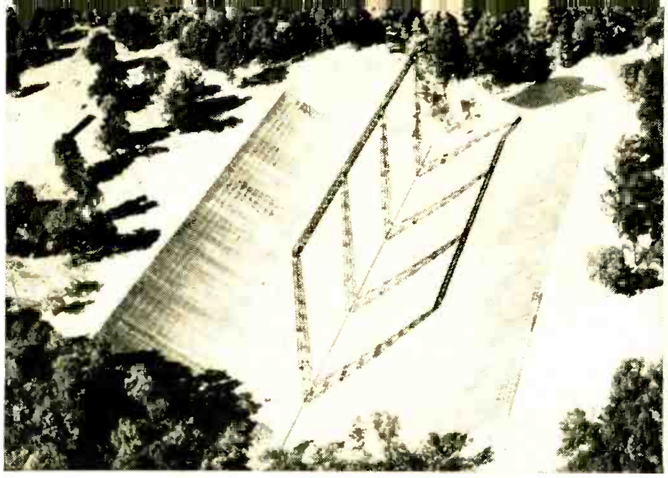


Fig. 4. The University of Illinois parabolic cylinder antenna. This particular radio telescope uses electronic beam scanning.

lengths between 1 cm. and 2 cm. (corresponding to frequencies between 30 and 15 gc.). In addition to its extreme surface accuracy, the University of Texas radio telescope has an exceptionally high pointing accuracy. The drive system used on each axis consists of a dual-electric drive in which one motor is biased against the other to eliminate backlash. Both the reflector accuracy and pointing accuracy must be maintained regardless of the temperature; consequently, the reflector backup structure is made of "Invar," a steel alloy having a low coefficient of expansion.

Nonsteerable Types

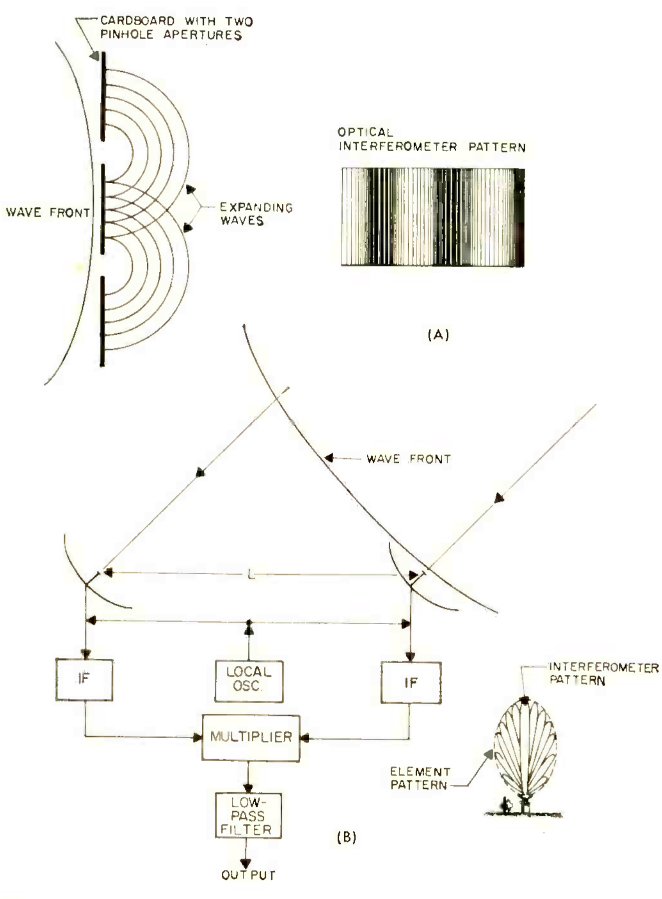
Generally speaking, the larger the dish (and the resultant aperture) the more sensitive is the antenna and the better is its resolution, *i.e.*, its ability to distinguish between closely spaced signal sources. However, at the frequencies normally used in radio astronomy, there is a practical limitation to reflector size beyond which structural deformations, manufacturing inaccuracies, and excessive cost rule out any advantages to be gained in operating performance. To overcome these limitations, engineers and radio astronomers have devised several ingenious techniques to increase the aperture area of their radio telescopes.

Ohio State University Tiltable Reflector Antenna: One method, employed at Ohio State University, uses a 260- by 100-foot tiltable, flat reflector to reflect energy from the sky onto a fixed parabolic section (see Fig. 2). The radio waves reflected from this movable reflector are focused onto a 360- by 70-foot fixed parabolic (curved) section located at the other end of a 3-acre ground plane consisting of a 0.005-inch thick aluminum sheet cemented to a concrete slab. A feed horn located on the ground plane near the base of the flat reflector receives the radio signals from the parabolic section. The output of the feed horn is coupled to a highly sensitive receiver whose output is displayed on various graphic recorders. The principle of operation is shown in Fig. 3.

The beam of this antenna is elliptical in shape and covers an area three degrees in elevation, by one degree in azimuth. Operating at a frequency of 250 mc., the Ohio State radio telescope is used primarily to survey the Milky Way.

University of Illinois Cylindrical Reflector: Another large, low-cost radio telescope having good surface accuracy (hence, good resolution) and very low side lobes is the 600-foot parabolic cylinder designed and developed at the University of Illinois (see Fig. 4). The huge cylindrical section, 600 feet long by 400 feet wide, is supported by the earth. The feed for this radio telescope consists of an array of 276 non-uniformly spaced conical spirals lying along the focal line and supported by a tower structure 450 feet long and 153 feet high. The antenna is electronically steered by adjusting the relative phase of the conical spiral elements. The sky coverage of this telescope is from +10 to +70 degrees above the equatorial plane, its operating frequency is 611 mc., and its beamwidth is a narrow one-third degree. This antenna,

Fig. 5. (A) Interference pattern through pinholes. (B) How interference pattern is produced using two reflector dishes.



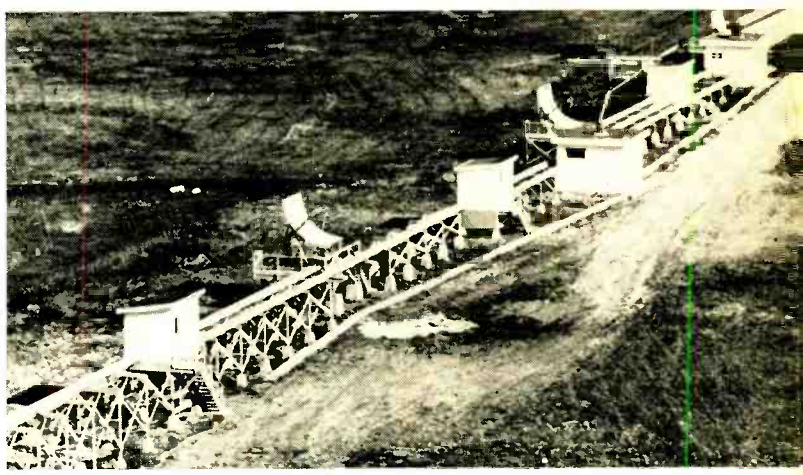


Fig. 6. National Research Council (Canada) 600-ft. compound interferometer. Waveguide transmission line is supported on concrete and wood pillars. Shelters house waveguide junctions.

Fig. 7. Stanford University's 375-ft. pencil-beam cross interferometer consists of 32 interconnected 10-ft. reflector dishes.

bigger than four football fields, will be used in one of the most ambitious radio telescope projects to date—the mapping of radio emissions in the entire universe.

Arecibo Radio/Radar Telescope: One of the world's largest non-movable, reflector-type telescopes is the recently dedicated 1000-foot spherical reflector antenna located at Arecibo, Puerto Rico, the site of the Arecibo Ionospheric Observatory. Nestled in a huge crater 450 feet deep, this massive antenna is being used in conjunction with a powerful radar system to probe the earth's outer ionosphere (exosphere) in order to define the electron density distribution of that region and to bounce radar signals off the planets to improve our knowledge of their surfaces and atmospheres. This antenna is so sensitive—16 times more so than the Jodrell Bank radio telescope—that it can detect signals from stars 12 billion light-years away.

The three huge pylons which support the feed assembly are each 400 feet tall. The feed itself weighs five tons and consists of a cantilevered 96-foot length of slotted aluminum waveguide. The tip of the feed facing the spherical bowl must be positioned to within one inch of the center of the bowl at all times to assure a beam-pointing accuracy of 0.03 degree. Scanning is accomplished by moving the feed system: the scan area encompassed is ±20 degrees from the axis of the reflector.

Unlike a movable radio telescope, the Arecibo telescope is fixed; consequently, it cannot be steered. This means that by the time a radar signal can be reflected from Saturn (round-trip time 184 minutes), the earth's rotation would take Arecibo out of the range of the returning signal. To resolve this problem, a companion movable telescope half way around the world will be used to detect the radar echo and transmit the information back to Arecibo.

The radar transmitter used in this installation has an output of 2.5 megawatts peak and, when fed into a reflector of almost 785,000 square feet having a gain of 60 db, the effective radiated power is a staggering 2,500,000,000,000 watts.

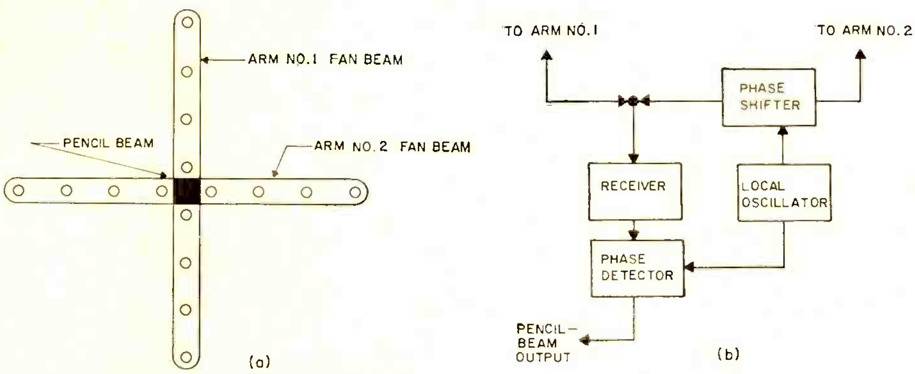


Fig. 8. (A) The arms of a cross-type interferometer are combined to produce a narrow pencil beam. (B) The block diagram of the antenna and receiver sections shows system operation.

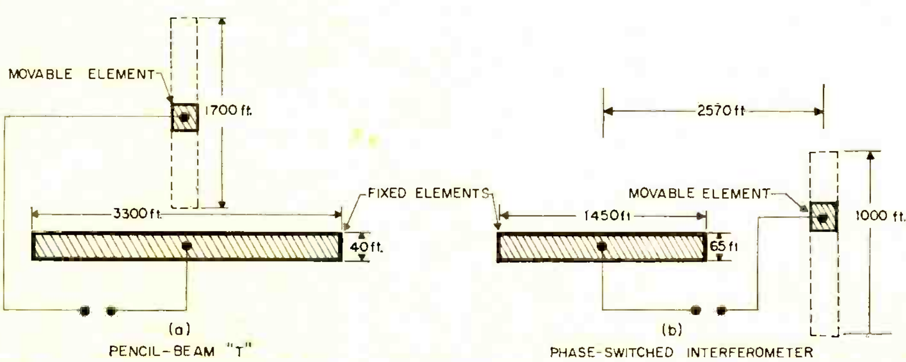


Fig. 9. (A) T-configuration (modified cross). (B) The phase-switched configuration. Both used by University of Cambridge.

Multiple-Aperture Types

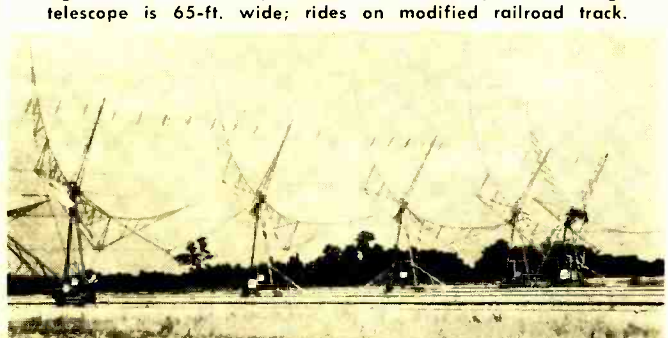
If greater resolution than that provided by single-aperture antennas is needed, much larger apertures are required. However, as previously stated, there is a certain practical size of such antennas past which construction becomes economically and mechanically unfeasible. To increase the aperture size of radio telescopes, several smaller apertures (*e.g.*, parabolic reflectors) can be coupled to yield the equivalent of a very large reflector. For example, an array of steerable reflectors can be interconnected to make a radio telescope having somewhat less beam-scanning capability but the same sensitivity and resolution as a single large reflector.

An array of earth-supported reflectors can also provide the same sensitivity and better resolution than a single antenna, but with less scanning ability. In both cases, the operating bandwidth will depend upon the angle of scan from the zenith and the particular arrangement of the reflectors. However, there are certain limitations in multiple-aperture arrays that proscribe their capabilities. First of all, the complexity of the feed system introduces problems in controlling the amplitude and phase of the received signal. Second, the sensitivity of a radio telescope depends upon its actual collecting area, and the relative lack of reflective surface limits the sensitivity of this type of antenna.

Interferometers: To further increase the resolving power of available apertures beyond that of single-aperture antennas, radio astronomers have adapted the Michelson stellar interferometer to radio waves. Fig. 5A shows the analogy between an optical interferometer and a radio telescope using the interferometer principle. When light waves from the same source pass through two apertures (in this case a piece of cardboard having two pinholes as apertures), two sets of expanding waves are produced that cross each other. When the crossing waves are in phase they add and bright bands or "fringes," occur; when the waves are out of phase, they cancel and dark bands occur. Michelson produced such fringes with two widely spaced light beams whose distance apart could be varied. By varying the distance between these light sources, he was able to vary the width of the fringes as well as their separation.

In a radio telescope, if an electromagnetic wave comes toward the interferometer at some angle with respect to the base line L, (Fig. 5B), the radiation

Fig. 10. The movable portion of the University of Cambridge telescope is 65-ft. wide; rides on modified railroad track.



reaching the antenna element at the left of the figure travels an extra distance. A phase difference then exists between the two elements. So, as the direction from which the radiation comes changes (*e.g.*, due to the rotation of the earth), the radiation at each antenna will be alternately in and out of phase. The result is a multi-lobed antenna pattern similar to the fringe pattern of the optical interferometer. The tapering of the pattern follows the response pattern of the reflectors. Since the separation between the two elements can be made large, and since the lobe widths depend reciprocally upon the distance between the elements, very narrow lobes (and, hence, high resolution) can be achieved.

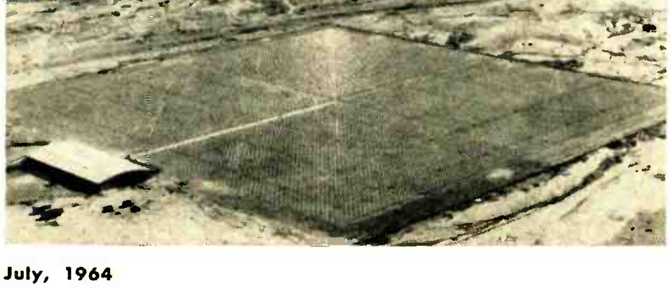
The outputs of the two antenna elements are mixed, multiplied, and passed through a low-pass filter. The resultant output is the mean difference between the outputs from each element. Since background noise is eliminated in this type of antenna, extremely sensitive recording devices can be used.

A two-element interferometer at the Owens Valley Observatory in California (operated by the California Institute of Technology), consists of two 90-foot steel-mesh paraboloids that can be separated up to 1600 feet in either the north-south or east-west direction by riding on railroad tracks. This antenna, operating at 960 mc. is used to chart the distribution of radio noise in our galaxy. Its beamwidth is as fine as 0.03 degree, and its pointing accuracy is within plus or minus 0.002 degree.

Another multiple aperture radio telescope is the Canadian 600-foot compound interferometer operated by the National Research Council in Ottawa. A 150-foot long waveguide horn is used as one section of an interferometer and a four-element grating antenna is used as the other section of the interferometer. See Fig. 6. This interferometer operates between 2800 and 3000 mc. as a meridian telescope to examine the surface brightness of the sun. The beam pattern of this radio telescope is a narrow fan beam 0.02 degree wide in the east-west direction and 2 degrees wide in north-south.

Cross-Type Radio Telescopes: To measure complex noise distributions, such as those emanating from the sun, the ideal beam to use is a sharp pencil beam that can locate special regions of radio emission and can resolve details within the over-all signal source. The leading development in this area is the pencil-beam interferometer developed by W. N. Christiansen at Sydney, Australia, in 1953. A typical descendant of Christiansen's radio telescope is Stanford University's "cross" located at Palo Alto, California (Fig. 7). Each arm of the cross consists of sixteen 10-foot paraboloids arranged along a 375-foot line. The cross radio telescope operates in the 2700- to 3350-mc. region producing multiple beams ("fringes") 0.05 degree in width. This antenna scans the sun line-by-line much the way a television camera scans. As shown in Fig. 8A, each arm produces a very narrow fan beam. By mixing the outputs from each arm alternately in equal and opposite phase and phase-detecting the modulated signal, a pencil-beam pattern is produced, as shown in Fig. 8B. The main-beam pattern of the interferometer cross consists of the pencil beam shown at the intersection point in Fig. 8A.

Fig. 11. This dipole array radio telescope at Jicamara, Peru, contains over 9000 dipoles backed by chicken-wire ground plane.



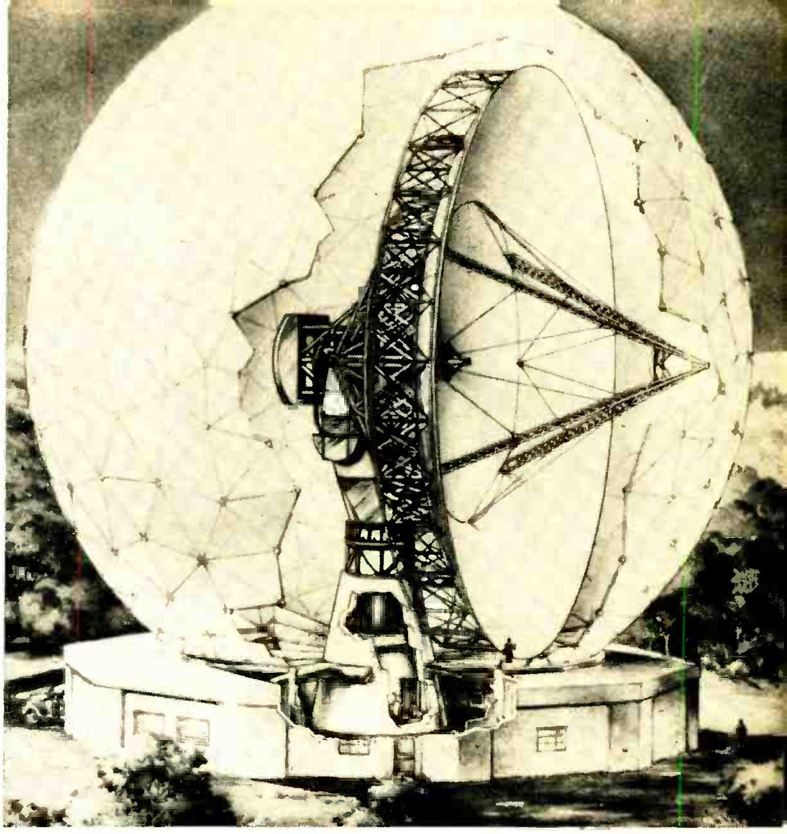


Fig. 12. Artist's conception of 120-ft. Haystack Hill radio telescope soon to be operating for MIT's Lincoln Laboratory.

Russia also has a cross-type radio telescope, nearing completion at the Oka Radio Astronomical Station outside Moscow. This highly sensitive interferometer, having a beamwidth of approximately 0.25 degree at 100 mc., will be used to examine radiation from the sun's outer atmosphere between 50 and 130 mc. The east-west arm of the cross consists of 37 60-foot towers supporting a 3280-foot, wire-surfaced parabolic cylinder 131 feet wide. The arm is rotated about the long axis by simultaneously energizing synchronous motors located on top of each tower. The north-south arm (not yet completed) is a fixed parabolic cylinder whose fan-shaped beam will be steered by a line feed consisting of a phased array of dipoles.

A similar cross has been designed for the University of Bologna, Italy, except that the north-south arm is an array of parabolic cylinders. In Australia, a one-mile-long cross of two parabolic cylinders is being designed for the University of Sydney.

Aperture Synthesis: To achieve the high-resolution capability of switched-interferometer radio telescopes with a much smaller expenditure of steel and aluminum, the technique of "aperture synthesis" is used. In aperture synthesis, a large antenna is synthesized (*i.e.*, several small antennas are connected so that they look like a large antenna) by a pair of much smaller elements that cover successively the physical area that would be occupied by the large antenna. By sampling the radio signals received at different times with the elements at different positions and then combining the results of the separate observations in a computer, a radio telescope of any size and with any antenna pattern can be duplicated.

Fig. 9 shows how aperture synthesis has been used at the University of Cambridge in England to simulate a T-antenna (a modified cross antenna) and an interferometer, each having the equivalent collection area of 200,000 square feet. Fig. 10 shows the movable element. Both the cylindrical parabola (not shown) and the movable element have been used in a radio-star survey to generate a synthesized beamwidth 0.3 by 0.4 degree at 178 mc. for a cost of only $2.00 per square yard of aperture.

Dipole Arrays: Another method of achieving a large aperture is through the (*Continued on page* 60)

RATING UNKNOWN POWER TRANSFORMERS

How to find the current rating and operating characteristics of standard power transformers by using two simple graphs.

By
H. Q. DUGUID

POWER transformers are designed and built to do a certain job. Their ratings are clearly spelled out in the manufacturers' catalogues and this makes the selection of an appropriate transformer a relatively simple matter.

What should be done, however, when such catalogues are not available? This is often the situation when salvaged transformers are being considered for a project. A few simple measurements will permit the rating of a transformer with the aid of the curves given here. This makes it possible to avoid a power transformer that is too small for the job at hand.

The method to be discussed is useful for checking unknown power transformers to be used with a full-wave, center-tapped rectifier circuit, as shown in Fig. 1. The curves cover a size range of about 30 to 300 volt-amperes (va.).

Unenergized Testing

The first step in the rating process is to tighten the through bolts and check the leads. If the transformer is still mounted in a piece of equipment, it will be necessary to remove tubes or disconnect other loads before making the required measurements. Check the continuity of all windings and record the d.c. resistance values for these windings. If the leads are not properly color-coded, tag them. The winding(s) having the highest resistance will be the high-voltage winding for the rectifier. If only two high-voltage leads are found, check to see if the center-tap is grounded internally. The resistance to ground—core or case—will be about half that of the resistance between leads if this is so. If the high-voltage or other winding is tapped, this may be determined by the continuity and resistance checks.

Occasionally an extra lead is found which does not appear to connect to any winding. This lead may connect to a Faraday shield located between the primary and the several secondary windings. The other winding having appreciable resistance will be the primary. The d.c. resistance of most heater windings is usually too low to be measured conveniently. After identifying all windings by continuity check, make another check from winding to winding to make sure that there is no internal short between windings. This completes the unenergized testing on the transformer.

"Cooking" the Transformer

Hook the transformer primary to a source of power. The transformer should be allowed to "cook" for several hours to see how hot it gets under no-load. A transformer with a shorted turn will usually destroy itself very quickly. Most transformers will become warm at no-load—warm but not hot. The transformer must become warm even though not loaded electrically because the iron losses must be dissipated. Excessive heating or noise are warnings of trouble although the noise might be due to a loose lamination in the core.

While the transformer is "cooking," check and record the no-load voltage developed by the several windings. This check will further identify the various heater windings. *CAUTION*: Never connect more than one voltmeter lead to a winding before energizing the transformer. The transient voltage developed in the secondaries by current inrush into the primary can damage the voltmeter. Learn the one-hand technique—one hand in the pocket. Use insulated alligator clips on the meter leads and it will be easy to make all connections with one hand. If possible, measure the no-load primary current. This is a relative indicator of trouble.

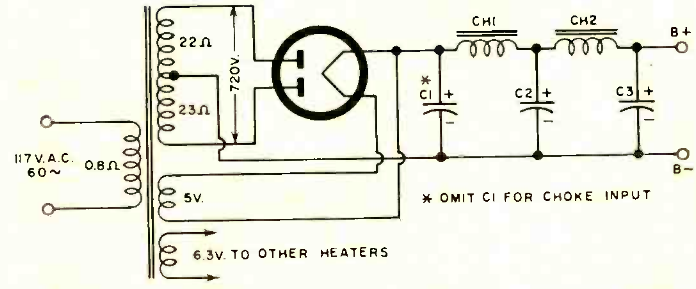
Current Ratings

The no-load primary current will range from about half of full-load current for very small transformers—particularly those operating at high magnetic flux density in the iron—to about one-eighth of full-load current for larger units of, say, 300-va. rating.

To determine the maximum current that can be drawn from the high-voltage secondary as d.c. current from the filter, it is necessary to calculate the unit resistance of the high-voltage winding. Divide the measured d.c. resistance in ohms by the open-circuit or no-load a.c. voltage to get ohms/volt. Since the two halves of the high-voltage winding may be slightly different, use the total voltage and the total ohms to get an averaged value. Read on the curves of Fig. 2 the permissible d.c. current (in ma.) that can be drawn from the filter for either choke or capacitor input filter.

The plate-to-plate a.c. voltage of the high-voltage winding under load can be approximated by subtracting from the measured no-load voltage the product of the d.c. load current (in amps.) and twice the measured d.c. resistance from plate-

Fig. 1. Transformers are to be used in full-wave circuit. Typical resistance values and voltages are indicated here.



to-plate. The resultant d.c. voltage into the filter can be found for a particular rectifier tube from curves in a tube handbook.

Practical Transformers

Practical transformers are built under restrictions imposed by economics, space, and required electrical characteristics. This often results in a design that is far from ideal. By one definition, an ideal transformer would have a core of square cross-section as for a given voltage per turn, the length of each turn would be least. This means less resistance and thus lower I^2R losses and better regulation. Transformers with cores having a square cross-section are uncommon—most transformers having a core thickness greater than the width of the center section. This construction reduces the weight slightly and may reduce mounting area. The reduction in iron losses is offset by increased copper loss because of the fact that the turn length is greater.

It is worthwhile to look at the changes that take place in transformer design as size is increased from about 30 to 300 va. The outside surface does not increase as rapidly as the volume. Since volume determines rating and surface determines cooling, it is necessary to improve the efficiency as size increases by reducing the iron and/or copper losses. The losses in the iron core can be reduced by lowering the magnetic flux density or by using a better grade of iron. As size is increased it is also desirable to reduce the permissible current density in the copper wire of the windings. This means larger wire of lower resistance and less I^2R loss. These factors may improve the voltage regulation of the transformer—generally speaking, the larger transformers will have the better voltage regulation.

The curves of Fig. 2 show the relationship between the unit resistance (Ω/v.) of the high-voltage winding and the permissible current that may be drawn from the filter. The curves were developed by plotting data taken from transformers of several manufacturers, covering the size range of about 30 to 300 va. rating. The data plotted very well with little spread. Although permissible d.c. load current for choke input is about one-third greater than for capacitor input, the transformer load is not increased as the r.m.s. current from the transformer is less for a given d.c. load when operating into a choke input filter.

The ratings of heater windings are more difficult to determine unless the wire of the winding is brought out as a lead. In this latter case, the permissible current is easily calculated after the wire size is measured—allowing one ampere for each 700 circular mils of wire cross-section. Standard copper-wire tables can be used to relate measured wire size to cross-section area in circular mils. (For example, No. 22 wire will carry about 0.9 a.; No. 20, about 1.5 a.; No. 18, about 2.3 a.; No. 16, about 3.7 a.; and No. 14, about 5.9 a.)

In service, the heater winding voltage should be checked. If the voltage under load is less than the nominal rating, *e.g.* 6.3 volts, the winding is probably overloaded. The method used for rating the high-voltage winding could also be used to rate the heater windings—with different curves. The method would not be too practical as few experimenters have the necessary equipment to measure such low resistances.

Final Check

One final check which can be made with the transformer under full-load is to check the primary current. The primary current must not exceed the value shown on the curve of Fig. 3, which relates the permissible primary current to the primary d.c. resistance in ohms. The values on the plot are for 117-volt primaries. For the occasional 220-volt primary, enter the curve with one-quarter of the measured resistance. The winding of a 220-volt primary is approximately twice as long as a 117-volt primary and is wound with wire having about half of the cross-sectional area, which doubles the resistance per unit of length.

For example, take a power transformer having the d.c. resistances and high-voltage secondary open-circuit voltage shown in Fig. 1. Calculate *ohms/volt* = (22+23)/720 = 45/720 = 0.0625. From the curves of Fig. 2, read 245 ma. for a capacitor-input type filter and 325 ma. for a choke-input type filter.

The plate-to-plate a.c. voltage into the rectifier under load will be approximately 720 − (2 × 45 × .245) = 720 − 22 = 698 volts. The actual voltage will vary with the total transformer load but, for design purposes, this value is more useful than the open-circuit voltage. This transformer will be fully

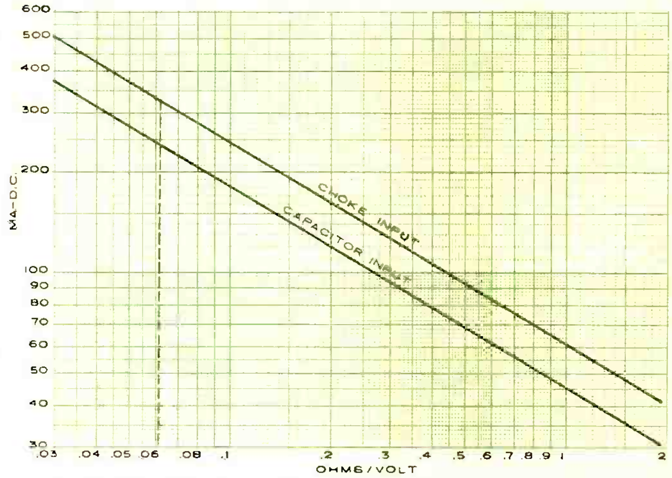


Fig. 2. Unit resistance of h.v. winding vs permissible current.

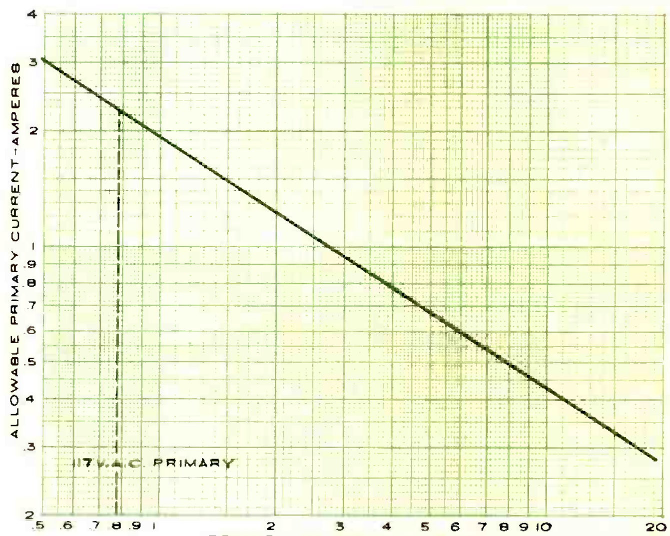


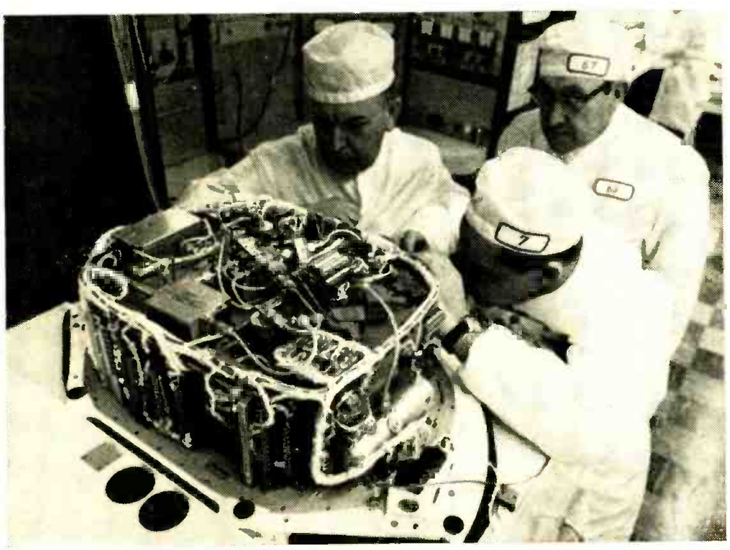
Fig. 3. Primary current plotted for various primary resistances.

loaded when the primary current reaches 2.3 amperes, which is the value corresponding to a resistance of 0.8 ohm on the curve of Fig. 3.

The curves given in this article are for standard radio and TV type transformers—not hermetically sealed but equipped with standard end shells. Transformers with special heat radiating fins inserted into the core are capable of somewhat higher loads—the increased surface makes it possible to dissipate more heat. Standard-type transformers will run hot at full-load as the copper losses as well as the iron losses must be dissipated. The method detailed in this article may be extended to hermetically sealed transformers but this will require collection of data to prepare additional curves. Generally speaking, ratings for hermetically sealed units will be lower because of the increased difficulty in dissipating the heat. ▲

RECENT DEVELOPMENTS in ELECTRONICS

Gemini Rendezvous Radar. (Below) The first production prototype rendezvous radar for the Gemini program is shown being acceptance tested before delivery by Westinghouse. The radar will be used to guide our astronauts to their target when they reach a point about 250 miles from each other. Through the use of a command link designed into the system, the astronauts will have the ability to exercise command and control over the Agena vehicle with which rendezvous is to be performed.

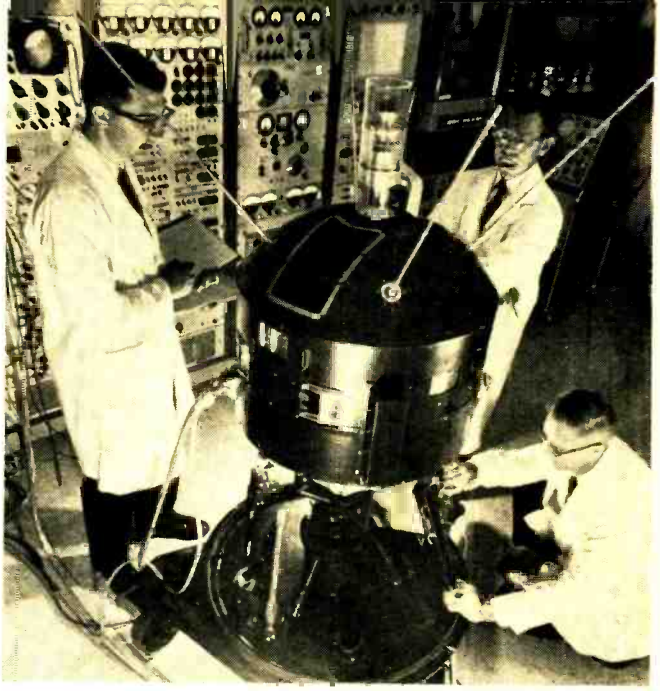


Integrated-Circuit Hearing Aid. (Below) The first widespread consumer-product application of integrated circuits is in the new Zenith "Arcadia" hearing aid. The complete six-transistor amplifier was fabricated by Texas Instruments on a single chip with ten leads as shown. The amplifier has a maximum gain of 75 to 80 db and draws only 2 ma. from a silver oxide 1.55-v. battery. Including the transducers and battery the entire hearing aid weighs only ¼ ounce and is designed for behind-the-ear use. Cost of the aid is $295.

TV for Surveillance. (Above) An expanded gate-surveillance TV installation is used on each of five gates at G-E's Syracuse, N.Y. plant. A single guard is shown monitoring all five gates. The guard has a two-way audio system for conversations with personnel and vehicles entering any of the gates. The system also uses automatic gate openers, close-up cameras, and pressure mats for signalling entry and exit of personnel and cars.

Microelectronic Computer. (Above) The IBM System/360 is the first commercially available data-processing system whose design is based on the use of microelectronic circuits. As a result of these circuits, computer size has been reduced while speed has been increased. The microelectronic logic card (center foreground) contains 12 circuit modules. It succeeds circuit cards (right) on which separately packaged transistors and diodes were mounted. This technique was an advance over the use of racks of vacuum tubes in assemblies shown at left previously employed in early computers.

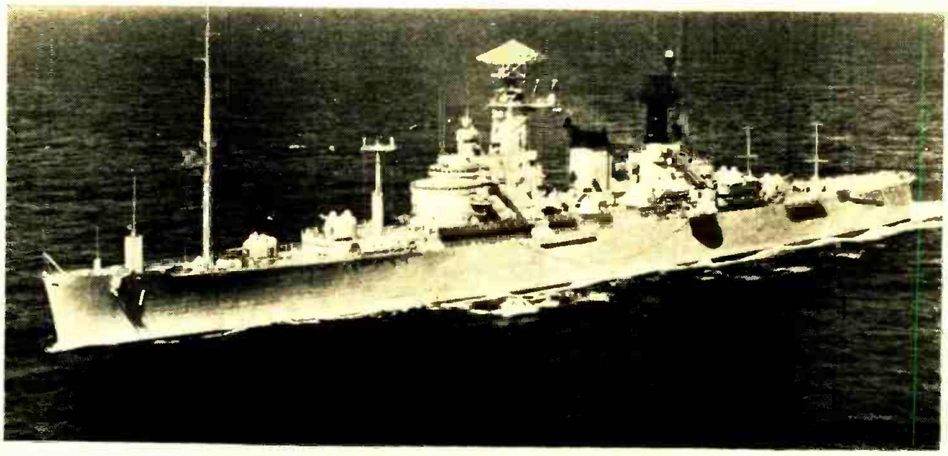
Electroluminescent Lighting Tape. (Below) Flexible lighting tape, called Tape-Light, that will be available by the foot was demonstrated recently by Sylvania. The tape uses a thin strip of aluminum foil, a layer of phosphors, and a transparent conductive coating which are sandwiched between protective layers of clear plastic. It is $\frac{1}{32}$ in. thick and has a lighted width of 1 in. The tape is manufactured in lengths up to 150 feet and can be factory-sealed to form any desired length for unusual lighting applications in those cases where low-level illumination for decorative or marking purposes is required.



International Scientific Satellite Launched. (Above) The UK-2 satellite, second in a series of scientific satellites built under the cooperative program of the U.S. and United Kingdom, was launched from Wallops Island by NASA. Built by Westinghouse, the spacecraft will add to our knowledge of the upper atmosphere, distant stars and galaxies during its 1-yr. lifetime. The satellite has equipment to measure galactic noise between 0.75 and 3 mc., high-altitude ozone, and micrometeoroids.

College TV Center. (Right) A new Television Center has been opened at Brooklyn (N.Y.) College with a full complement of broadcast-quality equipment. The Center is one of the largest and best-equipped TV production facilities in U.S. education. It has six cameras, two TV film systems, two video tape recorders, and a complete control-room setup, all supplied by RCA. The equipment will all be handled by students as part of their college training. The Center will also produce video tapes that are to be employed for instruction. Technical capability is equal to most commercial TV stations, and superior to some.

First Ship-to-Shore Tropo System. (Right) A teletypwriter message was sent completely around the world and back to a ship at sea in under a half second via the first ship-to-shore tropo scatter equipment. The FM tropo gear, made by Radio Engineering Labs, is installed aboard the USS Northampton, a new heavy cruiser. In this form of transmission, radio waves are beamed into the troposphere where scattering occurs. Antennas located over the horizon several hundred miles away pick up the signal. Tropo scatter is suitable for covering difficult terrain and large bodies of water with reliable communications.



BINARY COMPUTER CODES and ASCII

By ED BUKSTEIN
Northwestern TV and Electronics Institute

A new binary language has been standardized to permit different makes of computers and data processors to "talk" to each other. This is the American Standard Code for Information Interchange.

COMPUTERS and other digital equipment are implemented from two-state ("on-off") devices such as flip-flops and gate circuits. Data and instructions are therefore handled in the two-symbol notation of the binary system. Various codes have been developed in which these two symbols, 0 and 1, are used to represent the decimal digits from zero through nine. One such code, known as BCD (binary-coded decimal), is shown in Table 1. As indicated, the decimal digits are represented by the four-bit binary groups from 0000 (zero) to 1001 (nine). The decimal number 1964 would therefore be represented in BCD as: 0001 1001 0110 0100.

BCD is sometimes referred to as 8421 code because, in each four-bit group, the four positions from left to right are assigned *weights* or values of 8, 4, 2, and 1. For this reason, 0110 represents six (4 and 2), 1001 represents nine (8 and 1), and so on.

Another weighted code in which the positional values are 7,4,2, and 1 is shown in Table 1. Decimal 7 in this code is 1000, decimal 8 is 1001 (7 and 1), and 9 is 1010 (7 and 2). An advantage of this 7421 code over the 8421 code is that no four-bit group contains more than two ones. In certain card-handling machines in which the ones are represented by notches in the edge of a card, it is advantageous to use a code requiring no more than two notches for each decimal digit.

The Gray code shown in Table 1 is a non-weighted code. The four-bit combinations which represent the decimal digits are selected in accordance with the requirement that *only one bit changes in going to a next higher digit*. For example, in going from 7 to 8 (0100 to 1100) only the left-most bit changes. By contrast, all four bits change in BCD in going from 7 to 8 (0111 to 1000). Having only one bit change at a time is advantageous in certain types of analog-to-digital converters.

Excess-3 (XS-3) is also a non-weighted code. A characteristic of this code is that any two digits whose sum is nine are exact opposites in terms of zeros and ones. The digits 3 and 6, for example, are exact opposites (0110 and 1001). Similarly, 2 and 7 (0101 and 1010) are exact opposites. This characteristic of the code is advantageous in computers using nines-complement arithmetic because the nine-complement of any number can be obtained simply by changing the ones to zeros and the zeros to ones.

The 2-out-of-5 code uses five-bit groups to represent the decimal digits. These are shown in Table 1. An important characteristic of this code is that each five-bit group contains exactly two ones (hence the name 2-out-of-5). This characteristic simplifies error-detection in the computer. Should the error-checking circuits discover a five-bit group containing either more or less than two ones, an error is indicated. Another name for the 2-out-of-5 code is *63210* code. These numbers are the weights or positional values of the system. For this reason, 01100 (3 and 2) represents decimal digit 5, 10010 (6 and 1) represents 7, etc. To retain the 2-out-of-5 characteristics, 00110 is used to represent decimal digit *zero*. The computer is designed to recognize this five-bit group as zero, and therefore does not confuse it with the representation for 3 (01001).

In computers designed for business data processing, it is necessary to deal with alphabetic as well as numerical data. Customer names, street addresses, city and state, etc. must be expressed in binary form for invoice and billing applications. Similarly, in payroll work, employees names must be represented by meaningful configurations of binary bits. One system of alphanumerical coding is illustrated in Table 2. As shown, each of the four vertical columns of the table is identified by a pair of zone bits. Each of the 16 horizontal rows of the table is identified by a group of four *detail* bits. Any numeral, alphabetic character, punctuation mark, or special symbol can, therefore, be represented by a total of six bits. The letter E, for example, is represented as 110101 (zone bits 11 and detail bits 0101). Likewise, the letter N is represented as 100101, the letter G is 110111, and the numeral 8 is 001000. The unused combinations in Table 2 can

Table 1. Commonly used binary codes employed in computers.

Decimal	BCD	7421 Code	Gray Code	XS-3 Code	2-out-of-5 Code
0	0000	0000	0000	0011	00110
1	0001	0001	0001	0100	00011
2	0010	0010	0011	0101	00101
3	0011	0011	0010	0110	01001
4	0100	0100	0110	0111	01010
5	0101	0101	0111	1000	01100
6	0110	0110	0101	1001	10001
7	0111	1000	0100	1010	10010
8	1000	1001	1100	1011	10100
9	1001	1010	1101	1100	11000

be assigned for other punctuation marks, mathematical symbols or other material the user may require.

To facilitate error-detection, a *parity* bit is often added to the six-bit combinations of the alphanumeric code. Each alphabetic character, numeral, or special symbol is therefore represented by a seven-bit combination. The parity bit is selected so that there will be an even number of ones in every seven-bit combination. Should the error-checking circuits detect a seven-bit combination with an odd number of ones, an error is indicated. With the inclusion of a parity bit in the left-most bit position, the previously given examples become: E = 0110101; X = 1100101; G = 1110111; and 8 = 1001000.

Some computers employ an odd-parity check, that is, the parity bit is selected to produce an odd number of ones in every seven-bit combination. Here, the error-checking circuits are designed to respond to an even number of ones.

	00	01	10	11
0000				
0001	1	/	J	A
0010	2	S	K	B
0011	3	T	L	C
0100	4	U	M	D
0101	5	V	N	E
0110	6	W	O	F
0111	7	X	P	G
1000	8	Y	Q	H
1001	9	Z	R	I
1010	0	%	!	?
1011	#	,	$	.
1100				
1101				
1110				
1111				

Table 2. One type of alphanumerical code.

A Standard Code

In the past, each manufacturer has selected a code (or created a new one) to suit his own convenience. As a result, equipment of different manufacturers are incompatible. A magnetic tape produced by one computer cannot be used directly on another; data available in one installation cannot be directly communicated to another. Code-to-code conversion must be performed by time-consuming programming or by expensive translation equipment. Not only do codes vary from manufacturer to manufacturer, but from computer to computer of the same manufacturer, and even in some cases from user to user of the same model computer.

The recent trend toward "networking" of computers has emphasized the need for a standard code. Such a standard would facilitate information interchange between computer installations. Through telephone lines or other communications links, an airline reservations computer in one city could communicate directly with the computer of another airline in another city; a customer's computer noting a decreasing inventory of a particular item could phone-in an order directly to the computer of the manufacturer of this item; a bedside unit in a small-town hospital could "talk" directly to the computer in a large medical center in a distant city. Some of these computer-to-computer applications already exist, others are still in the future.

A standardized *language* for all data processing equipment is now available and will do much to accelerate developments in this field. The new code, recently approved by the American Standards Association, is known as ASCII (American Standard Code for Information Interchange).

As shown in Table 3, ASCII employs seven-bit representations for the alphanumeric characters, punctuation, and special symbols. The letter W, for example, is represented as 1010111, and the numeral 5 is 0110101. Other seven-bit combinations are used for device controls ("on-off" control of remote equipment), format control for printed messages (carriage return, form feed, vertical tabulation), audible signal (bell), information separation (end of address, end of message, word separator, etc.). Additional unused seven-bit combinations are available for future applications.

The introduction of a new standard involves additional expense and inconvenience while manufacturers gear their operations to the new practices. The long-term benefits, however, more than justify the changeover. That computer manufacturers recognize the ultimate benefits of standardization is evidenced by the fact that the four-year study which culminated in ASCII was sponsored by the Business Equipment Manufacturers Association.

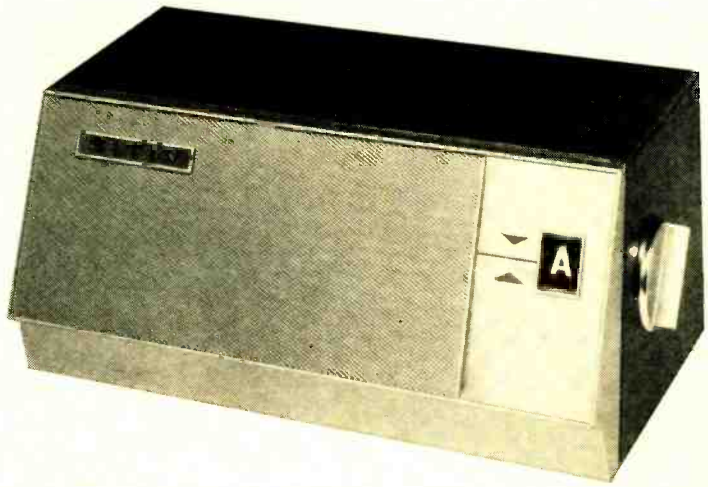
Copies of the new standard, identified as American Standard Code for Information Interchange X3.4-1963, are available for one dollar from the American Standards Association, 10 East 40th Street, New York, New York 10016. ▲

	000	001	010	011	100	101	110	111
0 0 0 0	NULL	DC_0	b	0	@	P	↑ UNASSIGNED ↓	↑ UNASSIGNED ↓
0 0 0 1	SOM	DC_1	!	1	A	Q		
0 0 1 0	EOA	DC_2	"	2	B	R		
0 0 1 1	EOM	DC_3	#	3	C	S		
0 1 0 0	EOT	DC_4 (STOP)	$	4	D	T		
0 1 0 1	WRU	ERR	%	5	E	U		
0 1 1 0	RU	SYNC	&	6	F	V		
0 1 1 1	BELL	LEM	' (APOS)	7	G	W		
1 0 0 0	FE_0	S_0	(	8	H	X		
1 0 0 1	HT/SK	S_1	)	9	I	Y		
1 0 1 0	LF	S_2	*	:	J	Z		
1 0 1 1	V_{TAB}	S_3	+	;	K	[		
1 1 0 0	FF	S_4	, (COMMA)	<	L	\		ACK
1 1 0 1	CR	S_5	—	=	M	]		①
1 1 1 0	SO	S_6	.	>	N	↑		ESC
1 1 1 1	SI	S_7	/	?	O	←		DEL

Table 3. American Standard Code for Information Interchange.

LEGEND

NULL	Null/Idle	DC_1-DC_3	Device control
SOM	Start of message	DC_4 (Stop)	Device control (stop)
EOA	End of address	ERR	Error
EOM	End of message	SYNC	Synchronous idle
EOT	End of transmission	LEM	Logical end of media
WRU	"Who are you?"	S_0-S_7	Separator (information)
RU	"Are you . . . ?"	b	Word separator (space, normally non-printing)
BELL	Audible signal	<	Less than
FE_0	Format effector	>	Greater than
HT	Horizontal tabulation	↑	Up arrow (Exponentiation)
SK	Skip (punched card)	←	Left arrow (Implies/Replaced by)
LF	Line feed	\	Reverse slant
V_{TAB}	Vertical tabulation	ACK	Acknowledge
FF	Form feed	①	Unassigned control
CR	Carriage return	ESC	Escape
SO	Shift out	DEL	Delete/Idle
SI	Shift in		
DC_0	Device control reserved for data link escape		



The program selector accepts three pay-TV and one FM music and information channels supplied by the cable system and converts them to a low-band v.h.f. TV channel.

NEW PAY-TV SYSTEM TO START IN JULY

Three color-TV channels and an FM music and program information channel are transmitted by coaxial cable.

OFFERING a choice of three simultaneous color-TV channels and an FM music and program information channel, *Subscription Television Inc.*, of Santa Monica, California, is hoping to start pay-TV transmission in both Los Angeles and San Francisco, California on or about July 1, 1964.

The *STV* system is a leased coaxial-cable system with the local telephone company supplying the necessary interconnecting cable between the subscribers and the master control station. The subscriber is supplied with two elements of the system, a telephone company coaxial cable housedrop connector and an *STV* program selector (see photo). The program selector is connected to the housedrop, to the customer's conventional TV antenna, and to the customer's TV set antenna terminals. The program selector remains switched on at all times, in the interests of component reliability, and consumes 1.7 watts of power. When the program selector is placed in the "Off" position, the cable system is disconnected from the set antenna terminals and the customer's antenna is switched in.

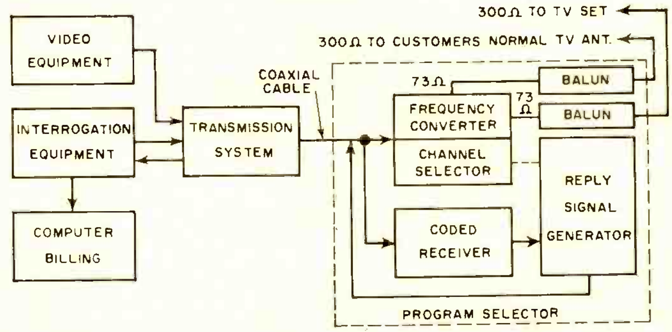
The basic system is shown in Fig. 1. The video equipment consists of three independent TV channels that can be fed from any color-TV program source. The interrogation and billing equipment is computer-operated and transmits a digital-coded signal down the transmission system to interrogate each program selector hooked onto the system at six-minute intervals. Coded replies that identify each program selector and the channel to which it is tuned are transmitted back to the computer. This information, together with the name and address of the viewer, is recorded on magnetic tape at the billing station. At the termination of a free program-sampling period, dependent on the length and nature of the program being transmitted, the customer is then charged the price of that particular program if he is still watching it. Approximately 712,000 customers can be handled by one computer installation.

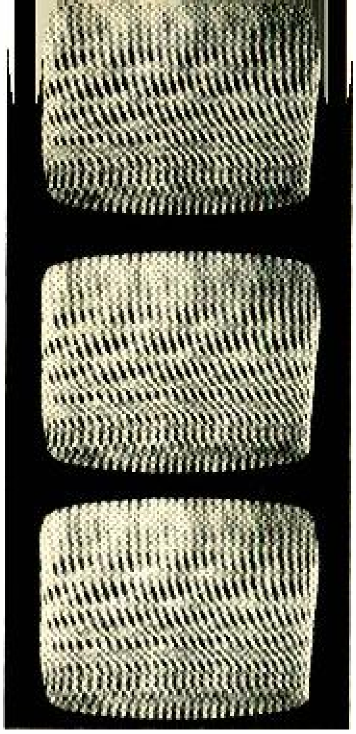
The signals leaving the studio operate on a baseband between 26 and 54 mc. When they arrive at the viewer's program selector, they are converted to an unused low-band v.h.f. channel (usually channel 6 although channel 5 will be used in some areas of the country). The customer then tunes his set to this channel and sets the program selector to choose one of the three available pay-TV channels, or the free FM music and program information channel. Placing the program selector channel switch in the "Off" position will detach the program selector from the TV set and replace it with the customer's normal TV antenna. As the program selector channel switch is rotated to the various settings, the digital coding signal sent back to the interrogation equipment will change to indicate the program selector status.

Service and installation of this pay-TV system will be by *Lear-Siegler Service Inc. (LSSI)*. This wholly owned subsidiary of *Lear-Siegler Inc.* will handle the equipment between the telephone company coaxial housedrop and the customer's TV set. They do not contemplate any servicing of the customer's TV set other than making sure it can receive the output of the program selector. Present plans call for $10 installation fee and a $1 per week minimum charge.

Negotiations are presently underway for a similar system to be installed in England with *STV* receiving the British royalties. ▲

Fig. 1. Over-all STV pay-TV system. The three TV signals, an FM music and information channel, and a computer-generated interrogation signal are passed down the coaxial cable simultaneously. The viewer's program selector answers the interrogation with a code signal identifying the program selector and the particular channel to which it has been set.





RESULTS of EW TESTS on U.H.F. CONVERTERS

Laboratory tests of eight u.h.f. converters showed that several models exceed the FCC prescribed local oscillator radiation limits.

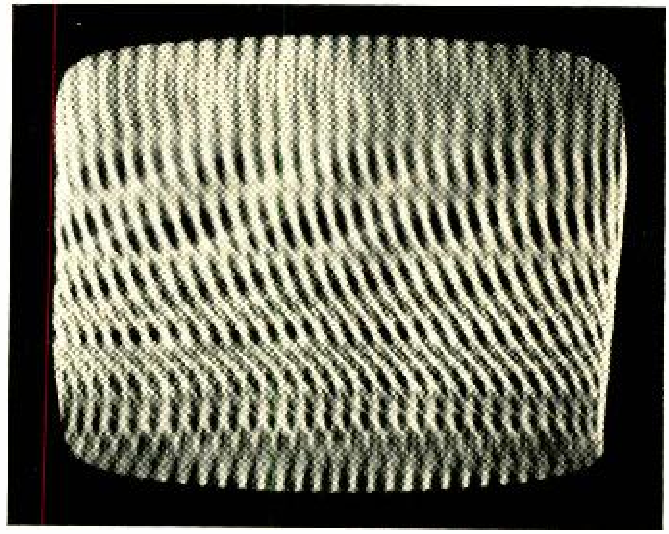


Fig. 1. Classical r.f. interference pattern is the result of a radiating converter being picked up on a u.h.f. receiver.

As of February 1964, there were 124 u.h.f. TV stations in operation in the United States, and 60 new construction permits for u.h.f. TV stations had been granted by the FCC. These figures will rise considerably as more u.h.f.-equipped TV sets come on the market as a result of the FCC ruling that all TV sets manufactured and sold in the United States after April 30, 1964, must be equipped to receive not only the 12 v.h.f. channels, but also the 70 available u.h.f. channels.

Most set manufacturers have designed independent u.h.f. tuners or composite u.h.f.-v.h.f. tuners for use in their latest model TV sets. However, the millions of v.h.f.-only TV sets already in operation will have to be equipped with an outboard u.h.f. converter if their viewers want to take advantage of u.h.f. programming. A u.h.f. converter picks up the desired u.h.f. station and, by means of superheterodyne techniques, converts the signal into a low-level r.f. signal at v.h.f. channel 5 or 6 frequency.

Most TV sets (like other forms of superheterodyne receivers, including u.h.f. converters) can act as miniature radio transmitters and radiate their local oscillator signal unless the device is carefully designed, constructed, and well shielded. Such radiated disturbances can interfere with signals removed from TV viewing. For example, a TV set operating on channel 2, using a 45.75-mc. picture i.f., has its local oscillator operating at 101 mc. If this local oscillator radiates a strong enough signal it would interfere with reception on the 88- to 108-mc. FM band. If a strongly radiating local oscillator signal happens to fall within another TV channel, then reception of that channel will be impaired.

To minimize the possibility of such interference, FCC regulations require that TV and FM receivers and tuners manufactured after December 31, 1957 have a seal or label affixed stating that they meet the radiation limits imposed by FCC Regulation Part 15, Subpart C. For u.h.f. sets operating between 470 and 1000 mc., they are required to limit their radiation to 1000 μv.-per-meter (at 100 feet) under a grant ending April 30, 1965. At that time, they will revert to 500 μv.-per-meter, the same as v.h.f. sets. Manufacturers and distributors are authorized to affix such a seal or label only after the set has been tested for compliance.

The owner of the set is responsible for complying with these FCC requirements. However, the Commission recognizes that the user cannot test the set to determine whether it meets specifications. The FCC feels, therefore, that the manufacturer or distributor should assume this obligation to their customers and affix the required seal so that the purchaser is assured that the unit he buys conforms to radiation requirements.

The FCC is receiving excellent cooperation from United States and foreign set makers in this program. Most are willing to test their receivers or tuners to make sure they comply and then affix the required seal when they do.

However, some sets (TV, FM, and u.h.f. converters) are being sold without this seal. It is possible that many of these may meet the radiation requirements imposed by the FCC, but that the manufacturers either have not made the prescribed tests or have not affixed the required seal showing compliance.

The FCC notes that operation of a set manufactured after December 31, 1957 that does not have the radiation seal affixed is prohibited. The Commission suggests that the buyer

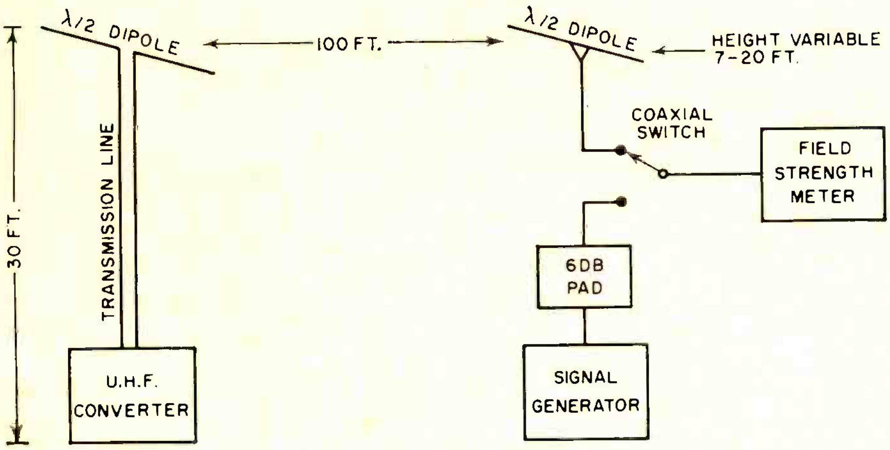


Fig. 2. This is the arrangement employed at a typical oscillator radiation level test range. Antenna spacing is 100 ft.

Method of Measurement

The u.h.f. converter being checked is connected into a testing arrangement as shown in Figs. 2 and 3. This is a standard method of testing oscillator radiation and consists of two antennas; one for the device undergoing test, and the other for the test receiver—spaced 100 feet apart. Both antennas are made half-wave at the frequency of operation and provisions are made to rotate both antennas and to vary their height to maximize signal transfer.

The converter under test is then tuned to appropriate channels to give a good sampling coverage of the frequency range covered by the device and, at each of these channels, its local oscillator radiation level is measured at the test receiver end of the measurement range.

To determine the absolute magnitude of the radiated field in microvolts-per-meter for the local oscillator of a u.h.f. converter, the test procedures outlined in the pertinent IRE Standards (51 and 1751) were followed except: a 3-foot length of 300-ohm twin-lead, terminated in a 300-ohm resistor, was connected to the v.h.f. TV set termination of the converter to simulate the interconnection between the converter and associated v.h.f. TV set; a folded u.h.f. dipole was used for the converter to provide a good impedance match and reduce standing waves on the u.h.f. antenna transmission line; and relatively short antenna masts were used to reduce signal-strength variations caused by wind gusts moving the antennas during the tests.

The weather must be dry when such tests are run because moisture in the air can affect propagation conditions and the test site itself must be dry as water puddles on the ground between test antennas could cause variations in ground reflections. All test equipment was calibrated with standard instruments and the alignment and noise figure of the field-strength meter being used as the test receiver was checked and calibrated.

The field-strength meter (Fig. 2) is tuned to the frequency of the oscillator to be measured and the two antennas are aligned broadside to each other. The u.h.f. converter under test, together with its associated antenna, are rotated as a unit in the horizontal plane until the field-strength meter indicates a maximum received signal.

The antenna of the field-strength meter is now varied in elevation between 7 and 20 feet, maintaining the same relative azimuth alignment to the other antenna, until the meter indicates maximum received signal. At this point, the coaxial switch connects the field-strength meter to the calibrated signal generator and the field-strength meter readings are reproduced. Calibrated output of the signal generator, plus known attenuation of the 6-db pad, are combined to determine the level of the received signal.

These same procedures are followed for all frequencies that the test requires. The entire series of tests is repeated for the other u.h.f. converters.

At the other test site, three varieties of tests were made; one similar to that just described for straightforward oscillator radiation; another with the u.h.f. antenna reversed at the converter in order to minimize effects caused by standing waves, ground reflections, or antenna mismatching; and a measurement of local oscillator radiation with the u.h.f. antenna detached from the converter and a 300-ohm resistor connected in its place. This latter test would determine the amount of local oscillator signal being radiated by the u.h.f. converter oscillator alone. ▲

Fig. 3. In the actual test range, the u.h.f. converter under test is connected to the antenna on the right. The small house on the left contains the u.h.f. receiver used for calibration.

insist that the seal be attached to the set before purchase is made. By doing so, he will insure the continued cooperation of set manufacturers in the program. The owner of an unlabeled set which causes interference to his neighbor's reception may be required to take remedial action or stop using the interfering set.

Recently, we purchased a pair of u.h.f. converters for use in the ELECTRONICS WORLD office in New York. Both worked fine. However, when two TV sets, each equipped with a u.h.f. converter, were placed in operation within a hundred or so feet of each other, a problem cropped up that bodes no good for future u.h.f. TV viewing. When one of the u.h.f.-converter-equipped sets was tuned to an operating u.h.f. channel, both picture and sound on this set were wiped out by the high-level local oscillator radiation from the other converter as its local oscillator passed across the frequency of the channel being viewed. This interference took on the appearance of a typical r.f. interference pattern and is shown in Fig. 1.

Discussion with members of the broadcasting industry brought out the fact that the FCC is aware of this problem and is, accordingly, assigning u.h.f. channels on a staggered (frequency and physical separation) basis.

However, with a little thought, it can be seen that in areas served predominately by u.h.f. TV or in multi-dwelling buildings where a large number of sets would be in operation in close proximity, the presence of literally thousands of low-power transmitters operating in and around the u.h.f. band could pose some severe interference problems.

To say that a problem may develop is putting it mildly. In fact, chaos could result as hundreds of these u.h.f. converters, all located in the same general area, are tuned across the u.h.f. band in search of stations. It must be remembered that the interfering signal generated by each converter would be "amplified" by the gain and directivity of its associated antenna. Because at u.h.f. the use of high-gain antennas is normal, the situation would be compounded.

Because we feel that ELECTRONICS WORLD has a responsibility not only to its readers, but to the industry it serves, we decided to have some radiation level tests made on a number of available u.h.f. converters, and compare the results with the FCC specifications.

The eight u.h.f. converters used in these tests were over-the-counter purchases of one available model from each manufacturer having u.h.f. converters on the market at the time. Since then, some changes have been made to certain of these converters, while others have been coming on the market. The radiation level of these newly merchandised units is not known.

The eight units were shipped to an r.f.

Converter Manufacturer and Model	Radiation Level in Microvolts Per Meter			
	Antenna Reversed		Antenna Removed	
	Lowest	Highest	Lowest	Highest
Standard-Kollsman, Model A	60	573	28	307
Blonder-Tongue, BTU-2	150	462	80	387
Jerrold, VC-100	143	1045	187	1025
Gavin, G-3	1435	7875	962	2625
Regency, RC-53	7500	29,250	8500	23,350
Tel-Ray, Model 200	132	33,075	11	5400
Enercon, Mark II	6587	12,650	7150	14,725
J. L. Johnson, Sidemount	700	7875	140	975

Table 1. Radiation (μv./m.) of the eight u.h.f. converters with their antenna connections reversed, and with antenna removed from the device and replaced with a 300-ohm resistor.

testing and antenna measurement range maintained by a well-known manufacturer and located on the West Coast. After their series of tests, the same eight units were shipped to another r.f. testing and measurement range, also operated by a well-known organization, and located on the East Coast. The results arrived at by the first range were not disclosed to the second, so that we might compare testing results.

Fig. 4 shows the results obtained at one of the measurement ranges while Fig. 5 shows the results from the second range. Although these tests were performed on the same eight units on standard measurement ranges, the results show some differences. Such variation can come about because of the difference in u.h.f. propagation at each site. Such things as moisture in the air can change readings at one frequency, and water puddles on the ground, or watersoaked ground near the test antennas, can also produce ground reflections which can change results. As most of these tests were performed under winter conditions, water problems could have been met.

Another source of possible variation is also apparent after a close physical examination of the interior of some units. Several manufacturers use point-to-point wiring where components dangle in the air, thus changing their capacitance-to-ground value, possibly detuning circuits, and possibly causing other problems as the components move about during shipment. Some converters use very long interconnecting wires stretched around within the device. These lengthy wires are usually connected between the u.h.f. converter switching device and the antenna input/output terminals and the u.h.f. mixer output. In many cases, these relatively long wires run directly past the local oscillator section and thus permit r.f. coupling to the u.h.f. antenna. Such r.f. is then passed directly out of the antenna to raise the level of local oscillator radiation. Even the use of an r.f. amplifier, which would reduce local oscillator feedthrough to the antenna in normal circumstances, would be bypassed by this unintentional r.f. leakage path.

To remove the effect of possible mismatch between the converter under test and the u.h.f. antenna and transmission line being used, and the possible effects of ground reflections on the radiated signal, the tests were re-run with the antenna connections to the u.h.f. converter reversed. Antenna mismatching could cause a change in the side-lobe structure of the antenna polar diagram and if there were pools of water, or water-soaked ground to one side of the direct path between the two test antennas, then reflections from these layers could produce a different signal level.

Table 1 shows the result of this antenna reversed test and also shows the signal level measured when the u.h.f. antenna was removed from the u.h.f. converter and a 300-ohm carbon resistor substituted for it.

Because of the differences existing between the results as measured at the two test sites (shown in Figs. 4 and 5), it was decided to re-run the tests on some of the converters once again. This third test showed some differences in the local oscillator radiation level. Some of this difference can be attributed to mechanical variations within the converter as they were once more shipped across the country, and to changes in the propagation conditions between the times of the two sets of tests. The noted differences, however, were not great and those units having radiation levels below the FCC specification, remained there. ▲

Fig. 4. Local oscillator radiation as measured at one of the test sites. The FCC radiation limit is 1000 μv. per meter.

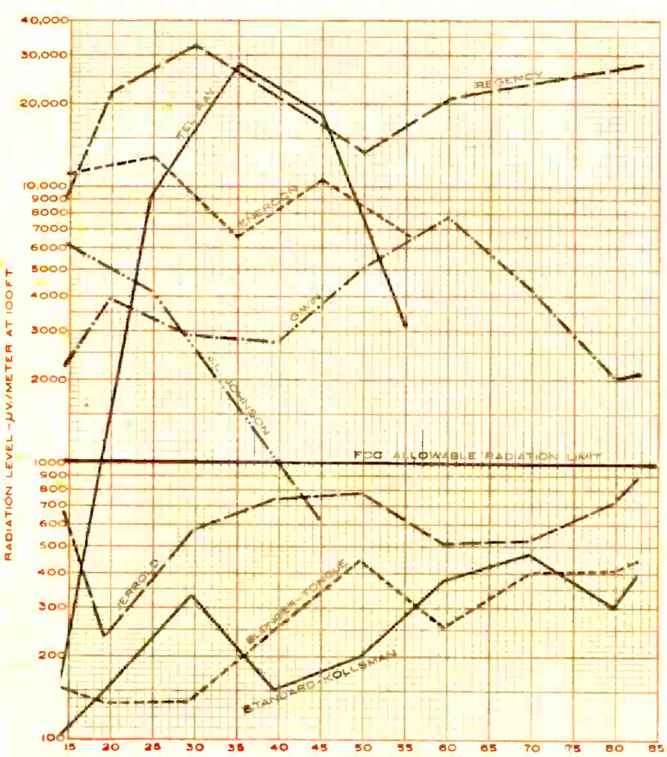
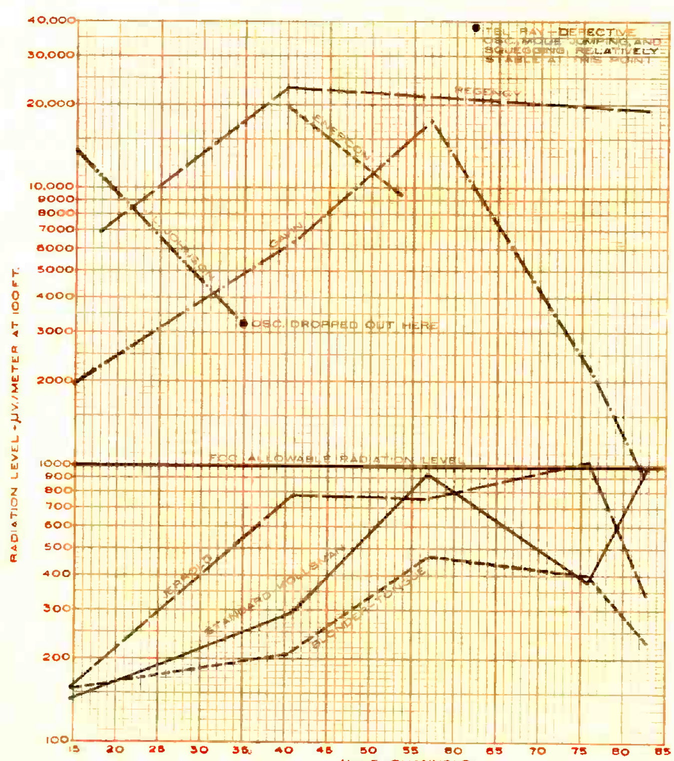
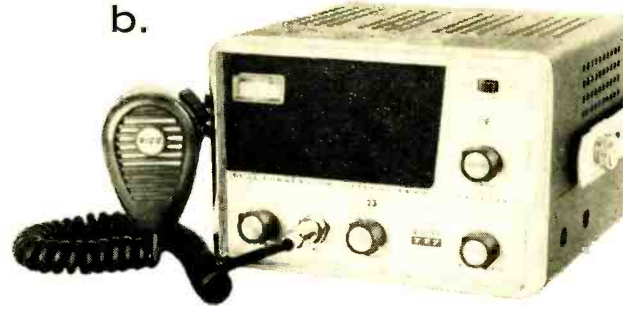


Fig. 5. Local oscillator radiation measured at second site. Differences between Fig. 5 and Fig. 4 are explained in text.



a.



b.

NEW CITIZENS BAND CIRCUITS

c.

By LEN BUCKWALTER

Keyed compression, a novel frequency-spotting method, and delta tuning are featured in recent CB products.

KEYED compression, spotting, and delta tuning are relatively new terms in the CB field. We consider, this month, how each is applied to practical circuitry in an effort to enhance CB communications. Keyed compression, for example, is illustrated by an especially interesting new circuit device by *Tram* for its TR-27 transceivers. A significant boost to modulation is achieved with few components. The frequency spotting idea, although not new to CB, is given a new twist by *Eico*. And *Olson Electronics* has fitted its recent sideband rig with a delta-tuning control to keep an extremely sharp receiver from attenuating desired signals.

(a) Tram "Keyed Compression"

About a dozen audio boosting devices are on the accessory market; external units which promise to improve transceiver performance by raising modulation percentage. Some are merely "pre"-preamps to multiply mike voltage. Others employ the clipper-filter idea which limits loud tones, then applies the total signal to the modulator. (The filter reduces distortion implicit in the clipped signal.) In a third category is the compressor. Its action on audio in the speech amplifier is similar to that of a.g.c. Quiet speech tones automatically increase audio gain; the strong voice creates voltages which reduce audio amplification. By selecting appropriate circuit values, it is possible to maintain modulation percentage at consistently high, efficient levels. The popularity of these devices is increasing—more CB manufacturers are installing them in transceivers as original equipment.

The *Tram*[1] approach to audio compression, as applied to its TR-27D (and E) transceivers, is one of the simplest engineering solutions to date. It is a disarmingly simple arrangement, but one that provides the compressor function; maintaining punch to the audio signal under varying modulation levels. Unlike its forebears, the *Tram* circuit uses no tubes or transistors to develop what the company calls "keyed" compression. The circuit is built around a strategically placed silicon diode rectifier, plus resistors and capacitors. These components control the suppressor grid of the mike preamp tube.

The circuit of Fig. 1 shows the TR-27D audio section along the bottom, transmitter at the top, with compressor components at the extreme left-hand side. If it is assumed that the rig is on transmit, an amplified mike signal appears across the modulation transformer primary (at the lower right). Most audio energy modulates the r.f. amplifier, *V*2, but a portion is sampled from a voltage divider formed by *R*7 and *R*8. (These resistors are across the transformer primary.) At the junction of *R*7 and *R*8, a lead may be traced over to the bottom left of the schematic. The audio sampling, *via* this lead, is applied through *C*2 to silicon diode *D*1. According to the direction of the diode in the circuit, only negative-going audio appears on the anode side of *D*1. The resistor-capacitor network following the diode serves as a smoothing filter. Thus, applied audio makes available negative d.c. which reflects modulation levels. But before noting how this is used to control gain of the mike preamp, several details are worth considering.

Note that diode *D*1 not only receives the audio sampling but also a potential through three resistors, *R*2, *R*3, and *R*4. Feeding the right end of *R*3 is a "B+" source. The resistors divide the voltage so a total of approximately +100 volts d.c. biases the diode. (This is in the diode's reverse direction so no current flows.) The biasing arrangement explains the "keyed" effect of the compression action. Only when audio exceeds 100 volts can it flow through the diode for rectification. Its effect on the over-all system is to delay compressor action until audio attains a level equivalent to about 65 or 70 percent modulation. If a very soft voice speaks into the microphone, the compressor circuit is relatively inoperative due to diode bias. In a normal speech amplifier, this suggests low modulation percentage but not in the TR-27D circuits. The speech amplifier has been designed so even a soft voice easily attains 65-70 modulation percentages.

Now to trace the action for medium or loud voices. Stronger audio levels, as we have seen, overcome diode bias and establish a negative d.c. voltage. This potential, after it emerges from the smoothing filter at the top of *D*1, may be traced to the suppressor grid of the mike preamp, *V*3. The suppressor varies the gain of the tube, *e.g.*, increasing negative bias (equivalent to the stronger voice) reduces audio

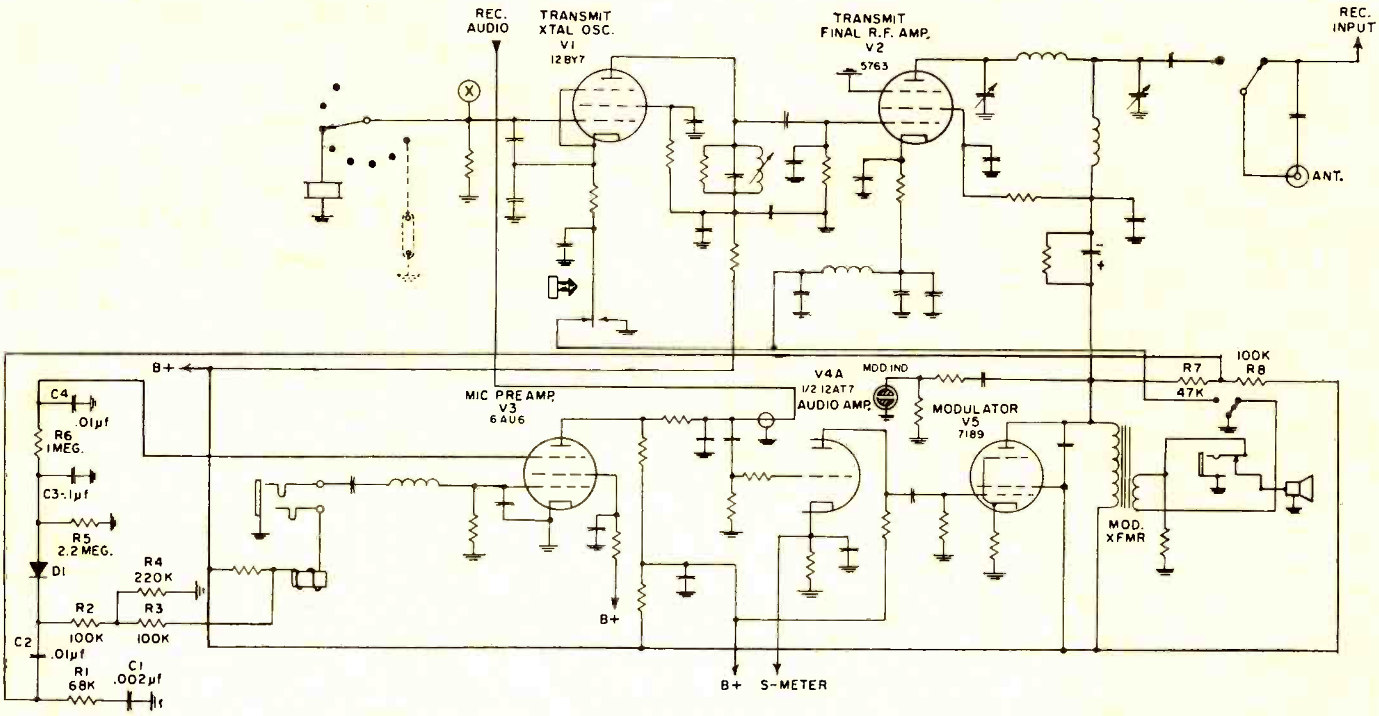


Fig. 1. Partial schematic of the Tram TR-27D with the audio compressor circuit shown at the left.

amplification. In this fashion, a wide dynamic range of audio consistently maintains high modulation percentage.

Besides this basic action, certain other refinements occur in the circuit to optimize performance. Returning to the input of diode *D*1, we note *R*1 and *C*1. These components form a frequency-compensating network which rolls off higher frequency audio tones. It was discovered that during periods of heavy compression, voice crispness tended to be lost, giving way to "bassy" speech response. The network, however, attenuates highs prior to the diode. Highs, therefore, do not appear in the negative d.c. fed back to the mike preamp suppressor.

Another point of interest is the smoothing filter following *D*1. Resistors and capacitors in this section were selected for fast-attack, slow-decay response. Otherwise, rectified d.c. could cancel audio in the mike preamp if it reacts too quickly —or not follow speech variations if it occurs too slowly. A final point (not apparent in the schematic) is what happens when the transceiver is switched to receive, where no compression is desirable. The bias on *D*1 is increased from 100 to about 240 volts d.c. Incoming audio of any level is unable to overcome higher level bias, and the compressor is effectively removed from the speech circuit.

(b) Eico Model 777 Transceiver

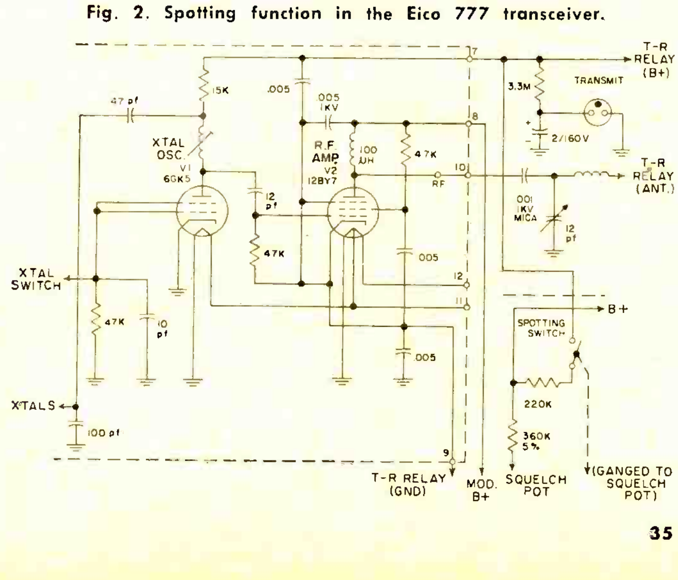
Although most CB transceivers are equipped with crystal-controlled receivers for convenient, accurate channel selection, the continuously tunable dial is still much in evidence. It provides the most inexpensive route to all-channel reception. But precision tuning and repeatability with such dials is another matter. Only the more expensive ham and communications receivers can provide the operator with a stable, self-excited local oscillator for tuning a given frequency with any consistency. The continuous-tuning problem is further aggravated in CB with the emergence of the double-conversion receiver. Its narrow i.f. passband requires precise setting of the tuning dial or the signal is lost.

The *Eico*[2] Model 777 transceiver, in addition to providing up to six crystal-controlled receive channels, incorporates a novel technique to overcome calibration error in its continuous-tuning dial. Utilizing crystals already installed in the transmitter, the circuit forms a miniature reference oscillator to inform the operator of an exact dial setting. The method is different from that found in other "spotting" circuits in that it generates an audible calibrating tone, but without special audio circuitry.

The schematic of Fig. 2 shows the principal circuits activated during the spotting operation. When the operator desires to set the tuning dial, he closes the spotting switch (shown near the bottom right of the schematic). The spotting switch, incidentally, is ganged to the squelch control. Rotating the squelch fully off initiates the spotting function. As the switch closes, it picks up "B+" from the power supply. The voltage is dropped by the 220k resistor, and subsequently applied to the transmitter crystal oscillator situated at the top left.

The oscillator stage, V1, is normally inoperative during receive due to lack of "B+" from the transmit-receive relay. The spotting switch, however, overrides the open relay and the transmit oscillator commences to generate 27-mc. energy. The exact channel frequency depends on the transmit crystal selected by the operator. Functioning with reduced "B+," oscillator energy is considerably below the level required during transmit. The r.f. (*Continued on page* 64)

Fig. 2. Spotting function in the Eico 777 transceiver.



ELECTRONIC SCANNING SIMPLIFIES TELEMETRY

By LEO G. SANDS

High-speed electronic switching permits a large number of remote indicator units to be checked and their status transmitted over a relatively narrow-band signal link.

THE cost of transmitting information is directly related to the amount of bandwidth required. A 15-cps wide circuit for handling telemetry and control signals costs about $1.50 per mile per month to rent, a 3-kc. wide voice-grade circuit rents for about $4, while TV circuits rates range from $45 to $80 per mile.

In remote control and telemetering systems, tone signaling is often used to transmit up to 30 channels of information simultaneously over a single voice-grade circuit. The tone signals are digitally modulated by pulsing the tones on and off, or by frequency shift keying (FSK) of the tones. Each tone channel operates at a different audio frequency, and the technique is known as frequency-division multiplexing.

It is seldom necessary to transmit all of the information simultaneously. Instead, sampling techniques can be used to transmit up to 40 channels of information over a single tone channel. If a voice-grade circuit is used as the transmission medium, and 20 tone channels are provided, 800 different signaling channels can be handled, each functionally independent of the others.

When sampling techniques are used, the system is said to employ time-division multiplexing and electronic scanners are employed to divide the time into discrete time slots. As in motion pictures, only one scene is observed at any one time. An electronic scanner takes a look at several electrical circuits in sequence. But, unlike the motion picture, the same points are looked at over and over again.

Electronic Scanning

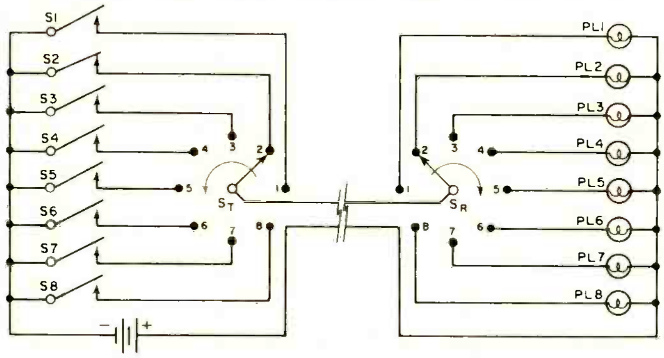
An electronic scanning system consists of a scanner transmitter and a scanner receiver. The transmitter automatically scans a bank of control switches or circuits to be monitored. The receiver operates in synchronism with the transmitter and determines the status of each control switch or monitored circuit at the time it is checked by the transmitter.

The basic principle of the scanner is illustrated in Fig. 1. Here, rotary switch S_T moves from one position to the other closing its contacts 1 through 8 sequentially. Switch S_R moves in synchronism with S_T (the rotary switch driving circuits have been omitted for the sake of simplicity). If S_T finds S2 closed, current flows through the circuit between S_T and S_R, and lamp *PL2* lights. Whenever S_T finds a closed switch, as it scans switches S1 through S8, the appropriate lamp at the receiver lights. When it finds an open switch, the associated lamp remains dark.

Hence, this simple scanner system automatically checks the status of 8 circuits, one at a time. If it operates fairly rapidly, a change in status of any of the monitored circuits is made known in ample time for most practical purposes.

An electronic scanning system operates in the same manner, but employs no moving parts and can scan at any rate from 15 to 1000 points per second. In most applications, the scanner operates at a speed of 15 pps. If it is equipped to scan 8 points, each circuit is looked at every 530 milliseconds, approximately twice per second. In a 40-point scanning system, operating at 15 pps. a circuit is looked at every 2½ sec. Electronic scanners operate much faster than this.

Fig. 1. In a simple electronic scanning system, when the two rotating switches are synchronized and S2 is closed at the transmitter end, receiver indicator lamp PL2 will be lit.



Transmitter

In one type of scanner transmitter, stepping from one sampling portion to the other is achieved by employing an electronic clock to trigger a series of binary counters (flip-flops). Fig. 2 is a block diagram of such a scanner transmitter. The pulses from the clock are counted by the binary counters, and each pulse causes a negative pulse to appear at the output of the "Space Gate," if all of the monitored contacts are open. After 8 pulses have been counted, the "Sync Gate" is closed and no pulse appears at its output. This period of absence of output between trains of 8 pulses each is recognized by the distant receiver as the sync signal.

However, if one of the monitored contacts is closed, one of the 8 output pulses in a pulse train will be positive instead of negative. This pulse appears at the "Mark Gate." If contacts 1, 2, 4, 6, 7, and 8 are closed, for example, the pulse train will consist of 2 negative pulses (pulses 3 and 5) and 5 positive pulses (pulses 1, 2, 4, 6, 7, and 8). Hence, closed contacts cause positive pulses to appear at the output. Negative pulses represent open monitored contacts.

Receiver

At the receiver, whose block diagram is given in Fig. 3, the pulses are regenerated and separated. The negative (space) pulses as "0" signals and the positive (mark) pulses as "1" signals, are fed to the "Shift Register" where they are stored. The first pulse, whether space (negative) or mark (positive) is stored first in the No. 8 section of the "Shift Register." The next pulse causes the first pulse to move to the No. 7 section, and so on until all eight pulses are stored in the "Shift Register" in the proper sequence.

The absence of pulses between the space and mark pulses advances the "Shift Register." A longer period of absence of signal between words (pulse trains) provides the required sync information which keys the transmitter and receiver in step with each other. If all 8 pulses have been received, the sync information at the end of the word causes the $N+1$ stage of the "Shift Register" to contain a "1" signal, and the $N+2$ stage to contain an "0" signal. If the "Sync Coincidence Gate" finds this to be true, the information in the "Shift Register" is transferred to the "Output Register." This can be either a lamp display or bank of relays.

The "Shift Register" is then reset and the next word (pulse train) starts its way through this register. The process is repeated more than 100 times per minute.

Pulse Transmission Medium

When the scanner transmitter and receiver are linked by a d.c. circuit (wire line), both positive and negative d.c. pulses can be transmitted. In most cases, however, the pulses are transmitted over a voice-grade wire line, carrier telephone channel, or radio link in the form of frequency shift

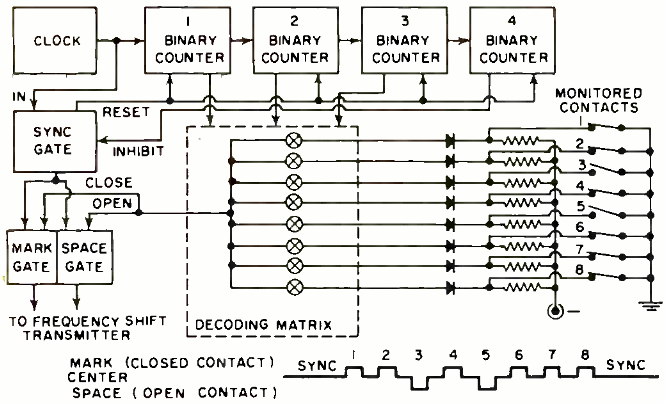


Fig. 2. Digital-type electronic scanner transmits a mark or space tone depending on whether a contact is open or closed.

keyed (FSK) audio tones. The positive pulses are transmitted as "mark" tones and the negative pulses are "space" tones. The absence of signal between pulses and at the end of a word (sync signal) is transmitted as a neutral or center frequency tone.

The pulses from the scanner transmitter cause the frequency of the tone to be shifted upward or downward in frequency from its normal center frequency, depending upon whether a mark or space tone is to be transmitted. During the periods when pulses are absent, the tone is transmitted at its center frequency.

Since it is important that the scanning system accurately report the transmitter's findings to the receiver, the transmitting code system must be selected with great care. It is possible to transmit the information using the pulse-duration code, the pulse-position code, the pulse-amplitude code, or the mark-space-return-to-zero code.

The mark-space-return-to-zero code is used in the system just described because it simplifies the circuitry and alleviates the problems of synchronization. After each information bit is transmitted, the code returns to zero, signaling the receiver that it should get ready to receive the next bit. This eliminates the need for critical clocks (time references). Also, this type of code is very secure with respect to noise and code checking is very simple. The word (pulse train) must contain the correct number of bits (pulses), whether mark or space. If not, the transmission is ignored.

Error Elimination

Noise might readily corrupt a pulse length coded signal by lengthening or shortening the pulse. But, a return-to-zero coded signal requires an incorrect signal of the exact opposite type (positive or negative, mark or space) and time duration to be present in sufficient strength to override the correct incoming signal. The scanner must not receive more nor fewer pulses than the anticipated number of pulses in each scan. An incorrect count prevents the receiver register from transferring its information to the output register. Loss of three successive transmissions actuates an alarm.

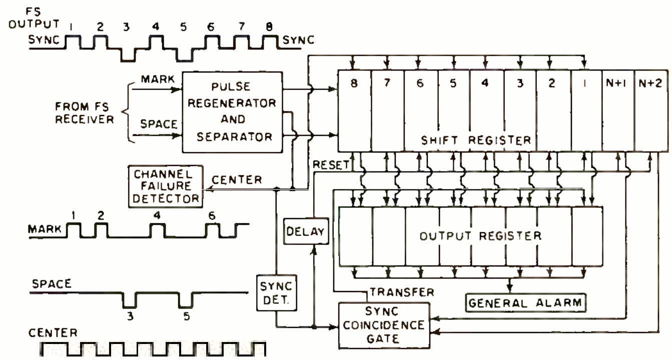


Fig. 3. Digital-type electronic scanner receiver that works in conjunction with the scanner transmitter shown in Fig. 2.

This means of code checking, while simple, has been found to be very powerful. When even greater security is required, the scanner receiver can be equipped so that it must receive the same code in two sequential scans.

The bits of two successive scans should correspond on a 1-to-1 basis as each bit (pulse) of a previous word is forced out of the shift register by the corresponding bit of the new incoming word passing into the first stage of the shift register. After the new incoming word has been received in its entirety, and is found to be identical to the preceding word, only then is the information transferred from the shift register to the display register. Hence, a change in status of any of the contacts monitored by the scanner transmitter must be interrogated twice before it is displayed.

Displays

In the event of failure of the tone channel or d.c. interconnecting circuit, the prolonged absence of signal causes an alarm to operate and the display to indicate the last correct status condition. The display register may be a bank of lamps, one for each point to be scanned, which light when the associated contacts being monitored are closed. The display circuits may then be (*Continued on page 70*)

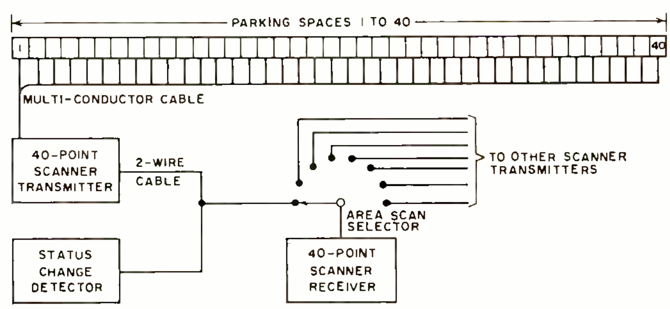
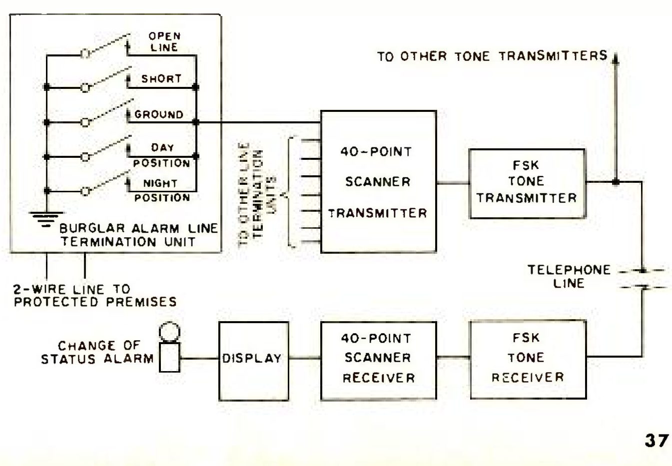


Fig. 4. Typical electronic scanning system as used in a garage to indicate presence of available parking spaces. Each scanner shows 40 spaces. Total of 320 spaces can be checked.

Fig. 5. In a typical burglar-alarm setup, one 40-point scanner can be used to determine five conditions at 8 locations.



TAPE-RECORDER EQUALIZATION CURVES

By HERMAN BURSTEIN
Co-author, "Elements of Tape Recorder Circuits"

An over-all summary of the present equalization standards and current practices at various speeds.

TO overcome noise, distortion, or frequency losses, equalization is used for each of the three basic program sources of high-fidelity—FM, phono, and tape. FM equalization was standardized many years ago, while standard phono equalization was agreed upon about a decade ago. But the matter of tape equalization is, in good measure, still unresolved, partly because the affiliated question of tape speed is also unresolved. Operation at 7½ and 3¾ ips, long with us, has recently been joined by 1⅞ and 15/16 ips, thanks to the increased feasibility of good performance at reduced speed. Each speed requires different equalization. Furthermore, continued improvements in tapes and heads and other aspects of the art have a bearing on the equalization that is needed or desirable, making it less easy to be conclusive about the equalization which is best for each speed.

The audiophile has several reasons for looking forward to the day when there will be equalization standards for each tape speed. Through standard equalization he can achieve flat response when playing commercially prerecorded tapes. If he exchanges recorded tapes with fellow enthusiasts, standard equalization makes it possible to maintain flat response. If he confines his activity to playing tapes recorded on his own machine, standard equalization is beneficial to the extent that it reflects the industry's effort to achieve an optimum compromise among the conflicting requirements of extended treble response, low noise, and low distortion.

In the meantime, as industry groups study the problem, there remains a good deal of haze around the subject of tape equalization. The purpose of this article is to help dispel the haze by discussing the reasons for tape equalization, the various methods of achieving equalization, the pros and cons of these methods, the effect of tape speed, and where we presently stand with respect to equalization standards and practices. Much of the discussion will gravitate about the 7½-ips speed inasmuch as this is the accepted speed for high-fidelity tape reproduction in the home.

Reasons for Equalization

Curve ABC in Fig. 1 shows what would typically happen to the record-playback response of a modern tape machine operating at 7½ ips if it provided *no* equalization. There would be a serious deficiency of both bass and treble, essentially due to the inherent behavior of a playback head and to two magnetic phenomena that cause unavoidable treble loss in recording.

The playback head responds to changes in the magnetic field of the tape and the more rapid these changes the greater the head's output. A low frequency on the tape corresponds to relatively few magnetic changes per second, so that the head delivers an extremely weak signal. A high frequency corresponds to many magnetic changes per second, and the playback head delivers a stronger signal. Line ABD in Fig. 1 shows what the unequalized record-playback response would be in the absence of treble losses that occur in recording. It reveals that playback-head output varies in direct proportion to frequency, that is, it rises 6 db per octave.

The treble losses in recording are indicated by the distance between Line ABD and Curve ABC. Thus, at 15,000 cps, there is typically about 30-db loss.

Treble loss is mainly due to self-demagnetization and bias erase. Self-demagnetization denotes the following. A frequency recorded on tape consists, in effect, of a series of bar magnets end to end, each having a north and a south pole. The higher the frequency, the more magnets necessarily occur per inch of tape and the shorter must each magnet be, thus providing an increasing opportunity for its north and south poles to cancel each other. The result is treble loss. Bias erase results from the high-frequency current fed to the record head in order to minimize tape distortion and maximize the recorded signal. Unfortunately, to an extent, bias makes the record head behave like an erase head, particularly at high frequencies, which penetrate the tape oxide less deeply than low frequencies and are therefore more susceptible to erasure. So there is further treble loss.

Four additional factors can produce treble loss, but these losses are completely or largely avoidable and therefore not represented in Fig. 1. One factor, called iron losses, pertains to electrical characteristics of the record or playback head. But iron losses are quite negligible in a modern head of good quality. Another factor is the gap of the playback head—*not* of the record head, as seems to be a popular misconception. Substantial response to 15,000 cps requires a gap no wider than about 250 microinches (a microinch is one-millionth of an inch) at 7½ ips; 125 microinches at 3¾ ips; 63 microinches at 1⅞ ips; and 31 microinches at 15/16 ips. Modern playback heads have gaps from about 40 to 100 microinches, presenting little or no threat to treble response except at 15/16 ips. A third factor is separation loss, pertaining to lack of intimate tape-to-head contact because of a fault in the tape machine or an accumulation of dirt and tape oxide on the heads. Fourth, there may be azimuth loss, indicating that the gaps of the record and playback heads do not maintain exactly the same angle with respect to the length of the tape—an angle of ninety degrees is the commonly accepted standard.

Equalization Methods

For flat response, the losses of Curve ABC in Fig. 1 must be compensated by the tape amplifier. The minimum amounts of bass and treble boost required are shown in Fig. 2 as the distance between the unequalized record-playback curve and the horizontal line representing flat response. These amounts are considerable, particularly with respect to bass boost.

Where should the equalization be supplied? In the record amplifier? In the playback amplifier? Or in both? The best answer is that which not only achieves flat response but also minimizes distortion and maximizes signal-to-noise ratio. A high-quality machine, in accordance with professional practice, does the following: it supplies all or nearly all the bass boost in playback and it supplies all or nearly all the treble boost in recording.

If substantial bass boost were employed in recording, this would tend to overload the tape and perhaps the record head as well. On the other hand, it is feasible to employ substantial treble boost in recording, without excessive distortion, because in typical audio material the high frequencies are not as strong as the rest of the spectrum. This reduces the likelihood that treble boost will raise the high frequencies to a magnitude which causes overloading. Treble boost in recording is further feasible because, for a given amount of distortion, the tape can be subjected to a somewhat stronger magnetic field at high frequencies than at low ones. Treble boost is largely or altogether avoided in playback because this would emphasize the noise of the tape and of the playback amplifier, resulting in a degraded signal-to-noise ratio.

Some home tape recorders take the easy way out by dividing both the bass and treble boost requirements equally between recording and playback, as in Fig. 3. "Half-and-half" equalization, as this is called, allows the manufacturer to use the same equalization in recording and in playback, thereby saving the cost of additional circuitry and of facilities for switching between different record and playback equalization. But such a machine tends to lose with respect to distortion and signal-to-noise ratio. Also, since it has its own special brand of playback equalization, it will reproduce prerecorded tapes with a decided lack of bass and an excess of treble.

Returning to Fig. 2, it may again be pointed out, but this time with emphasis, that the bass and treble boosts indicated are *minimum* requirements. It is possible to use appreciably more bass and treble boost and still come out with flat response, as can be visualized in Fig. 4. Here 16-db treble boost is employed at 15,000 cps, compared with 10 db in Fig. 2. And 36-db bass boost is used at 50 cps in Fig. 4, compared to 30 db in Fig. 2. Yet in both instances flat response is achieved.

Why use more than the minimum boost? The extra treble boost, *provided that it is applied in recording,* puts more audio signal on the tape and the tape delivers greater output in playback. Hence the signal-to-noise ratio is improved. Getting additional signal on the tape at high frequencies is important because tape noise and tape amplifier noise appear high pitched to the ear.

However, there are limits to the treble boost that may safely be used in recording. Too much treble boost causes the record head to produce an excessively strong magnetic field, thus overloading the tape and causing distortion. The rise in distortion could be overcome by increasing bias, but this would complete the circle by attenuating treble response. Or, the rise in distortion could be offset by reducing the recording level, but this would negate the purpose of augmented boost, which is to increase the recorded level.

Altogether, the amount of equalization employed, and its distribution between recording and playback, reflect a compromise among the conflicting requirements of good treble response, high signal-to-noise ratio, and low distortion.

Current Equalization Practices

A compromise of the sort just described, presumably an optimum one, is entailed in NAB equalization, which is widely employed at 7½ ips. The NAB standard stipulates that playback equalization shall conform to the curve in Fig. 5, *i.e.*, it shall consist of bass boost commencing (3 db up) at 3180 cps and leveling off (3 db below maximum) at 50 cps. This curve shall be modified to the extent that the particular playback head which is used deviates from a 6 db per octave char-

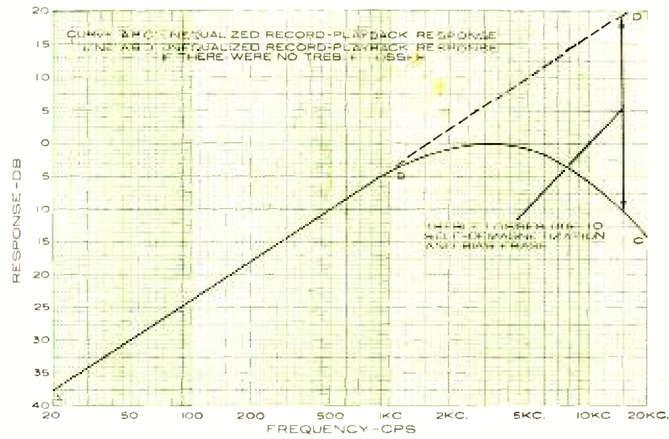


Fig. 1. Unequalized record-playback response at 7½ ips.

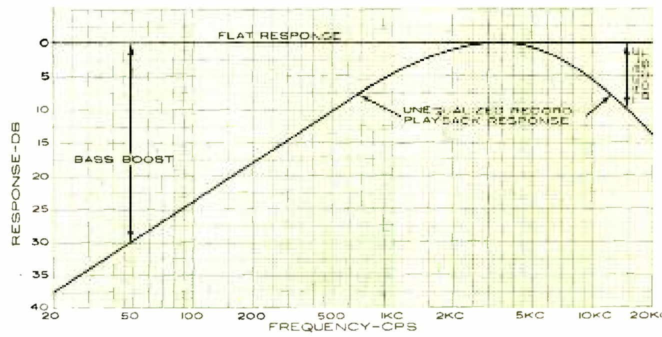


Fig. 2. The minimum equalization required at 7½ ips.

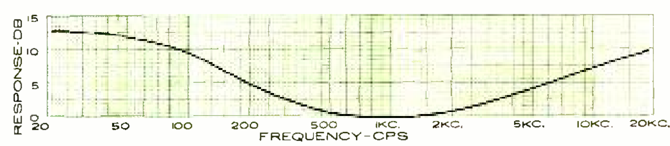


Fig. 3. "Half-and-half" equalization used in some recorders at 7½ ips. Same curve is used for recording and playback.

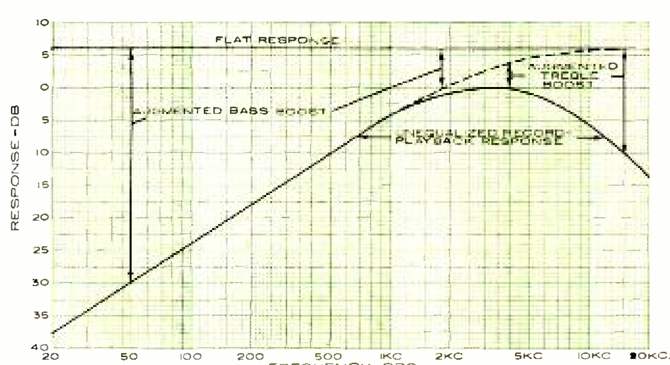


Fig. 4. Use of augmented treble and bass boost at 7½ ips to improve signal-to-noise ratio by recording more signal.

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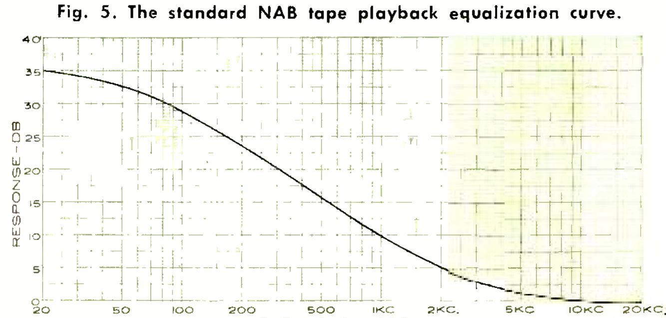
Fig. 5. The standard NAB tape playback equalization curve.



acteristic (some heads, for example, produce somewhat more than the theoretical output at the extreme bass frequencies; some may exhibit significant iron losses, resulting in treble attenuation). Record equalization shall be such that, in conjunction with playback equalization and the particular record head which is used, it will result in record-playback response flat within the following tolerances: ±1 db from 100 to 7500 cps; not more than 1 db up or more than 4 db down at 50 and 15,000 cps.

The NAB playback curve in Fig. 5 is an official standard only for 15 ips. However, it has been found practical for use at 7½ ips as well and is widely, although not universally, employed at the latter speed. (*Ampex* and *RCA* test tapes for 7½ ips—Nos. 31321-01 and 12-5-61T, respectively—incorporate NAB equalization.) Tapes prerecorded at 7½ ips conform to the NAB standard, that is, NAB equalization applied to a

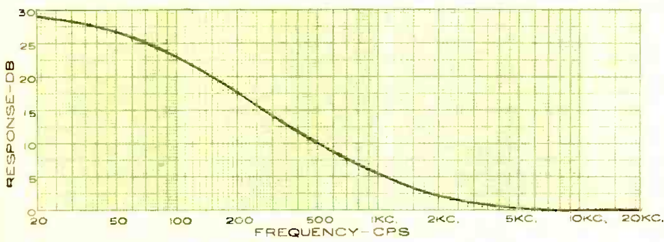


Fig. 6. The modified NAB tape playback equalization curve.

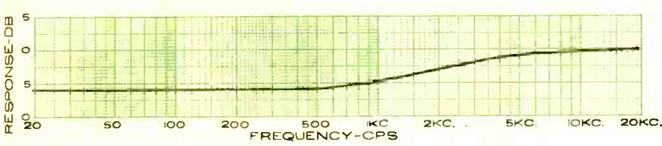


Fig. 7. Bass loss resulting from use of modified rather than the actual standard NAB tape playback equalization.

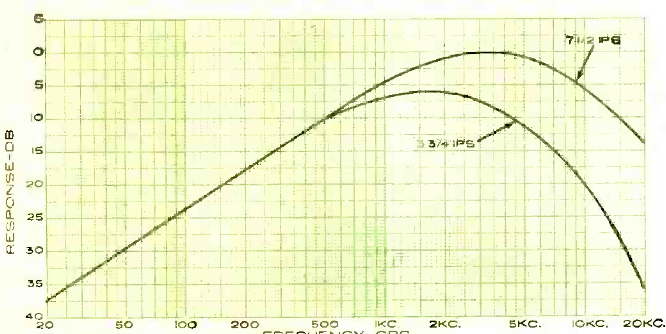


Fig. 8. Comparison between typical unequalized record-playback response at tape speeds of 7½ ips and 3¾ ips.

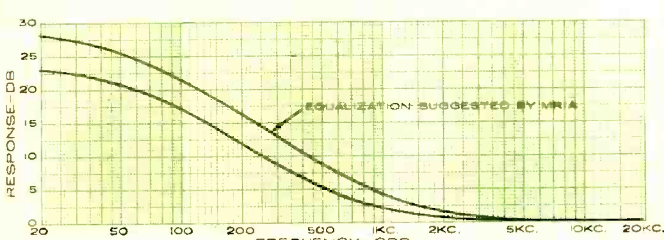
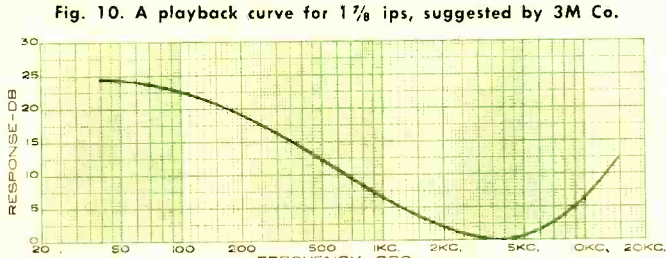


Fig. 9. Two playback curves that are widely used at 3¾ ips.

Fig. 10. A playback curve for 1⅞ ips, suggested by 3M Co.



7½-ips prerecorded tape results in nominally flat response. Virtually all high-quality home tape machines use NAB equalization at 7½ ips.

On the other hand, it has been questioned in some quarters whether the NAB curve is truly optimum for 7½ ips, inasmuch as it implicitly requires quite a substantial amount of treble boost when recording *at this speed* (less boost is needed when recording at 15 ips). Fig. 4 gives an approximate idea of how much treble boost is needed at 7½ ips in keeping with NAB requirements. Some feel that there is too much risk of overloading the tape with so much treble boost, and they point to the European practice (CCIR equalization) which requires significantly less treble boost in recording—about 5 db less at 15,000 cps. However, CCIR equalization entails a slightly poorer signal-to-noise ratio, everything else being equal. The European practice trades a reduction in the amount of distortion for a reduction in signal-to-noise ratio.

Instead of incorporating NAB playback equalization at 7½ ips, some home tape machines provide "modified NAB equalization," such as that of Fig. 6. Now the bass boost commences at 1590 instead of 3180 cps and results in 6 db less total boost. And there is a corresponding reduction in the amount of treble boost that is needed. When a prerecorded tape is played back with modified NAB equalization, the result, as shown in Fig. 7, is to take a broad scoop out of bass response. To some extent this loss can be offset by use of a bass tone control, but is not altogether satisfactory inasmuch as the typical bass control provides a steadily rising boost instead of a broad plateau.

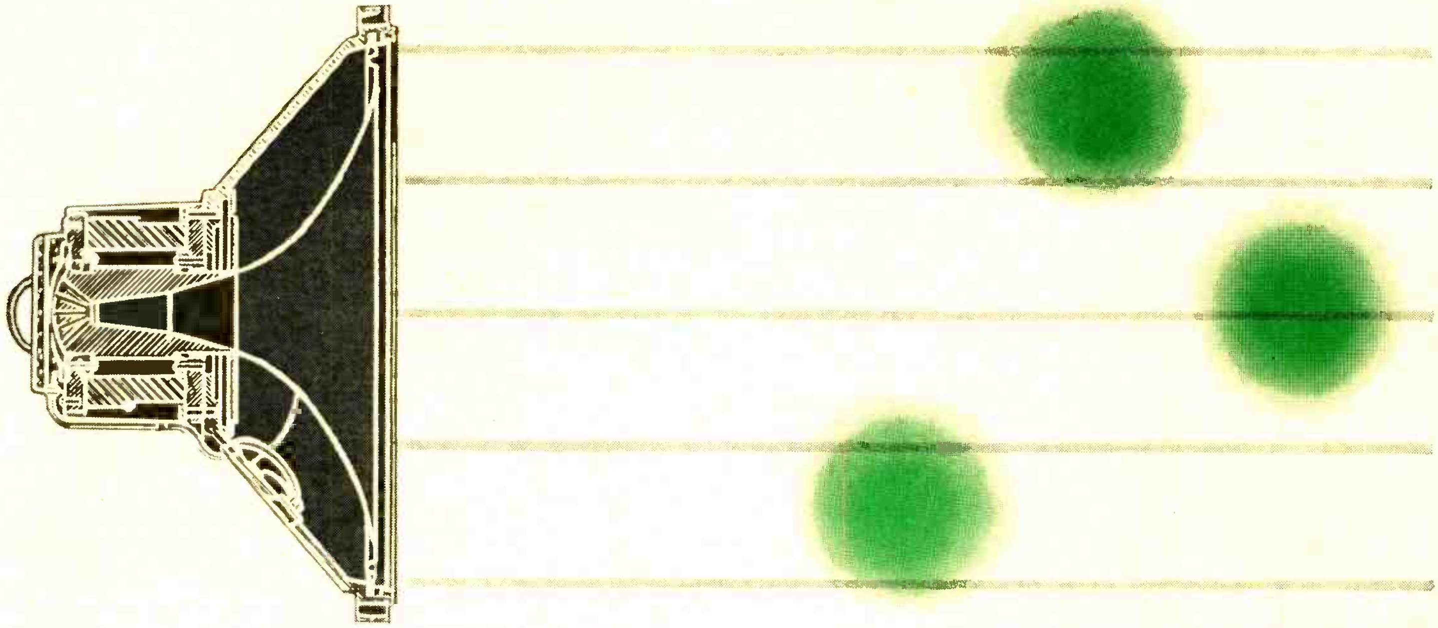
Equalization at Other Speeds

The treble losses previously described, with the exception of iron losses, grow more pronounced as tape speed is reduced. The reason is that the amount of loss depends on the recorded wavelength, which is related to tape speed and frequency by the formula: *wavelength = tape speed in ips/frequency*. The shorter the recorded wavelength, the greater is the loss due to self-demagnetization, bias erase, playback head gap, tape-to-head separation, and azimuth misalignment. It may be seen from the formula that as tape speed is reduced, wavelength also decreases, resulting in greater treble loss. To illustrate, Fig. 8 compares unequalized record-playback response at 7½ ips with that at 3¾ ips for a typical tape machine for home use.

Accordingly, the slower tape speeds require different amounts of treble boost and corresponding bass boost than the faster speeds. By the same token, their optimum equalization curves—reflecting optimum compromises with respect to treble response, noise, and distortion, are also quite different.

Whereas NAB equalization has gained wide acceptance at 7½ ips, at slower speeds there is less uniformity with respect to equalization. At 3¾ ips the situation is probably not too bad, because two fairly similar playback curves, shown in Fig. 9, have come into popular use; one is a curve suggested by MRIA—the Magnetic Recording Industry Association. *Ampex* puts out two test tapes for 3¾ ips. No. 31331-01 incorporates 120-μsec. (MRIA) equalization, while No. 31334-01 incorporates 200-μsec. equalization. Fig. 10 shows the playback equalization that has been recommended for 1⅞ ips by the *3M Co.*, which makes a tape recorder with response extending substantially to 15,000 cps at this speed. In the case of 15/16 ips, the equalization situation appears to be wide open.

It is to be hoped that existing industry bodies will, in the near future, accord to each tape speed in home use the boon of standard equalization, which will permit compatibility between a recording made on one machine and played on another and promote optimum tape-recorder performance as well. ▲



TRANSISTOR-PHOTOCELL COLOR ORGAN

By FRED BLECHMAN

Construction of 3-channel device that changes sound to vari-colored light display. Uses transistors and new high-power photocells to drive 75-w. light source.

HERE is a device which translates audio-frequency signals into a three-colored light display wherein the *color* depends on the *frequency* of the electrical signals, and the *intensity* of the lights responds to the *loudness* of the audio source. This concept of a colored light display that varies in step with music is not new; this device is, however, distinctive in that it provides adequate light output at low cost, using a newly available component.

Previous "dancing light" designs either used small pilot lights driven by transistors or regular 120-volt light bulbs driven by silicon controlled rectifiers. The pilot light units either do not put out much light or require a large array of parallel bulbs, with the consequent additional complexity, expense, and fabrication effort. The high-powered units using regular 120-volt bulbs are quite expensive to build since the required silicon controlled rectifiers and high-current capacity diodes are costly. This color translator, on the other hand, cost the author less than $28 and will safely drive a standard 25-watt bulb for each channel, for a total of 75 watts of light—adequate for viewing under normal levels of living room lighting.

Responsible for the simple and inexpensive design of this device is the new *Delco Radio* LDR-25 power photocell. (See "High-Power Photocell" by James E. Cain in the March, 1964 issue.) Costing only $1.50 each, these photoconductive cells have a maximum power dissipation of 25 watts (when properly mounted on an adequate heat sink), and are designed to operate directly from the 120-volt a.c. line. Since they have no polarity, the LDR-25's are more properly called "light dependent resistors." Since the high dynamic sensitivity of the LDR's allows complete control from a small pilot light, it is a natural combination to use simple low-powered bandpass circuits driving pilot lights to shine directly on the LDR's which, in turn, control the 120-volt bulbs.

The Circuit

The audio input of the user's audio system (from the speaker terminals of a radio, phono, tape recorder, or TV set) passes through a level control and is then separated by *RC* filters into three broad, overlapping frequency ranges or "channels." Each channel is separately amplified to light a small pilot light bulb which, in turn, shines on the light dependent resistor. Each LDR controls the intensity of series-connected 120-volt incandescent light bulbs totaling 25 watts per channel. These bulbs can be arranged in any desired fashion to suit the builder. The display then glows in relation to the frequency (color) and power (brilliance) of the instantaneous audio input.

The schematic of the color translator (Fig. 1) shows the relative simplicity of the device. The circuit, up to the pilot lights, is an adaptation of Leon Wortman's "Transistorized Photorhythmicon" (ELECTRONICS WORLD, May 1962).

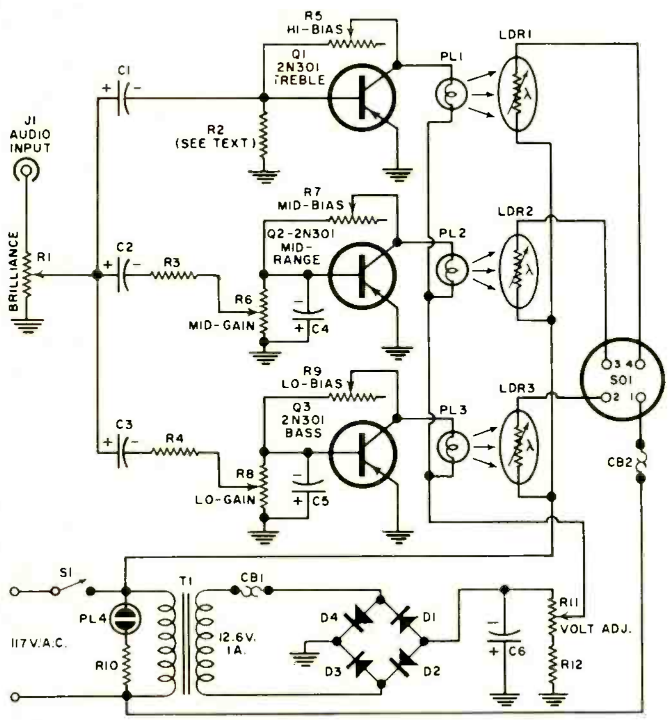
Notice the use of circuit breakers *CB*1 and *CB*2. These low-current (1-amp) glass, self-resetting circuit breakers, which resemble oversized NE-2 glow lamps, are ideal for this application; a short in the power supply, transistors, or pilot lights will open *CB*1 protecting the transformer while a short in the display will open *CB*2 which protects the connecting cable.

The display, Fig. 2, is at the end of any reasonable length of four-conductor cable which plugs into the color translator unit. Any number of bulbs totaling no more than 25 watts per channel can be used in the display.

Construction

The photos show the author's unit which was built onto an 8"x 12"x 3" chassis. Actually, a smaller chassis could be used, as there is room to spare. Wiring and parts placement is not critical, but the mounting of the LDR's must be done carefully. Although this power photocell is a reasonably rugged device, proper mounting of the unit requires a flat surface, controlled mounting torque, and a minimum resistance conduction path for the heat generated by the LDR. The use of a thin layer of silicone grease is mandatory if maximum transfer of heat from the photocell to the heat sink is to be obtained. Make sure the LDR is insulated from the heat sink electrically but connected to the heat sink thermally.

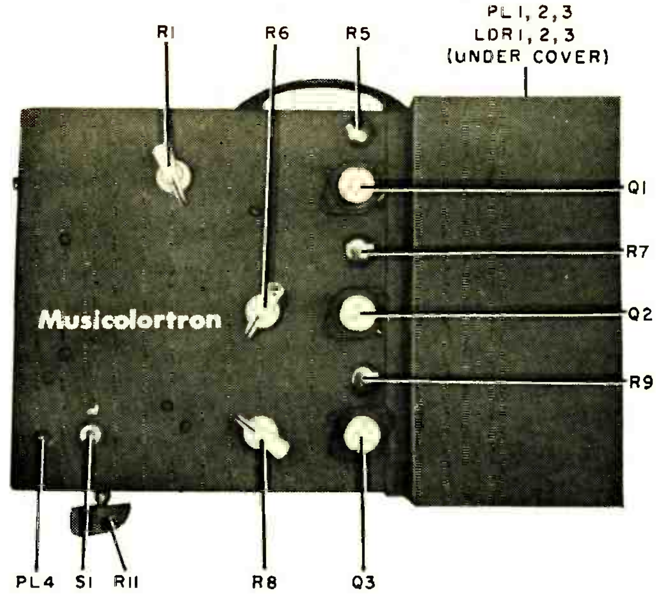
Selection of the proper heat sink is a tricky business which involves heat transfer coefficients, mounting position, LDR dissipation, and other factors. Basically, three low-priced



R1,R6,R8—100 ohm, 1 w. wire-wound pot
R2—100 ohm, 1 w. res.
R3,R4—15 ohm, ½ w. res.
R5,R7,R9—10,000 ohm miniature pot
R10—100,000 ohm, ½ w. res.
R11—25 ohm, 5 w. pot
R12—75 ohm, 5 w. res.
C1,C4—1 µf., 15 v. elec. capacitor
C2—10 µf., 15 v. elec. capacitor
C3—50 µf., 15 v. elec. capacitor
C5—20 µf., 15 v. elec. capacitor
C6—160 µf., 15 v. elec. capacitor
S1—S.p.s.t. toggle switch
J1—RCA phono jack
PL1,PL2,PL3—#47, 6-v., .15 amp pilot light
PL4—NE-2 neon glow lamp
SO1—4-pin receptacle (Amphenol 78-S4S. To match plug on display unit.)
CB1,CB2—Miniature 1-amp. self-resetting circuit breaker (Sylvania "Mite-T-Breaker," Allied 34B075)
LDR1,LDR2,LDR3—Light dependent resistor with insulated mounting kit (Delco Radio LDR-25)
D1,D2,D3,D4—750 ma., 50 p.i.v. silicon power rectifier (Lafayette type SP-266)
T1—Fil. trans. 12.6 v. @ 1 amp (Olson T-304)
Q1,Q2,Q3—2N301 transistor (Delco Radio, with insulated mounting kit)
3—Delco heat sinks (7281360, 7278482, or 7270606. See text on correct unit to use.)
(Delco Radio, 700 E. Firmin, Kokomo, Indiana)

Fig. 1. Circuit of color organ is a modification of one that has previously appeared in this publication.

heat sinks are available from *Delco*. The author, using the smallest heat sink (7281360) has been running 25-watt bulbs per channel with no LDR failures, but the unit gets quite warm. If you want a cooler unit, use the next larger 7278482 heat sink—or the largest, 7270606, which requires a larger chassis.



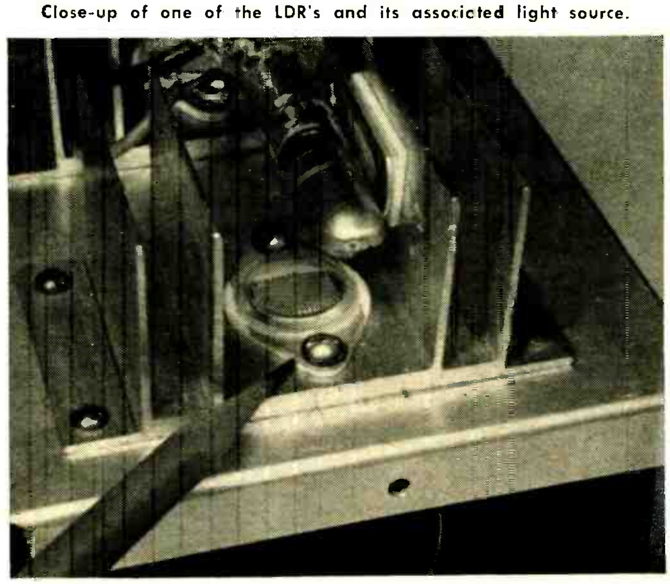
The author has added a carrying handle for ease in handling. The cover at right shields the LDR's against ambient light.

Although measurements show that maximum power dissipation of each LDR is only 8.2 watts when in series with a 25-watt bulb, certain practical limitations prevent the casual experimenter from running the LDR's at higher power levels. The importance of good heat sinking cannot be overemphasized. High transient currents (output bulbs with cold filaments and slow response time) can cause "freckles" (little burned out spots) on the surface of the photocell.

The builder is cautioned against trying to "squeeze" 40 watts per channel out of this unit. Larger heat sinks don't help, since the instantaneous current surge causes spot heating before heat dissipation can relieve the condition. Little bright blue flashes on the surface of the LDR mean that you are running it above its current rating. Since each arc becomes a freckle and each freckle is a high-resistance spot, a few freckles can destroy the cell's ability to act as a low resistance, no matter how much light you shine on it. The result is a sluggish display that won't light brightly.

The pilot light sockets should be placed directly above the LDR's so that the pilot-light filament is above the center of the LDR. The author cemented the sockets to pieces of insulating material that, in turn, are cemented to the heat-sink fins. (Make sure the socket does not make electrical con-

Close-up of one of the LDR's and its associated light source.



tact with the heat sink.) Small metal hoods over the pilot lights help direct their light onto the LDR's, but they are not absolutely necessary.

The transistors must be insulated from the chassis, which is easily and neatly done using the insulating mounting kits supplied with the *Delco* 2N301 transistors. These transistors run very cool in this circuit so no special heat sinking is required. The LDR heat sinks are bolted directly to the chassis which acts as an additional heat sink.

Terminal strips are used where convenient—such as for the silicon power rectifiers and bandpass components. Be sure to observe all diode and capacitor polarities, remembering that chassis is "plus" in this circuit. A four-prong socket on the chassis allows easy disconnection of the display from the color translator. A thin cardboard or metal cover over the LDR section will shield them from ambient light which would affect operation. Paint the completed unit dull black or dark grey to help dissipate the heat and to improve the appearance. Labeling with dry-transfer letters, decals, or embossed tape completes the color translator.

The Display Unit

Ask ten people what they think would be an effective display and you will get ten different ideas. The author's unit is simple and inexpensive. A sheet of white fiberglass is bowed into a "U" shape and nailed to a backboard. A cover piece, cut to the "U" shape, is nailed on top. This forms an enclosure for the three-bulb display which is made from a couple of pieces of wood, sockets, and wiring. A four-conductor cable and plug provide connections for power and control.

You may prefer a horizontal display, with a row of nine 7½-watt bulbs (three per color). Just as long as the total wattage per color does not exceed 25 watts, the system will work. Even colors are a matter of choice. Some people like yellow in the center instead of green; others say the red should be for *high* frequencies, the blue for *low* frequencies.

Checkout and Operation

Do not connect the display or audio source to the color translator at this point. Turn the voltage adjust control, *R*11, to the full-voltage position, the *R*1 brilliance control to minimum, and *R*6 mid-gain and *R*8 lo-gain controls to maximum. Most important, set bias controls *R*5, *R*7, and *R*9 to *maximum* resistance. The pilot lights should be installed. Now plug the color translator into the 117-volt, 60-cycle power line and turn on switch *S*1. The only thing that should happen is that the neon power light should go on. Voltage at the top of *R*11 should be around 15 volts d.c. negative, measured to the chassis. Slowly rotate *R*5 toward a lower resistance setting until *PL*1 starts to glow. Do the same with *R*7 (*PL*2) and *R*9 (*PL*3).

Now connect an audio source (3.2- to 16-ohm speaker terminals) to *J*1. Normal volume provides plenty of driving power. Increase *R*1 and the pilot lights should start "dancing." An audio generator will give you some idea of the frequency response of each channel, but no adjustments are provided or necessary. For sharper bandpassing, the "front end" would require inductors, with a dubious gain in the end product.

Adjust *R*6 and *R*8 to verify that they control the action of *PL*2 and *PL*3 respectively. *PL*1 is controlled by the basic setting of *R*1; using a 100-ohm pot in place of *R*2 will provide added control over *PL*1 if it is needed.

Now you are ready to add the display. Turn off *S*1. Plug the display into *SO*1 and turn the power back on. Remember that the full line voltage appears at the common display bulb terminals, so be careful! With *R*1 set to minimum and the LDR's shielded from external light, set bias controls *R*5, *R*7, and *R*9 so that the incandescent lamps in the display barely glow, and then back off a little to the about-to-glow condition. There is some interaction, but not enough to be troublesome. This will give you the best dynamic response.

The positions of the bias controls will vary with the color and wattage of the bulbs used in the display. They also act as sort of dynamic controls which is why these controls are used instead of fixed resistors. Advance the brilliance control and adjust the mid-gain and lo-gain controls for the desired color balance, a subtlety best left to individual choice. As the unit operates over a period of time, the transistors will heat up a little (especially if they are near the LDR heat sinks) and their characteristics will shift somewhat. This may allow the display bulbs to glow even with no signal. Rather than re-adjusting the bias controls, simply lower the over-all translator power supply voltage with control *R*11. This same control is also useful to correct for any power-line voltage variations. ▲

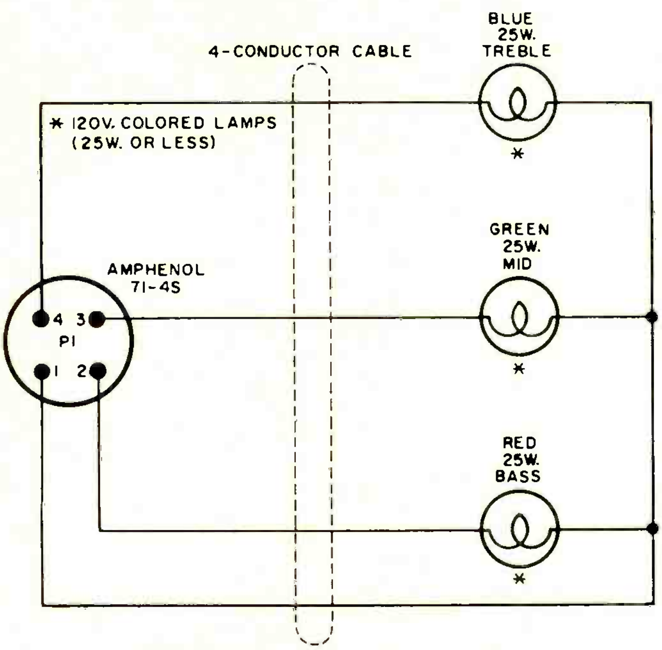
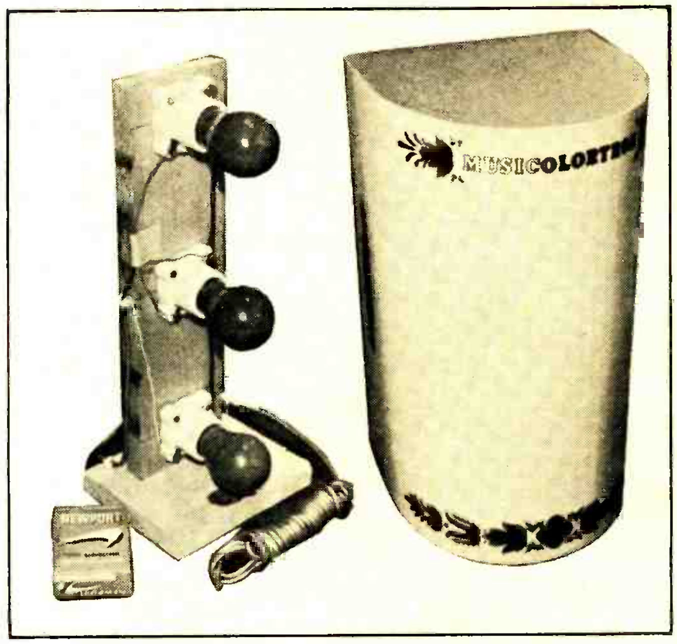


Fig. 2. Circuit diagram of the 75-watt light display unit.



One type of light display that has been used by the author.

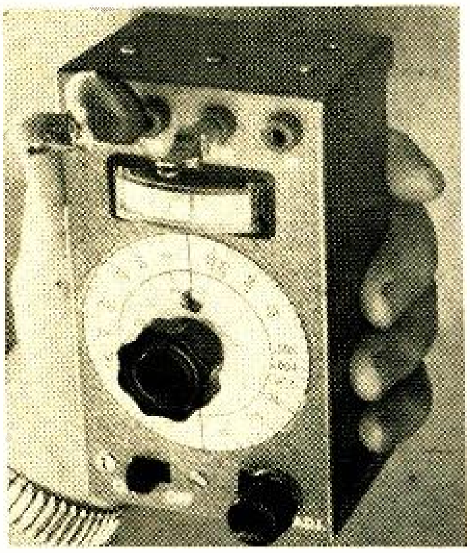


Fig. 1. The capacitance checker can also be used as 1-mc. calibration oscillator.

CAPACITOR VALUE CHECKER

By A. A. MANGIERI

Simple one-transistor capacitance checker can also be used as 1-mc. calibration signal for receivers.

RELIABILITY, portability, and ease of operation are features of this transistorized capacitor value checker. Providing measurement ranges of 0-80 pf., 0-1000 pf., and .001-.1 μf., the checker easily measures the value of small trimmers, variable capacitors, ceramic and disc capacitors, micas, and paper bypass capacitors. In-circuit tests are often possible.

Including a 1-mc. crystal-controlled oscillator, the instrument can also be used as a frequency standard for communications receivers. Construction costs can be as low as a few dollars if you have a 1-mc. crystal and a microammeter. As shown in Fig. 1, the checker resembles a grid-dip oscillator and operates on similar principles.

Circuit Operation

Employing one transistor, the circuit (Fig. 2) uses a 2N1379 transistor as a 1-mc. crystal oscillator. Microammeter *M1* measures the d.c. current in the collector circuit. *L2-C2* is a parallel-resonant tank circuit which resonates at or near the crystal frequency. *L1*, *C1*, and *C3* comprise a second tank circuit inductively coupled to the first tank circuit. *C1* tunes the second tank circuit to resonate at 1 mc.

With *C1* set at near maximum capacity, *L1* is adjusted to resonate the tank circuit to 1 mc. Resonance is indicated by a dip in collector current as indicated on *M1*. As an example of measuring an unknown capacitor, upon connecting a 50-pf. capacitor between jacks *J1-J2*, the tank circuit no longer resonates at 1 mc. with *C1* at near maximum capacity. To re-establish resonance, *C1* must be reduced in value until the series combination of *C1* and *C3* is reduced by 50 pf. At this new setting of *C1*, *M1* again dips, indicating resonance. The scale card of *C1*, calibrated in terms of the unknown C_x, indicates the value of the unknown capacitor.

Range (B), 0-1000 pf., connects the unknown in series with the parallel combination of *C4* and *C5* and the resulting combination in parallel with *C1*. Selecting 1000 pf. as the upper limit of this range is arbitrary. By using the appropriate value for *C5*, the upper limit may be as high as .01 μf. or as low as 350 pf.

For capacitors larger than .01 μf., the circuit arrangement used for range (B) is not suitable as it results in excessive scale crowding at the high end of the scale due to placing a comparatively large capacitor in series with a much smaller one. To avoid this difficulty, the larger capacitors are placed in series with an .01-μf. capacitor, *C6*, and the resulting combination is stepped down in capacitance, as seen from *L1*, by transformer action *via* winding *L3* added to *L1*. This arrangement spreads out the scale calibration nicely for the decades from .001 to .1 μf. over most of the dial. However, leakage reactance between *L3* and *L1* results in undercoupling between the two tank circuits causing small dips in current as *C1* is rotated through the dip point. To compensate for this, a one-turn loop (*L4*) placed on the upper end of *L2* and connected in series with *L3* provides additional energy transfer to the second tank circuit.

Control *R4* serves two purposes. First, it adjusts the gain in the oscillator portion thereby controlling the a.c. power level in the tank circuit. This, in turn, controls the magnitude of the dip in current as *C1* is rotated through the dip point. Excess gain reduces the magnitude of the dip while insufficient gain results in stoppage of oscillations at, or near, the dip point. Second, because transistor *beta* varies with temperature, *R4* is used to compensate for large variations in room ambient. Because the circuit consumes only 1.2 milliwatts of battery power, the temperature of the transistor will be that of room temperature. Once set, control *R4* requires no further adjustments while checking capacitors on any of the ranges.

Resistor *R3* reduces the open base transistor leakage to a much lower value thereby eliminating the need for bucking-out circuits for the meter. *R3* also determines the sharpness of the current dip. With *R3* too high in value, the dip is somewhat gradual with rotation of *C1* through the dip point. With *R3* too low in value, the current dip is over-damped which results in the stoppage of oscillation at or near the dip point. An intermediate value of *R3* results in a sharp and stable dip point. These effects, with respect to the value of *R3*, are gradual, rather than critical, making it easy to select *R3* when using transistors other than the one specified.

R2 limits the maximum current in the circuit for protection of the meter and transistor due to inadvertent shorts, wrong polarities, etc. *R2* may be reduced or eliminated when using less sensitive meters. Collector current is about 130 microamperes with *C1* set well off the dip point. *R1*, shunted across the meter, places the meter pointer at full scale or 100. Trimmer *C9* is used to zero beat the crystal frequency with National Bureau of Standards station WWV.

Construction

A 5¼ x 3 x 2⅛-inch box houses the components. When installing components, allow clearance to permit replacement of the bottom half of the box. Using the parts specified, the centerline of the meter face is 1¼ inches from the top. The variable capacitor shaft is located 2¼ inches from the bottom. Pre-punched holes on the capacitor frame will accept

6-32 self-tapping screws for mounting of the inductors and resistor board. Avoid running the screws into the capacitor plates. Fig. 3 shows the parts layout.

Mount inductors $L1$ and $L2$ exactly ⅞-inch apart and midway between the capacitor frame and the back of the box. Allow a 1/16-inch clearance between the top end of the inductors and the inner surface of the box side. Stiff aluminum brackets support the inductors while a fiber strip spans the top end of the inductors as shown. The resistor board, secured to the capacitor frame, supports several resistors and the transistor. Mount $C4$ on a bracket secured to the top end of the box. The battery compartment is made of light gauge aluminum. Secure the crystal to the box by means of a clamp around the base. Solder a pair of clips removed from an octal socket to the lugs of $C9$. Slip this assembly onto the pins of the crystal. Provide holes in the box for screwdriver adjustment of $L1$, $L2$, $C4$, and $C9$.

Wind $L3$ directly over the lower portion of $L1$ as shown in Fig. 3. Starting from the lower end of $L1$ (nearest the terminal lugs) wind 7 turns of a #26 magnet wire in a clockwise direction from start to finish as viewed from the lower end. Allow a three-inch length at the finish of $L3$ to form the one-turn loop $L4$ on $L2$. Secure $L3$ with coil cement. Loop $L4$ is wound on the upper end of $L2$ in a clockwise direction as viewed from the upper end of $L2$. Locate $L4$ 1/16-inch from the upper end of $L2$.

For rigidity, use #22 solid wire for all wiring in the second tank circuit. Use lighter gauge wire in the remaining portion of the circuit. Insulate the top of the battery plug to prevent shorts. Using thin plastic sheet and a fluted knob, make a double pointer knob for $C1$. Fasten the pointer to the knob with the epoxy cement after roughening surfaces to be joined. Provide a blank scale card for $C1$.

Adjustment and Calibration

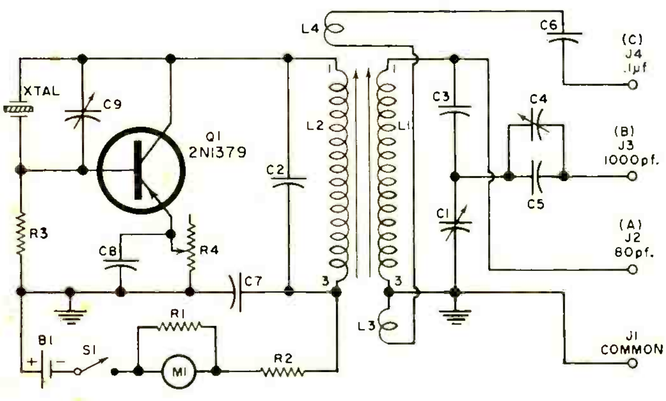
Make, or check the effects of, all circuit adjustments with the lower half of the box in place. First, set $L2$ at near maximum inductance, set $R4$ ("Dip Adj.") at minimum resistance, and turn the power on.

If the circuit is oscillating, $M1$ will deflect to a scale indication between 90 and 100. If not, tune $L2$ until oscillations occur. Set $C1$ at 95 percent of maximum capacitance and adjust $L1$ until a dip takes place. If no dip can be found, increase $R4$. Note that the magnitude of the dip can be altered by variation of $R4$. The above position of $C1$ establishes the zero scale mark on the dial. Set $R4$ so that $M1$ dips from about full scale to half scale as $C1$ is varied through the dip point. If $R4$ is set near midposition, readjust $L2$ slightly to obtain the dip with $R4$ at midposition.

The transistor used had a *beta* of 125. If the transistor the builder uses differs greatly from this value, $R3$ may require selection as follows. Set $C1$ at the dip point and $R4$ for a dip down to 50. Then rotate $R4$ gradually over its entire range and observe $M1$ carefully. It should be possible to set $M1$ at any point on the scale. If not, increase the value of $R3$ by 25,000 ohms and repeat the above procedure. Conversely, $R3$ may be lowered to sharpen the dip point but not to the point where the dip becomes unstable. Adjustments on $R3$, $R4$, and $L2$ interlock to some extent but are quite simple to make.

The next adjustment on $L4$ provides equal dips for C_x equal to zero and .1 µf. without re-adjustment of $R4$. With the 0 to .10 µf. scale pointer set at zero, dip $M1$ to 50, adjusting $R4$ as required. Allow $R4$ to remain at this setting during the following. Connect a .1-µf. capacitor between $J1$ and $J4$ front-panel jacks. Rotate $C1$ to the dip point. If no dip can be found, either $L4$ is undercoupled, or $C6$ may be too large. First, shift $L4$ slightly closer to the center of $L2$ and recheck. Position $L4$ to obtain a dip down to 40 or 50. If $C6$ is too large, the dip point is out of the range of $C1$. $C6$ was made up of several mica capacitors in parallel totaling .0098 µf. Adjust the value of $C6$ (*Continued on page 68*)

Fig. 2. The circuit and the parts list for the capacitor checker. Resonance of the secondary circuit is changed by addition of unknown capacitor. When C1 returns circuit to resonance, collector current dip is indicated on the meter.



R1—3500 ohm, ½ w. res.
R2—47,000 ohm, ½ w. res.
R3—200,000 ohm, ½ w. res.
R4—10 ohm midget pot (Mallory VW-10 or equiv.)
C1—15-409 pf. var. capacitor
C2, C3—200 pf. silver mica capacitor
C4—110-580 pf. trimmer
C5—300 pf. silver mica capacitor
C6—.01 µf. mica capacitor (see text)
C7, C8—.01 µf. disc ceramic capacitor
C9—4-40 pf. midget trimmer
L1, L2—35-300 µhy. inductor (J. W. Miller 2002 or equiv.)
L3—7 t. #26 d.c.c. magnet wire (see text)
L4—1 t. #26 d.c.c. magnet wire (see text)
M1—0-100 µa. meter (Triplett 120 or equiv.)
S1—S.p.s.t. midget slide sw.
B1—9-v. battery
J1, J2, J3, J4—Midget banana jack
Xtal.—1000-kc. crystal (James Knight H-93 or equiv.)
Q1—2N1379 "p-n-p" transistor

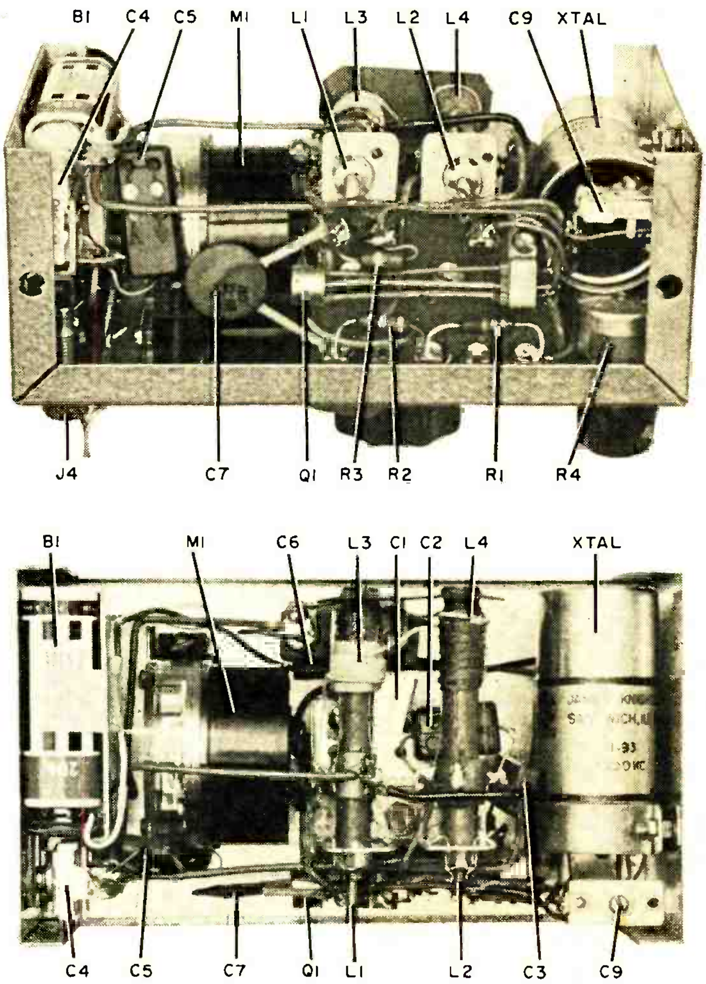


Fig. 3. Physical placement of the component parts of the capacitance checker. Use of the transistor socket is optional.

LIGHT DIMMER & POWER-TOOL CONTROL

By DONALD LANCASTER

Construction of 250-watt dimmer using bilateral switching diode. Can be built into light switch.

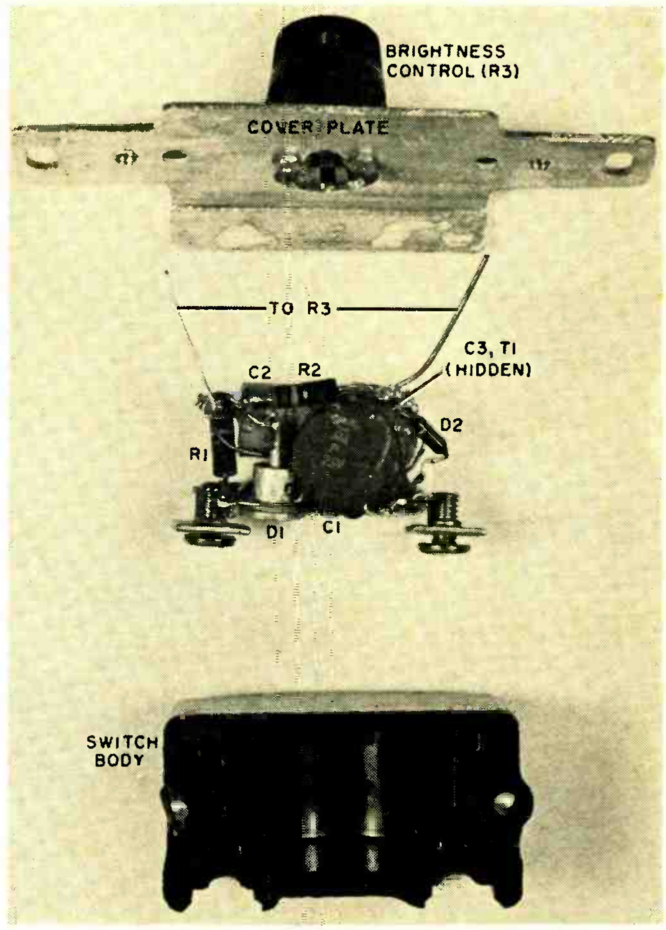
MOST readers will find the electronic control to be described useful either as a light dimmer capable of handling up to 250 watts of lighting power or as a controller for regulating the speed of an electric motor. It can be used to vary the speed of an electric drill or buffer. It can also be used to vary the heat of a small drying oven or other heat source; the temperature of a soldering iron or gun to allow both fine and heavy work from one iron; or the speed of a kitchen mixer or blender.

Unlike some similar devices, this low-cost, 250-watt unit is a full-wave proportional a.c. controller that will give a smooth, continuously variable control of power from zero to full load with a single turn of the control knob. The device is built from standard parts and can be assembled in a few evenings' work.

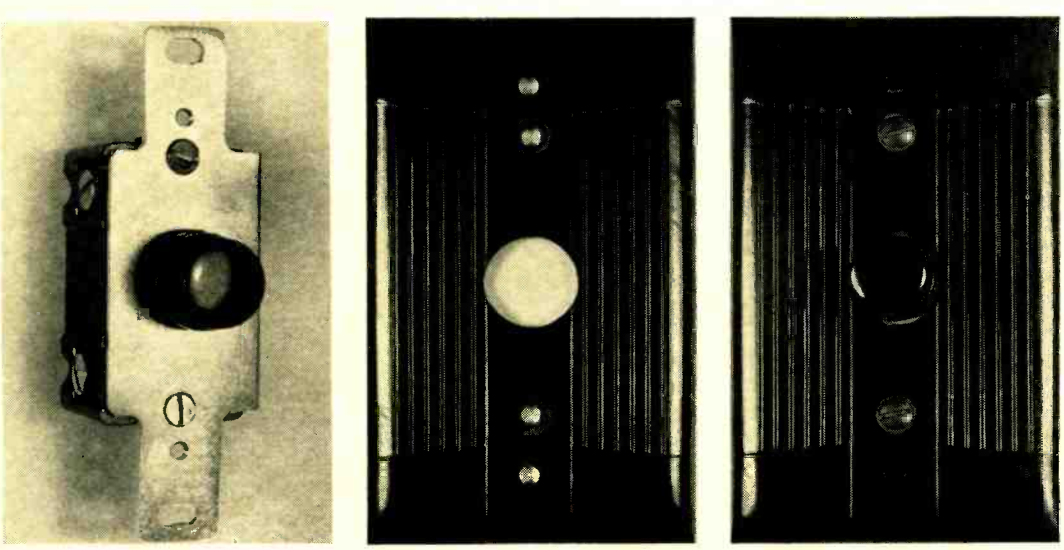
It is built into a conventional light switch and will fit the same space, providing a direct replacement for the conventional wall switch. A double box and a duplex outlet adapt the circuit for the control of power tools.

How It Works

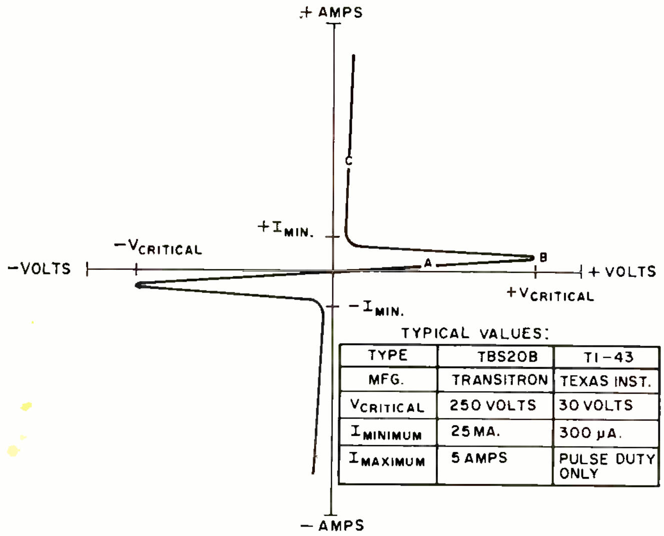
The key to the unit's operation is the relatively new semiconductor device known as a "bilateral switching diode." This device has the unique ability to control large amounts of a.c. power but, unlike silicon controlled rectifiers or thyra-



Photos showing the construction and assembly of the dimmer.



(Left) The completely assembled light dimmer uses a special cover that is screwed into a standard wall-switch housing. (Center) Modified coverplate for the dimmer unit. (Right) Appearance of the completely installed unit.



TYPICAL VALUES:

TYPE	TBS20B	TI−43
MFG.	TRANSITRON	TEXAS INST.
$V_{CRITICAL}$	250 VOLTS	30 VOLTS
$I_{MINIMUM}$	25 MA.	300 μA.
$I_{MAXIMUM}$	5 AMPS	PULSE DUTY ONLY

Fig. 1. When applied voltage is less than $V_{critical}$ (A), the diode draws little current; circuit is "off." At higher voltages (B) avalanche conduction causes diode to conduct heavily. Current is now limited only by load (C). Diode continues to conduct as long as current is at least I_{min}. At lower currents, diode is returned to "off" state. The operation of the device at reverse voltage polarities is exactly the same.

trons, does it equally well in either current direction. This new switching diode is similar to two silicon controlled rectifiers that have been connected in parallel and in opposite directions.

There are two ways of turning an SCR on—the common one of pulsing the gate and the less familiar method of exceeding the forward breakover voltage and avalanching the SCR into conduction. Either method achieves the same results; the SCR turns on and stays on until the anode current reverses direction or is turned off. But this only works in one current direction. A second SCR is needed for bilateral avalanche operation. This is what the bilateral switching diode does. Actually, this device is less complicated than the two-SCR combination and consists of a single five-layer *p-n-p-n-p* structure.

Fig. 1 shows the volt-ampere (*VI*) characteristics of a bilateral switching diode and details diode operation. Basically, we have a device that is in an "off" state until a high-voltage pulse (in excess of the diode's $V_{critical}$) avalanches the diode into conduction, or "on." The diode stays "on" until the circuit current becomes nearly zero and then returns to the "off" state. Current reversals every a.c. zero will always return the diode to the "off" state. Since the circuit is "off" during the presence of the high-voltage pulse, very little pulse power is required to trigger the diode. This high-voltage pulse can be introduced by adding a transformer secondary in series with the diode and the load. This transformer must have a very low 60-cycle a.c. impedance. A high-turns-ratio transformer would allow a low voltage pulse to be stepped up to a high enough voltage value to trigger the bilateral switching diode.

By controlling the point in each a.c. half cycle when this pulse occurs, load power may be varied from zero to full power. This is detailed in the waveforms that are illustrated in Fig. 2.

A variable timer is needed to determine when in each cycle the high-voltage pulse and diode "turn-on" is to be produced. A simple saw-tooth generator consisting of an *RC* circuit shunted by a low-voltage bilateral switching diode is used. A resistor, *R*, charges up a capacitor, *C*, until the voltage across *C* exceeds $V_{critical}$ of the diode. The diode turns "on," discharging *C*. If a high-voltage step-up transformer primary is in the discharge path, high-voltage spikes will be generated. Varying *R* will vary the delay and, ultimately, the amount of power reaching the load. Further, if the *RC* circuit is itself shunted by the main bilateral switching diode (BSD), the entire operation is locked (synced) to the a.c. line. This insures that each delay time will start exactly as the a.c. input swings through zero and that the delay will occur after every a.c. zero. Except for a capacitor filter to eliminate any r.f. noise from the high-voltage spike and the fast turn-on of the main diode, this is all there is to the dimmer-controller circuit which is to be described below.

Practical Circuit

With this design plan, the actual circuit of the unit in Fig. 3 is simple. The a.c. power (*Continued on page 81*)

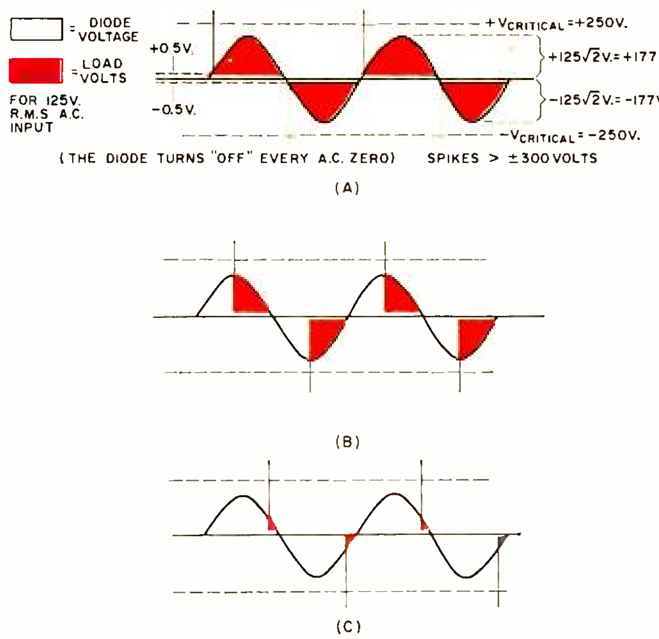
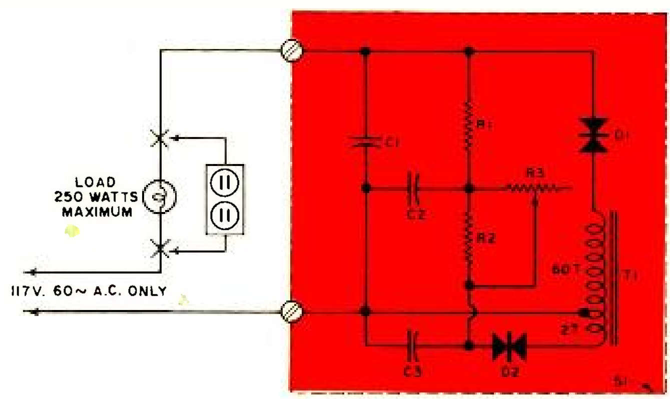


Fig. 2. An RC network and a low-power bilateral switching diode can be used to generate a spike of voltage that can be stepped up by a transformer and used to turn on a main switching diode. With the network adjusted to produce spikes very early in each alternation (A), maximum load current flows. When spikes occur in the middle of the alternations (B), normal load voltage exists only half the time, so only half the power reaches the load. With the circuit set to trigger very late in the alternations (C), very little power reaches load.

Fig. 3. Circuit of dimmer. D1 determines the load current. D2 and RC network produce pulses that act to trigger D1.



R1—10,000 ohm, ½ w. carbon res.
R2—68,000 ohm, ½ w. carbon res.
R3—250,000 ohm miniature pot (Centralab B-16-123 or equiv. Note: Center shaft must be insulated from front plate and operator.)
C1—.02 μf., 200 v. disc capacitor
C2—.1 μf., 200 v. capacitor
C3—.22 μf., 50 v. flat Mylar capacitor (or two .1 μf. discs in parallel)
S1—S.p.s.t. 10-amp Leviton wall switch case (see text)
T1—62 t. #22 en. wire wound on Arnold A4-500-187-HA-P core, tapped at 2 t.
D1—5 amp, 200 v. p.i.v. "Bi-switch" (Transitron TBS-20-B. See text for other ratings.)
D2—30 v. silicon bilateral trigger diode (Texas Instruments TI-43 or Transitron ER-900.)
Note. D1, D2, and Arnold core are available as a "kit" from Kimball Electronics, 3614 N. 16 Street, Phoenix, Ariz., 85016 @ $7.00 each plus postage.

SIMPLIFIED MEXICAN COLOR TV

By LESLIE SOLOMON
Associate Editor

Developed in Mexico, this simple approach to TV switches a three-gun CRT at field rate.

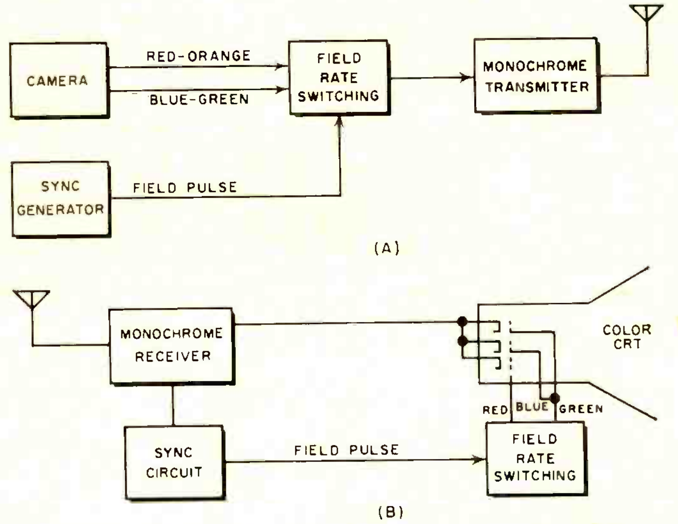


Fig. 1. (A) Transmitter switches between blue-green and red-orange signals at field rate. (B) Receiver is synchronized with transmitter by vertical sync pulse to produce images.

FOR the past year, a TV station, XHGC-TV in Mexico City, has been transmitting an experimental color program every Saturday morning. Although this is not unusual, considering the present state of the art in the U.S.A., what is different is that this station is transmitting a compatible color signal using a simple switching technique developed in Mexico.

The new color system, called Simplified Bicolor System (SBS) and shown in block diagram form in Fig. 1, uses a conventional monochrome transmitter with a special camera and associated switching system. The camera is so arranged that during one field interval, the camera output consists of the red-orange components of the scene being televised and, during the other field interval, camera output is the blue-green component. Because monochrome pulse standards are used, the system is compatible.

The receiver is a conventional monochrome unit feeding a three-gun color CRT. There are no chromatic circuits such as required for viewing the NTSC color signal. Instead, the vertical sync signal is used to switch the red and blue-green guns of the color CRT in accordance with the transmitter. Once the field switching is synchronized, there are no other color controls (except preset individual gun brightness) and color saturation is handled by the contrast control.

Transmitter

The transmitter is a conventional monochrome unit, operated with standard monochrome pulses, but with a special color camera and its associated field-level corrector.

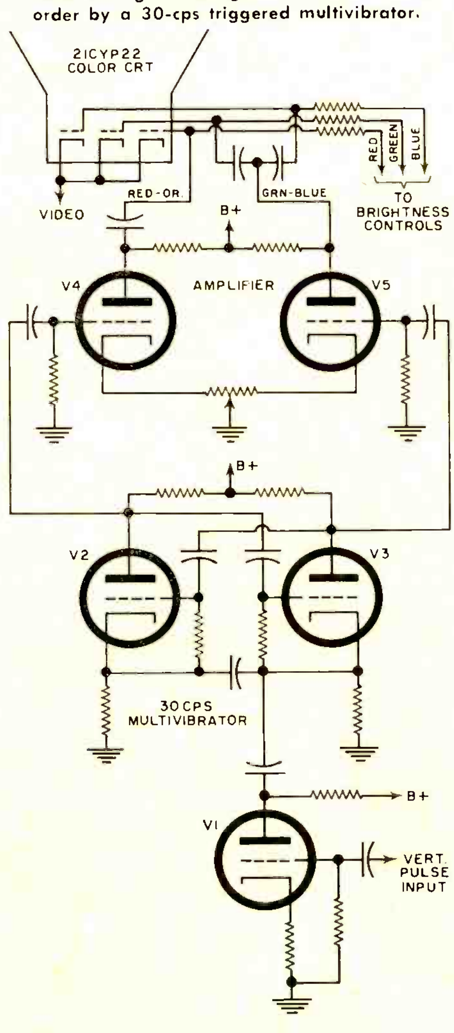
At present, the experimental camera consists of a dual-filter color wheel rotating at field rate in front of an image orthicon with one half of the transparent filter passing only red-orange (700 to 580 millimicrons) and the other half passing blue-green (580 to 470 millimicrons).

Another variation of the camera is being considered. Here, a pair of image orthicons, each with its own filter, is used with the outputs switched into the transmitter at field rate.

Although standard monochrome pulses are used in this color system, it is necessary that each vertical picture field be compensated to avoid the "blinking" that would be annoying if one color field had areas of greater brightness than the other. The "blinking" that is caused by differences in color brightness between fields is reduced by using a maximum color saturation of 60% for each individual color field.

The "blinking" that would be produced by unequal average levels in each field is reduced by a compensating circuit. In this circuit, the uncompensated video is applied through a vacuum-tube mixer whose other input is a square wave having a duration of one field. The field level control adjusts the level of the square wave fed to the mixer so that each field output is biased to average the brightness levels. Once this control is set, there are no other chromatic controls required at the transmitter.

Fig. 2. This is the color switching circuit for the Mexican color system. The color CRT guns are gated in the correct order by a 30-cps triggered multivibrator.



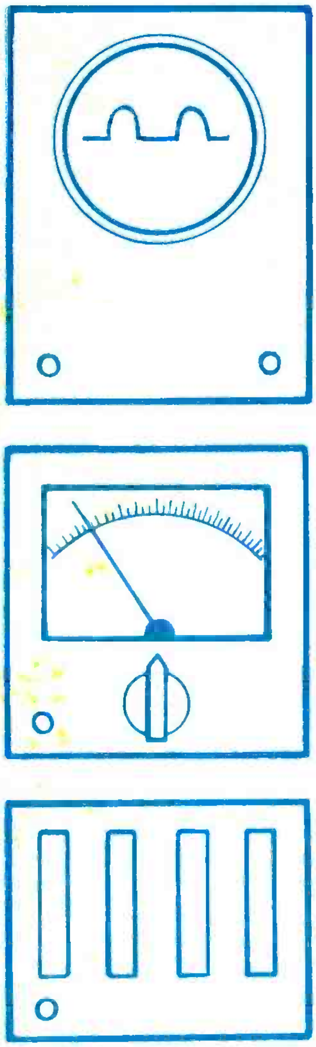
Receiver

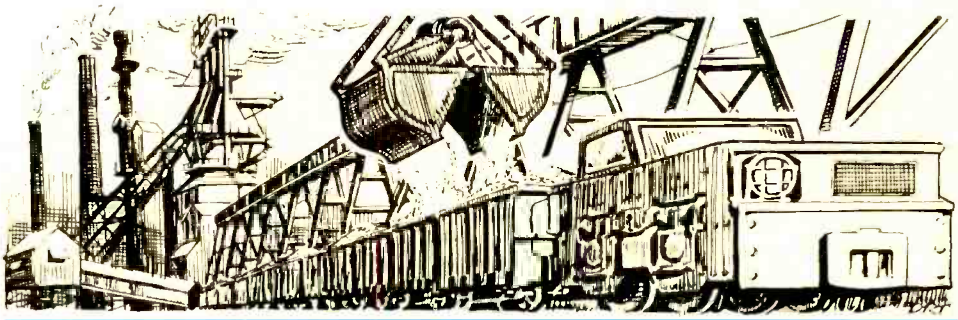
The receiver for use with this color system can be either a conventional black-and-white receiver equipped with a color CRT with its associated color purity components and circuits, but not with any of the usually used chromatic circuits, or a color-TV set with its associated color tube and color purity components and circuits, with the chromatic circuits disabled.

In place of the normally used color signal extraction and processing circuits found in NTSC signal receivers, the electronics for this system consists of an electronic switch operating at field rate (30 cps) synchronized by the vertical sync pulse. The circuit is shown in Fig. 2.

The vertical pulse is amplified by *V1* and is used to synchronize 30-cps multivibrator *V2-V3*. The 30-cps output signal from this multivibrator is amplified by *V4* and *V5* with the resultant signal used to gate the color CRT on and off

(*Continued on page* 71)





TRANSDUCERS FOR INDUSTRIAL INSTRUMENTATION

By RAY A. SHIVER / Instrumentation Lab., Air Research Mfg. Co. of Arizona

Simplicity of operation is the keynote of the many varied industrial transducers used to convert a great number of mechanical parameters into useful electrical signals.

INSTRUMENTATION in industry is concerned with the measurement of physical phenomena associated with the operation of an industrial process. Of prime interest to the instrumentation engineer and technician is the accurate determination of such factors as heat, pressure, vibration, strain, speed, position, and flow. To convert a physical factor into a corresponding electrical signal that can be measured with an instrument requires a device called a transducer. Although these devices range from simple to very highly sophisticated types, they all operate on well-known physical principles. This article covers some of the most common types used, along with the electronic instrument used to provide the readout system necessary to convert the electrical signals into meaningful information.

Transducers can be separated into two basic types—those that require an external excitation signal, and those that are self-generating. The former require some type of excitation voltage (a.c., d.c., or r.f.) and return a portion of this voltage to the measuring instrument as the signal to be measured. The self-generating types generate signal voltages without the use of any external excitation voltage.

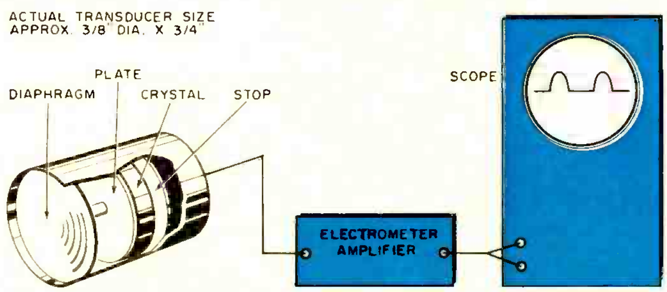
Piezoelectric

A well-known example of a piezoelectric transducer is the crystal pickup cartridge used in record players where mechanical vibration is converted to electrical signals that correspond to the original recorded material. This is possible because of the ability of certain crystals, such as Rochelle salts, to produce electrical signals when acted upon by mechanical stress. Such crystals will also produce mechanical vibrations when an external voltage is impressed on them.

Piezoelectric transducers for use in instrumentation circuits are generally made from one of the ceramic materials (such as barium titanate) having piezoelectric properties. Such ceramic materials are not as susceptible to changes in temperature and humidity as are some of the natural crystalline structures and are useful in instrumentation because they offer high output, excellent frequency response, practically no phase shift, and small, compact construction.

One use for piezoelectric materials is the construction of miniature pressure transducers to measure rapidly fluctuating pressure pulses such as those found in the combustion chambers of engines and rocket motors. Fig. 1 shows such a transducer and associated circuit. The transducer is made very small to respond to high-frequency pulses. In operation, pressure pulses striking the tiny diaphragm distort the crystal

Fig. 1. Piezoelectric transducer generates a voltage when the diaphragm is struck. Electrometer prevents crystal loading.



and produce an output voltage analogous to the pressure signal. The electrical signal is then fed to the electrometer amplifier and thence to the oscilloscope. The electrometer amplifier is necessary to prevent loading the transducer crystal. The input impedance of this type of amplifier is very great, generally above 10^{10} ohms.

The transducer is usually calibrated statically; that is, an accurately known pressure is applied to the pickup and the oscilloscope is adjusted for the desired d.c. displacement. Some electrometer amplifiers, designed for this type of transducer, have a built-in variable capacitor to supply a static charge equal to that produced by the pickup. The dial reads directly in pounds per square inch (psi) and is set to the desired calibration point.

Since high temperature is the great enemy of piezoelectric transducers, some means must be used to protect them when operated at elevated temperatures. In the case of miniature pressure transducers, this is accomplished by special mounting features which are air or water cooled to prevent excessive heat from destroying the pickup.

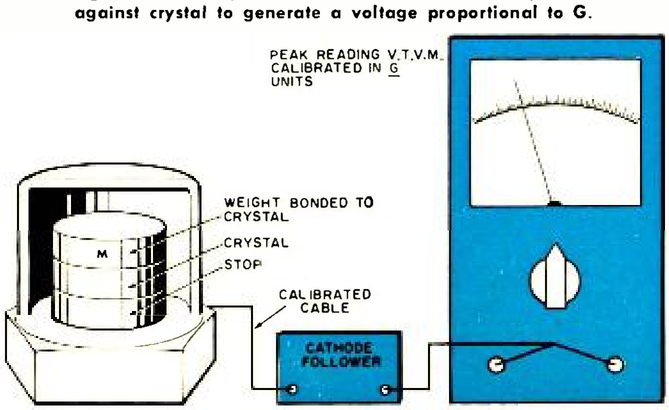
The accelerometer is another type of transducer that can make use of the piezoelectric principle. The device shown in Fig. 2 is of the compression type; that is, the crystal element is compressed by mass M when the unit is subjected to vibration. Since the crystal accelerometer is also a very-high-impedance device, the cathode follower is necessary to permit long cable runs without excessive loss of signal and frequency response. The short length of cable between the cathode follower and the accelerometer is designed for extremely low-noise characteristics to eliminate static-charge noise caused by flexing and bending of the cable when the unit is subject to vibration. The cable is generally calibrated and furnished with the accelerometer. The peak-reading voltmeter is used as a readout instrument because vibration is seldom a simple sinusoidal motion but rather is a complex waveform that would introduce considerable error in an r.m.s.-type voltmeter.

One accurate method for calibrating piezoelectric accelerometers is the use of a sine-wave generator, test fixture, and a calibrated microscope. The accelerometer to be calibrated is mounted on the vibrating test fixture and the fixture is made to vibrate at some low frequency. The desired amount of displacement is arrived at by adjusting the drive current to the vibrating fixture while viewing a reference mark on the fixture through the calibrated microscope. Once the displacement and frequency are known, the accelerometer can be calibrated in G units from the formula: $G = 0.0511Df^2$ where G is units of gravity (386 inches/sec^2), D is displacement peak-to-peak amplitude in inches, and f is vibration frequency of the accelerometer in cycles per second.

Photovoltaic

Photovoltaic transducers convert light energy directly into electrical energy and are useful for a variety of purposes in

Fig. 2. In this crystal accelerometer, the weight presses against crystal to generate a voltage proportional to G.



industrial instrumentation. When coupled to a sensitive microammeter, a photovoltaic cell can measure light intensity directly. This approach is the basis for the photographic light meter.

One of the more efficient types of solar cells is constructed of silicon. A junction is formed of a p- and n-type layer which induces electron flow when exposed to a light source. Banks of these silicon solar cells are used to power satellite instruments.

An electronic tachometer using a photovoltaic cell as a transducer is shown in Fig. 3. The perforated disc is usually attached to the shaft of the rotating member (electric motors, generators, engines, turbines, etc.) and the pin-point light source is adjusted to illuminate the photovoltaic cell with the passage of each perforation in the disc. The pulsed signal is fed to the electronic tachometer which reads directly in rpm.

Calibration is simple and depends solely on the number of perforations in the disc. The formula is: $f = (DP/60)(rpm)$ where f is the frequency in cps, DP is the number of disc perforations, and rpm is in revolutions per minute.

For example, if the disc used contained 20 perforations and it was desired to calibrate the tachometer for 9000 rpm, substitution in the equation would give an answer of 3000 cps. An audio oscillator can be used to furnish the 3000 cps signal to calibrate the tachometer at the 9000-rpm point. It

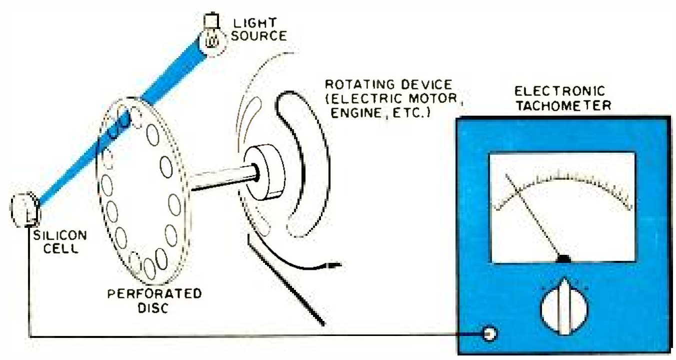


Fig. 3. Electronic tachometer is used for rotating machinery.

is quite convenient to use a disc containing 60 holes if it is desired to read output rpm directly in cps.

Electromagnetic

Electromagnetic transducers operate on the principle of a conductor cutting magnetic lines of force. They are principally dynamic transducers; that is, their operation depends on movement of either the conductor or magnetic material. A well-known example of a magnetic transducer is an electric generator.

Fig. 4 illustrates a device for measuring flow in liquids and gases which uses this principle. Gas or liquid flow through the device causes the miniature turbine wheel to spin at a rate proportionate to the flow-rate of the liquid or gas. A magnetic pickup, located within the flowmeter, generates a pulse for every passage of a turbine blade and thereby produces an a.c. voltage whose frequency is an indication of flow.

The vanes that support the turbine wheel at the inlet side of the transducer "straighten" the flow stream so that when it reaches the turbine wheel, it is not turbulent or swirling as this would tend to produce false readings from the instrument. The interior of the turbine housing is streamlined to prevent turbulence from forming at the outlet of the flowmeter.

The digital frequency meter shown in the diagram is one of the more commonly used instruments for the readout of flowmeters. If flow rate is desired, the instrument is set to read frequency (events-per-unit-time) usually in cps. Flowmeters

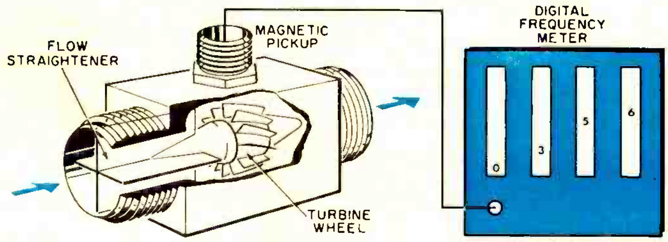


Fig. 4. The flow-rate transducer uses the gas or liquid flow to generate a voltage proportional to the material flow rate.

are furnished with calibration sheets to convert the cps reading into gallons-per-minute, pounds-per-hour, or other desired quantity.

If total flow in a given length of time is desired, the digital frequency meter is set to start counting at the beginning of the flow and stopped when the flow ceases. The total count indicates the volume of flow between time limits.

Thermoelectric

The thermoelectric (Seebeck) effect is the generation of a voltage by the difference in temperature between the junctions of two dissimilar metals. Transducers that use this principle to indicate temperature are called thermocouples. They are widely used in instrumentation since they can be produced cheaply, are extremely accurate, and can be used over long cabling distances.

Fig. 5 shows a typical setup for measuring temperature. The particular thermocouple used in this example is iron-constantan which has a linear output for a temperature range from around the freezing point up to about 1500 degrees F. The cold junction must be maintained at some constant temperature, in this example 150° F. Before accurate temperature-regulated reference junctions were available, it was common practice to use ice water for the cold junction since it maintained a constant temperature of about 32° F.

The wire used between the thermocouple and the reference junction must be made of the same material as the thermocouple, otherwise a junction of dissimilar metals would be formed at the thermocouple which would lead to inaccurate readings. From the cold junction to the readout instrument, conventional copper wire is used. The digital voltmeter reading can be converted into temperature by consulting a set of tables published by the National Bureau of Standards for the particular type of thermocouple material used.

Self-balancing potentiometers are also widely used as a readout instrument for thermocouples. They employ a built-in reference junction, a chopper-type d.c. amplifier, and a large servo-operated drum-type dial calibrated directly in temperature. This, together with banks of push-button selector switches, permits the rapid reading of many thermocouples in a short period of time. Conventional thermocouples are not suited to measure rapidly fluctuating temperatures since the thermistor bead constitutes a considerable mass and does not cool or heat rapidly. For fast response types, a fine filament of the thermocouple material is strung between two supporting pieces to permit a very rapid heating and cooling cycle. Signals from this type of transducer are usually displayed and photographed on an oscilloscope, or recorded on an oscillograph using high-frequency galvanometers.

Capacitive

Transducers that employ a change in capacitance to indicate some mechanical function are commonly used in instrumentation. Since this type of measuring system is all electronic, it possesses excellent frequency response and is capable of high accuracy when used within limitation. Such systems are very useful for measuring minute spacings.

A tuned circuit can be used to measure deviations from true center (runout) on the shaft of a rotating device as shown in Fig. 6. The probe consists of a number of turns of wire, tapped at a suitable point to permit low impedance coupling between the pickup coil and the instrument. The capacitance position of this tuned circuit is formed between the grounded rotating shaft and a small disc located at the ungrounded end of the coil. The networks are coupled to the tank of an oscillator at the measuring instrument and a change of capacitance between the disc and the metal shaft produces a frequency change that is proportionate to distance. A demodulator circuit converts the FM signal into an analog output voltage.

A device such as this is quite temperature sensitive and, if large gradients are present, steps must be taken to retain a near constant temperature at the probe or excessive drift is likely to result. This can usually be accomplished by subjecting the pickup to a steady stream of cooling air.

Calibration of the transducers requires a precision set of measuring blocks (similar to automotive feeler gages) for the range of displacement desired. The probes will indicate differences of a few microinches and great care is required for an accurate calibration. The probes are first balanced for zero output at the operate position, then, using the precision blocks, they are moved toward the shaft to the desired calibrate position. Once the probes have been calibrated, they are returned to the operate position and the amount of deflection is noted on the oscilloscope.

When the test setup is in operation, a small circle or dot on the oscilloscope screen indicates the shaft is stable. A large circle indicates a corresponding amount of instability.

Resistive

Transducers making use of this principle to generate signals employ a variety of materials including carbon, wire, foil, and semiconductors. When excited with a current, a change in resistance of the element will produce a corresponding output signal. Fig. 7 shows a setup for measuring force using a device called a load cell. This transducer uses

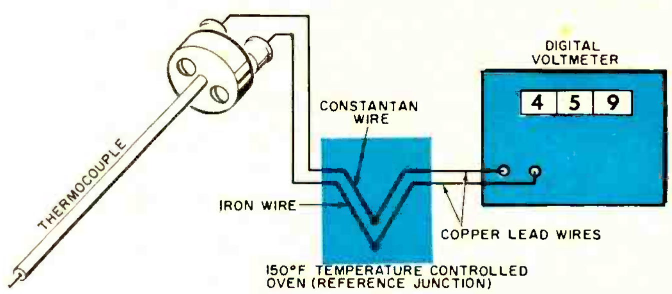
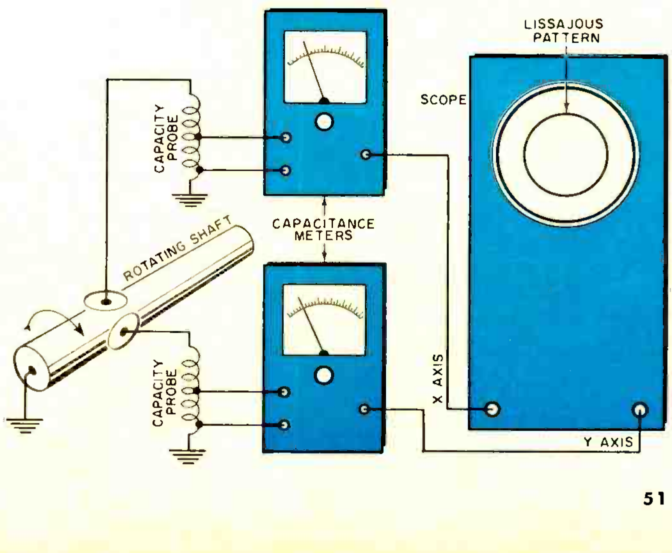


Fig. 5. Temperature measurement by the thermocouple technique.

Fig. 6. If the rotating shaft is off center, frequency of the tuned circuits vary and eccentricity is read out on scope.



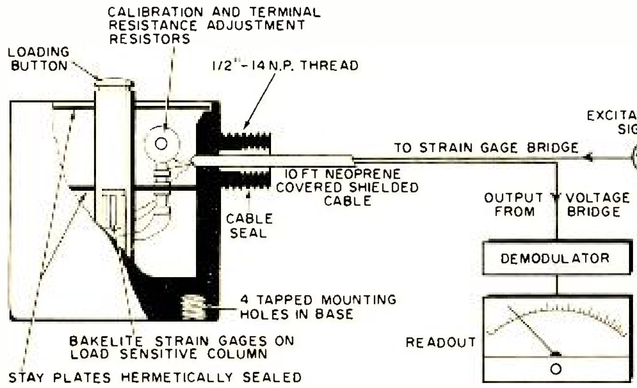


Fig. 7. When weight is applied to the load cell, it unbalances the strain-gage bridge thus producing an electrical readout.

wire resistance elements (or strain gages) arranged in a bridge circuit. As shown in the diagram, they are bonded to a metal column which receives the force-action to be measured. A force applied to the column causes the strain gages to change resistance and thereby unbalance the bridge, producing an output voltage. Either a.c. or d.c. voltages can be used to excite this type of transducer and very accurate results can be obtained. An audio frequency signal powers the transducer while the readout is a phase-sensitive demodulator circuit for the bridge unbalance voltage. If d.c. current is used to excite the unit, a sensitive galvanometer-type instrument can be used to indicate the load directly.

Load cells for the lower ranges (about 0-1000 lbs.) can be calibrated by the application of accurate weights to the transducer while adjusting the readout instrument accordingly. For calibrating larger sizes, a hydraulic force-testing machine is used.

Manufacturers of load cells stipulate a gage (or sensitivity) factor for each load cell for calibration purposes. Readout instruments designed for use with this type of transducer generally have a calibrated gage factor dial which permits the instrument to be used with transducers of different sensitivities. As long as the transducer retains the basic sensitivity it can be calibrated by setting the readout instrument for the appropriate gage factor figure.

To illustrate the versatility of resistive type transducers, a unique one is shown in Fig. 8. This particular instrument is known as a hot-wire anemometer and is capable of detecting very slight changes in wind velocity. It is useful for detecting minute pressure changes in shock tubes, wind tunnels, air compressors, and related applications.

As shown in the diagram, the anemometer comprises one leg of a Wheatstone bridge circuit. The filament (resistive element) of the transducer is usually made of nichrome or platinum wire since it must run at quite a high temperature in order to be effective. To operate the probe, it is placed into the air stream to be investigated and current is applied in small steps while keeping the bridge circuit in balance. This procedure is followed until the desired output is obtained. The resistance of the probe increases as more current is applied. As air passes the transducer, the exposed filament is cooled causing a resistance change proportionate to air velocity. The readout instrument shown is an oscilloscope although other instruments having a suitable frequency response can be used including a recording oscillograph to provide a permanent record.

Hot-wire anemometers are rather difficult to calibrate precisely since they require an air flow with the dynamics similar to that under investigation if they are to be accurate. A good approximation can be arrived at by changing the flow rate by known steps while noting the output from the anemometer at a constant current setting. If turbulence is present in the flow under conditions of actual use, the anemometer readings will not reflect true flow conditions.

Inductive transducers require an a.c. excitation voltage and generally some form of resistive and capacitive balance. This principle is applied to transducers for measuring such physical phenomena as pressure, vibration, displacement, and flow. They exhibit good resolution, high output, and relatively good linearity.

Such a device is the differential transformer shown in Fig. 9. This transducer can be used either to measure large displacements of several inches or accurately indicate a total travel of only a few hundred microinches. The construction consists of three windings around a movable core of magnetic material. *L*1 is the excitation winding and is coupled to a source of a.c. voltage. *L*2 and *L*3 are connected so that their outputs cancel when their mutual coupling to the excitation winding is the same. In this condition, the transducer is balanced and the output will be zero. When the core is moved, the coefficient of coupling between the pickup coils and the excitation winding changes, the transducer is no longer in balance, and an output voltage appears proportionate to the amount of core travel. Balance controls are used to eliminate small differences in resistance and reactance between the two pickup coils.

The a.c. excitation voltage used with typical differential transformers ranges from the low audio frequencies to frequencies as high as 20 kc.

If sufficient excitation voltage is used, a vacuum-tube voltmeter can be used as a readout instrument. It should be capable of reading down to 10 millivolts r.m.s. or less since the output of the transducer for small lengths of core travel will be quite small.

The variable differential transformer can also be constructed with a rotating core, in which case it is used to measure degrees of rotation. Precise angular measurements can be made to fractions of a minute. This type is useful for indicating the movement of valves, control surfaces, and the like.

Although the transducers discussed in this article are used for the measurement of pressure, temperature, flow, force, speed, proximity, angle-position, and vibration, the list is by no means complete. There are many transducers that can be used for measuring a single physical phenomenon, each using a different principle. For example, temperature can be measured by thermocouples, a resistance thermometer, optical pyrometer, or a mercury thermometer. The one chosen for a specific application would depend on the range to be measured, convenience of use, and accuracy desired. For this reason, the examples chosen for this article were meant to illustrate some of the more widely used types of transducers but not necessarily the only ones for a specific application. ▲

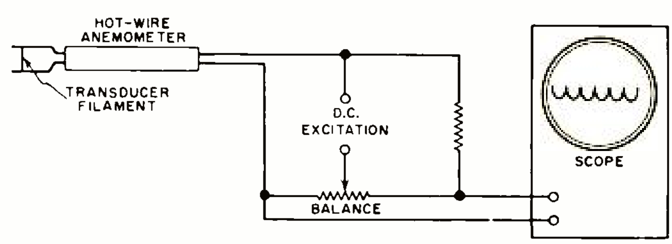
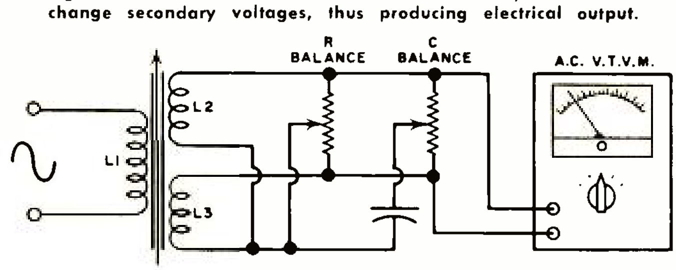


Fig. 8. Hot-wire anemometer measures changes in wind velocity.

Fig. 9. Differential transformer uses core displacement to change secondary voltages, thus producing electrical output.



THIS NEW HEATHKIT® FM STEREO GENERATOR

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• Produces all signals required for trouble-shooting and alignment of multiplex adapters, FM tuners and receivers • Generates mono FM or composite stereo FM signals • Crystal-controlled 19 kc (±2 cps) pilot signal, level adjustable from 0 to 10% for check of tuner lock-in range • Switch selection of 400 cps, 1000 cps, 5000 cps, 19 kc, 38 kc, 65 kc or 67 kc SCA test signals for complete alignment capability • 100 mc sweep signal (adjustable ±2 mc) for overall RF & IF alignment • Built-in markers for 10.7, 90.95, 96.3, 101.65 & 107 mc • No balance adjustment required for equal right and left channel modulation levels • Phase test for accurate adjustment of subcarrier transformers

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Versatile Performance! Signals generated by the Heathkit IG-112 include an audio or composite stereo signal for multiplex adapter adjustments or an RF carrier modulated by these same signals to produce an "on-the-air" signal just like that transmitted by an FM station. A sweep function is also provided for over-all RF-IF alignment with marker frequencies at 90.95 mc, 96.30 mc, 101.65 mc and 107 mc for checks of dial tracking. Instant selection is made between either Right or Left channels, as well as a special "Phase Test" for accurate adjustment of stereo subcarrier transformers. No balancing is required for equal right and left channel modulation.

Advanced Design! Switch-selected audio frequencies include 400 cps, 1000 cps, 5000 cps, 19 kc, 38 kc and special SCA frequencies for either direct or RF carrier modulation use. The SCA frequency is selected by a rear panel switch to be either 65 kc or 67 kc, providing a versatile system capable of aligning even the most deluxe tuners of advanced design. A crystal-controlled 19 kc (±2 cps) pilot signal adjustable in level from 0 to 10% is provided to check the lock-in range of stereo receivers.

Easy To Use! RF signals supplied by the generator terminate at a 300 ohm balanced output, designed for direct connection to the antenna terminals of the tuner or receiver being tested . . . no complicated matching networks for impedance or balance required. A three-step (20 db per step) RF attenuator in addition to the variable output control, prevents overloading tuner input, and the carrier is adjustable ±2 mc up or down to permit alignment on a clear portion of the FM band.

Easy To Build! Clean, open circuit layout provides easy access to all components for greatly simplified assembly. Complete with test leads and detailed stereo alignment instructions. Order your Heathkit FM Stereo Generator now for faster, easier servicing . . . extra profits in this greatly expanding field of Stereo FM.

Kit IG-112, 10 lbs. $99.00

Export model available for 115/230 V. AC, 50-60 cps; write for details.

IG-112 SPECIFICATIONS—RF Signal Output: Center frequency: 100 mc adjustable by approx. ±2 mc. **Pilot modulating frequency:** 19 kc ±2 cps. **FM modulation:** Left channel (stereo), right channel (stereo), Phase test (left plus right channel in phase). Monophonic FM. **Deviation:** Adjustable to 75 kc. **Sweep rate:** 60 cps. **Sweep width:** Adjustable to 750 kc. **RF attenuator range:** 60 db in 20 db steps. **Crystal-controlled markers:** 10.7, 90.95, 96.30, 101.65, & 107 mc. **Composite signal output:** Left channel (stereo). Right channel (stereo). Phase test (left plus right channels in phase). **Audio output:** 400, 1000, & 5000 cps; 19 kc (±2 cps); 38 kc; & SCA (65 or 67 kc). **Maximum distortion:** (at 400, 1000 & 5000 cps) 5%. **Front panel controls:** 19 kc pilot level control, deviation-sweep width-composite, level-audio level control, function switch, frequency switch, & RF attenuator switches. **Rear panel adjustments:** Balance adjust, 38 kc sync, pilot level adjust, & SCA frequency switch. **Chassis adjustments:** Oscillator adjust, frequency adjust & modulation adjust. **Tube complement:** 12AT7—19 kc oscillator & 19 kc doubler; 6AU8—19 kc buffer & 38 kc amplifier; 6AN8—Reactance tube modulator & 100 mc oscillator; (3) 12AU7—Audio osc.; audio cathode follower & 19 kc pilot amplifier; composite/audio amplifier & 5.35 mc crystal osc. **Power requirements:** 105-125 volts AC, 50/60 cps, 35 watts. **Dimensions:** 10¼" H x 8" D x 13" W.

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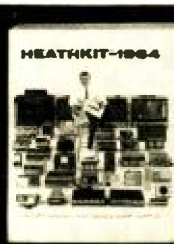

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JOHN FRYE

How frequency mixing achieves stability in an SSB receiver or lets a few crystals substitute for many in a synthesizer.

MIXING MAGIC

"YOU know, Mac," Barney remarked during a breather from work at the service bench, "I think frequency mixing is one of the most fascinating and versatile tools in the kit of the modern radio and TV designer. Yet basically it's such a simple thing. You merely combine two different frequencies and pass them through a non-linear device, such as a mixer tube or crystal diode, and presto-chango! you have two new frequencies equal to the sum and difference of the original pair. Since you still have the frequencies with which you started, it's almost as though one plus one equals four."

"Or one minus one equals three," Mac suggested with a smile. "What started you on this kick?"

"I've been studying how *Collins* manages to get such excellent frequency stability and linear tuning in its 75S-3 SSB receiver. When amateurs used AM, an ordinary bandswitching superheterodyne could be made frequency-stable enough for their use. If the receiver drifted a few kc. in a half hour on ten meters, so what? But now most of us are on SSB, a drift of only 50 cycles is annoying. We need receivers that will really stay put.

"But it is practically impossible to design a bandswitching oscillator that will tune frequencies all the way from 3.5 to 30 megacycles that will not drift with temperature change. If you compensate the oscillator at one end of this range, the compensation will not be correct at the other. We can, however, design an oscillator with excellent frequency stability and frequency/tuning-rate linearity if: (1) the frequency is low, (2) the tuning range is small, and (3) no switching is used in the circuit. *Collins* came up with a different type of superheterodyne that used just such an oscillator, and several other ham-band receiver manufacturers have followed suit.

"In the 75S-3, a preselector stage that can be tuned from 3.4 to 30 mc. picks the desired signal. The non-critical tuning of this preselector is separate from that of the main tuning control. The output of the preselector is combined with the output of a crystal-controlled heterodyne oscillator in a first mixer tube. Crystals are available for this oscillator with selected frequencies at 200-kc. intervals lying between 6.555 and 33.155 mc. The particular crystal selected by the band-change switch is such that the difference between its frequency and the frequency of the desired signal will fall somewhere between 2.955 and 3.155 mc.

"This 200-kc. range represents the passband of the circuitry connecting the output of the first mixer with the input of a second mixer. Any frequency within this range passes without attenuation; all other frequencies are greatly attenuated. In this second mixer, the input signal lying between 2.955 and 3.155 is mixed with the output of a linear master oscillator (LMO) that tunes from 2.5 to 2.7 mc. The output of the second mixer feeds into a sharply tuned 455-kc. i.f. amplifier.

"Suppose we want to tune a signal at 3.5 mc. The preselector is tuned to this frequency, and a 6.555-mc. crystal is switched into the heterodyne oscillator. The two frequencies combine in the first mixer. Their sum frequency of 10.055 is rejected by the bandpass filter in the mixer output, but their difference frequency of 3.055 mc. falls squarely in the center of that passband and is fed to the input of the second mixer. Now if we tune the LMO to the center of its range at 2.6 mc., once more the sum frequency, 5.655 mc., will be rejected by our 455-kc. i.f. amplifier, but the difference frequency is precisely the frequency the amplifier accepts.

"See what happens at 28.6 mc. The preselector tunes this frequency, and a 31.555-mc. crystal is switched in. The difference frequency of 2.955 mc. falls just inside the passband of the filter and is fed to the second mixer. When our LMO is tuned to the lower limit of its range at 2.5 mc., the difference frequency is again 455 kc.

"The main tuning dial that controls the LMO reads 0-200, with 0 being at the high-frequency end of the oscillator range. Each of the 200 marks, spaced linearly about ⅛" apart, represents a kilocycle, no matter if you are tuning at 3.5 or 30 mc. The band selector switch indicates the lower limit of each 200-kc. tuning range. For example, the position that selects the 6.555-mc. crystal is marked '3.4.' You add the dial reading to this figure to determine the frequency to which you're tuned. In the first example, we set the bandswitch to 3.4 and our tuning dial to 100. The received frequency is 3400 plus 100, or 3500 kc.

"For the received frequency to drift, either the heterodyne oscillator or the LMO must drift. Since the LMO design satisfies all requirements for a rock-steady linear-tuning oscillator and since the heterodyne oscillator is crystal-controlled, the result is a very stable receiver."

"No disadvantages?" Mac inquired skeptically.

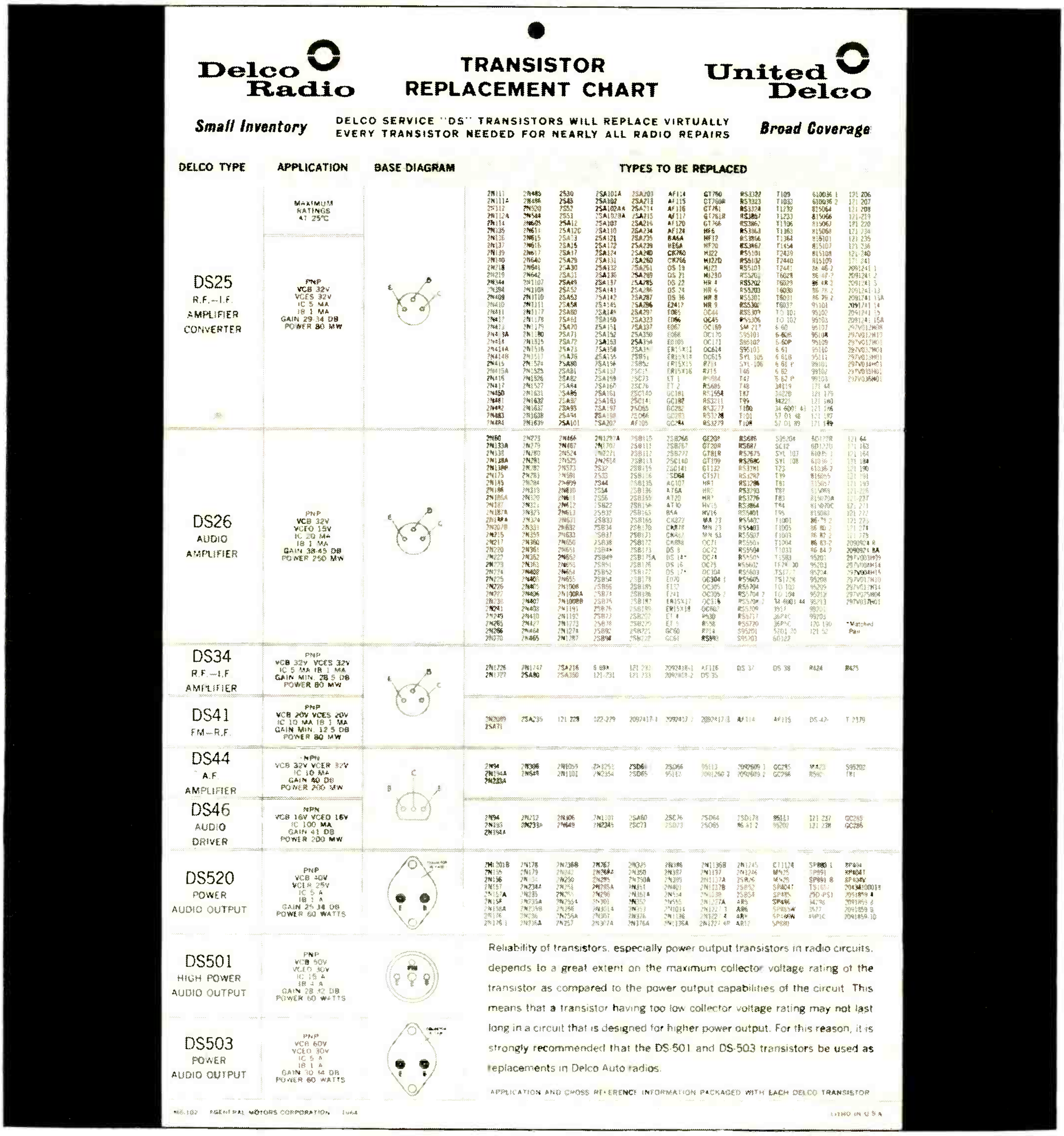
"Maybe one. A different crystal has to be used for each 200-kc. segment tuned. If all ham frequencies between 3.5 and 30 mc. are covered, you need 19 crystals. A reduction in this number can be effected by increasing the range of the LMO. *Heath*, for example, in its new SB-300 has the LMO tune from 5 to 5.5 mc., a range of 500 kc.; and this reduces the number of heterodyne oscillator crystals to 8. Greater pains, though, must be taken to make the LMO tune linearly over this increased range; and to retain the same kc.-covered-per-tuning-knob-revolution, it's necessary to increase the gear ratio of the dial-drive mechanism.

"Speaking of reducing the number of crystals, very recently a crystal-conserving device called a 'frequency synthesizer' has shown up in ham and CB equipment. Do you know what it is?"

"I've heard of it," was Mac's guarded reply.

"Well, it certainly puts frequency mixing to work. Suppose we want to make a crystal synthesizer to replace the LMO in the *Heath* SB-300 that tunes from 5 to 5.5 megacycles. We must be able to produce *any frequency* between these limits and yet have all oscillators crystal-controlled. An article by M. R. Briggs and H. J. Morrison in the January, 1964, issue of *QST* describes one way of doing this with only 16 crystals.

"Ten crystals cover the range from 27.165 to 27.255 mc. in 10-kc. steps. Any frequency from the oscillator controlled by these crystals can be selected for mixing with the output



FREE

This is United Delco's new transistor replacement wall chart. ◻ It lists hundreds of transistors that Delco's compact line will replace (as you can see, that pretty well wraps up the field). It also features specifications for many other applications. It's easy to read (11" x 17"), and it's yours for the asking. ◻ Just let us know you want one.

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of another oscillator controlled by crystals operating on 4050, 4150, 4250, 4350, or 4450 kc. A little pencil work will show you frequencies from these two oscillators can be selected and combined so their *sum* frequency will produce any 10-kc. step frequency from 31.215 to 31.705 mc. in the mixer output.

"A crystal-controlled oscillator can be moved in frequency a small percentage by varying reactive elements in the crystal circuit. Suppose we use a crystal on 13.103 mc. and arrange a small capacitor so we can move its frequency from 4.5 kc. higher to .5 kc. lower. That means the second harmonic of the oscillator can be tuned continuously from 26.205 to 26.215 mc.

"If this second harmonic frequency is mixed with the 31.215-31.705 mc. output of our first mixer and the *difference* frequency is extracted by a passband filter, we come up with a frequency range of 5 to 5.5 mc.—exactly what we wanted. Our tunable crystal permits us to fill in the gaps between the every-10-kc. spot-frequencies produced by mixing the 27-mc. and the 4-mc. crystal frequencies. For all practical purposes, we have a crystal-controlled continuously variable oscillator covering a range of 500 kc.

"Some CB manufacturers are using crystal synthesizers. Since CB channels are multiples of 10 kc. apart, a synthesizer built along the lines of the one I described, less the variable crystal oscillator, can be used. Output frequencies of the synthesizer and the i.f. frequency of the receiver section are chosen so that the *difference* between the frequency of a desired channel and the proper frequency from the synthesizer is always the i.f. Then the same synthesizer output frequency can be mixed with the output of another oscillator crystal-controlled at the i.f. and the *sum* of these two frequencies will be the proper frequency for operating the transmitter on that same channel. *Regency* uses an arrangement similar to this in its "Range Gain" double-sideband transceiver. The crystal-selecting operations are ganged, of course, so that the operator just moves a pointer to the channel on which he wishes to transmit and receive. Eleven crystals in this transceiver take the place of forty-six crystals that would be necessary for controlling both receiver and transmitter on all 23 channels with separate crystals."

"You agree, though, don't you, that designing a crystal synthesizer is no job for a beginner?"

"You're not kidding! Frequencies used in a synthesizer must be very carefully selected to make sure no spurious frequencies are present in the output. Remember each time we mix frequencies to get a desired frequency, there are three other frequencies that we must keep out of the act, and that can become pretty hairy at times."

"Fine. I'm glad you appreciate that. Now I'd like to know what you think of the new *Hewlett-Packard* Model 5100/5110A frequency synthesizer. With it you can select any one of five billion discrete frequencies from d.c. to 50 mc. in steps as fine as .01 cps. Spurious signals are down 90 db."

"Wow! What a job that must be! And you sitting there smugly admitting you'd 'heard' of a crystal synthesizer! How accurate are the frequencies put out?"

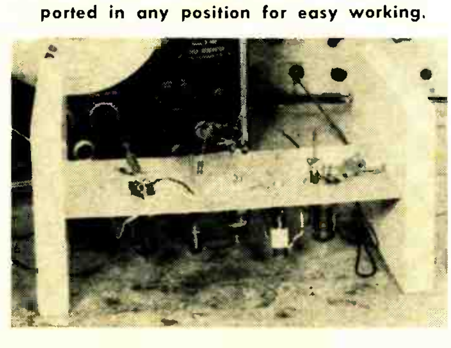
"Well, you can punch out any frequency from .100000000 cycle to 49.9999999 mc. on the keyboard frequency selector and know that every digit is significant. Good enough?"

"I should hope. When are we going to get one?"

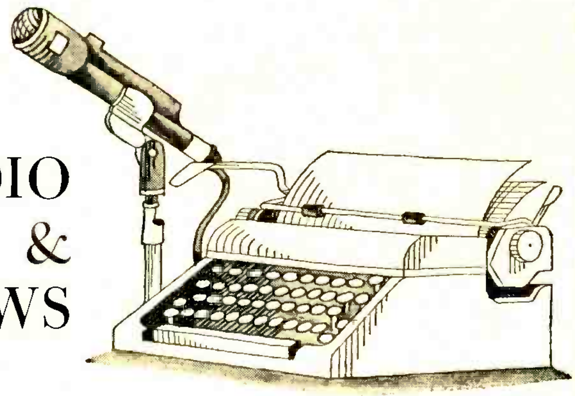
"Not for a while." Mac admitted with a grin. "The price tag on this little gem is $15,250. The gadget has more than 6000 electrical components in it, of which more than 600 are semiconductors of one kind of another. *Hewlett-Packard* points out that since you can select five billion different frequencies, that $15,250 comes out to be only 305 microcents per frequency. Still, it doesn't seem to fit into our budget. But I think it is an interesting example of what good electronic engineers can do with the mixing process that fascinates you so much." ▲

"In exactly 55 seconds we'll know if it's in orbit."

Tom Lamb suggests that a versatile and inexpensive breadboard chassis can be made by supporting sheet aluminum, Masonite, or copper-clad in slotted wood pieces as shown. The chassis may be supported in any position for easy working.



RADIO & TV NEWS



IT looks like a big year ahead for the consumer electronics products industry. The U.S. Department of Commerce feels that, stimulated by the high public demand for color-TV receivers, small-screen (personal) models of black-and-white TV receivers, and stereophonic combinations, the total output of all types of consumer electronics products is expected to hit the $2.5 billion mark in 1964.

Imports of consumer electronic items increased about 33% in 1963 and are expected to continue to increase at about the same rate in 1964. Their projected value of $260 million, an all-time peak, will be about 10% of the total U.S. output of these products. U.S. exports will probably continue to decline in 1964, owing to strong competition in world markets from West Germany, the Netherlands, and Japan.

Despite the anticipated increase in factory output, employment in the consumer electronics products industry will probably increase less than 2% in 1964, owing to continued improvement in production techniques.

The Department of Commerce is also anticipating that U.S. producers will ship 1.1 million color-TV receivers in 1964. In fact, 88,977 of these units were produced in January of 1964. The output of color receivers in 1963 was somewhat curtailed by the unavailability of color picture tubes. However, supplies of these tubes are expected to meet the present demand.

Factory sales of monochrome TV receivers are expected to fall off somewhat, probably to about 6.8 million units in 1964. Unit volume held up well in 1963 despite the decline in the sales of consoles, because there was a demand for small-screen sets.

Foreign competition, especially from Japan, is still strong. Imports of TV receivers topped 400,000 units, nearly triple the 159,000 units imported in 1962.

Household radio sales declined to 10.3 million in 1963, but the shipment of auto radios went up to 8.2 million units. Auto radios are expected to hit 8.3 million in 1964.

About 1 million radios were imported in 1963, and these accounted for nearly 58% of the total U.S. market for household radios. Imports of transistor radios are expected to increase by 12% during 1964.

Manufacturers' sales of phonographs and radio-phonograph combinations increased about 10% in 1963. Sales of these items had a strong start in early 1963 but slowed down somewhat later in the year as the demand for color-TV sets and combinations increased.

Sales of tape recorders rose only a moderate 5% in 1963, failing to achieve the much higher levels anticipated by U.S. producers. Imports of recorders are substantial, coming principally from Japan, although West Germany and the Netherlands are also important suppliers.

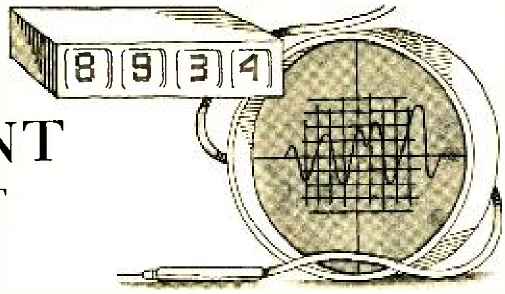
U.S. producers are relatively strong competitively in markets for coin-operated phonographs, TV receivers, and component parts for the assembly of TV receivers. They also export a substantial volume of tape recorders but these items are principally commercial types for use in broadcast studios and similar applications.

In other areas, the Department of Commerce also reported that the total shipment value of all semiconductor devices, excluding integrated circuits, is expected to reach $610 million in 1964, a 3.4% increase over the 1963 sales. Continued improvement in production techniques and stiff price competition will bring lower average unit prices. In 1964, exports of these items should increase to $40 million, 18% over last year's level. Imports are expected to continue at the 1963 rate of about $3 million.

The combined factory shipments of all types of electron tubes is expected to total about $853 million in 1964, a 3.1% decline from sales of $880 million in 1963. Exports should increase somewhat in 1964, over the total of $53.2 million, while imports are expected to show about a 10% gain over the 1963 total of $29.1 million.

The factory shipment of phonograph records is expected to hit a high of $290 million in 1964. ▲

TEST EQUIPMENT
PRODUCT REPORT



Sennheiser Model ZP-2 Audio Impedance Tester

For copy of manufacturer's brochure, Circle No. 40 on coupon (page 12).

THE *Sennheiser* Model ZP-2 impedance tester is a portable, battery-operated transistorized test instrument used to measure impedances of *R*, *C*, and *L* components (or combinations thereof) at audio frequencies. As with ohmmeters, the principle of operation is that of measuring the current through or the voltage across the component or circuit under test with constant voltage applied to a series circuit including the unknown. Because the applied voltage is a.c. in this case, it is possible to determine impedance (reactance and resistance). Also, since three audio test frequencies are used, it is possible to determine whether the impedance is resistive, capacitive, or inductive in nature.

Because of the instrument's negligible loading, accurate measurements can be made on microphones, tape heads, and audio transformers with high-permeability iron cores. Impedances from 1 ohm to 1 megohm can be measured in twelve overlapping ranges.

A two-stage *RC* oscillator (see block diagram) generates the 250-, 1000-, and 4000-cps test signals. The circuit uses a regulator lamp in a bridge configuration for stability. The measuring circuit consists of two transformers that are connected as shown. Transformer *T1* is connected to the output of the audio generator stages; it is tapped to provide the required output voltage to the component under test. Since the unknown component is connected between the output of *T1* and the input of *T2*, the amount of current flow and, hence, voltage across *T2* is inversely proportional to the unknown impedance. Transformer *T2* is also tapped to provide for various ranges of measurement.

In order to prevent errors of measurement arising from small differences in the transformers used, a load is connected in parallel with *T2*. This load is adjusted for the different ranges so that it is possible to compensate for transformer variations.

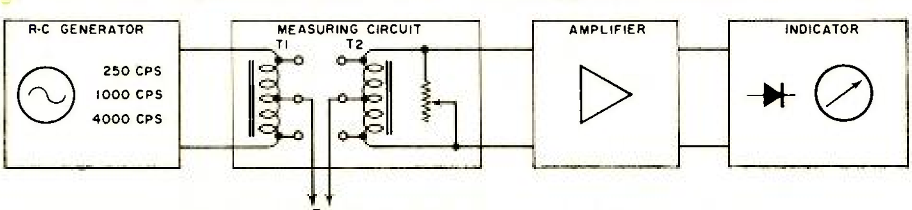
The output of *T2*, which depends on the value of the unknown impedance, is then applied to an instrument amplifier. The amplifier raises the signal level from about 3 mv. to 1 volt for full-scale meter deflection. The amplifier consists of four stages with large amounts of inverse feedback applied to the first and last stages. Any variations in gain still remaining can be compensated by means of a front-panel calibration control, which adjusts the gain of the first two stages.

The output of the amplifier is then fed to a full-wave diode bridge circuit and then to the indicating meter. The meter is directly calibrated in ohms of impedance.

A "Calibrate" switch is provided, which applies a calibrated a.c. voltage to the amplifier input. The instrument is then adjusted for full-scale reading before making an impedance measurement.

The meter also includes a separate scale for battery checking. As long as the voltage of the self-contained 9-volt battery does not fall below 7 volts, accuracy of the instrument is maintained.

The Model ZP-2 is housed in a heavy steel case and all switching is done by means of push-buttons. The instrument, manufactured in West Germany, is distributed under the manufacturer's name in the United States at $175. ▲

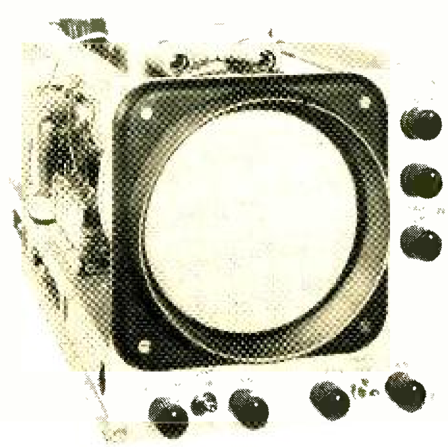


General Atronics K-12-R Monitor Oscilloscope

For copy of manufacturer's brochure, circle No. 41 on coupon (page 12).

MONITOR oscilloscopes are, in most instances, custom-tailored instruments. However, *Electronic Tube and Instrument Div.* of *General Atronics Corp.* has recently introduced the Model K-12-R monitor oscilloscope which covers a wide range of requirements, thus minimizing the need for custom equipment.

Although the monitor oscilloscope is recognized as one of the most versatile forms of read-out devices, it presents a perplexing question to the designer: what constitutes a universal monitor oscilloscope? Since virtually all its applications are specialized and range from production control in industrial electronics to guidance and surveillance in military electronics, it is obvious that no one piece of equipment can satisfy all such requirements. From a less idealistic viewpoint, a practical solution to the problem would be to design an oscilloscope which could be readily adapted for custom applications or, in less complex systems, be used "as is."



Generally speaking, low cost monitor oscilloscopes may be inadequate in terms of frequency response, relative phase shift between vertical and horizontal amplifiers, calibration accuracy, stability, and cathode-ray-tube light output. Many laboratory-caliber instruments are too complex, because of overdesign, too heavy, and too large both physically and in the size of their price tag. The physical and electrical specifications on the Model K-12-R were established to overcome these typical limitations.

Small panel size along with compact design are the prime requisites for any non-custom monitor oscilloscope, since the designer cannot predict where the equipment will be used or installed. The panel of the oscilloscope measures only 7¾ inches square, yet it incorporates a five-inch cathode-ray tube. Additional panel space is obtained by locating all input connectors on the rear panel. Monitor oscilloscopes, unlike laboratory oscilloscopes, very seldom require changing input cables.

Over-all length of the instrument is 17¾ inches. It may be rack-mounted or used on the bench. Although designed with vacuum tubes for ease of maintenance and economy, the weight has been held to 23 pounds. A camera-mounting bezel includes an edge-illuminated graticule. A special circularly polarized filter is used to produce maximum contrast between the CRT trace and surrounding screen, even under conditions of high ambient lighting.

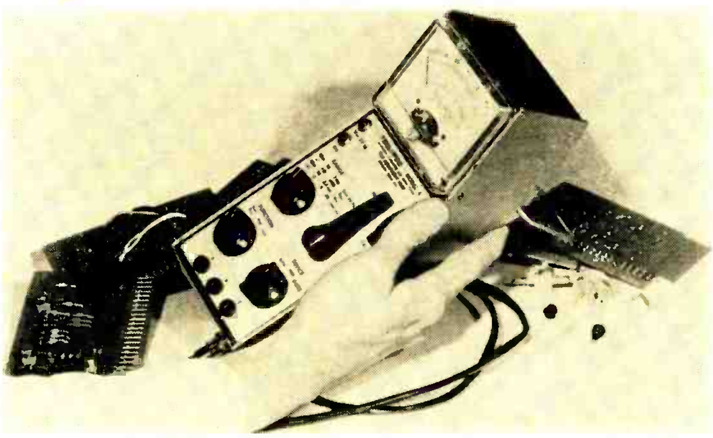
Both vertical and horizontal amplifiers of the scope have identical sensitivity and frequency-response characteristics. Bandwidth is d.c. to 750 kc. Precision attenuators of both amplifiers are frequency compensated for optimum square-wave response. Basic sensitivity of the amplifiers is 0.1 v./cm.

An adjustment located in the vertical amplifier permits setting its relative phase shift to zero degrees with respect to the horizontal amplifier at the minus 3-db point (750 kc.). This is very important when signals at or near the response limit are displayed as Lissajous figures or in many other X *vs.* Y curve-tracing applications.

Two Z-axis inputs are also available. One injects the applied signal into the control grid of the cathode-ray tube for intensity modulation of the beam; the other input drives the cathode of the tube. Operation is possible from line voltages of 105 to 130 volts, 48 to 400 cps. Power consumption is 90 watts. Price of the Model K-12-R is $465. ▲

Tequipco Model 4 Transistor Tester

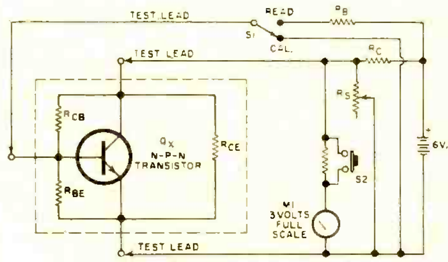
For copy of manufacturer's brochure, circle No. 42 on coupon (page 12).



THE *Test Equipment Corporation* has originated a method of identifying faulty transistors without the necessity of removing them from the circuit in which they are installed. Known as the $V_{CE(sat)}$ method, this technique is said to be extremely reliable. The *Tequipco* $V_{CE(sat)}$ tester, the Model 4 in-circuit transistor and diode tester (design and utility patents pending), balances the effects of circuit shunting to provide both a qualitative and a quantitative evaluation of the transistor's condition. The Model 4 is a moderate-cost, portable instrument that is easy to operate. It can be used in the testing and in the maintenance of various types of transistorized equipment.

The transistor under test is shown in dashed lines (with its associated circuit) in the drawing. With switch S1 in the "Cal" position, the base of the transistor is shorted to the emitter and the transistor is cut off. The shunting effects of the circuit elements are normalized by adjusting the R_s for a full-scale reading on meter *M*1. In this condition the collector voltage is 3 volts, and the source resistance is equal to $R_C/2$ since the parallel combination of the circuit resistance R_{CB} and R_{CE} and shunt resistor R_S has been made equivalent to the known value of the series collector resistor R_C.

S1 is then switched to the "Read" position and the saturation current is supplied through R_B (which is equal to $2R_C$). The voltage across R_{BE} is very small compared with the drop across R_B and the current lost in R_{BE} may be neglected. The current in R_{CE} merely adds to the base saturation current. Since the effect of circuit shunting has been normalized in the measurement, the in-



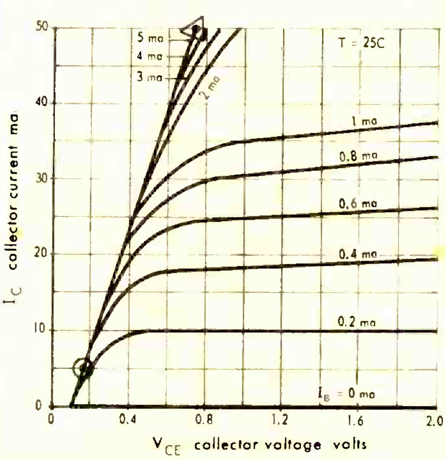
circuit reading of $V_{CE(sat)}$ will be exactly the same as the out-of-circuit reading. Switch S2 is used to expand the meter reading from 3 volts full-scale to 0.3 volt full-scale.

The graph at the bottom of this column shows the collector current, collector voltage curves in the saturation region for a typical transistor. The low-current range of the Model 4 measures $V_{CE(sat)}$ at a collector current of 5 milliamperes. The saturation base current under these conditions is approximately 2.5 ma. This point is shown in the small circle at a $V_{CE(sat)}$ of around 150 millivolts. The point in the small triangle shows a $V_{CE(sat)}$ of about 720 mv. when tested at a collector current of 50 ma.

The Model 4 provides test currents of 5 ma., 50 ma., and 500 ma. for testing low, medium, and high-power transistors. Accurate readings can be obtained in circuits with shunting elements as low as 20 ohms at a test current of 50 ma. The accuracy of the tester is ±5% full-scale in-circuit and ±3% full-scale out-of-circuit.

In addition to qualitative indications of shorts, opens, and gain, a further evaluation of the transistor's condition can be made by comparing the actual $V_{CE(sat)}$ reading of either *n-p-n* or *p-n-p* transistors with the characteristic value listed by the manufacturer. An excessive reading will indicate a deteriorating transistor.

A similar technique can also be used to test signal diodes, rectifiers, and silicon controlled rectifiers in-circuit. The tester supplies a gate current of 100 ma. for testing silicon controlled rectifiers. The Model 4 also measures leakage currents and d.c. *beta* (H_{FE}) out-of-circuit. Price of the tester is $125. ▲



Radio Telescopes

(*Continued from page 23*)

use of an array of half-wave dipoles connected in phase and located above a reflecting screen or metal sheet. Dipole arrays provide reasonably efficient large apertures at relatively low cost for use at frequencies below the microwave range.

The 22-acre square of more than 9000 half-wave dipoles shown in Fig. 11 is located at the foot of the Andes Mountains at Jicamara, near Lima, Peru, where the U.S. National Bureau of Standards has established an observatory for ionospheric research and for radio and radar astronomy. At its operating frequency of 50 mc., the 1-degree pencil beam can be scanned ±3.3 degrees from the perpendicular to the desert floor.

An unexpected use of this large array occurred a few minutes after the July, 1962, high-altitude nuclear blast in the Central Pacific. The radio noise received by this antenna jumped abruptly to a level nine times its normal value. Investigations later showed that the antenna was measuring electromagnetic radiation from electrons that the explosion had injected in the earth's magnetic field.

Future Radio Telescopes

Radio telescopes in the near future will be further developed versions of those presently in use. More steerable dishes in the 100- to 300-foot range will be designed and built and fixed-reflector systems will continue to grow in size and will have better accuracy and resolution. One of the latest single-aperture radio telescopes now nearing completion is the 120-foot-dish antenna located at Haystack Hill, Massachusetts, and operated by MIT's Lincoln Laboratory. See Fig. 12. The antenna is mounted on an "azimuth-elevation" (az-el) mount that allows the reflector to scan the sky in azimuth from horizon to horizon at any elevation almost up to the zenith. The r.f. feed used with this antenna is a Cassegrainian type. A Cassegrainian feed consists of a feed horn and a small sub-reflector located in front of the focal point of the large, or primary, reflector. The received signal is focused by the primary reflector onto the sub-reflector.

The sub-reflector, in turn, reflects the received energy into a feed horn located at the vertex of the primary reflector. This feed system boasts a high signal-to-noise ratio, a definite requirement for radio astronomy. A 150-foot metal space-frame radome protects the entire antenna structure from wind loads and, to a great extent, from differential thermal expansion of the reflector by the sun.

At its normal operating frequency of 8 gc., the beamwidth of the antenna is only 0.07 degree. Because of this narrow beamwidth, the Haystack Hill antenna can accurately pinpoint a celestial radio noise source without being bothered by spurious signals coming from adjacent radio sources.

Although radio astronomers would like to see radio telescopes designed to have pinpoint resolution coupled with extreme pointing accuracy, it would take an astronomer years to survey even a small portion of the sky with such a device. Consequently, steps being taken in this direction visualize large, multipurpose arrays of very-narrow-beam antennas observing in several adjacent directions at once. This approach to radio astronomy will give radio telescopists the equivalent of the optical image-forming telescope, *i.e.*, a telescope through which the astronomer can see a vast area of sky and yet can pinpoint discrete signal sources.

An example of a multiple-beam radio telescope now being designed is the Benelux Cross. This venture is a joint project financed by the three Benelux countries: Belgium, the Netherlands, and Luxemburg. The telescope is a cross antenna whose arms will consist of about 100 parabolic reflectors, each 100 feet in diameter. The arms of the cross will be so long (about one mile) that they will overlap the territories of the three contributing countries. (Compare this antenna to the 375-foot Stanford cross previously described.)

This antenna will have a beamwidth of 0.02 degree (close to the resolving power of the unaided human eye), and will be used to map the galaxy at the hydrogen-line frequency of 1420 mc. The signals received by each of these beams will be combined to produce a simultaneous radio image of the whole region in the field of view of the cross.

Benelux scientists and engineers are also working on a new version of this antenna that uses only one arm of the cross. The new technique, called "super synthesis," simulates a cross-type interferometer by using the rotation of the earth to provide the movable element. In other words, signals received by the lone arm of the super-synthesis antenna would be continuously fed into computers for 12 hours, during which time the rotation of the earth would have moved the antenna array perpendicular to its original direction; thus, synthesizing a cross interferometer. Using this technique, radio astronomers hope to achieve a radio telescope having a beamwidth of only 0.005 degree at a wavelength of 21 cm.

Orbiting radio telescopes are also on the drawing boards. Because the earth's ionosphere is opaque to radio waves below a few megacycles, radio astronomers cannot receive extraterrestrial signals at those frequencies. Since the data from signals at this wavelength hold the key to explaining the composition of the stars and the mysterious bursts of radiation from Jupiter, scientists and engineers are working toward the development of a spaceborne radio telescope. One such instrument would be constructed of a material that could be rocketed into orbit as a collapsed mass and, upon reaching its assigned altitude, would expand to form a gigantic Vee antenna oriented towards outer space. Another technique would utilize wire embedded in inflatable plastic tubes that, when at orbiting altitude, would unfurl into the desired antenna configuration. Because of the weightless state, these antennas could be made very large without physical means of support.

Lunar-based radio telescopes are also in the works. The craters of the moon would make natural supports for wire mesh reflectors, and since the moon's gravitational pull is much less than that of the earth, radio telescopes could be constructed in sizes that would dwarf today's earth-bound giants. These "moon-scopes" will give future generations of radio astronomers unparalled opportunities to study the universe and to probe its deepest secr ts. ▲

MAINTAINING TV COLOR BALANCE

THE *General Electric* Color-Balance Stabilizer was developed to maintain correct color values with changes in brightness and contrast. It provides correct color hues and tints by keeping the d.c. bias voltages applied to the picture tube cathode at a constant ratio. This regulates the level of the d.c. component at each cathode so that a constant ratio exists between the a.c. and d.c. components of the video signal with changes in brightness and/or contrast.

The signal from the second video amplifier is further amplified by the third video amplifier *V1* and passed to the red cathode of the picture tube *via* *C1*, the primary of *T1*, and a service switch (not shown in figure). *R1* maintains the d.c. component. In addition, the signal on the red cathode is fed to the blue cathode through the blue drive control *R2* and to the green cathode through the green drive control *R3*. These components plus *R4*, *R5*, and *R6* (current adjust) make up the stabilizer.

The green drive control *R3* and the blue drive control *R2* are connected in parallel. Also, *R4*, *R5*, and *R6* are in series-parallel with *R2* and *R3*. The "B+" is connected between *R4* and *R5*. Two approximately equal loads are connected to this network. At the bottom of the network, the load to ground consists of *R6* while at the top of the network, the load to ground is the third video amplifier *V1*. Current flow to the two loads is nearly equal but in opposite directions through the blue and green drive controls *R2* and *R3*. The net current through the two drive controls to the two loads is close to zero even with changes in *V1* plate current.

The video signal is fed through the primary of *T1* to the red cathode and one side of the blue-green drive controls. The signal is also fed to the other side of the drive controls from the secondary of step-down transformer *T1*. A difference in signal potential exists between the ends of each drive control and the amount of video drive to the blue and green cathodes can be adjusted.

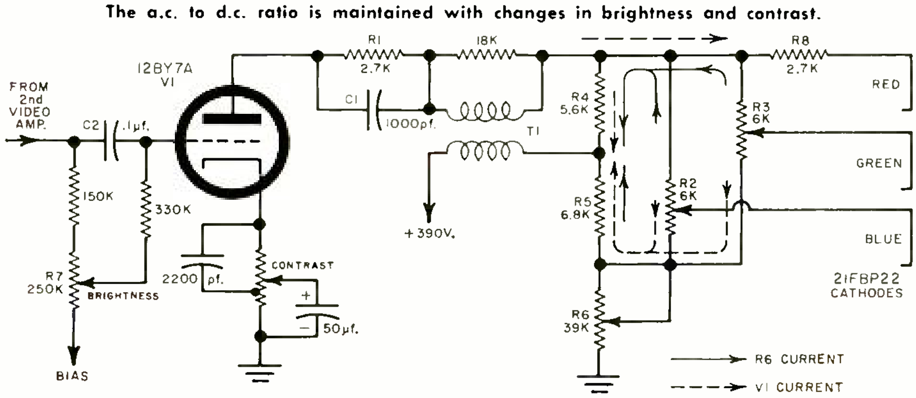
With the above conditions, the only d.c. current through the drive controls is the beam current as no other effective d.c. current flows through the controls. Thus, good regulation is attained at the picture tube cathodes and the ratio between the a.c. and d.c. components remains constant.

Brightness control *R7* is connected in parallel with coupling capacitor *C2* thus a constant ratio between the a.c. and d.c. signal components is maintained with any brightness setting.

The constant ratio between the a.c. and d.c. components that now exists maintains the beams at a proper bias ratio to eliminate changes in the hue with changes in brightness or contrast.

R8 reduces spot size blooming of the red gun on peak whites. ▲

The a.c. to d.c. ratio is maintained with changes in brightness and contrast.



REMOTE VOLUME CONTROL

By CHARLES W. MARTEL
Manager, Tech. Info. Svce., Raytheon Company

Simple control circuit using a new component, the "Raysistor," a photocell with self-contained light.

HERE is a remote volume control that offers these advantages: very easy to make and install, requires only four parts; usable with any volume control in radio, TV, or hi-fi set; requires no circuit changes and only two connections to present volume control; provides any volume below that determined by the setting of the present volume control; and requires only two small, low-voltage, easily concealed wires to run to remote-control location.

This remote control requires a *Raytheon* "Raysistor," an unusual kind of electronic component which was described in the article "New Light-Operated Switch" in the November 1963 issue. The Type CK1114 is especially small but the Type CK1121 is less expensive and only slightly larger in size. Either may be used in the circuit of Fig. 1A.

In this circuit the low end of the volume control is shown grounded for this is true of practically all equipment. *R*1 is a limiting resistor to insure that the voltage at the "Raysistor" never exceeds a safe value. *S*1 is an "on-off" switch on the volume control *R*2. *R*2 should be connected so that *S*1 opens when the resistance of *R*2 is at its maximum. *B*1 is the battery with voltage as explained below. Polarity is unimportant and need not be observed in wiring this remote control.

For "Raysistor" CK1114 the battery should be a simple mercury cell such as the *Mallory* Type RM502R or RM12R. These were selected because the maximum voltage is 1.35 volts and they provide good life. The maximum control voltage for the CK1114 is one volt at a current of 17 ma. so *R*1 works out to 20.6 ohms. A 22-ohm, ½ watt, ±5% resistor is recommended. *R*2 should be a wire-wound rheostat or pot with a resistance rating of at least 100 ohms to insure that the control voltage can be reduced enough for full volume control. A higher value such as 150 or 200 ohms is electrically usable but would reduce the amount of shaft rotation required between settings for maximum and minimum volume.

Caution: Because of the very low voltage and current required to control the Type CK1114, the use of power supplies or batteries giving higher voltage is not recommended. The manufacturer will not replace "Raysistors" damaged by over-voltage.

For CK1121, the control lamp is rated at 5 volts and 55 ma. maximum. Four mercury cells, in series, are required to give a total of 5.4 volts. *R*1 should then be 7 to 7.5 ohms and *R*2 should be about 260 ohms.

If desired, batteries may be eliminated and the CK1121 operated from d.c. supplies when available. (Many preamplifiers using tubes have a d.c. heater supply and, of course, transistorized equipment has a d.c. supply.) When using an existing d.c. supply, care must be taken to use the correct values of *R*1 and *R*2. In this case *B*1 of Fig. 1A becomes the d.c. supply for the transistors. $R1 = (\textit{supply volts} - 5)/.055$ ohm. Use the nearest value available above that calculated. $R2 = (\textit{supply volts} - 0.5)/0.019$ ohm and again, use the nearest available value above that calculated.

If the equipment with which you will use the remote control has a 6.3-volt a.c. supply for tube heaters, this may be used as shown in Fig. 1B.

Remember that *R*1 and *R*2 must be calculated for CK1121 as explained in the above paragraph but to obtain the value of the d.c. voltage, you must measure the voltage at the terminals marked *X-X* in Fig. 1B. Do not connect a "Raysistor" to these terminals without the correct values of *R*1 and *R*2 in the circuit. In Fig. 1B, *D*1 may be any silicon rectifier rated for continuous d.c. current of more than 60 ma. and peak inverse voltage greater than 20 volts. ▲

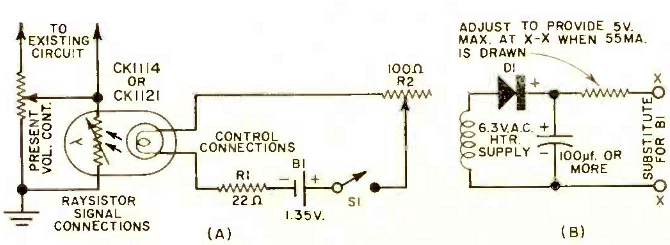


Fig. 1. (A) All components tied to the control connections may be installed in a small box located at a remote distance from equipment being controlled. (B) The d.c. for "Raysistor" may be obtained from the heater circuit.

U-31

The Big Plus—Uniline Sound Columns

Performance is the big plus when you install University Uniline Sound Columns. Unlike conventional columns, Uniline employs specially-designed speakers with higher power handling capacity. "Acoustic-Tapering — *another University exclusive*, prevents excessive high frequency beaming and assures a uniform sound volume within its fan or beam. The result—higher intelligibility, optimum sound dispersion at all frequencies, greater listening comfort. All individuals hear the same sound! The table below shows complete specifications for all Uniline Sound Columns, including the new weatherproof model CSO-6 for outdoor installation. For complete PA Loudspeaker Catalog, write Desk S-7.

	UCS-6 Full Range Music and Speech	CS-4 Full Range Music and Speech	CS-3 Music and Speech	CSO-6 Full Range Music and Speech
speakers	6 extended range 8"	4 extended range 8"	8 special multi-design	6 extended range 8"
frequency range	55—17,000 cps	70—17,000 cps	150—10,000 cps	55—17,000 cps
power capacity	120 watts IPM*	80 watts IPM*	25 watts IPM*	120 watts IPM*
impedance	16 ohms	8 ohms	16 ohms	16 ohms
vertical angle	16°	22°	22°	30°
horizontal angle	120°	120°	120°	120°
dimensions	59¼" x 10⅞" x 9 1/16"	40⅜" x 11" x 9 1/16"	48" x 7½" x 8¾"	60¼" x 11⅞" x 7¾"
shipping wt., lbs.	61	46	33	61

*Integrated program material.

LTV UNIVERSITY
9500 West Reno, Oklahoma City, Oklahoma

CIRCLE NO. 133 ON READER SERVICE PAGE

New CB Circuits

(*Continued from page* 35)

power amplifier, V2, remains de-energized during spotting.

The complete receiver section of the 777 is alive at this time. If the operator rotates the tuning dial, he will not only see the oscillator signal as a strong "S"-meter deflection, but also hear an audio tone in the speaker. The tone occurs under two conditions. If a station on the channel is being picked up by the receiver, it heterodynes with the 27-mc. oscillator to produce an audible beat note. The tone varies with receiver tuning since the incoming station frequency in the i.f. strip shifts with movement of the tuning dial. The operator may zero beat the receiver with the incoming signal, and the dial is calibrated.

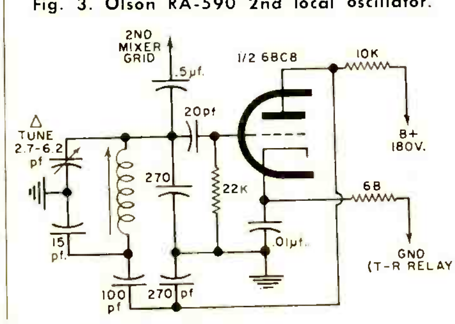
In the second case, the tuning dial may be set without an external station providing a beat note. This is valuable for standing by on a given channel for an expected call. Even though the crystal oscillator is operating at reduced output, it is still strong enough to trigger an oscillatory path through the receiver circuits. It begins as signal overload in the i.f. strip. Strong crystal energy through the i.f. section ultimately reaches the speaker which, in turn, feeds back mechanical energy to the crystal. The rate of feedback is acoustic and the net effect is an audio note in the speaker. Again, the operator may use tone as a convenient reference for setting up the tuning dial. The system is especially convenient in mobile operations.

(c) Olson RA-590 "Delta Tuning"

Anyone who views the panel of a new 23-channel transceiver may note an apparent anomaly. In addition to the channel-selector switch, there is a receiver tuning dial. This is not the channel-selector switch, which detents into position, but a smoothly rotating dial reminiscent of the continuous-tuning knob for non-crystal reception. The control provides "delta" tuning, a vernier action needed in transceivers of exceptionally sharp selectivity and complete crystal control of the receiver.

The reasons for delta tuning relate to frequency tolerances encountered in CB service. FCC specifications state that .005% shall be the transmitter frequency limits on any given channel. In light of that figure, it is possible for a CB unit to transmit a carrier approximately 1300 cps above or below the nominal 27-mc. frequency and still be perfectly legal. But the effects on some receiver circuits often prove troublesome. For the continuous-tuning type there is no problem; the operator manually shifts the signal into the i.f. passband. In crystal-controlled receivers of single-conversion design, there is adequate bandwidth to accept slightly off-frequency signals. The double-conversion units, however, are quite sharp. Considerable selectivity produced by their low i.f. frequency requires that an incoming signal be dropped accurately into the i.f. slot or suffer attenuation. Error may occur in receiver crystals, too. It is possible for a .005% crystal in the local oscillator to shift an incoming channel even farther out of the passband. So, couple these factors—dual-conversion and 23-channel crystal receive—and the need for the delta tuning control becomes evident.

Fig. 3. Olson RA-590 2nd local oscillator.



The recently introduced *Olson*[3] "Side-Bander" Model RA-590 exemplifies the circuit technique. The transceiver has a double-sideband reduced-carrier transmitter and dual-conversion receiver. The receiver utilizes frequency synthesis to obtain 23-channel crystal control for both transmit and receive. Appearing in the schematic of Fig. 3 is the unit's method for providing delta tuning. The stage shown is one of two local oscillators which convert the incoming 27-mc. signal down to the i.f. At the left in the diagram is the front-panel delta "Tune" control; a variable capacitor, which is identified by the Greek letter *delta*. Situated in the oscillator tank circuit, the capacitor is able to shift the frequency of the second local oscillator. Note the low capacitance assigned to the component. Its full range is from 2.7 to 6.2 pf. Thus, complete rotation of the control causes only small changes in oscillator frequency. The shift in oscillator frequency is 3.5 kc. above or below the center frequency of the i.f. strip.

In actual use, the operator may leave the delta knob in any position without too great a risk of missing slightly off-frequency calls. Such signals are partially attenuated in the i.f. strip. To compensate, the operator uses the delta knob to visually peak the signal on the "S" meter. In this fashion, the ability of the dual-conversion receiver to reject images and adjacent-channel interference is not sacrificed to the frequency tolerances common to CB systems. ▲

REFERENCES

1. Tram Electronics Inc., Box 187, Winnisquam, N.H.
2. Eico Electronic Instrument Co., Inc., 131-01 39th Ave., Flushing, N. Y. 11352
3. Olson Electronics, Inc., 260 S. Forge Street, Akron, Ohio 44308.

R.F. PICKUP IN AUDIO AMPLIFIERS

QUITE often, an audio amplifier will start acting like a radio receiver, especially when there is a radio transmitter within close range. As detection is not the purpose of an audio amplifier, such signals must be removed.

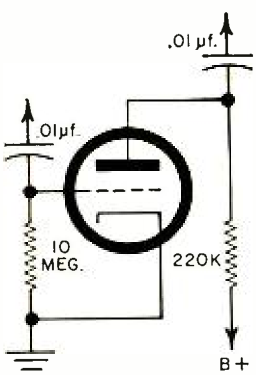
In almost all cases, rectification takes place in the first, or input, stage because this is usually a high-impedance circuit conducive to extraneous signal generation.

The circuit shown in (A) is typical of an amplifier input stage. Bias is developed by the grid resistor and with class-A operation, normal signal inputs between .5 and .75 volt peak-to-peak result in bias voltages between 1.5 and 2 volts. However, it is possible that a nearby transmitter can induce enough r.f. signal to produce bias voltages much greater than this. Such action results in an overdriven amplifier in which the clipping action of the large negative voltage swing produces grid rectification. The output voltage of the circuit is composed of the desired audio signal and the undesired audio signal detected from the r.f. envelope. The presence of distortion and the amount of gain reduction depends entirely on the amount of bias developed by the r.f. signal.

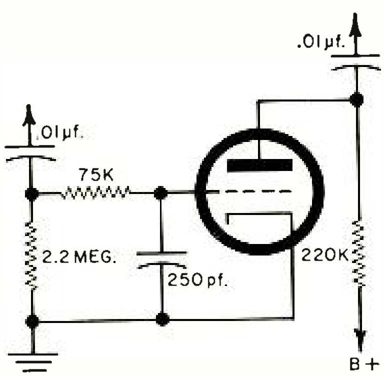
Major reasons for amplifier susceptibility to r.f. pickup are: very long input leads, unshielded input leads or poor solder connections to the shields, unshielded tube in the input stage, ungrounded control shaft, and input stage bias developed by a grid bias resistor. The first four conditions are easily corrected, but the fourth condition requires circuit modification.

(B) shows changes to an inexpensive phonograph amplifier while (C) could be used in a high-fidelity amplifier. The 75,000-ohm series grid resistor shown in (C) can be replaced by a .5 to 1 mhy. r.f. choke if desired. The choke may require a grounded shield can to minimize pickup.

This information has been extracted from *Westinghouse* "Tech-Lit News." ▲



(A)



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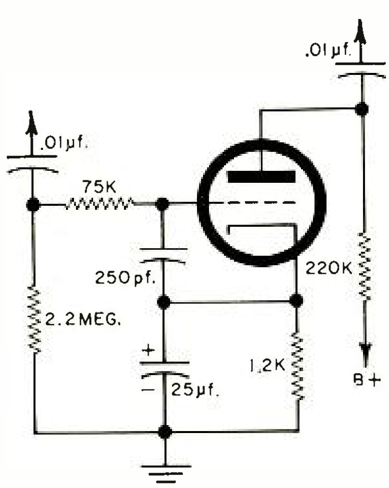


(C)

BOOTSTRAP CIRCUITS

• By GORDON J. DEBOO / Chief Engineer, Electro-Medi-Dyne Inc.

Basic theory and operation of this widely used circuit along with two practical applications.

IN ORDER to describe the many complex processes that take place in electronic circuits, many words normally having everyday, non-technical meanings have been adopted by engineers. The technical meaning is usually analogous to the everyday meaning, some examples of such words being "gate," "noise," "clamp," "pedestal," and many more. This article is concerned with the use of a word in which the analogy is still there but is not quite so obvious as in the examples given above. The circuit to be discussed is one which has found wide application throughout the electronic industry—the "bootstrap."

In order to show the usefulness and versatility of the bootstrap circuit, let us

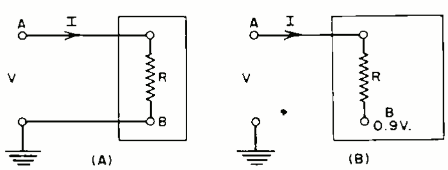


Fig. 1. Equivalent circuits, emitter-follower.

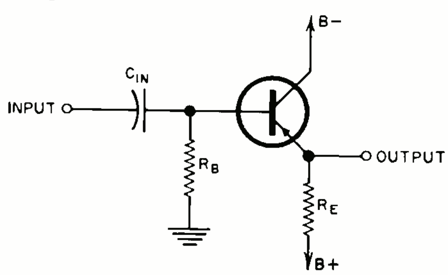


Fig. 2. Emitter-follower circuit diagram.

investigate two widely different applications of the principle. We will show how the input impedance of a transistor circuit can be increased, in this case an emitter-follower, and then how the linearity of a vacuum-tube sweep circuit can be improved—both using the bootstrap principle.

Equivalent Circuits

Let us consider first how we can increase the input impedance of an emitter-follower., Fig. 1 represents such a transistor circuit having, an equivalent input resistance *R*.

If with $V = 10$ volts it is found that $I = 10$ ma., then the input resistance *R* must be 1000 ohms by Ohm's Law. Suppose now that the terminal "B" is disconnected from ground and is connected to some point in the circuit, the potential of which is varied in proportion to the voltage fed in at "A." For example, arrange the circuit so that the voltage at "B" is always 90% of the voltage at "A." The circuit can now be redrawn as is shown in Fig. 1B.

Now with $V = 10$ volts, *I* will again be the voltage across *R* divided by the value of *R*, which we just found to be 1 kilohm. Therefore, $I = (10\text{-}9)/1000 = 1$ ma.

Thus, whereas with "B" grounded, 10 volts at "A" produced 10 ma. of input current, with "B" in the new connection 10 volts input produced only 1 ma. of input current. Thus the effective input resistance of the new circuit is: $10/.001 = 10$ kilohms. This is ten times more than it was before.

The reason such a circuit is called a "bootstrap" is not, in the author's opinion, a very good one but is because V_A pulls up V_B, as it were, by its own bootstraps.

Emitter-Follower Circuit

To take a practical application of the above principle, consider the circuit in Fig. 2 which is an emitter-follower. R_E is the emitter resistor and R_B the base bias resistor. Without R_B the circuit has an inherently high input impedance, but R_B must be there to provide bias and, for good temperature stability, it should be as small as possible. However, a low value for R_B reduces the circuit impedance since it appears in parallel with the emitter-follower input. Thus one of the main reasons for using an emitter-follower, that of obtaining a high input impedance, has been defeated. The solution is to use the bootstrap principle, which is done very simply by adding a capacitor C_B and splitting R_B, as in Fig. 3.

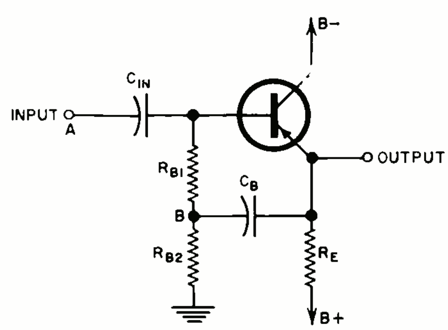


Fig. 3. Emitter-follower bootstrap circuit.

Any a.c. signal fed to the input "A" will be reproduced at the emitter by follower action and, if C_B is large enough, transmitted through C_B to point "B." Thus, the effective base bias resistance is increased because "A" pulls up "B" by its bootstraps exactly as in our original example. Another way to have increased the input resistance would be to increase R_B but this would have reduced the circuit's temperature stability. Using the bootstrap principle, we can keep $R_{B1} + R_{B2} = R_B$, which will give us the same stability factor as before but we have also increased the input impedance.

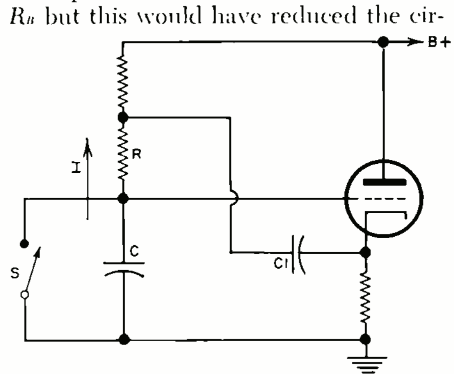


Fig. 5. Bootstrap sweep-signal generator.

Tube Sweep Circuit

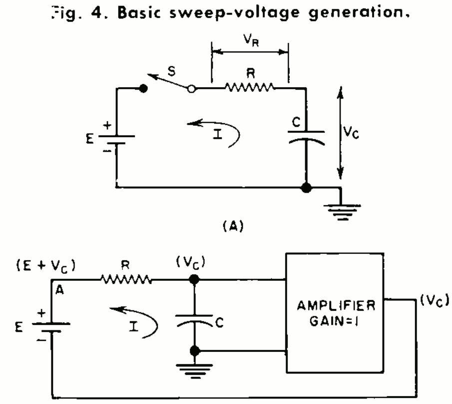
Now let us consider the second application, this time to a vacuum-tube sweep circuit such as might be used in an oscilloscope.

Practically all voltage sweep generators operate on the same general principle, the charging of a capacitor from a constant-current source. If the charging current is absolutely constant, the saw-tooth will be perfectly linear.

Consider the simple circuit in Fig. 4A. When *S* is closed, the capacitor *C* will be charged through resistor *R* by current *I*. Notice that since $E = V_R + V_C$ where *E* is fixed, and because V_C is increasing, then V_R must be decreasing. Hence the current through *R* must be decreasing, according to Ohm's Law. This non-constant charging current results in the well-known exponential waveform for the capacitor voltage which is, of course, non-linear.

Suppose now that an amplifier with unity gain is included in the circuit, as in Fig. 4B. The negative side of the battery has been disconnected from ground and connected to a point the voltage of which is, at all times, equal to the capacitor voltage. As the capacitor charges point "A" assumes a potential of $E + V_C$. The potential difference across the re-

Fig. 4. Basic sweep-voltage generation.



sistor is: $(E + V_c) - V_c = E$ which is a constant, therefore current I must be constant. If the amplifier input impedance is designed to be large enough so that negligible current flows into it, all of I must flow into C. We have therefore achieved the desired effect, that of charging C with a constant current which will result in a linear sweep voltage V_c.

A vacuum-tube version of a linear sweep circuit, using the bootstrap principle, is given in Fig. 5. In this circuit R is the charging resistor and C is the charging capacitor. When S is opened, current I charges capacitor C, and the voltage across capacitor C is transferred by cathode-follower action to the cathode of the tube. If $C1$ is very large it will transmit the cathode-voltage change to the top of R and once again the potentials at each side of our charging resistor are changing by the same amount and in the same direction, keeping the voltage drop across R and hence the current through R constant. Since the grid of a tube is a high impedance, practically all the current will flow into C, giving a linear sweep.

For a repetitive sweep, S would be some kind of electronic switch and it is possible to arrange this so that the sweep is either free-running or triggered externally. ▲

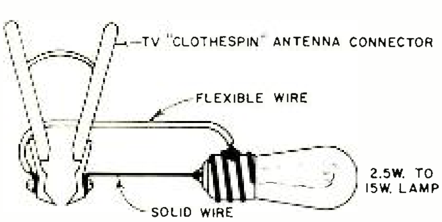
CLIP-ON TEST LAMP FOR TUNING HAM RIG

By PAUL FALK, K3EJU

THE simplest and least expensive r.f. indicator for tuning up amateur-radio transmitters and antenna arrays is still the old-fashioned light bulb. The device shown here differs from the usual lamp load only in the ease with which it can be clipped on to various test points: antenna relay, lightning arrester, antenna driven element terminals, and so on.

The clip-on feature is obtained by using a plastic clothespin-type TV antenna connector. In this instance, we connect a short solid copper wire to one "claw" terminal. To this wire is soldered one side of an intermediate lamp socket of the type used for 117-volt Christmas tree lights. A flexible insulated copper wire is connected from the other side of the socket to the other "claw" terminal.

Lamps of this base size come in various ratings: 2.5, 6, 7.5, 10, and 15 watts. It is a good idea to have a complete assortment of these wattages. Start with the larger size and work down to the lamp that just glows—to prevent burnouts. ▲



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Capacitor Checker

(*Continued from page* 45)

so as to locate the .1-μf. division mark on the scale at the desired point. With J1 and J4 jacks shorted, a dip may be found corresponding to C_x equal to infinity. If desired, this point may be placed out of the range of C1 by adjustment of C6.

With a 1000-pf. capacitor between J1 and J3, adjust C4 until a dip occurs with C1 set to near minimum capacity. At your option, the upper limit can be made .01 μf. by reducing C5. Also, by replacing C4 and C5 by a short, the range will be up to about 380 pf.

Next, set C1 to minimum capacity, R4 to minimum resistance, and adjust C9 to zero-beat the crystal frequency with that of station WWV. Connect jack J1 to the receiver chassis. Connect a wire to either the J2, J3, or J4 jacks to couple the 1-mc. signal to the receiver. The receiver b.f.o. should be off. During the unmodulated transmission period of WWV, zero-beat is indicated by the gradual rise and fall of the "S"-meter indication or background noise.

Having completed these adjustments, the final step is to calibrate the scale card for C1. This is done by connecting known values of capacitors between the appropriate front-panel jack and J1 and rotating C1 dial for a dip on the meter. Mark the scale lightly in pencil, and after doublechecking, mark them in ink. A suitable arrangement of major and minor scale divisions is shown in Fig. 4.

When using the instrument, first adjust R4 to obtain a current dip from 100 down to 40 or 50 as indicated on M1 scale. R4 requires no further adjustment.

Connect the capacitor to be checked across the pertinent front-panel jacks and adjust C1 to dip the meter. Read the value of the capacitor from the C1 scale.

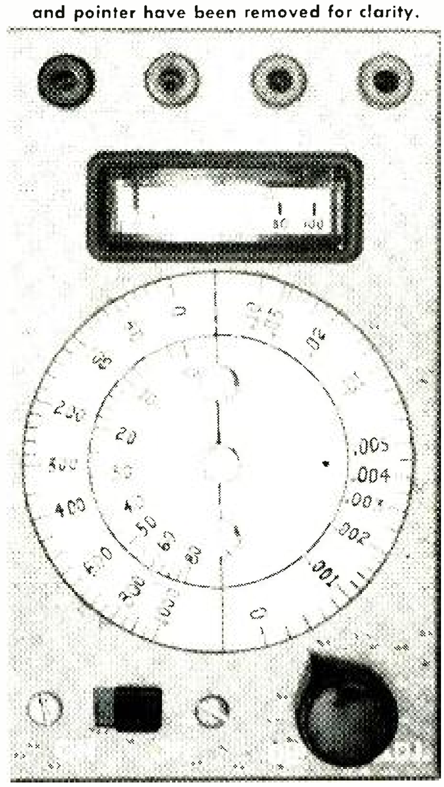
On the 80- and 1000-pf. ranges, when measuring capacitors having small values, measure, and deduct the capacitance of the test leads from the indicated capacitance value.

On the .1-μf. test range, connect the capacitor directly to the test jacks. If a test lead is required, use a six- or eight-inch long length of flexible coaxial cable fitted with banana plugs at one end and small alligator clips at the other. Do not use long separate leads on this range as the inductive reactance of such leads will not be negligible compared with the capacitive reactance of larger value capacitors.

If desired, an additional scale calibration can be prepared for this range based on the use of a two-foot flexible coaxial cable connecting link between tester and capacitor.

For in-circuit tests for capacitors of .1 μf., .01 μf., 1000 pf., and 100 pf., shunt resistance may be as low as 20, 200, 2000, or 20,000 ohms respectively. A d.c. leakage test using a v.o.m. would be required if the capacitor is suspected of being leaky. ▲

Fig. 4. This front-panel view shows the calibration of the readout dial. The knob and pointer have been removed for clarity.



SIMPLE U.H.F. TEST SET

According to Blonder-Tongue engineers, it is very easy to simulate u.h.f. TV broadcasts for testing all-channel TV sets in areas where there is no u.h.f. broadcasting at the moment. It is also useful for testing multi-channel reception of u.h.f. transmissions in areas having only one u.h.f. station.

All that is needed is a conventional u.h.f. converter that does not have either an i.f. or r.f. stage. The simple ones having just a local oscillator and mixer diode will work fine.

The u.h.f. converter is hooked up "backwards" for this use. Connect an ordinary v.h.f. antenna to the u.h.f. converter terminals marked "To TV Set" and a u.f.h. antenna to the u.h.f. antenna input terminals of the converter.

Because the output filter of most u.h.f. converters is tuned to approximately channels 5 and 6, these frequencies will be present at the mixer diode. This frequency is then mixed with the u.h.f. converter local oscillator, the upper i.f. (u.h.f.) is then selected by the converter input circuits, and is then passed to the u.h.f. antenna. This low-level u.h.f. signal will radiate a short distance and the frequency will be determined by the dial setting of the u.h.f. converter. The video will be either channel 5 or channel 6, whichever is used in the testing area.

If neither channel 5 nor channel 6 is available at the test site, then any other low channel can be used if the output filter of the u.h.f. converter is adjusted accordingly. ▲

NOW...GET THE FINEST STEREO TEST RECORD ever produced for just...$4.98

Featuring Tests Never Before Available Outside Of The Laboratory

Why We Make the Model 211 Available Now

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

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

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

Stereo Checks That Can Be Made With the Model 211

- ✓ Frequency response—a direct check of eighteen sections of the frequency spectrum, from 20 to 20,000 cps.
- ✓ Pickup tracking — the most sensitive tests ever available on disc for checking cartridge, stylus, and tone arm.
- ✓ Hum and rumble—foolproof tests that help you evaluate the actual audible levels of rumble and hum in your system.
- ✓ Flutter—a test to check whether your turntable's flutter is low, moderate, or high.
- ✓ Channel balance — two white-noise signals that allow you to match your system's stereo channels for level and tonal characteristics.
- ✓ Separation—an ingenious means of checking the stereo separation at seven different parts of the musical spectrum—from mid-bass to high treble.

ALSO: ✓
Stereo Spread
Speaker Phasing
Channel Identification

PLUS SUPER FIDELITY MUSIC!

The non-test side of this record consists of music recorded directly on the master disc, without going through the usual tape process. It's a superb demonstration of flawless recording technique. A demonstration that will amaze and entertain you and your friends.

UNIQUE FEATURES OF HiFi/STEREO REVIEW'S MODEL 211 STEREO TEST RECORD

- Warble tones to minimize the distorting effects of room acoustics when making frequency-response checks.

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

- White-noise signals to allow the stereo channels to be matched in level and in tonal characteristics.
- Four specially designed tests to check distortion in stereo cartridges.
- Open-air recording of moving snare drums to minimize reverberation when checking stereo spread.

All Tests Can Be Made By Ear

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

Note to professionals: The Model 211 can be used as a highly efficient design and measurement tool. Recorded levels, frequencies, etc. have been controlled to very close tolerances—affording accurate numerical evaluation when used with test instruments.

DON'T MISS OUT—SUPPLY LIMITED

The Model 211 Stereo Test Record is a disc that has set the new standard for stereo test recording. Due to the overwhelming demand for this record, only a limited number are still available thru this magazine. They will be sold by ELECTRONICS WORLD on a first come, first serve basis. At the low price of $4.98, this is a value you won't want to miss. Make sure you fill in and mail the coupon together with your check ($4.98 per record) today.

FILL IN AND MAIL TODAY!

Stereo Test Record
Electronics World—Dept. SD
One Park Ave., New York 16, N.Y.

Please send me ________ test records at $4.98 each. My check (or money order) for $________ is enclosed. I understand that you will pay the postage and that each record is fully guaranteed. (Orders from outside the U.S.A. add 50c to partially defray postage and handling costs.)

Name ______________________________
(Please Print)

Address ______________________________

City ______________ Zone ________ State ________

SORRY—No charges or C.O.D. orders! EW-74

Electronic Scanning

(Continued from page 37)

arranged so that the affected lamps remain lit only until their associated monitoring contacts re-open. Or, they may remain lit until reset to indicate that a change of status had occurred.

Two lamps for each point can be provided, one to indicate normal condition, the other to indicate off-normal condition. A red lamp could be used for one, a green one for the other. These lamps may be located at the scanner receiver or at a remote location using a multi-conductor cable to extend the lamp circuits.

In lieu of lamps, a bank of relays can be used to control lamps, alarms, or other devices. A relay pulled in by an off-normal signal can be used to actuate another relay which locks until released.

The scanner system can be equipped to scan up to 40 points. A basic 8-point system can be expanded in increments of 8 points to as many as 40 points. The scanner transmitter, scanner receiver, tone transmitter and tone receiver can be operated from a battery or other 12-volt d.c. source. Hence, the equipment can be used at locations where utility power is not available or is unreliable. A power supply can be used to convert a.c. line power to d.c.

Applications

Scanning systems are used by many industries as well as in military and aerospace applications for monitoring, telemetering, and remote control.

In a garage, for example, a scanner system can be used to determine the locations of unoccupied parking spaces by personnel at one or more points. As shown in Fig. 4, each parking space is monitored by an ultrasonic, magnetic, or other type of vehicle detector that senses the absence or presence of a vehicle. In a garage with 320 parking spaces, one 40-point scanner transmitter is required for each 40 parking spaces.

Only one scanner receiver is required since it can be switched to receive pulses from any of the eight 40-point scanners. An attendant at a central location can quickly determine where empty parking spaces are located.

Central station alarm system operators use scanners to cut down the requirement for leased wire lines between the central station and protected premises. As shown in Fig. 5, one 40-point scanner transmitter can be used to determine five status conditions at eight different locations. Each wire line from protected premises is terminated at the scanner location where the scanner checks four status conditions—open circuit (open wire line or break in fire alarm circuit/intrusion circuit loop), shorted line, grounded line, burglar alarm turned on and in normal condition, or burglar alarm system turned off.

Only one tone channel is required between the scanner and the central station. If 19 other scanners feed their tone signals to the same central station line, 160 premises can be monitored.

Another application for scanners is in multi-channel radio communications systems. Here, one operator can monitor four radio channels and four status conditions at a remote base station. He can also select the output of any four receivers and select any of four transmitting frequencies.

Two scanner systems are required, one for monitoring and the other for control. Three tone channels are required, one for each scanner system and one for controlling the transmitter, and only one wire line or carrier telephone circuit is required since a filter can be used at each end of the circuit to remove the tones from the speech signals.

Quantitative information can also be transmitted over a scanner system. In this method, the scanner transmitter looks sequentially at eight sets of contacts each representing a different level of temperature, speed, liquid level, pressure, voltage, or other condition.

A more elaborate data acquisition system is used to select any of 40 data transmitters at a storage tank farm to transmit temperature and liquid level information from 20 tanks.

As the scanner transmitter operates, its associated receiver sequentially connects the output contacts of 40 shaft encoders (electro-mechanical analog-to-digital converters which are coupled to a temperature or liquid level meter shaft) to the keying circuits of a bank of tone transmitters. As each of the 40 shaft encoders is interrogated, a combination of tones (some mark, some space) is transmitted to represent the measured value. The data could also be derived from the output of an electronic analog-to-digital converter into which the analog information is fed.

At the scanner transmitter location, the coded tones actuate a paper tape punch which records the temperature and quantity of liquid at each of the 20 tanks. The punched paper tape is then read out by a teleprinter to produce a printed record, or fed to the input of a computer.

One of the most popular uses of scanners is in microwave communications systems for fault reporting. In a typical system, an 8-point scanner transmitter monitors eight different conditions.

The scanner receiver normally monitors the status change tones transmitted by each of the eight stations. When a change of status occurs at any station, the tone transmitter and scanner transmitter are turned on, and the change of status is noted by the scanner receiver which actuates an alarm. ▲

Mexican Color TV

(*Continued from page 48*)

at the 30-cps rate. When using a conventional color CRT, one amplifier operates the red gun while the other amplifier gates both the blue and green guns connected in parallel. The red gun is operated during the odd number fields while the green and blue guns operate during even number fields.

Once the field switcher is operating and individual electron gun brightness is determined, and the video applied to the three cathodes connected in parallel, color saturation is determined by operation of the set's contrast control.

An experimental circuit has been designed and built that is capable of distinguishing between odd and even fields. The output from this circuit is used to lock the CRT electronic field switch.

Color CRT

To display this two-color system properly, three-gun tubes such as the 21CYP22 whose persistence is approximately 28 milliseconds for the red and 25 milliseconds for the green is used. Such long persistence means that "blinking" of the viewed picture will be reduced. A CRT with a shorter persistence such as the 21FJP22 whose red and green phosphor persistence is approximately 60 microseconds (about 1 horizontal line time) will produce "blinking" of the received picture.

Because the red-orange scan falls on odd number fields and the blue-green scan falls on even number fields, it becomes possible to design a two-color CRT with a screen consisting of red-orange and green-blue stripes alternating from top to bottom of the CRT. Such a tube is under design at the moment and, when operational, is expected to greatly reduce the cost of receivers capable of receiving this latest approach to the transmission of color TV.

This Mexican-developed color-TV system joins the NTSC (American-developed compatible system in use today), PAL (phase-alternate line method of color transmission and reception developed in Germany), and the SECAM (a third color system developed in France). Each of these systems has its good points and each has certain drawbacks.

Although this Mexican system suffers from certain color deficiencies, it appears to use what are probably the simplest circuits of the four systems.

Our thanks to Ing. Jesus Carvajal Sosa who provided details of this system invented by Dr. Guillermo Gonzales Camarena, chief technical advisor for *Telesistema Mexicano*, Mexico City. ▲

RACKS FOR TEST EQUIPMENT

By JAMES L. HARTLEY

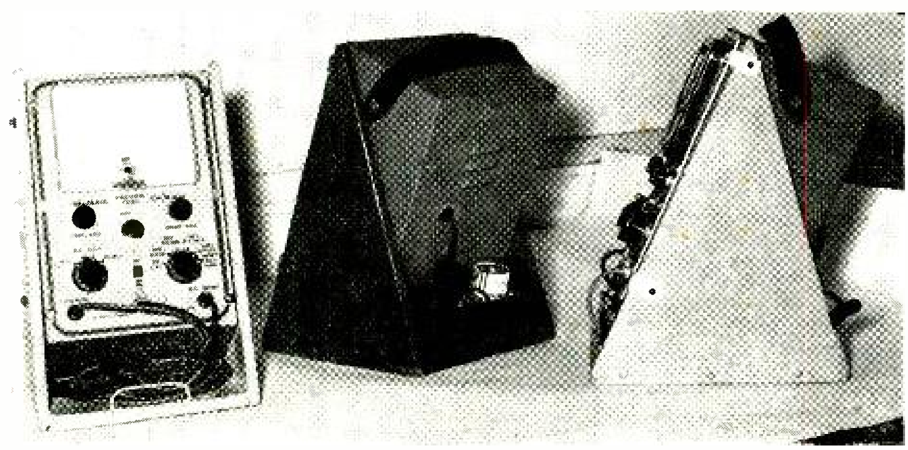
FOR the protection of v.t.v.m.'s, signal generators, and other test instruments, we have found it desirable to mount them in plywood racks as shown in the photograph below.

Such racks protect the instruments from damage; keeps them from falling over on the bench, and provides ready stowage for tests leads and line cords. The dry cell for the v.t.v.m. is mounted outside the case for easier access. Also, the instrument is easier to read in the sloping-front position.

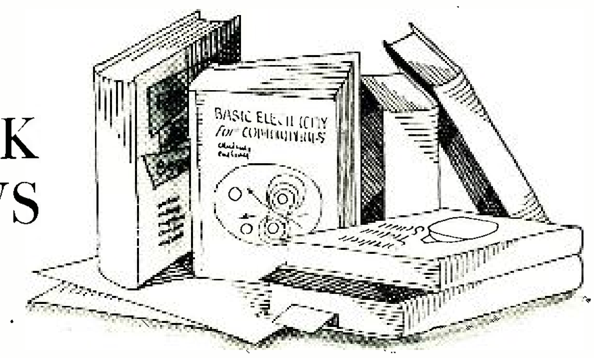
The two side panels of the rack are of $^3/_8$" plywood with an 8" base and a height of about 11". The baseboard is ½" plywood, 8" wide with a length to accommodate the width of the instruments. A strip of Masonite across the back makes a good place to tuck in the line cord. The U-shaped wire is set in at the front edge to hold the test cables.

We found it better to bolt the instrument case directly to the side panels, as seen at the left in the photo below, instead of using the right-angle metal brackets, shown at right.

For school use, we have a large number of instruments mounted in such racks and any technician with a few pieces of test equipment could easily adapt this same idea to his own needs. ▲



BOOK REVIEWS



"AUDIO AND ACOUSTICS" by G. A. Briggs. Distributed by *Herman Publishing Service, Inc.* Stamford, Conn. 164 pages. Price $2.95.

All of Mr. Briggs' devoted "fans" will welcome this new volume which is intended as a partial replacement for the author's now-out-of-print "Sound Reproduction." By limiting the scope of several individual treatises rather than revising the original volume, the author feels that the cause of timeliness can be better served.

In this volume he covers audio and acoustics in twelve chapters which deal with early and modern methods of sound reproduction, the ear, resonance, echo and reverberation, room acoustics, free-field sound rooms, transient response, stereo, schools and constant-volt lines, concert halls and studios, TV studios and ambiophony, and live *versus* recorded tests.

The treatment throughout is Briggsian with informality the keynote and sly bits of humor inserted. The author has assembled an interesting assortment of modern and historical photographs to illustrate his text—many of which will be familiar to U.S. readers since they show well-known products by such firms as *Ampex* and *Fisher*, with pictures of *Harvey's* hi-fi department and *Bloomingdale's* phono section in 1904.

This is an altogether delightful and informative text for anyone interested in audio and its reproduction.

° ° °

"TRANSISTOR TRANSMITTERS FOR THE AMATEUR" by Donald L. Stoner. Published by *Howard W. Sams & Co., Inc.* 126 pages. Price $2.95.

This volume serves a dual purpose in providing a lot of practical information on transistor circuitry along with use-tested construction projects for both the Novice and advanced amateur as well as the CB-er.

A comprehensive introductory chapter covers transistor development, unique circuit problems encountered with transistors, high-frequency operation, transistor parameters, circuit configurations, power supplies, bias, and testing and alignment.

The rest of the book provides circuit details on an interesting array of equipment—some of which is intended to be built breadboard style and the rest housed in professional looking cabinets which would not be out of place in any ham shack. Complete parts lists, schematics, and in some cases pictorial diagrams are included for each construction project.

° ° °

"MARKETING PRACTICES IN THE TV SET INDUSTRY" by Alfred R. Oxenfeldt. Published by *Columbia University Press.* 276 pages. Price $10.00.

This analysis of the marketing practices in the TV set industry is interesting because of the almost "Alice in Wonderland" atmosphere prevailing. One of the first setbacks Dr. Oxenfeldt, who is Professor of Marketing at Columbia's Graduate School of Business, encountered was the almost impenetrable curtain of secrecy surrounding all marketing and sales planning activities. Those few top and middle management personnel who were willing to talk would do so only with the understanding that it was "off the record" and that they would not be quoted.

Many of the firms interviewed were unable to provide price and budget breakdowns since, as multi-product manufacturers, they failed to segregate TV costs from those incurred in making, for instance, their refrigerator and washer lines.

Ad budgets, distribution costs, and promotion allocations varied widely from company to company and were established on no rational basis, as far as Dr. Oxenfeldt and his research team could determine. His group also deduced that often firms with aggressive marketing organizations were able to weather relative inefficiencies in production, product design, and handling by sheer sales volume.

Although, basically, this book has been unable to establish a single firm conclusion regarding TV set marketing, it is interesting to the extent of providing an "outsider's" view of a complex merchandising operation.

° ° °

"GOD & GOLEM, INC." by Norbert Wiener. Published by *The M.I.T. Press.* 95 pages. Price $2.95.

When Dr. Wiener died early this year at the age of 69, the world lost not only one of its great theoretical mathematicians but a humanist and truly civilized man as well.

The man who coined the word "cybernetics" and is generally acknowledged to be the "father" of the art, here considers the moral and ethical implications of automation and automatization, as he calls it. Dr. Wiener contends that man must always remain a "partner" to the machine since no matter how perfected, the machine is merely a machine and unless every possible contingent is programmed into it, some of its decisions can be catastrophic.

He likens the machines—even the most sophisticated of them—to the "Golem" of the Rabbi of Prague who, according to Jewish legend, is merely an embryo Adam—shapeless, not fully created—an automaton. Until man's intelligence and control is brought to bear on these machines, they are monsters. According to Dr. Wiener, the watchword should be "Render unto man the things which are man's and unto the computer the things which are the computer's." His book explains why this must be so.

° ° °

"ELECTRONIC FUNDAMENTALS AND APPLICATIONS" by John D. Ryder. Published by *Prentice-Hall, Inc.* 681 pages. Price $17.00.

This is an updated Third Edition of a volume that has been a standard text in engineering colleges throughout the country for many years. Emphasis in this edition is on an integrated treatment of solid-state devices as well as the older vacuum and gaseous forms of active electronic devices.

The text material has also been reconsidered in the light of present-day developments with more stress being placed on solid-state devices and the treatment of vacuum devices then paralleled wherever possible.

Since this is a text designed for college-level engineering courses, a knowledge of differential equations and basic circuit theory has been assumed by the author. Those without this requisite background would be "lost" before they completed the first chapter.

° ° °

"MASERS AND LASERS: HOW THEY WORK, WHAT THEY DO" by Dr. M. Brotherton. Published by *McGraw-Hill Book Company, Inc.* 201 pages. Price $8.50.

This is a basic handbook for the interested layman, the student, and the science instructor. The author deals with the basic principles and ideas involved in masers and lasers, the development of the maser principle, and the method of producing laser action by harnessing the orbital electron system of atoms and molecules.

The sixteen chapters of this book include discussions on electro-magnetic waves, laser radiation, spectroscopy, atomic theory, nature of the atom, concept of the photon, concept of stimulated emission, traveling-wave ruby masers, ruby and helium-neon lasers, the semiconductor junction laser, uses of masers and lasers, communicating with lasers, the significance of frequency bandwidth, and a capsule history of maser and laser development.

The treatment is non-mathematical and the writing is lively and informal.

° ° °

"SILICON CONTROLLED RECTIFIER MANUAL" compiled and published by *General Electric Rectifier Components Department*, Auburn, N.Y. 409 pages. Price $2.00.

This is the Third Edition of the firm's popular handbook on silicon controlled rectifiers and features the first major coverage of light-activated SCR's and gate turn-off switches, with characteristics, ratings, and a number of suggested circuits for a variety of applications.

The manual includes 21 chapters with more than 50 percent of the material not hitherto published. A major feature is a chapter on the reliability of power semiconductors. This chapter discusses failure modes, ways to minimize failures, and the statistical aspects of reliability. There are new circuits for high-gain phase control and a comprehensive listing and analysis of the many categories of inverter and chopper circuits, tables of circuit constants, and examples of their usage.

° ° °

"PASSIVE AUDIO NETWORK DESIGN" by Howard M. Tremaine. Published by *Howard W. Sams & Co., Inc.* 283 pages. Price $4.95.

This is a practical handbook for the audio technician or engineer who needs design, construction, and testing information on audio networks.

The volume is divided into four main sections: attenuators, equalizers, wave filters, and network measurements. Each of the first three sections contains a preliminary chapter covering basic design in which the component is introduced and generalized details are given. Those with just a modest mathematical background will be able to work with the material included in the text.

The book is lavishly illustrated with photos of commercial units, graphs, and useful tables of various types.

° ° °

"ELECTRONIC ENGINEERS & TECHNICIANS REFERENCE HANDBOOK" and **"MODERN DICTIONARY OF ELECTRONICS."** Published by *Howard W. Sams & Co., Inc.* $4.95 and $6.95 respectively.

These two volumes are designed for the reference section of the electronics library shelf.

The Handbook contains 11 sections ranging from vacuum-tube fundamentals to network analysis. These sections include power dissipation and transfer, amplification and tube bias, semiconductors, *LC* oscillators, multivibrators, diode clampers and clippers, capacitors, inductance, impedance, resonant circuits, and network solutions. Widely used circuits are presented schematically along with the theoretical and mathematical concepts and graphical data on their performance.

The Dictionary, compiled by Rudolf F. Graf, is an up-dated and enlarged version of this publisher's earlier volume. There are now more than 12,400 terms listed including words applicable to the fields of microelectronics, semiconductor devices, reliability, computers, data processing, and programming. Presentation is in standard dictionary format with line drawings, cutaway views, and partial schematics.

° ° °

"MICROWAVE SOLID-STATE ENGINEERING" edited by Nergaard & Glicksman. Published by *D. Van Nostrand Company, Inc.* 226 pages. Price $8.00.

This volume was prepared by and for *RCA* personnel for use in its training programs and represents the thinking of various of the company's experts in the field, as presented in a series of lectures on "Solid-State Phenomena and Their Microwave Applications."

In eleven chapters the text covers elementary quantum mechanics, solids, semiconductor devices, microwave diode devices, molecular resonance, molecular resonance amplifiers and oscillators, general properties of ferrites, ferrite devices, general properties of plasmas, microwave properties of plasmas, and microwave solid-state devices.

Of necessity, the treatment is mathematical but problems are appended to each chapter for self-checking and pertinent reference material is cited for additional study on the subject.

° ° °

"THE TRANSISTOR RADIO HANDBOOK" by Stoner & Earnshaw. Published by *Editors and Engineers, Ltd.* 172 pages. Price $5.00.

There is a wealth of interesting and practical circuits in this "do-it-yourself" handbook for the audiophile, the ham, the SWL, CB-er, and the experimenter. Construction projects range from deluxe audio compressors to a wide range of power supplies for various applications. By way of introducing the reader to the "why's and wherefore's" of the circuits to be built, the authors impart a generous amount of basic transistor theory.

The text is lavishly illustrated with photographs of equipment and components, line drawings, schematics, graphs, and charts. The parts lists accompanying the construction schematics are clear, complete, and printed in large boldface type to make the job of the constructor easier. ▲

NEW PRODUCTS

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 12.

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

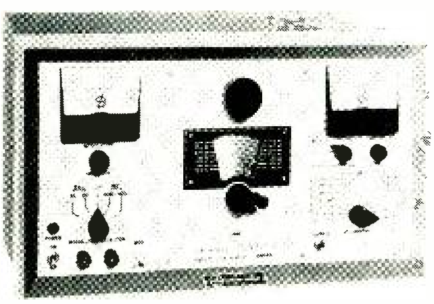
PHOTOCONDUCTOR KIT

1 **Sylvania Electric Products Inc.** has assembled a basic photoconductor kit which can be used to construct a remote utility switch to open and close garage doors, an automatic volume control for stereo and hi-fi sets, an electronic target shooting game, or an electronic guard for model railroad crossings, and other devices.

The kit includes three photoconductors with moisture-detecting blue dots that turn pink if the hermetic seal is broken; a **Sigma** a.c.-d.c. relay; a 22,000-ohm, 1-watt resistor; mounting bracket; and a 52-page circuits booklet describing a variety of applications.

R.F. STANDARD-SIGNAL GENERATOR

2 **Ferris Instrument Company** is now offering the Model 200A, a laboratory standard signal reference designed for research and development on receivers and r.f. amplifiers and for the measurement and calibration of sensitivity,



selectivity, gain, image rejection, and harmonic distortion in r.f. circuitry and equipment.

Frequency range is continuously tunable from 15 kc. to 70 mc. in seven ranges, with an engraved direct-reading dial individually calibrated to 1% accuracy. Supplementing this facility is an internal 100-kc./1-mc. crystal oscillator and an audio output jack permitting zero-beat frequency settings to 0.01% accuracy at crystal check points.

The r.f. output is adjustable from 3 volts down to 0.1 microvolt into 50 ohms by means of a vernier potentiometer, step attenuator, and front-panel output meter, with an accuracy of ±2 db from 0.1 to 1000 μv. and ±1 db from 0.001 to 3 volts.

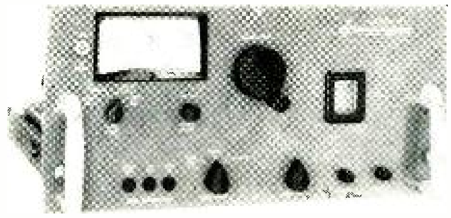
DB PADS

3 **Fairhill Products Corporation** is in production on a new db pad which is designed for use in communications and testing. The pads use PJ-055 telephone plugs on each end and cable-type CO-02 MGE (2/20) 0263, per MIL spec. C-3432. Cable and plug terminations, either military or industrial, can also be supplied.

The compact pad is made of a black Nylon outer shell with white Nylon end inserts.

SOLID-STATE OSCILLATOR

4 **Technical Products Company** has announced the availability of a new wave analyzer system, the all-solid-state TP-626T oscillator. In addition to being solid-state, it features greater frequency stability and amplitude, very wide continuously adjustable scanning rate, and a scanning rate meter to accurately adjust scanning rate to loop length.



In addition to supplying an output to the companion TP-627T analyzer, the oscillator produces a low-distortion audio output at the frequency to which it is tuned for closed-loop wave analysis such as vibration table applications. The new oscillator is compatible with the firm's entire line of wave analyzer system units.

D.C./A.C. CALIBRATOR

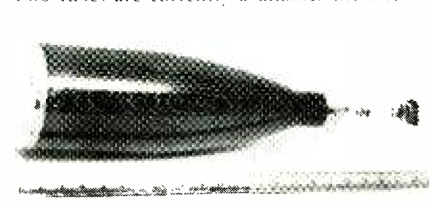
5 **Ballantine Laboratories** is now in production on the Model 421 a.c.-d.c. calibrator whose output is 0 to 111 volts a.c. or d.c. The a.c. may be r.m.s. or peak-to-peak at either 100 or 1000 cps. Output voltage to four significant figures is indicated digitally from left to right. Accuracy is 0.15%.

The principal applications are calibration of voltmeters, oscilloscopes, recorders, and other voltage-sensing devices. Model 421 is portable and may be taken to the instruments to be calibrated rather than requiring that these instruments be brought to a calibration department. The accuracy guarantee holds for operation from a wide range of power-line voltages and ambient temperatures.

CRT'S FOR U.H.F.-V.H.F. XMTRS

6 **Amperex Electronic Corporation** has developed two cathode-ray tubes which are specifically designed for use in u.h.f. and v.h.f. transmitters. Use of these tubes in transmitter design allows direct monitoring of r.f. output without demodulation. Non-linearity and instability associated with demodulation can thus be avoided and depth of modulation can be determined from the r.f. directly.

Two tubes are currently available: the D13-23



for u.h.f. is tunable to frequencies between 300 and 900 mc.; the D13-16 for v.h.f. is capable of displaying r.f. signals from 0 to 250 mc. Both tubes are electrostatically focused and deflected, have 5-inch flat faces, and utilize helical post-deflection acceleration systems.

NEW VIDEO TAPE

7 **3M Company** has developed a video tape which permits a new process of television control. Called "stop-motion," the process allows technicians to stop a recorded television picture instantly and to continue to show one single picture for up to 10 minutes without picture degradation.

The new "Scotch" No. 388 offers higher resolution and longer tape life for closed-circuit video tape recorders due to a new low-noise oxide and high temperature binder formulation.

The tape was developed specifically for helical scan or portable recorders. These slant-track tape recorders are being widely used in the medical, dental, and educational fields due to their compact nature and moderate cost.

BYPASS CAPACITORS

8 **Aerovox Corporation** has announced a new series of dipped bi-electric ±10% DBE Mylar-paper bypass capacitors which feature low power factor, high insulation resistance, and humidity specifications that meet the requirements of MIL-C-25 for moisture resistance and temperature.

The solid-setting thermo impregnant will not crack, soften, or flow within the operating temperature range of -55 to +125 degrees C. Capacitors in this line are available for 200, 400, and 600 v.d.c.w.

PORTABLE INFRARED VIEWER

9 **Varo, Inc.** is now marketing a lightweight, completely portable infrared viewer as the Model 5500 "Detectirscope." The unit is completely self-contained and includes the image converter tube and a power supply.

The viewing device operates in the "near IR" range and responds to 4000 to 12,000 angstroms,

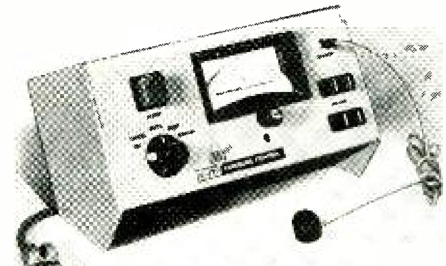
peaking at 8000. Operating temperature range is -25 to +115 degrees F. It is powered by a 1.34-volt d.c. mercury battery, converted to 12,000 volts. Focus range is 1 foot to infinity and the field of view is 26 degrees.

Weight of the new unit is 21 ounces, including the power supply. A variety of infrared light sources and lens assemblies are adaptable to this device.

EXPOSURE CONTROL

10 **Self-Organizing Systems, Inc.** has developed an accurate, automatic exposure control for photographic operations requiring a high degree of precision.

The SI-370, by responding only to useful light,



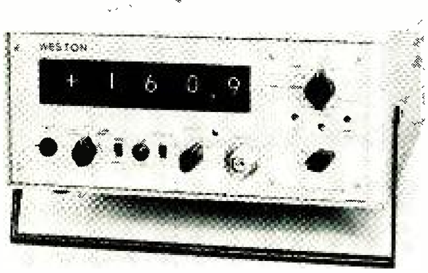
eliminates bad exposures caused by change of light color or intensity arising from line-voltage fluctuations, lamp aging, electrode corrosion, or light placement.

A variety of sensors especially calibrated for specific operations is available for use with the instrument. These include sensors for process camera work; print-frame work; photo-resist processes; microphotography; and a general purpose sensor.

INTEGRATING D.V.M.

11 **Weston Instruments and Electronics Division** is now marketing a precision integrating-type digital voltmeter, the Model 1420.

The new unit has a four-digit readout and a minimum input range of 20 millivolts. In the 20-mv. range, input impedance is 50 megohms



and resolution is 10 μv. The all-solid-state unit has a completely isolated input and a common mode rejection of more than 120 db at 5000 ohms unbalance. The instrument gives 33 readings per second and can be used as a counter-timer.

It measures 14¼" wide x 6½" high x 16¼" deep and weighs 25 pounds.

NEW METAL-FILM RESISTORS

12 **Sprague Electric Company** has announced an improvement in manufacturing techniques for metal-film resistors which permits as much as a 15-fold increase in resistance in a given resistor size.

MIL size RN55 resistors in characteristic C and E with a $\frac{1}{10}$-watt rating, $\frac{9}{32}$" d. x ¼" long, are available with a resistance value of 1.5 megohms. Previously these resistors have been available in a maximum resistance value of 100,000 ohms.

While presently available in the firm's Type 416E $\frac{1}{10}$-watt resistors, the new technique will later be extended to achieve comparable gains on other of the company's MIL units.

"UNIVERSAL" TRANSISTOR KIT

13 **General Instrument Corporation** is marketing a compact transistor kit for radio-television dealers and technicians containing a "universal" group of transistors that can be used to replace more than 500 JEDEC and manufacturers' numbers.

Packaged in a small six-drawer cabinet that fits into the service case, the kit contains 22 units in all, covering 10 basic entertainment-type transistors.

HIGH-VOLTAGE SCR'S

14 **National Electronics, Inc.** is in production on two new series of SCR's rated at 1000 and 1200 volts p.r.v. Designed especially for ignitron firing, the new units are also applicable to other circuitry. Both the NL-510 and NL-511 types are rated at 7 amperes d.c. and 11 amperes r.m.s. The NL-510 types have a low p.r.v. to permit a reduction in costs by using a series diode. The NL-511 types have a p.r.v. equal to the peak forward breakover volts.

CRIMPING TOOL/WIRE STRIPPER

15 **Vaco Products Company** has combined four wiring tools into a single instrument which features a patented bolt slicer that operates on a new principle which requires less hand pressure to slice a bolt.

The stripping holes of the tool will accommodate insulated wire from 10 to 20 gauge. The holes are numbered according to gauge size, allowing the cutting and stripping of insulation in one simple operation.

The tool comes in a strong plastic pouch which includes a "kangaroo pocket" containing a supply of the firm's insulated and non-insulated terminals.

TRANSISTOR PROTECTION

16 **Tung-Sol Electric Inc.** has recently introduced three new circuit components called "Barretters" which provide protection of power transistors from damaging current surges or overloads. The circuit elements are made with tungsten filaments carefully chosen for their positive temperature coefficient of resistivity.

Located in series with a transistor emitter, the units act like variable resistors, offsetting any increase in transistor collector current by a corresponding increase in the resistance of their filaments.

Three types are currently available. They all measure 1½" maximum length with a glass bulb diameter of 0.775" maximum. The leads are .018" diameter and up to 1" long.

TV/FM BOOSTER-COUPLER

17 **Winegard Company** has developed a new booster-coupler, the Model BC-208, which is designed to run one to four TV or FM sets with a +8 db gain to each output.

New ampliframe shielded triode tubes are responsible for the higher gain and reduced noise. They are designed with high input impedance and extremely low interelectrode capacitance for high gain at TV/FM frequencies. For improved isolation between outlets, the balanced resistive method is used. This new circuit completely isolates sets in the system, preventing any interaction.

COLOR-TV ANALYZER

18 **Mercury Electronics Corporation** is now offering a new color-TV analyzer, the Model 900.

This low-cost instrument provides for the dynamic check of color, video, and picture-tube circuits as well as the over-all performance of

color-TV sets. All color-TV troubles are diagnosed from the top of the chassis with the Model 900 while the TV set is in operation.

An exclusive circuit eliminates the need for range switching, putting the meter on the right range automatically. A special safety feature allows safe measurement of up to 7000 volts at the focus grid of the color tube. The unit gives fast push-button readings of both current and voltage automatically.

HI-FI—AUDIO PRODUCTS

REPLACEMENT RECORD CHANGER

19 **RCA Parts and Accessories** has announced the availability of an improved "Studiomatic" record changer which features the company's "Feather Action" tonearm.

Designed as a replacement unit or hi-fi system component, the unit features a pressure limiting pickup which protects records against audible scratch even when the tonearm is bounced or slid across the record. A hinged cartridge floating inside the tonearm head adjusts automatically to external pressure and tracks even badly warped records. Pressure on the tonearm is prevented from causing excessive stylus force on the record. A specially treated dusting pad is incorporated in the tonearm.

STEREO SPEAKER SYSTEM

20 **Conar Instruments** is now in production on a new center-channel stereo loudspeaker system which is designed to be used with any existing stereo amplifier. It provides the "left plus right" center signal without additional crossovers or amplifier.

Frequency response is 40 to 17,000 cps. Power capacity is 25 watts and impedance is 8 or 16 ohms. Twelve full-range speakers provide the center-channel mix.

The Model 3SP system is housed in an oiled-walnut cabinet which measures 25" x 20" x 5" deep.

MAGNETIC-DISC RECORDER

21 **Ampex Corporation** has demonstrated an engineering prototype of its new solid-state magnetic recorder/reproducer which makes use of a magnetic disc instead of tape reels for recording and reproducing sound. Designed especially for the broadcast industry, the unit features a disc which is inserted in a slot in the front of the recorder which automatically centers and cues it for recording or playback.

The record/reproduce head is mounted on a carrier which moves across the rotating disc from the outer edge toward the center in a straight line. Playing time of the magnetic disc is three minutes and maximum cue time is 5 seconds.

TWO-WAY SPEAKER SYSTEM

22 **Sherwood Electronic Laboratories** has added a two-way speaker system to its line as the "Newport."

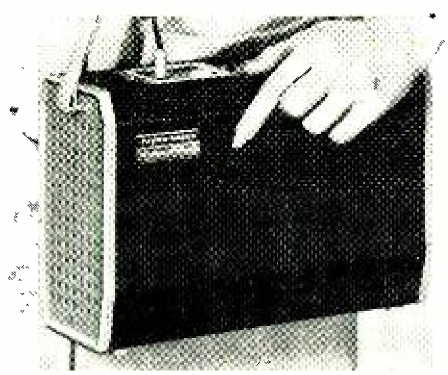
The system features a 10" woofer, a 4" mid-tweeter, and an 1800-cps crossover network. The woofer has a single-roll suspension which provides 23-cps free-air resonance for extended low-frequency response. In addition, the woofer voice coil has a four-layer winding which boosts efficiency and a one-inch-long throw to minimize distortion.

Over-all response of the system is 53 to 17,000 cps ±2½ db. The unit will handle 45 watts of program material and minimum drive requirement is 10 watts.

The enclosure is available in hand-rubbed walnut finish with cane grille or in unfinished birch. It measures 24" x 13" x 9½" deep.

PORTABLE P.A. SYSTEM

23 **Fanon-Masco** has announced a completely portable p.a./music system which is no larger than an over-the-shoulder handbag. The Model MVS-5 "Speech Master" is capable of am-



plifying both voice and music to a full 8-watt sound output, providing an effective range of approximately 600 yards.

The system is completely transistorized and comes with a dynamic microphone and coiled cord. There are separate inputs for the microphone or for any music source.

The system weighs less than 10 pounds and measures 11" x 8" x 4". It is powered by six standard "D" flashlight batteries.

SOLID-STATE STEREO AMP

24 **Harman-Kardon, Inc.** has added an 80-watt solid-state stereo power amplifier to its "Citation" line.

Frequency response is flat from 1 to 100,000 cps. The amplifier delivers 40 watts per channel of continuous power with both channels operat-

ing simultaneously, and will deliver its full rated power output at 10 to 60,000 cps.

Computer-grade silicon transistors are used in the circuit. The chassis itself is divided into five subassemblies to assure logical layout of parts and minimum operating temperatures through efficient heat dissipation. The design is also said to provide easier accessibility for servicing.

PROFESSIONAL TAPE RECORDER

25 **Magnecord Division of Midwestern Instruments, Inc.** has announced availability of the Model 1028 magnetic tape recorder which is being offered in a portable version or with a rack adapter for rack or console mounting. Plug-in transformers are available to match impedances to studio console or speech equipment.

The Model 1028 will handle reel sizes up to 10½ inches and operate at tape speeds of 7½

and 15 ips. Half-track or quarter-track stereo heads are available at the purchaser's option. Equalization is NAB standard.

NEW LOUDSPEAKER LINE

26 **Jensen Manufacturing Company** is now offering a new line of speakers which has been dubbed the "Delta" series.

Included in the series are the Model DL-220 3-element 12" coaxial unit; the DL-120 dual-cone 12" unit; and the Model DL-80 dual-cone 8" speaker. Each of the speakers features the company's "Syntox-6" magnetic system, low-distortion "Flexair" suspensions, and binding post terminals for quick, easy connections.

VOICE-ACTUATED RECORDER

27 **Miles Reproducer Company** has put into production the "Walkie-Recordall-64," a miniaturized, light weight, fully transistorized, self-powered tape recorder.

A feature of this recorder is the optional provision for "start-stop" operation by voice actuation. Recording starts instantly at the sound of voice or telephone and stops, automatically, after sound ceases. Up to 5 hours of solid recording may be automatically accumulated at intervals over an extended period of time.

Recording is done on a thin plastic belt having a capacity of up to 5 or 10 hours, depending on the model used.

INTERCOM/STEREO SYSTEM

28 **NuTone, Incorporated** is now marketing an all-transistor stereo music system that combines, in one unit, a dual-channel amplifier with FM-AM tuner. Designed to be built-in, the unit has ten switches for activating extension speakers throughout the house.

The system includes the amplifier-tuner and a fold-away record changer to provide stereo music from FM broadcasts or records, AM radio, and room-to-room intercom features. Accessories designed to work with this system include a matching built-in stereo tape recorder, a built-in record storage cabinet, and 5" or 8" indoor or outdoor speakers.

TRANSISTORIZED TAPE RECORDER

29 **American Geloso Electronics, Inc.** has added the "Unicorder 61" tape recorder to its line. The new unit is a six-transistor, 5-pound porta-

ble which includes built-in synchronizer for home movies.

The instrument operates on penlight batteries and a.c. power on its own built-in power supply. The unit has two dynamic speakers and connection for a remote extension speaker. A recording meter indicates recording level and battery condition. The circuit has fast forward and fast rewind. The unit will operate two hours on one tape. There is an automatic volume control and input for radio, microphone, or television program material.

TAPE-PLAYBACK DECK

30 **Tape-Athon Corp.** has recently introduced a new magnetic tape-playback deck featuring a pulse-initiated repeating program. The new unit will accept programs of any duration from 20 seconds to 8 hours, recorded on a suitable half-track recorder at speeds of 1⅞, 3¾, or 7½ ips. A program is started by providing an external momentary pulse of 6 to 12 volts a.c. or d.c. to the player via a built-in connector.

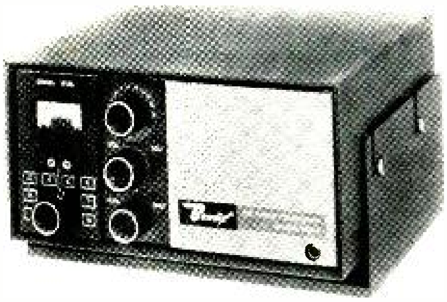
The deck is available in portable, rack-mounting, or console styles, mono or stereo.

CB-HAM-COMMUNICATIONS

23-CHANNEL CB UNIT

31 **Bendix Marine** has just introduced a new CB transceiver which is capable of providing communications on all 23 channels. Known as the Model MM8, the new unit is available for 12- or 32-volt d.c. systems, with the 12-volt model also provided with a 117-volt a.c. power connection.

Among the features of the new transceiver is an 8-channel transmit-receive crystal-controlled selector switch and a transmitter crystal plug-in jack on the front panel for any of the other 15 channels that the user might desire. In addition, the receiver is tunable over the entire 23 channels.



Front-panel controls include full-range receiver tuning control, noise-limiter switch, and a receive spotting switch which is used for exact tuning of the receiver on frequencies not crystal controlled. A 4" speaker is mounted in the front panel. Provision is made for a remote speaker with a plug-in jack on the back of the unit.

148-174-MC. MOBILE RADIO

32 **Du Mont Laboratories Division** is now offering a compact new 15-watt two-way mobile radio unit for use in the 148-174-mc. band. Specifically designed for business radio users, the new ten-inch, two-way unit has been designated as the "Spokesman" (Type M-810).

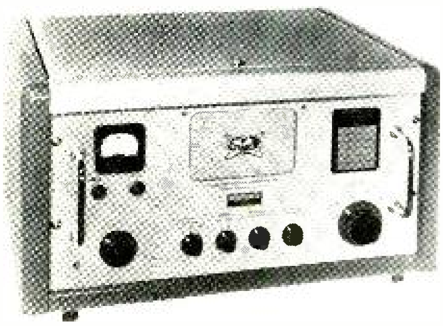
The unit features interference-free communications, reduction of harmonic radiation, hand-wired chassis, gold-alloy antenna relay contacts with dust-tight enclosure, and moisture-fungus proofing.

The instrument will operate on either 6 or 12 volts, features a transistorized power supply and low current drain. It carries FCC-type acceptance.

SSB TRANSMITTER/RECEIVER

33 **Communications Company, Inc.** has added the Model 606-SSB radio transmitter-receiver to its "Comco" line of communications equipment.

Designed to operate on up to six selected channels in the 1.5-16.0 mc. range, the new unit may be used in either the SSB mode (A3a emission) with the carrier suppressed or in the compatible-



AM mode (A3h emission) with the carrier transmitted. In either mode, the upper sideband is transmitted and the undesired lower sideband is suppressed 50 db.

Rated power output is 100 watts p.e.p. for A3a emission or 30 watts carrier for A3h emission. Receiver sensitivity is rated at better than 0.5 μv. for 10 db (S+N) N when receiving SSB signals and 1.5 μv. for 10 db (S+N) N, 30% modulation when receiving AM signals.

BASE-STATION ANTENNA

34 **Motorola Communications Division** has developed a new low-cost, easy-to-install antenna for use with two-way radio base stations operating on frequencies in the 25 to 50 mc. range.

The "Slim Profile" antenna is designed to improve message reception and transmission by minimizing static noise interference generated by charged dust and rain particles. Capable of handling as much as 500 watts r.f. power output, the antenna provides a vertically polarized omnidirectional pattern.

The antenna consists of a corrosion-resistant radome and whip and is coupled with a d.c. ground to reduce lightning damage. The antenna without whip stands 136 inches high and has a wind rating of 100 mph with ½ inch of ice and 125 mph without ice.

PORTABLE LINE TESTER

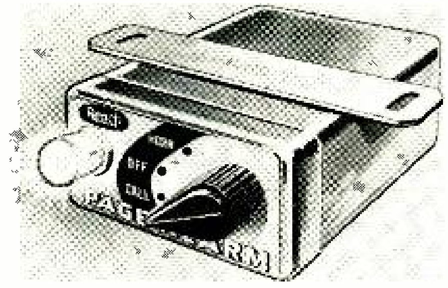
35 **Entron Incorporated** has developed a portable line tester, the Model LT-1, which provides a simple means of isolating common trunk and distribution line troubles with a direct-reading portable meter. It tests for line termination, line splitting, open line, and shorted line.

In operation, the LT-1 is connected into a section of distribution cable. An immediate indication of line condition for that section shows the necessary action to be taken. The unit includes a self-contained power supply and features push-button operation. It measures 7" x 2½" x 2⅞" and weighs 1 pound, 9 ounces.

MOBILE-CALL INDICATOR

36 **Reach Electronics Inc.** is now offering a mobile-call indicator for use with two-way radio systems. Known as the "Page Alarm," the new unit measures 1½" x 3" x 3½", making it easy to mount under a vehicle dash. It contains built-in decoding circuitry that enables the base-station dispatcher to select the mobile unit at will.

Models are available for 60 different single-tone codes and 3540 two-tone codes. Indication can be



either the auto horn or a panel light. Additional features include all-silicon transistor circuitry, compact encapsulated modular construction for reliability and ease in servicing, a connector for easy installation and removal, and no moving parts except for switches.

Although designed for use with mobile receivers, it can also be used for control by wire lines as well.

TRANSISTORIZED TRANSCEIVERS

37 **Westinghouse Electric Corporation** has added two new all-transistor transceivers to its line as "Communicators."

These low-power, license-free units have been designated 960TC4 and 961TC4. The latter model comes with carrying case and battery. Each unit is powered by a single 9-volt battery. The unit measures 5⅜" h. x 3½" w. x 1¾" deep. It uses a four-transistor chassis and a single crystal. The telescoping antenna extends to 48 inches in length. ▲

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30	Subscription Television Inc.
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34 (center)	Olson Electronics Inc.
37 (Figs. 2 & 3)	Quindar Electronics Inc.
58 (left)	Sennheiser
58 (right)	General Atronics Corp.
59	Test Equipment Corp.

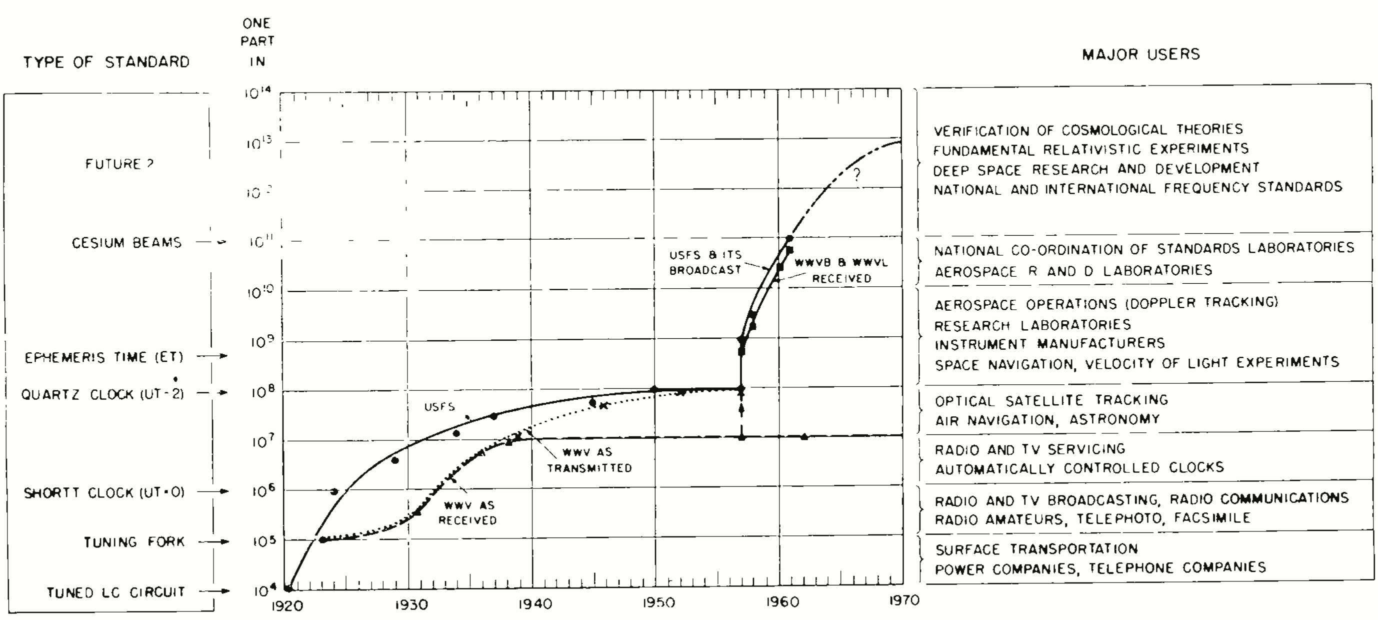
PRECISION OF U. S. FREQUENCY STANDARD

Improvements in the precision of the standard as well as in the stability of the standard signals that are broadcast are the result of research and development.

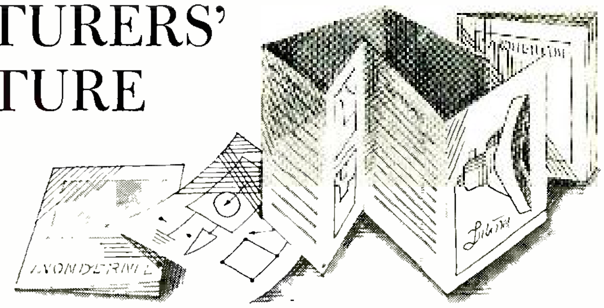
RESEARCH and development over the years has resulted in vast improvements in the precision of the United States Frequency Standard and of Bureau of Standards broadcast signals. In the figure below, the solid line represents the improvements in the precision of the USFS. The sharp upward turn in 1957 reflects the conversion to an atomic frequency standard. The present standard, a cesium beam maintained at the NBS Boulder Laboratories, is precise to 2 parts in 10^{12}, a precision much higher than that achieved in the measurement of any other quantity. One to two parts in 10^{11} are attainable for measurement times of about 10 hours.

Work is in progress at Boulder on a cesium standard that should provide about twice the precision of the present standard; on a thallium beam that to date has provided the same precision as the standard and can perhaps improve on the accuracy of the cesium beam by a factor of 10; and on a hydrogen maser that represents a potential increase in precision by a factor of 10.

The dotted line in the figure represents the stability of WWV (and WWVH after 1948) as transmitted. After 1957 the stability of all broadcast signals is essentially that of the USFS. The dashed lines show the stability of the WWV and WWVH signal as received. The leveling off of the signals as received at about 10^7, despite great increases in the stability of the broadcast signals, results from inherent limitations imposed on the signals by ionospheric instabilities. Low-frequency stations WWVL and WWVB provide a much higher received accuracy. ▲



MANUFACTURERS' LITERATURE



TERMINAL CATALOGUE

43 **Sealectro Corp.** has just issued a 40-page, two-color catalogue covering its complete line of "Press-Fit" Teflon-insulated terminals. In addition to providing full detailed specifications, the publication includes comprehensive guides for selection and installation.

The terminal configurations include stand-offs, feed-thrus, bushings, test-point jacks, taper-pin receptacles, probes and plugs, transistor holders and sockets, and others designed to specific customer requirements. All are available from stock in ten EIA colors.

INFORMATION HANDLING

44 **Radiation Incorporated** is offering a new 32-page illustrated brochure, "Information Handling Systems," featuring aerospace and ground information handling systems applicable to telemetry, analog and digital acquisition, digital data processing, digital command, display, antenna tracking, and transmitters and receivers.

TANTALUM CAPACITOR DATA

45 **U.S. Semcor** has issued a single-page data sheet which lists its new TSD series of cost-and-space-saving polar, epoxy dip-coated solid-electrolyte tantalum capacitors with full-rated d.c. voltages.

The units which are designed to operate between −55 and +85 degrees C. are available in five case sizes and with radial lead construction.

TAUT-BAND METERS

46 **Assembly Products, Inc.** has issued a four-page product bulletin that lists the firm's line of taut-band panel meters which are offered with standard plus or minus 1% tracking at no extra cost.

Bulletin 38 includes a discussion of why ±1% tracking is important to meter users and carries brief definitions of tracking and absolute accuracy. The units are pictured and complete specifications tabulated.

DISCONNECT DEVICES

47 **Waldom Electronics, Inc.** is now offering a handy wall chart which covers its line of "quick-disconnect" devices. The chart, printed in red and blue on 8" x 11" heavy stock, has 14 actual samples mounted on it. A metal-reinforced hole is provided at the top for permanent, convenient display.

For ease of reference, the devices are listed on the chart in various categories, including snap plugs, push-on type terminals, adapters, insulated snap-plug and tab receptacles, etc.

ETV EQUIPMENT GUIDE

48 **Sylvania Electric Products Inc.** is now offering a new booklet, "Equipment Guide for Classroom Television," which discusses closed-circuit camera equipment and describes a variety of applications ranging from teacher-operated single camera systems to professional studio operations. Other features of this 36-page booklet include explanations of lenses and lighting for television, master antenna and distribution systems, and building-to-building transmission.

TERMINAL BLOCKS & SWITCHES

49 **Kulka Electric Corp.** has published a 63-page catalogue covering terminal blocks, toggle switches, and components for the electronics and allied industries.

Catalogue No. 17 provides clear, concise data on terminal blocks presented in such a manner as to be of maximum usefulness to engineers in preparing drawings and specifications with minimal consultation.

TRIMMER CAPACITORS

50 **JFD Electronics Corporation** has announced the availability of a new precision piston trimmer capacitor catalogue, C-64, which describes in detail over 400 standard models.

The 40-page catalogue illustrates and describes the electrical and physical details of the firm's newly re-engineered line of highly stable trimmers, including a listing of military numbers corresponding to the firm's parts.

PUSH-BUTTON SWITCHES

51 **Dialight Corporation** has published an 8-page catalogue which covers its line of subminiature illuminated push-button switches and matching indicator lights. Data and specifications are furnished for assemblies with normally open, normally closed, or two-circuit (one normally open, one normally closed) switch action. Dry circuit switches are also discussed, available with a choice of switch forms "A," "B," or "C." Indicator lights, designed as matching companions to push-button switches, are also presented.

BUILT-IN MUSIC SYSTEMS

52 **NuTone Incorporated** has issued an 8-page multi-color catalogue sheet which describes an extensive line of built-in stereo music systems for the home. Pictured and described in considerable detail are tuner/amplifier/recorder/record changer systems; coaxial speakers for both indoor and outdoor applications; indoor and outdoor remote control units; electronic door chimes with intercom features; plus accessories for use with the various systems.

PRECISION-TOOL CATALOGUE

53 **Jonard Industries Corp.** has issued a 16-page catalogue covering a comprehensive line of precision tools for servicing, adjusting, testing, troubleshooting, assembly, and production-line work in the electronics, telephone, communications, electro-mechanical, and similar industries.

TECHNICAL PAPER REPRINT

54 **Airpax Electronics Incorporated** has available copies of the March 1961 issue of its technical journal which describes dropout failures of phase-locked loop and pulse averaging FM telemetry discriminators.

The article details signal-to-noise relationships, loss of lock, and comparison tests. Test results are shown pictorially by reproduction of the scope patterns.

WHITE ROOM ULTRASONICS

55 **National Ultrasonic Corporation** is offering copies of a six-page reprint which describes the ultrasonic theory and the equipment necessary for implementing white-room ultrasonic cleaning methods as typified by the facilities at Martin-Orlando.

The bulletin lists the various means of generating ultrasonic energy and how this energy removes the most microscopic contaminants from highly critical components. The ultrasonic system is broken down and explained by basic components in Catalogue EP2-A.

"BANKING BY MICROWAVE"

56 **Jerrold Electronics** has issued a "case history" covering its microwave TV system as used by The First Pennsylvania Banking and Trust Company for verifying check signatures and other routine banking procedures.

Photographs of the actual installation plus details on how the system works and its advantages are also included in this brochure.

SERVICE DATA FOR OBSOLETE SETS

57 **Supreme Publications** is offering a descriptive circular which covers four specialized manuals that deal with pre-war radio receivers. The manuals provide service data on practically every popular set of this period. The company can also supply individual schematic diagrams and service data for specific receiver models, as noted in the circular.

TECHNICAL DATA SERVICE

58 **Bird Electronic Corporation** has announced a new service to engineers and others concerned with r.f. measurements, practical solutions to r.f. problems, plus novel and exotic applications of the firm's instruments.

The company will publish from time to time a series of fact sheets under the title "Watt's New from Bird." Free subscriptions to this service will be entered upon request.

CAPACITOR CATALOGUE

59 **Semiconductor Specialists, Inc.** has issued an 8-page catalogue covering a line of 109 different miniature "Alumalytic" capacitors made by **General Electric Company** and handled by the firm. Ranging in capacity from 1 to 560 μf. and 3 to 150 volts, the units are offered in eight case sizes with axial leads or for printed-circuit board mounting.

The catalogue gives application information,

ELECTRONICS WORLD
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(Your requests will be forwarded to the manufacturers who will be glad to fill them promptly.)

43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70

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VOID AFTER JULY 31, 1964 7

electrical characteristics, dimensions, and lists values for each of the part numbers in the line.

MICROCIRCUITRY BROCHURE

60 **General Instrument Corporation** has published a 12-page illustrated booklet which describes in detail the functions, applications, design considerations, and method of fabrication of multichip microcircuits.

The brochure, entitled "What Every Design Engineer Should Know About GI Multichips," notes those applications where multichip circuits may be used to best advantage and those where monolithic devices are favored.

WIRE & CABLE CATALOGUE

61 **Alpha Wire Corporation** has announced publication of its 1964 Wire and Cable Catalogue, No. W-4. The 52-page publication details more than 7000 items available from stock, including two pages of coaxial cable made to military specifications.

Also illustrated and described are many new wire and cable items, including control and instrumentation cable, flat ribbon cable, unshielded control cable, and UL hook-up wire.

PORTABLE TV CAMERA DATA

62 **Kin Tel Division** has issued an illustrated technical application bulletin (8-53) which gives full details on its recently developed 3-inch-diameter portable television camera which weighs just 4½ pounds and has been adapted for use with standard broadcast equipment to provide on-the-spot coverage of outdoor news and sports events.

The bulletin describes the techniques employed by a commercial broadcast station in integrating this camera.

STEREO TAPE RECORDERS

63 **Newcomb Audio Products Co.** is offering copies of a four-page, two-color brochure which describes in considerable detail its new TX10 stereo tape recorder.

In addition to picturing and describing features of the new instrument, the bulletin provides complete technical specifications and information on accessories available for use with the TX10.

RESOLUTION EQUIVALENTS

64 **Sequential Electronic Systems, Inc.** is offering a laminated pocket or desk card containing resolution equivalents noting binary digits with related parts-per-turn, degrees, minutes, and seconds.

The card also lists small-angle approximations including linear-to-angle and angle-to-linear conversions.

DIGITAL METRONOME

65 **Universal Audio, Inc.** is offering a two-page data sheet which describes the firm's Model 960 digital metronome. The new unit provides 100 different tempo beats for use in producing live music scores for motion pictures and is of interest to musical directors, supervisors, and sound departments.

TRANSFER LETTERING CATALOGUE

66 **Chart-Pak, Inc.** has released a 20-page, two-color catalogue on "Deca-Dry," a new dry transfer lettering for a variety of applications.

The publication fully illustrates the application and each of the popular lettering styles and type faces. Sizes range from 8 point to 180 point.

INDUSTRIAL TRANSFORMERS

67 **General Electric Company** is now offering a four-page bulletin, GEA-7878, which describes features and applications for its line of industrial electronic transformers.

The bulletin covers 50- and 60-cycle transformers rated 20 to 3000 volt-amperes, for use in power and control circuits of communications and industrial electronic equipment, such as video recorders, tape transports, and data processors.

The bulletin provides helpful guidance for determining over-all and mounting dimensions, voltage regulation, and weight.

PHASE-CALCULATION NOMOGRAPH

68 **General Radio Company** is offering without charge a copy of a phase-calculation nomograph covering the frequency range from 200 to 10,000 mc. The nomograph permits quick conversion from wavelength to distance in centimeters and is especially useful in Smith Chart calculations with slotted-line measurements.

ENERGY USAGE FORECAST

69 **Westinghouse Electric Corporation** has issued a compact, a 28-page booklet which contains a digest of important information concerning the future industrial power market.

The material, presented in text, graphic, and tabular form, is divided into four categories: energy, individual industrial trends, products and processes, and the industrial market. Since a wide variety of industries is included in this analysis—steel, aluminum, chemical, paper, glass, transportation as well as civic and governmental departments—this booklet should be of interest to those setting up future planning programs.

HETERODYNE V.M./V.H.F. CONVERTER

70 **B&K Instruments, Inc.** has published a six-page specification sheet on the Model 2004/05 heterodyne voltmeter and v.h.f. converter. Designed specifically for empirical measurement of voltage amplitude, frequency, and percentage of AM in high-frequency signals, the instrument provides direct and instant readings on three meters.

The brochure provides detailed descriptions of the instruments, gives their specifications, and discusses typical application setups.

BATTERY ENGINEERING DATA

Union Carbide Corp., Consumer Products Division, 270 Park Avenue, New York, N.Y. 10017, has just published the "Eveready Battery Applications and Engineering Data Book" which it is offering free upon request on company letterhead and $4.95 a copy to others.

The book, over 500 pages in length, is said to be the most complete reference guide to dry batteries ever assembled. It contains basic data on carbon-zinc (Leclanche primary); alkaline-manganese (primary and rechargeable); silver (primary); nickel-cadmium (rechargeable); and mercury (primary) electro-chemical systems.

The book also includes physical specifications, service life data, and cross-reference information on the complete line of "Eveready" batteries.

NUMERICAL CONTROLS FILM

The Bendix Corporation's Industrial Controls Division, 8880 Hubbell Avenue, Detroit, Michigan has produced a new 25-minute, 16-mm. color and sound film covering numerically controlled drilling, milling, grinding and turning machines, as well as the new-generation multi-purpose machines designed specifically for numerical control.

Narrated by Chet Huntley, the film includes commercial case histories on parts machined by **General Motors, Corning Glass,** and other large companies.

Prints can be obtained for screening by interested industrial groups at no charge by contacting the Sales Department of the division.

MICROWAVE EQUIPMENT FILM

RCA Microwave Department, Building 15-5, Camden, N.J. has offered to loan prints of its new 15-minute color film, "The RCA Solid-State CW-60 Microwave" to communications engineers and to other technically oriented groups.

The 16-mm. film discloses the "state of the art" techniques used by the firm in the design of its microwave equipment. It includes scenes of the first field installation, detailed views of the equipment, and animated diagrams that explain the solid-state power generation and switching circuits. ▲

Light Dimmer

(*Continued from page 47*)

to the load travels through a high-power BSD and the "secondary" of the autotransformer, *T1*, a small 30:1 toroidal transformer.

The timer consists of *C3*, *D2*, and the parallel combination of *R2* and *R3*. The low-voltage pulses generated by *D2* discharging *C3* are coupled to the "primary" of *T1*. After the 30:1 step-up, they appear as the 300- to 400-volt high-voltage spikes used to trigger *D1*. A parallel combination of *R2* and *R3* gives a much more linear brightness control action and provides an adjustment for the amount of "off" time. Resistor *R1* and capacitor *C2* comprise a dropping and phase-shifting network. This phase shift aids brightness control linearity near maximum brightness. Capacitor *C1* is the r.f. interference filter and completes the controller circuit.

Parts size is somewhat critical if all the components are to be housed in the 1½ cubic inches of space inside a conventional wall-mounted light switch so the smallest available part should be used in each instance.

D1, the heart of the circuit, is a *Transitron* TBS-20-B "Biswitch." It is normally rated at 5 amps at room temperature and has a p.i.v. rating of 200 volts. Since heat sinking is not provided in this circuit, current must be limited to less than 2 amperes to prevent overheating of the part. This is the reason for specifying a 250-watt maximum load. *D2* is a standard *Texas Instruments* 30-volt silicon trigger diode, the TI-43, available at jobbers.

T1 consists of 62 turns of #22 enameled magnet wire wound on a small powdered iron core and tapped at two turns. This core is a very low-cost item and is a factory stock item. Actually, any small toroidal core of suitable material will work as well in this application.

Because of the limited space, *R3* is a miniature pot with its element built inside the control knob and is thus mounted on the outside of the controller case.

The housing for the controller is the body of a *Leviton* 10-amp "house-wiring" switch. The switch selected must be of the type with the terminals out the side of the case and with a simple riveted-on mounting plate that covers the entire front of the Bakelite case. Any other type switch might not come apart as easily and might require mechanical redesign.

Two parts have to be modified, *S1* and the blank outlet cover plate. Start with *S1*. Drill out the two eyelets holding the Bakelite body to the front plate. Remove and discard the eyelets, the front plate, and all moving parts. This leaves the case, two screw terminals, and two fiber spacers. File or drill out any bosses, spacers, or protrusions inside the switch body. The material is fairly soft and easily removed. Make a new front plate from 1/16" soft aluminum. The lip bent down the one side adds strength to this part and should be flush with the switch body. See photos.

The brightness control, *R3*, is next mounted on the front plate. A second knob is glued on top of the original to increase the gripping area and to insulate the operator from the hot center shaft of *R3*. A ⅝-inch diameter knurled black knob fits nicely.

The disassembled unit shown in the photo illustrates the construction technique used. There are two layers of parts. Start with the bottom layer and be sure to use spaghetti on all leads. Begin with *C2* and *R1*. Next tightly hand wind the transformer and wedge it (lightly) in front of *C2*. Diode *D1* is next followed by *D2*. Wiring follows the schematic diagram of Fig. 3. The top layer consists of *C1*, *R2*, and *C3*, added in that order, followed by the final two connections made to *R3*.

It is a good idea to test operation at this point. If the circuit is properly wired, the first ⅛ turn of the pot should leave the lamp load out completely. This is the control "dead space." From this point, the control should provide smooth, linear operation from practically zero light to full brilliance. The amount of dead space is determined by *R2*. To increase it, raise the value of *R2*; to lower it reduce the value. This compensates for high- or low-line voltage and for the type of load. Generally, less dead space is wanted in a power-tool control than in a dimmer. Five percent of available load power won't turn over an electric drill but it will cause an obvious orange glow in a light bulb that is supposed to be off. This is a case of too much dead space in one case and too little in the other.

Complete the assembly with 4-40 screws and nuts where the eyelets used to be in *S1*. The coverplate, as modified, is then mounted with its own hardware.

This controller will only work on 60-cycle a.c., 100 to 125 volts. The load must be held to less than 250 watts and preferably below 200 watts during any long-term operation. Generally, an a.c. appliance motor *with* brushes will work while any a.c. motor *without* brushes won't—and could be damaged. Any of the motor loads should be less than ¼ h.p., as any higher rating would draw too much current.

The circuit may be used to control 600 watts by replacing *D1* by the almost equal-cost TBS-20-BS if the new *D1* is bolted to a heat sink. With this unit, however, the circuit will no longer fit into the switch plate. For 1000-watt (1 h.p. motor or less) control, *D1* should be the TBS-20-AS which requires a much larger heat sink. ▲

ELECTRONICS MARKET PLACE

COMMERCIAL RATE: For firms or individuals offering commercial products or services. 60¢ per word (including name and address). Minimum order $6.00. Payment must accompany copy except when ads are placed by accredited advertising agencies. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance.

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GENERAL INFORMATION: First word in all ads set in bold caps at no extra charge. Additional words may be set in bold caps at 10¢ extra per word. All copy subject to publisher's approval. **Closing Date:** 5th of the 2nd preceding month (for example, March issue closes January 5th). Send order and remittance to: Martin Lincoln, ELECTRONICS WORLD. One Park Avenue, New York, New York 10016

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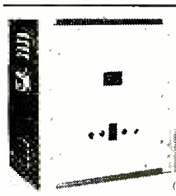
LM FREQ. METER 125 kc-20 mc w/xtl calib., cal. bk, plug, instruct., clean. OHC fob Los Angeles **57.50**

LEEDS & NORTHRUP BRIDGES #1725 (.05%), #4760, Galvos #2430-c & pointer types, K2 Pots, etc. WRITE FOR YOUR NEEDS!



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

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DIAGRAMS for repairing radios $1.00. Television $2.50 and $1.00. Give make, model. Diagrams, Box 55, Williamsport. Pa.

COMPLETE KNIFE catalog 25¢. Hunting. Pocket, Utility. Heartstone, Dept ZD, Seneca Falls, New York 13148.

WHOLESALE prices on TV cameras. transmitters, converters, etc. direct from factory. Catalog 10¢. Vanguard. 190-48 99th Ave.. Hollis. N.Y. 11423.

NEW transistor buried treasure, coin detectors. Kits, assembled models. $19.95 up. Free catalog. Relco, A-22, Box 10563. Houston 18. Texas.

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C-B'ERS—Ground Plane Antennas. List $9.95 and up. Dealers wanted. Write circular. Komet Electronics, P.O. 222EW. Tilton, N.H. 03276.

JAPAN & Hong Kong Electronics Directory. Products. components, supplies. 50 firms—just $1.00. Ippano Kaisha Ltd., Box 6266. Spokane, Washington 99207.

"SIGNAL Generators, Frequency Meters, Miscellaneous Electronic Test Equipment. Eight-Day Chronographs and Clocks: Panel or Desk Mount." Echols Electronics, P.O. Box 5522, Arlington. Virginia 22205.

KAY Megasweep, Megaliner, RCA WR-39B Calibrator. Ralph Hunter, Catskill, N.Y.

CONVERT any television to sensitive, big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans, $2.00. Relco, Box 10563, Houston 18. Texas.

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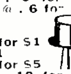

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D.C. Amps	300Piv 210Rms	400Piv 280Rms	500Piv 350Rms	600Piv 420Rms
3	.40	.50	.60	.66
12	1.10	1.35	1.50	1.70
18	1.00	1.30	Query	Query
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CIRCLE NO. 125 ON READER SERVICE PAGE

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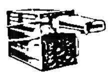

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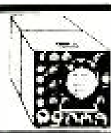


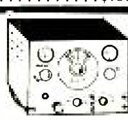
Has vertical and horizontal sweep with focus and intensity controls. Coaxial antenna changeover motor. Complete with 11 tubes and 3JP1 CR Tube. For 115 V. 400 cycle AC and 24 V DC. Circuit diagram included. LIKE NEW $14.95

TS100AP 'SCOPE, exc. used, like new, with all tubes, crystals and CR tube $39.50
As above, BRAND NEW $69.50

BC-929 3-Inch Scope, with all tubes, BRAND NEW $14.95

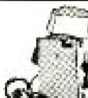
Conversion instructions, with diagram, for 100 V AC operation .... $.65

TS-16/APN TEST SET



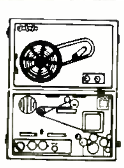
For aligning and calibration of radio altimeters. May be used to check calibration of count or circuits and modulator sweep freq. and bandwidth of transmitter. Audio oscillator range: 340 to 7250 cycles. 24 V DC input. Complete with tubes, connecting cables, instruction summary. BRAND NEW $19.95

EE-8 FIELD PHONES



Checked out, perfect working order. Complete with all parts. Excellent condition. LIKE NEW! Each $14.50

TG-34A CODE KEYER



Self-contained automatic unit, reproduces code practice signals recorded on paper tape. By use of built-in speaker, provides code-practice signals to one or more persons at speeds from 5 to 25 WPM.

Like New, Tested $29.50

Set of 15 Reels, Army Code Practice Lessons, BRAND NEW, original packing .... P.U.R.

IMPORTERS—EXPORTERS of ELECTRONIC EQUIPMENT

We specialize in the export of military surplus electronic equipment:

- All at LOWEST PREVAILING PRICES.
- In addition to items shown on this page, we have in stock for export and domestic customers, military electronic equipment made for World War II, Korean War, and later. We maintain one of the largest stocks of Government Electronic Surplus Equipment in America!
- IF YOU DON'T SEE WHAT YOU WANT HERE, WRITE US YOUR NEEDS. WE'LL QUOTE ON ANY GOV'T SURPLUS EQUIPMENT YOU SEE ADVERTISED ANYWHERE. Write or call today for our low LOW PRICE, and SPEEDY DELIVERY FROM STOCK!
- All packing and shipping is made directly from our own warehouse in NYC to give you substantial savings in handling costs!

AN/APR-4Y FM & AM RADIO RECEIVER

High precision lab instrument, suitable for monitoring and measuring frequency and relative signal strength of signals from 38 to 4000 Mc., in 5 tuning unit ranges. For 110 V 60 cycle AC operation, built-in power supply. LIKE NEW, SPECIAL $79.50

TN-16, TN-17, TN-18, TN-19 and TN-54 Tuning Units for above in stock .... P.U.R.

SCR-522 2-METER TRANSMITTER-RECEIVER

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

SCR522 as above, exc. used $32.50

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

BC-625 Transmitter only, with all tubes (of SCR 522 above). Clean. LIKE NEW condition $24.50

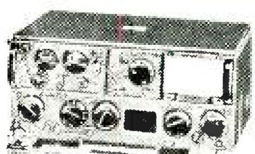
RA62 AC POWER SUPPLY FOR SCR522 Transceiver. Like New $42.50

AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc

$79.50 EXC. USED

complete with Tubes



Famous Collins Autotune Aircraft Transmitter, AM, CW, MCW. Quick change to any of ten pre-set channels or manual tuning. Speech amplifier clipper uses carbon or magnetic mike. Highly stable, highly reliable VFO. Built-in Xtal controlled calibrator. 813 in final up to 90% class "B" modulation. [illegible]

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

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

We carry a complete line of spare parts for above.

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 MC	12.45	17.95
BC-455	Receiver 6-9 MC	11.50	13.95
BC946	Receiver 550-1500 Kc Complete with all tubes. Brand New in original packing		$14.95
1.5 to 3 MC.	Receiver Brand New		$17.95

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

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

2.1 to 3 Mc Transmitter, Brand New $12.95

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

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

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

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

ALL ACCESSORIES AVAILABLE FOR ABOVE

SCHEMATIC DIAGRAMS For most equipment on this page, each 65¢

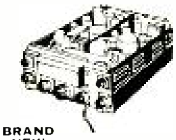
Please include 25% Deposit with order—Balance C.O.D., or Remittance in Full. 50c Handling Charges on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C. All Merchandise subject to Prior Sale and Price Change.

G & G RADIO SUPPLY CO.

Telephone: CO 7-4605
77 Leonard St. New York 13, N. Y.

FAMOUS BC-645 TRANSCEIVER

15 Tubes 435 to 500 MC



Can be modified for 2-way communication, voice or code, on ham band 420-450 mc, citizens radio 460-470 mc, fixed and mobile 450-460 mc, television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE-316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton. Shipping weight 25 lbs. SPECIAL! $19.50

BRAND NEW

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

SPECIAL "PACKAGE" OFFER: BC-645 Transceiver, Dynamotor and all accessories above, COMPLETE, BRAND NEW. While Stocks Last $29.50

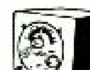
BC-344 RECEIVER. 150-1500 Kc., continuous tuning, 4-band, for 115 V 60 Cycle AC. Excellent used, perfect working order, complete with tubes. $79.50

BC-342 RECEIVER. 1.5 to 18 Mc. AC Only. Like New, complete with all tubes $79.50

BC-348 SUPERHET RECEIVER 200 to 500 Kc and 1.5 to 1800 Mc. Voice Tone, CW. Self-contained dynamotor for 24 V DC. Exec. Used. Checked out $89.50
AC Power Supply $14.50

BC-683 FM RECEIVER, 27 to 38.9 Mc., Complete with all tubes, exc. used. Checked out in working order $49.50
AC Power Supply for above, wired $12.95
12-Volt Mobile Dynamotor Power Supply, NEW $5.50

BC1206-C BEACON RECEIVER



195 to 420 Kc. made by Setchel-Carlson. Works on 24-28 volts DC. 135 Kc. IF. Complete with 5 tubes. Size 4" x 4" x 6". Wt. 4 lbs. LIKE NEW ... $9.95
less tubes $4.95

234-258 MC RECEIVER AN/ARR-2

BRAND NEW 11-tube UHF Tunable Receiver with schematic. Only a few at this low price! Complete with tubes. Exc. used $5.95 .... $8.88

ARB CRV 46151 NAVY AIRCRAFT RADIO RECEIVER 190 to 9050 KC in 4 bands: 190-550, 550-1600, 1.6 Mc, 6-9.050 Mc. 6-tube super with local and remote tuning, band change. Complete with tubes and dynamotor, like new $39.50
As Above, brand new $59.50
Power Supply, 110 V AC wired $8.95

ARC-3 RECEIVER!

Complete with All tubes Exc. Used $21.50
Like NEW $33.50

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

110 V A.C. Power Supply Kit for above 15.00
Factory Wired and Tested 19.95

ARC-3 TRANSMITTER

Companion unit for above tunes 100 to 156 MC on any 8 pre-selected channels. 9 tubes, crystal controlled, provides tone and voice modulation. 28V DC Power input. Complete with all Tubes: 3-6V6, 2-832A, 1-12SH7, 1-6J5, 2-6L6. Exc. Used .... Only $18.95
Like new condition $28.50
ARC-3 PUSHBUTTON CONTROL BOX $5.95

AN/ARN-7 RECEIVER

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

DYNAMOTOR VALUES:

Type	Input	Output	Excellent Used	BRAND NEW
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A 28V 7A	575V .16A 540V .25A	2.95	4.45
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-35	12V	625V .225A	—	19.50
DM-36	28V 1.4A	220V .080A	1.95	2.95
DM-43	28V 23A	925V .220A 460V .185A	—	7.95
DM-53A	28V 1.4A	220V .080A	3.75	5.45
PE-73C	28V 20A	1000V .350A	8.95	14.95
PE-86	28V 1.25A	250V .050A	2.75	3.85

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

MICROPHONES Checked Out, Perfect

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

HEADPHONES Checked Out, Perfect

Model	Description	EXC. USED	BRAND NEW
HS-23	High Impedance	$2.79	$4.95
HS-33	Low Impedance	3.15	5.45
HS-30	Low Imp. (featherwt.)	.90	1.85
H-16 U	High Imp. (2 units)	3.75	7.95

TELEPHONICS—600 ohm Low Impedance HEAD SETS. BRAND NEW. PER PAIR $3.95
CD-307A Cords, with PL-55 plug and JK26 Jack .89
Earphone Cushion for above—pair .50

BRAND NEW UNITED'S FIRST QUALITY TUBES DISCOUNTS up to 80% OFF

GUARANTEED ONE FULL YEAR! NOT USED! NO PULLS! **WHY PAY MORE?**

Tube	Price	Tube	Price	Tube	Price	Tube	Price	Tube	Price	Tube	Price	Tube	Price	Tube	Price
0A2	.80	3DT6	.52	6AN6	2.45	6CN7	.68	6GV5	.98	7G7	.95	12D4	.67	17L6	1.25
0A3	.90	3DZ4	.79	6AN8	1.50	6CQ4	1.03	6GW6	1.65	7H7	1.37	12DB5	1.05	18A5	1.54
0A4G	1.35	3GK5	.97	6AQ5	.52	6CQ7	1.80	6GW8	1.40	7HG8	1.67	12DE8	.81	18FW6	.47
0B2	.80	3HS8	1.29	6AQ6	.69	6CQ8	.90	6GX6	.92	7J7	1.50	12DL8	.85	18FX6	.51
0B3	1.20	3Q4	.79	6AQ7	1.55	6CR6	.58	6GX8	.92	7K7	1.45	12DQ6	1.02	18FY6	.48
0C3	.75	3S4	.73	6AQ8	1.20	6CS6	.55	6GY6	.92	7L7	1.45	12DQ7	1.33	19AU4	.85
0D3	.80	3V4	.61	6AR5	.84	6CS7	.67	6GZ5	.94	7N7	1.25	12DS7	.82	19BG6	1.35
0G3	2.75	4AU6	.94	6AR6	.95	6CU5	.56	6HF5	2.99	7Q7	1.50	12DT5	.74	19EA8	.77
0Y4	1.20	4AV6	1.15	6AR8	2.19	6CU6	1.05	6HF8	1.51	7R7	1.15	12DT7	.77	19HV8	1.44
0Z4	.77	4BA6	.85	6AR11	1.64	6CU8	1.75	6HG8	1.65	7S7	1.60	12DT8	.76	19JN8	1.20
1A3	.70	4BC5	.95	6AS5	.59	6CW4	1.75	6HJ8	1.25	7V7	1.45	12DW7	1.20	19T8	.83
1A5	.75	4BC8	1.69	6AS6	1.00	6CW5	1.10	6HS8	.93	7W7	1.45	12DY8	1.75	21EX6	1.47
1A6	.70	4BL8	.90	6AS7	2.75	6CX8	1.52	6H6	.56	7X6	.95	12DW8	.87	21GY5	1.92
1A7	1.05	4BN6	1.35	6AS8	1.20	6CY5	.68	6J4	2.95	7X7	1.25	12DZ6	.60	25AK4	.66
1AF4	1.30	4BQ7	.99	6AS11	1.87	6CY7	.69	6J4WA	3.65	7Y4	.95	12EA6	.99	25AX4	.68
1AG4	1.75	4BS8	1.35	6AT6	.47	6CZ5	1.40	6JB6	.98	7Z4	.95	12EC8	1.38	25BK5	1.35
1AX2	.60	4BU8	1.29	6AT8	.84	6CZ7	1.75	6JE6	3.25	8AU8	.93	12ED5	.60	25C5	.51
1B3	.77	4BZ6	.95	6AU4	.83	6D4	1.75	6JE8	1.50	8AW8	.96	12EG6	.60	25CA5	.57
1C5	.70	4BZ7	.99	6AU5	1.75	6D6	2.50	6J5M	.92	8BQ5	.63	12EK6	.60	25CD6	1.50
1DNS	.53	4CB6	.95	6AU6	.50	6D10	1.56	6J5GT	.50	8CG7	.66	12EL6	.48	25DK4	1.05
1G3	.77	4CS6	.59	6AU7	.54	6DA4	.66	6J6	.69	8CM7	.73	12EL8	.86	25DN6	1.40
1G4	.69	4CY5	1.25	6AU8	.85	6DA5	1.19	6J7	1.65	8CN7	1.00	12EZ6	.55	25EH5	.53
1G6	.80	4DE6	1.19	6AV5	1.75	6DB5	2.25	6J8	1.40	8CS7	.77	12F5	1.50	25L6	.55
1H4	.69	4DK6	.57	6AV6	.39	6DC6	1.20	6J11	1.83	8EB8	.97	12F8	.64	25W4	.66
1H5	1.00	4DT6	.55	6AV11	1.49	6DC8	1.25	6JH8	1.85	8EM5	.59	12FA6	.77	25Z5	.79
1H6	.70	4EH7	.60	6AW8	.88	6DE4	1.09	6K6	.61	8FQ7	.54	12FK6	.78	25Z6	.79
1J3	.77	4EM6	.94	6AX3	.92	6DE6	.59	6K7	.95	8GN8	1.58	12FM6	.48	27GB5	1.59
1J5	.95	4EW6	1.19	6AX4	.64	6DE7	1.29	6K8	1.45	8JV8	1.10	12FR8	.95	32ET5	.53
1J6	.95	4GK5	1.59	6AX5	.73	6DG6	.60	6K11	1.50	9A8	1.60	12FX5	.94	32L7	1.50
1K3	.77	4GM6	.59	6AX7	.95	6DJ8	1.17	6KD8	.99	9AU7	1.19	12FX8	.88	33GY7	2.99
1L4	.64	4GS8	1.29	6AX8	1.30	6DK6	.57	6L5	.90	9BR7	1.32	12GC6	1.04	34GD5	.79
1LA4	1.30	4GZ5	1.49	6AY3	.99	6DN6	1.48	6L6G	1.45	9CL8	.77	12GE5	1.44	35B5	.95
1LA5	2.50	4HM6	.92	6AZ8	1.75	6DN7	1.35	6L6-M	1.95	9U8	1.30	12J8	.82	35C5	.49
1LA6	1.45	4HS8	1.10	6B4	3.80	6DQ5	2.95	6L7	1.05	10C8	1.64	12K5	.73	35EH5	.84
1LB4	1.80	4HT6	.99	6B10	1.34	6DQ6	1.05	6M11	1.85	10DE7	1.35	12K8	3.00	35L6	.58
1LC5	1.25	5AM8	.77	6BA3	1.15	6DR7	1.25	6N6	1.45	10EG7	1.75	12L6	.71	35W4	.40
1LC6	1.80	5AN8	.88	6BA6	.48	6DS4	2.12	6N7	.98	10EM7	1.75	12L8	.50	35Z5	.58
1LD5	1.95	5AQ5	.52	6BA7	.92	6DS5	1.25	6P5	.95	10GN8	1.45	12Q7	.75	36AM3	.78
1LE5	1.95	5AS8	1.90	6BA8	1.50	6DT5	.79	6Q7-GT	.98	10JA8	1.30	12R5	1.18	40B2	1.50
1LE3	1.50	5AT8	.81	6BC4	2.00	6DT6	.51	6Q7-M	1.45	11CY7	.73	12SA7	1.25	50A5	1.70
1LG5	1.95	5BE8	1.10	6BC5	.59	6DT8	.92	6R7	.90	12A4	.59	12SC7	.78	50B5	.67
1LH4	1.25	5BK7	.84	6BC7	1.25	6DV4	2.99	6S4	.49	12A5	.95	12SF5	.63	50C5	.51
1LN5	1.25	5BQ7	.99	6BC8	1.00	6DZ4	1.90	6S7	.90	12A6	.55	12SF7	.67	50DC4	.71
1N5	1.20	5BR8	.81	6BD6	.95	6E5	1.95	6S8	1.15	12A7	1.45	12SG7	.79	50EH5	.53
1Q5	.95	5BW8	1.29	6BE3	1.15	6EA7	1.45	6SA7GT	.97	12A8	3.00	12SH7	.79	50HC6	.86
1R4	.80	5CG8	.79	6BE6	.53	6EA8	.77	6SA7-M	1.25	12A11	1.74	12SJ7	.75	50L6	.59
1R5	.75	5CL8	.74	6BF5	.88	6EB5	.71	6SB7Y	1.15	12AB5	.58	12SK7GT	93	50Y6	.95
1S4	1.15	5CQ8	.82	6BF6	.42	6EB8	.90	6SC7	1.35	12AC6	.53	12SK7-M		70L7	.95
1S5	.73	5DJ4	.84	6BF8	1.66	6EH5	1.10	6SD7	.70	12AD6	.55		1.25	117N7	3.95
1T4	.70	5EA8	.79	6BG6	1.60	6EH7	1.55	6SF5	.75	12AE6	.48	12SL7	.78	117P7	3.95
1T5	.80	5EU8	.79	6BH6	1.00	6EJ7	1.47	6SF7	1.00	12AE7	.92	12SN7	.65	117Z3	.83
1U4	.57	5EW6	1.12	6BH8	[illegible]	6EM5	.75	6SG7	.85	12AF3	.71	12SQ7GT		22	.95
1U5	.63	5GM6	.99	6BJ6	.63	6EM7	.80	6SH7	.80	12AF6	.65		.89	24A	.85
1V	1.05	5GX6	1.95	6BJ7	.77	6EQ7	1.05	6SJ7GT	.86	12AG6	1.50	12SR7	.98	26	.95
1V2	.70	5HC7	1.49	6BJ8	1.45	6ER5	1.47	6SJ7-M	.95	12AJ6	.60	12U7	.60	27	1.50
1X2B	.80	5J6	.70	6BK4	3.39	6ES5	1.25	6SK7GT	.90	12AL5	.45	12V6	.62	28D7	1.50
2A3	1.15	5T8	.84	6BK5	1.50	6ES8	2.79	6SK7-M	1.25	12AQ5	.58	12W6	.69	30	1.15
2A5	1.10	5U4	.59	6BK7	.84	6EU7	1.00	6SL7GT	.85	12AL8	.93	12X4	.45	31	1.75
2A6	1.10	5U8	.82	6BL7	1.05	6EU8	.77	6SN7	.63	12AT6	.48	13DE7	1.24	32	1.00
2A7	1.50	5V3	1.59	6BL8	1.49	6EV5	.73	6SQ7	.92	12AT7	.74	13EM7	1.95	33	.85
2AF4A	.93	5V4	1.45	6BN4	1.00	6EW6	.55	6SR7	1.00	12AU6	.49	14A4	.98	34	.79
2AH2	1.23	5V6	.55	6BN6	.73	6EW7	.78	6SS7	.95	12AU7	.59	14A5	1.10	35-51	.75
2AS2	1.25	5W4	.95	6BN8	1.03	6EY6	.73	6SZ7	.95	12AV3	1.30	14A7	1.10	36	.95
2B3	.98	5X4	.90	6BQ5	.95	6EX6	3.65	6T4	.95	12AV6	.39	14AF7	1.10	37	.70
2B7	.70	5X8	.80	6BQ6/		6EZ5	1.40	6T8	.84	12AV7	.80	14B6	1.20	38	.90
2BN4	.95	5Y3	.45	6CU6	1.05	6EZ8	1.75	6U5	2.25	12AW6	.98	14B8	.98	39/44	.85
2CY5	.95	5Y4	1.10	6BQ7	.98	6FA7	1.05	6U8	.81	12AX3	1.04	14C5	.98	41	.95
2D21	.70	5Z3	1.00	6BR8	1.40	6FD7	1.95	6V3	1.75	12AX4	.65	14C7	.98	42	.90
2X2	.60	5Z4	1.40	6BS8	1.25	6FJ7	1.89	6V4	.59	12AX7	.61	14E6	.98	43	1.20
2X2A	1.30	6A3	2.50	6BU8	.68	6F5	.80	6V6GT	.52	12AY7	1.42	14E7	.98	45	2.00
3A2	1.55	6A4	.80	6BV8	1.20	6F6	1.05	6V6M	2.50	12AZ7	.84	14F7	1.20	46	.95
3A3	.74	6A6	1.00	6BW8	1.25	GF6M	1.25	6W4	.60	12B4	.66	14F8	1.20	47	1.95
3A4	.74	6A7	2.25	6BX7	1.07	6F7	2.50	6X4	.39	12BA6	.65	14H7	.95	48	3.50
3A5	1.10	6A8M	1.45	6BY5	2.19	6F8	1.00	6X5	.75	12BA7	1.30	14J7	1.30	50	1.45
3AF4	1.50	6AB4	.45	6BY6	1.05	6FG5	2.15	6X8	.78	12BD6	.48	14N7	.98	53	2.95
3AL5	.44	6AB5	1.95	6BY8	1.07	6FG7	.67	6Y6	1.25	12BE3	1.39	14Q7	1.25	55	1.90
3AT2	1.25	6AB7	1.00	6BZ6	.54	6FG8	.65	7A4	1.15	12BE6	.51	14R7	.98	56	.95
3AU6	.52	6AC5	1.95	6BZ7	.99	6FM7	.77	7A5	.95	12BF6	.58	14S7	1.45	57	1.35
3AV6	.40	6AC7	.91	6BZ8	1.25	6FQ7	.94	7A6	1.15	12BH7	.75	14W7	.98	58	1.05
3B2	3.45	6AC7W	2.50	6C4	.43	6FS5	1.20	7A7	1.15	12BK5	.98	14X7	.95	59	2.00
3B7	1.35	6AD7	2.00	6C5	1.40	6FSG	1.15	7A8	.66	12BL6	.54	14Y4	.95	71A	.95
3BA6	.88	6AF3	1.00	6C6	2.00	6FV6	1.31	7AD7	1.15	12BN6	1.45	15AF11	1.95	75	1.90
3BC5	.61	6AF4	.99	6C8	3.25	6FV8	.77	7AF7	1.15	12BQ6/		15CW5	1.15	76	1.40
3BE6	.90	6AF4A	.99	6C10	1.45	6FW5	1.96	7AG7	1.15	CU6	1.09	15FY7	1.29	77	1.05
3BN4	.99	6AF11	1.92	6CA4	.79	6FW8	3.55	7AH7	.95	12BR7	.72	15HB6	1.28	78	1.15
3BN6	.73	6AG5	.68	6CA5	1.25	6FY5	1.10	7AU7	.63	12BV7	.74	16AQ3	1.42	80	1.25
3BU8	.76	6AG7	.95	6CB5	3.29	6G5	2.50	7B4	1.05	12BW4	1.09	17AX4	.65	81	1.25
3BY6	.56	6AH4	.79	6CB6	.53	6G6G	1.00	7B5	1.45	12BY7	.75	17BQ6	1.04	83	1.65
3BZ6	.54	6AH6	1.05	6CD6	1.45	6GE5	.91	7B6	1.25	12BZ6	.84	17C5	2.35	84/6Z4	.95
3CB6	.54	6AJ5	1.95	6CF6	.95	6GF5	1.39	7B7	1.95	12BZ7	.84	17DE4	1.29	85	.98
3CE5	.89	6AK5	.90	6CG7	.59	6GH8	.78	7B8	.95	12C5/		17DM4	1.22	84/6ZZ4	98
3CF6	1.00	6AK6	.79	6CG8	.78	6GK5	.59	7C5	1.35	CU5	.56	17DQ6	1.04	5881	2.95
3CS6	.56	6AL5	.45	6CL6	1.44	6GK6	.77	7C6	2.49	12CN5	.54	17DQ7	1.85	5881MP	
3CY5	1.15	6AL7	1.85	6CL8	.77	6GL7	1.95	7C7	1.45	12CR6	.65	17GE5	1.70		5.75
3D6	1.45	6AM8	.76	6CM6	1.24	6GM5	1.27	7E7	.95	12CT8	1.60	17GV5	1.73	6146	3.95
3DG4	.83	6AN4	3.18	6CM7	.67	6GM6	.95	7EY6	.73	12CU6/		17GW6	1.64	6336	5.95
3DK6	.58	6AN5	1.95	6CM8	1.60	6GN8	.92	7F7	1.75	BQ6	1.10	17H3	.95	6550	3.75
						6GT5	1.70	7F8	1.75	12CX6	.52	17JL8	1.45	807	.70

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35	1.05	1.30	1.50	1.70 ea.
50	1.60	2.10	2.40	3.00 ea.
100	1.80	2.30	2.75	3.25

D.C. AMPS	300 PIV 210 RMS	400 PIV 280 RMS	500 PIV 350 RMS	600 PIV 450 RMS
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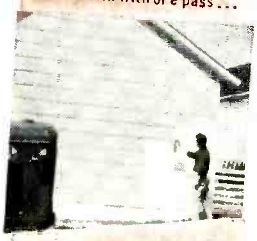

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ELECTRONICS WORLD JULY 1964

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CIRCLE NO. 127 ON READER SERVICE PAGE →

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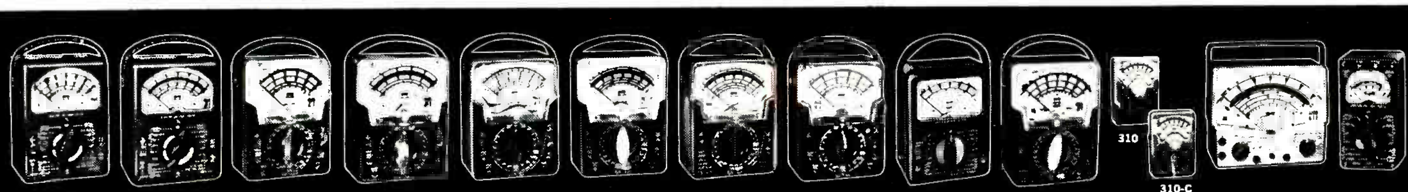

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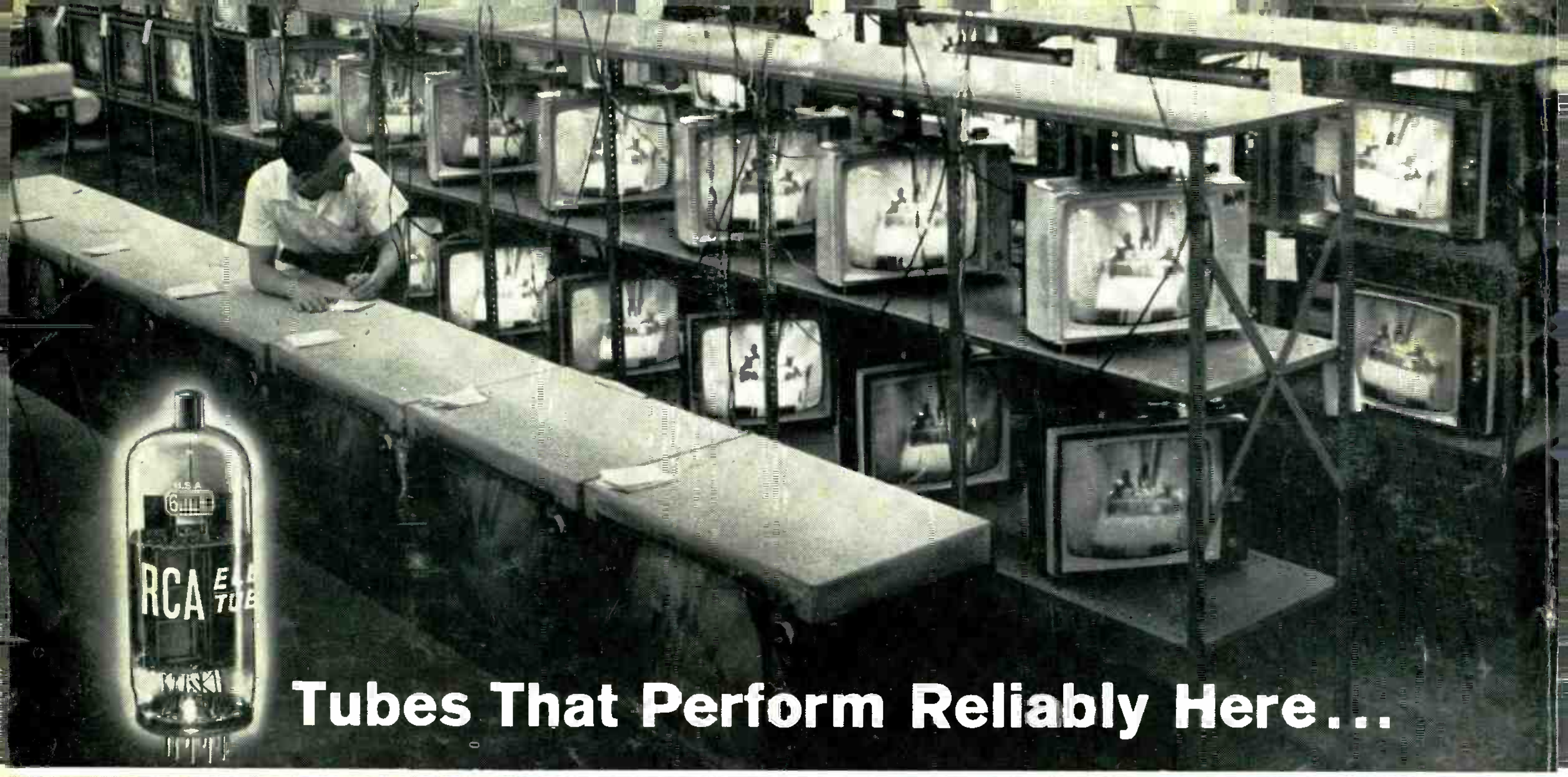

At top, you're looking into the RCA Receiving Tube Reliability Laboratory—a most important factor behind the exceptional reliability of RCA receiving tubes, and one more plus-value that you have in RCA tubes.

Here in two-hundred TV sets of all sizes—black-and-white and color—samples of each week's production of RCA receiving tubes are subjected to extensive tests under actual field conditions. The operating conditions for the TV sets vary from low-line to high-line voltages. And the sets are regularly cycled on and off to check the effects of heating and cooling on the tubes.

The Tube Reliability Laboratory reveals—*and allows us to eliminate*—problems that do not show up under normal production life testing. It also permits us to conduct pre-production tests of new tube designs to make certain that the RCA standards of quality will be fulfilled before the new tubes are marketed.

Testing in the Tube Reliability Laboratory enables us to verify the consistent high quality of RCA receiving tubes—to maintain uniformity of characteristics from tube to tube and throughout life. It is another example of the care we take to assure that RCA receiving tubes give RELIABLE PERFORMANCE where it really counts—in your customers' sets.

SEE YOUR AUTHORIZED RCA DISTRIBUTOR FOR TOP-QUALITY RCA RECEIVING TUBES

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N. J.

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