

Electronics World

DECEMBER, 1961

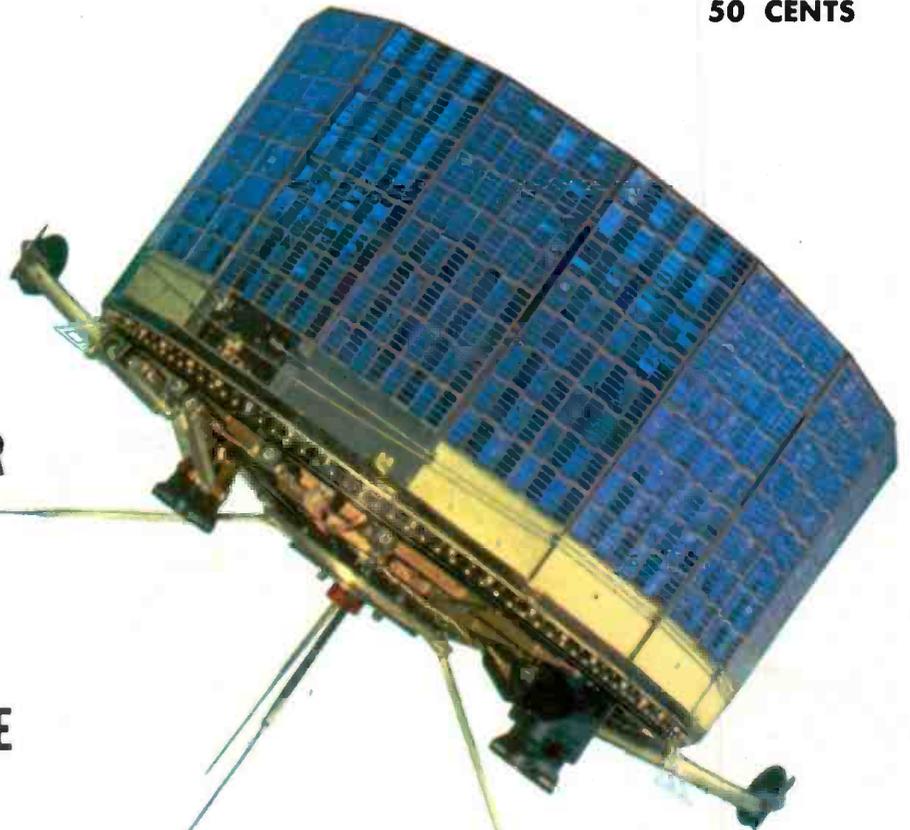
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**THE USE OF X-RAY
FOR INDUSTRIAL TESTING**

**RELIABILITY—
SPACE AGE REQUIREMENT**

**BUILD YOUR OWN
STEREO FM MULTIPLEX ADAPTER**

**GETTING USABLE 35-CPS BASS
FROM AN 8-INCH SPEAKER
IN AN EXPERIMENTAL ENCLOSURE**



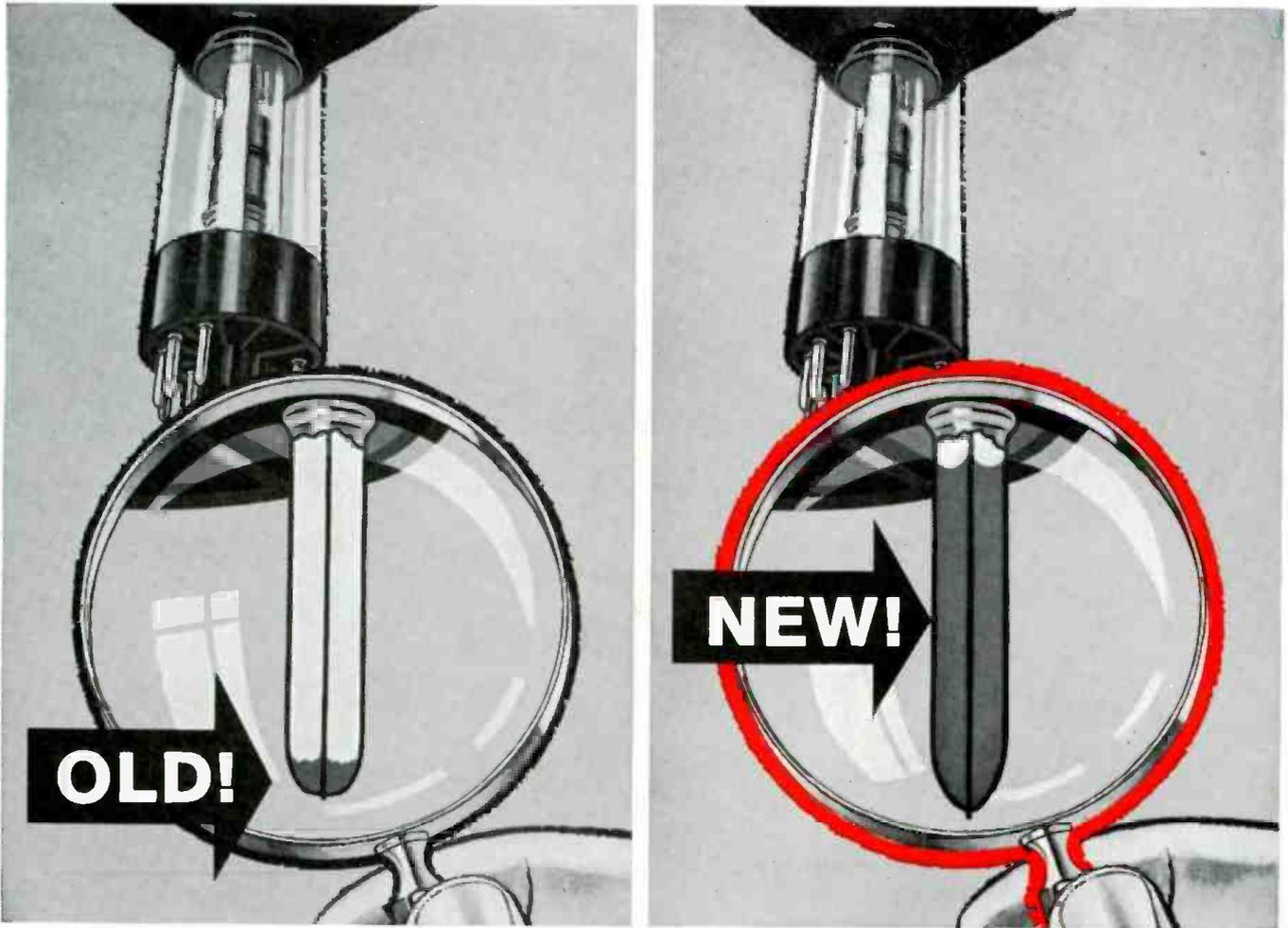
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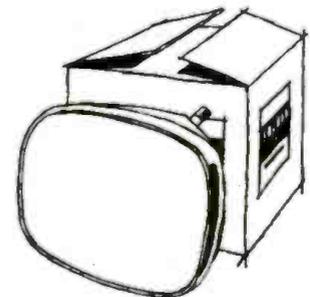


The "old" conventional pin soldering method relied upon contact between pin and wire only at their tips.

New Sylvania pin soldering technique extends solder far up into the pins—provides maximum contact with the wire—assures low electrical resistance and high mechanical strength.

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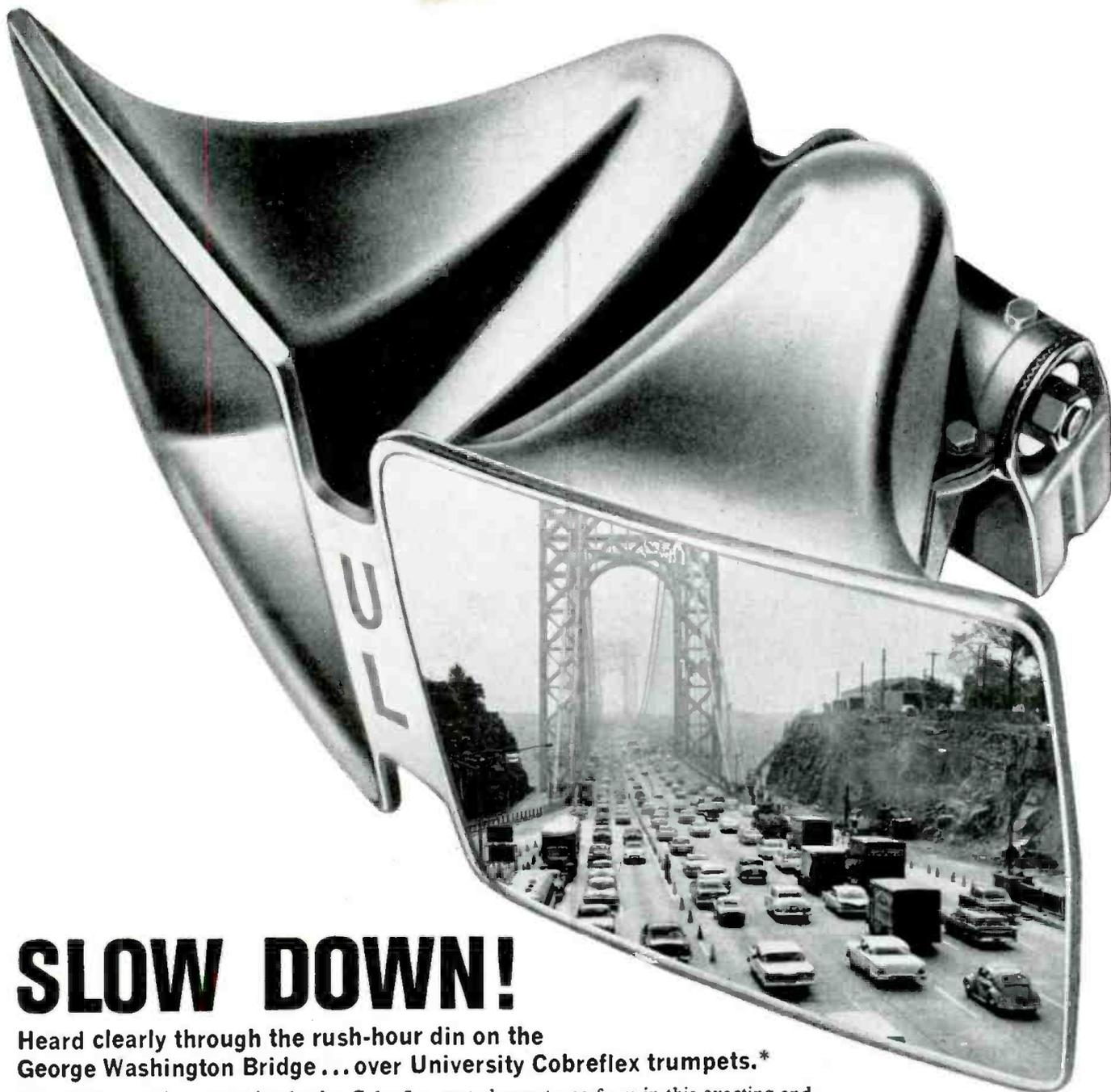


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Heard clearly through the rush-hour din on the George Washington Bridge ... over University Cobreflex trumpets.*

But what's most important is *why* the Cobreflex was chosen to perform in this exacting and difficult location. One of the main reasons is that every Cobreflex embodies the unique combination of *battleship* construction and *Swiss watch* precision! This unexcelled ruggedness of construction paired with its exceptionally high articulation of speech makes the Cobreflex ideal for the most gruelling applications. Its wide angle projection over 120° is but another good reason why it is sought after in situations that call for ultra-wide projection. And this extremely smooth, wide radiation pattern over the full frequency range is the result of University having incorporated a pair of folded exponential horns having twin air columns onto a *single* assembly. These two identical one-piece heavy aluminum die-castings with integral tone arm and reflectors ensure there are no separate parts to loosen or vibrate. Resonant vibration is non-existent! Reasons enough?

And for installations requiring full-range wide angle coverage, there's the CLH, a rectangular reflex trumpet loaded with significant engineering refinements. A conoidal reflector at the critical final bend improves high frequency response, and a rugged, *ribbed and braced* fiberglass bell subdues resonances, providing more extended, natural response for the reproduction of music as well as speech. The wide horizontal coverage helps you get sound into dead spots that would not be reached by ordinary trumpets, while narrower vertical directionality lets you practically 'tune' the speaker during installation for minimum reverberation and feedback.

But for the complete story of University Public Address Speakers, Write Desk S-12, University Loudspeakers, Inc., White Plains, N.Y.

NOTE: All University P.A. Loudspeakers are F.C.D.A. approved.

*Engineered with HIGH 'A'—HIGH AUDIBILITY—exclusive with University!



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"Rated" capacitance is not enough . . . *actual* capacitance during operation is equally important. Excessively high or low values as well as capacitance change with temperature can foul up a TV or radio set. Therefore, characteristics such as Capacitance Stability, Capacitance Tolerance, and Temperature Coefficient of Capacitance must be considered in replacement applications.

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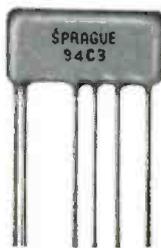


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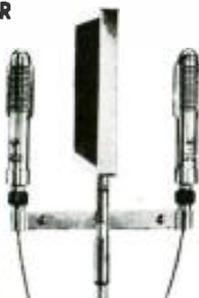
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A-450	120 watts	pp par KT-88, EL-34	39.95
A-470	35 watts	pp par EL-84, EL-34	24.95

(all with tapped primaries except A-440 which has tertiary for screen or cathode feedback)
Write for complete data on Dynaco transformers including suggested circuits and modernization of Williamson-type amplifiers to 50 watts output.

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COMING NEXT MONTH



ULTRASONICS IN TESTING

A new and fast-growing technique of non-destructive testing uses ultrasonic waves to pinpoint flaws in materials and measure thickness. Here's news about the latest equipment and how it works.

used? Even when possible, is a repair always worthwhile? The service technician must answer such questions himself in each case, but the material covered here provides much help.

IMPORTANCE OF SPEAKER EFFICIENCY

Do you believe high-efficiency speaker systems are "harsh" and "piercing" and that low-efficiency units are "flat" and "mushy"? Read this authoritative article which presents the case for the high-efficiency system and tells how it stacks up against its rival.

INDUSTRIAL ELECTRONICS VS TV SERVICE

A re-evaluation of the technician's dilemma based on the reactions of our readers to the article "From TV Service to Industrial Electronics" in the September issue.

DIRECT-WRITING OSCILLOGRAPH IN INDUSTRIAL INSTRUMENTATION

One of industry's most important instruments is discussed in detail in this comprehensive article. The technician is told just what the oscillograph will do and how it is used.

STEREO FM MULTIPLEX DETECTION

How do multiplex adapters recover the original left and right signals? Different manufacturers use different techniques—all of them of interest to the audiophile. The various methods are analyzed by an expert.

AMATEUR TRANSMITTING-TUBE TESTING

How far can a ham go in testing the transmitting tubes in his rig? The use of a slightly modified output stage can provide simple static emission information while a properly operating transmitter will do for dynamic tests. Here's how it is done.

DON'T OVERLOAD CAPACITORS

Choosing the right voltage rating for a replacement or for an original unit is not always simple, since the maximum voltage to which the unit may be subjected is not always obvious. Here is how to evaluate the application.

All these and many more interesting and informative articles will be yours in the January issue of **ELECTRONICS WORLD** . . . on sale December 16th

AILING PICTURE TUBES—REPAIR OR REPLACEMENT?

What defects can actually be repaired or compensated? What techniques are

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ELECTRONICS WORLD

What Does F. C. C. Mean To You?

What is the F. C. C.?

F. C. C. stands for Federal Communications Commission. This is an agency of the Federal Government, created by Congress to regulate all wire and radio communication and radio and television broadcasting in the United States.

What is an F. C. C. Operator License?

The F. C. C. requires that only qualified persons be allowed to install, maintain, and operate electronic communications equipment, including radio and television broadcast transmitters. To determine who is qualified to take on such responsibility, the F. C. C. gives technical examinations. Operator licenses are awarded to those who pass these examinations. There are different types and classes of operator licenses, based on the type and difficulty of the examination passed.

What are the Different Types of Operator Licenses?

The F. C. C. grants three different types (or groups) of operator licenses—commercial radiotelePHONE, commercial radioteleGRAPH, and amateur.

COMMERCIAL RADIOTELEPHONE operator licenses are those required of technicians and engineers responsible for the proper operation of electronic equipment involved in the transmission of voice, music, or pictures. For example, a person who installs or maintains two-way mobile radio systems or radio and television broadcast equipment must hold a radiotelePHONE license. (A knowledge of Morse code is NOT required to obtain such a license.)

COMMERCIAL RADIOTELEGRAPH operator licenses are those required of the operators and maintenance men working with communications equipment which involves the use of Morse code. For example, a radio operator on board a merchant ship must hold a radioteleGRAPH license. (The ability to send and receive Morse is required to obtain such a license.)

AMATEUR operator licenses are those required of radio "hams"—people who are radio hobbyists and experimenters. (A knowledge of Morse code is necessary to be a "ham".)

What are the Different Classes of RadiotelePHONE licenses?

Each type (or group) of license is divided into different classes. There are three classes of radiotelePHONE licenses, as follows:

(1) **Third Class RadiotelePHONE License.** No previous license or on-the-job experience is required to qualify for the examination for this license. The examination consists of F. C. C. Elements I and II covering radio laws, F. C. C. regulations, and basic operating practices.

(2) **Second Class RadiotelePHONE License.** No on-the-job experience is required for this examination. However, the applicant must have already passed examination Elements I and II. The *second class* radiotelePHONE examination consists of F. C. C. Element III. It is mostly technical and covers basic radiotelePHONE theory (including electrical calculations), vacuum tubes, transistors, amplifiers, oscillators, power supplies, amplitude modulation, frequency modulation, measuring instruments, transmitters, receivers, antennas and transmission lines, etc.

(3) **First Class RadiotelePHONE License.** No on-the-job experience is required to qualify for this examination. However, the applicant must have already passed examination Elements I, II, and III. (If the applicant wishes, he may take all four elements at the same sitting, but this is

not the general practice.) The *first class* radiotelePHONE examination consists of F. C. C. Element IV. It is mostly technical covering advanced radiotelePHONE theory and basic television theory. This examination covers generally the same subject matter as the second class examination, but the questions are more difficult and involve more mathematics.

Which License Qualifies for Which Jobs?

The **THIRD CLASS** radiotelePHONE license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The **SECOND CLASS** radiotelePHONE license qualifies you to install, maintain, and operate most all radiotelePHONE equipment except commercial broadcast station equipment.

The **FIRST CLASS** radiotelePHONE license qualifies you to install, maintain, and operate every type of radiotelePHONE equipment (except amateur, of course) including all radio and television stations in the United States, and in its Territories and Possessions. This is the highest class of radiotelePHONE license available.

How Long Does it Take to Prepare for F. C. C. Exams?

The time required to prepare for FCC examinations naturally varies with the individual, depending on his background and aptitude. Grantham training prepares the student to pass FCC exams in a minimum of time.

In the Grantham *correspondence course*, the average beginner should prepare for his *second class* radiotelePHONE license after from 200 to 250 hours of study. This same student should then prepare for his *first class* license in approximately 75 additional hours of study.

In the Grantham *resident course*, the time normally required to complete the course and get your license is as follows:

In the **DAY course** (5 days a week) you should get your *second class* license at the end of the first 9 weeks of classes, and your *first class* license at the end of 3 additional weeks of classes. This makes a total of 12 weeks (just a little less than 3 months) required to cover the whole course, from "scratch" through *first class*.

In the **EVENING course** (3 nights a week) you should get your *second class* license at the end of the 15th week of classes and your *first class* license at the end of 5 additional weeks of classes. This makes a total of less than 5 months required to cover the whole course, from "scratch" through *first class*, in the evening course.

HERE'S PROOF that Grantham Students prepare for F. C. C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

	License	Weeks
Don Fenimore, 1305 Ray Street, Dexter, Mo.	1st	12
Jim E. Miller, 8433 12th, S.W., Seattle 6, Wash.	1st	12
Robert R. Constance, 222 Sander St., Pineville, La.	1st	12
Michael J. Flaherty, 5 Wakefield Dr., Trenton, N.J.	1st	12
J. R. Pierce, Jr., Rt. 5, Kingsport, Tenn.	1st	12
Pias B. Jernigan, Rt. 2, Benson, N.C.	1st	12
Gordon Fritsch, Box 122, Edwall, Wash.	1st	12
Bert C. Erickson, P.O. Box 149, Arcadia, Fla.	1st	12
William F. Bratton, Jr., 435 Etna St., Russell, Ky.	1st	12
Richard P. Neal, 2 Carleton Place, Alexandria, Va.	1st	12

Resident Classes Offered at Four Locations

To better serve our many students throughout the nation, Grantham School of Electronics maintains four separate schools—located in Hollywood, Seattle, Kansas City, and Washington, D. C.—all offering the same resident courses in F. C. C. license preparation. (Correspondence courses are conducted from Hollywood.)

For further details concerning F. C. C. licenses and our training, send for our **FREE** booklet, "Careers in Electronics". Clip the coupon below and mail it to the School nearest you.

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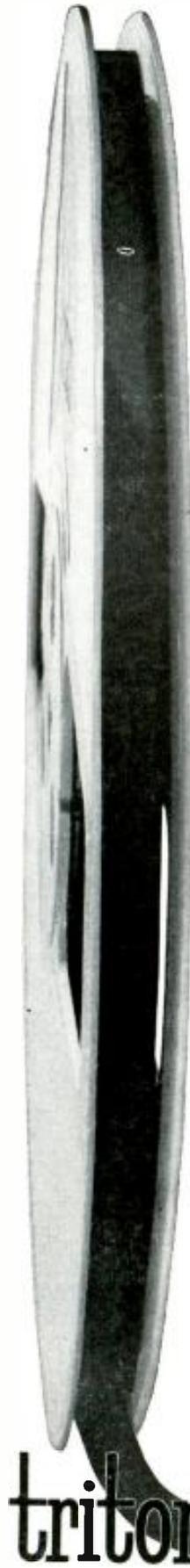
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... for the Record

By W. A. STOCKLIN
Editor

THE TECHNICIAN AND THE ENGINEER

WHEN one speaks of an electronics technician as being engaged in service, operation, maintenance, installation, sales, inspection, quality control—and there are many other categories—there is no doubt as to his specific function. One might not know the exact type of electronic equipment involved nor the degree of knowledge and training required, but we do know that a service technician performs service functions; an operating technician, obviously, operates equipment; an installation technician installs equipment, and there is no ambiguity. In all these categories his function is so clearly defined that the technician's work in no way becomes confused with the work of other divisions nor is he directly involved with the engineering department.

This does not hold true when a technician is engaged in engineering, research, and development work. Some confusion does exist as to a technician's specific function in these categories simply because different companies assign different tasks to their technicians. We have seen, on many occasions during our visits to various plants, qualified engineers performing tasks which could be delegated to technicians. We have seen engineers, for example, building prototype models, performing extensive tests on equipment, and in some cases, actually installing electronic equipment. This is a situation that is both economically unsound and a waste of the engineer's training and talents. In most of these cases, we know that technicians, because of their special training, are better qualified to perform these tasks than are engineers.

One can not argue that at times the functions of the technician and engineer overlap, yet there is, usually, a definite line of demarcation.

The engineer, because of his educational background and extensive

training in mathematics, physics, and electronic circuitry design, should use his knowledge creatively in the fields of research, design, and development. The engineer should plan, create, and perfect. He should not use his time performing a technician's function.

There are, of course, exceptions to any rule. It is certainly advisable and, in fact we would strongly suggest, that inexperienced engineers just out of college be required to learn a technician's work as part of their training program. This not only will provide good practical experience for the engineer but help him understand the true function of the technician.

In industry, technicians are usually employed as supporting personnel helping the engineer create. The technician should serve as the practical arms for the engineer. In essence, he is more adept in "how-to-do" and he is highly qualified to execute the engineer's plans and designs. In such areas, the technician is better qualified than the engineer and his company should make full use of these skills. For example, the technician should be expert in building prototype models of electronic equipment, he should be very proficient in making tests and measurements accurately, and he should be able to troubleshoot equipment quickly once it has been developed.

In all cases, technicians should be used as supporting personnel in the engineering, research, and development departments of a company. This should be made unmistakably clear if the relationship between engineer and technician is to be maintained at its most productive level. The engineer must have the opportunity to follow his profession in his own area of specialization and, at the same time, the professional electronics technician must be allowed to perform those tasks for which he is best qualified. ▲

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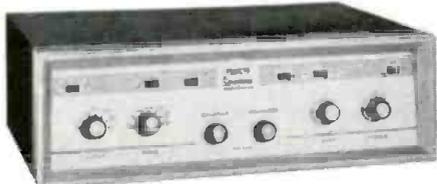
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Employs balanced vacuum tube bridge circuit for all voltage and resistance measurements plus 3-way probe for accurate, rapid test. Includes: 7 DC voltmeter ranges, 7 AC voltmeter ranges (RMS) from 0 to 1500 volts, and 7 AC voltmeter ranges (peak to peak) from 0 to 4000 volts. Also 7 decibel ranges, -6 to +66 db and 7 electronic ohmmeter ranges from 0.2 ohms to 1000 megohms.
V-70 Kit with "Twin-Tested" operating assembly manual \$31.95 net
V-70W: Factory-wired \$49.95 net



C-25 IN-CIRCUIT CAPACITOR TESTER KIT:
Reveals dried out, shorted, or open electrolytics—in the circuit—with Paco's exclusive Electrolytic Dial.
Simple Sequential Test: reveals open or shorted capacitors, even electrolytics.
Electrolytic Dial: indicates in-circuit capacity from 2 to 400 mfd: condenser is proved non-shorted and not open if capacity reading can be obtained.
Model C-25 Kit: with Paco-detailed operating assembly manual \$19.95 net
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SA-40 STEREO PREAMP-AMPLIFIER: Power: 20W (RMS) per channel, 40W total. Peak, 40W with 80W total. Response: 30 cps to 90 Kc, within 1.0 DB. Distortion: within 0.5% at 20W per channel. Includes: 14 inputs and 14 Panel Controls, black and gold case.
SA-40 Kit with enclosure, "Twin-Tested" operating assembly manual \$79.95 net
SA-40W: Factory-wired, ready to operate \$129.95 net
SA-50: Stereo Kit as above with different styling, 25w per channel TBA*



ST-25 FM TUNER: Sensitivity: 1.5 microvolts for 20 DB quieting. Harmonic Distortion: less than 1%. Includes: Dual Limiters, AFC and AFC Defeat, "Eye" type tuning indicator, Multiplex jack. Black and gold case or walnut enclosure at slight extra cost.
ST-25 Kit with fully-wired prealigned front end. "Twin-Tested" manual \$42.95 net
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ST-26 Tuner-Amplifier Kit: Same as ST-25, with built-in amplifier \$54.95 net
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DF-90 TRANSISTORIZED DEPTH FINDER KIT: Protect your boat against shoals and underwater hazards with this compact, easy-to-read depth finder. Locates hard-to-find schools of fish, too.
Fully Transistorized: 5 transistors, low battery drain for very long battery life.
Fast, Easy Readings: over-sized scale with 1-ft. calibrations from 0-120 ft.
DF-90 Kit: Complete with "Twin-Tested" assembly operating manual \$84.50 net
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G-15 GRID DIP METER: Major Functions:
1-Variable Frequency Oscillator covering 400 Kc up to 250 Mc in 8 bands;
2-Absorption Wavemeter, 400 Kc to 250 Mc;
3-Modulation Indicator. Applications: antenna tuning, standing wave checks, neutralizing. TVI suppression, carrier monitoring, etc: RF signal source for visual alignment marking between 400 Kc and 250 Mc. Weighs only 3 lbs.
G-15 Kit: Complete with 8 plug-in coils, "Twin-Tested" manual \$31.95 net
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"I built the Paco SA-40 Stereo Preamp Amplifier."

Larry Taylor, 8 Stevens Place, Huntington Station, N. Y. "It took me one-third less time to build the Paco kit than it took Don to make the almost identical preamp-amplifier by another kit maker. But it wasn't just the time; it was knowing you're using the right part, and that you understand the instructions completely. Paco parts are all pictured and labelled, the resistors are neatly mounted on cards for easy identification. And Paco's instruction book doesn't leave you guessing. The fold-out diagrams and drawings are always right beside the instructions, so you're not reading one part of the book and following a diagram in another part. Photographs in Paco's book show how each assembly should actually look. I enjoyed building Paco kits, because I wasn't wasting time or worrying."



"I built a competing Stereo Preamp Amplifier."

Don Taylor, 39 Cross Street, Smithtown, N. Y. "Neither Larry nor I are speed demons because we're very meticulous about wiring and soldering. So I was even more surprised when it took me 50% more time to finish my kit. My problem began when I tried to separate the parts. The resistors were in boxes, but not in any logical way: identical resistors often wound up in different boxes. The instruction book was clumsy to work from. It caused wasteful mistakes. Once I lost 20 to 25 minutes because I misread a tiny key letter that meant not to solder a certain connection. A lot of the fun of kit-building was lost when I had to spend time making up for shortcomings of the packaging and the instruction manual."



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(Continued on next page) →

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FROM OUR READERS

REVERBERATION UNITS

To the Editors:

I have been a regular reader of your magazine for six or seven years. Generally, it is one of the best magazines that carry hi-fi articles. However, I take exception to Bert Whyte's recent biased views concerning reverb units.

1. Is it not safe to say that many recordings made with close mikes might be helped by proper use of reverb, provided the recording is dry and that the composition is one that would be suited to reverberation? What is wrong with adding reverb to better simulate the atmosphere of listening to a live orchestra from somewhere in the hall away from the conductor's very close location?

2. The argument that reverb units are just gimmicks and that they are no good because Joe Doakes might misuse them, doesn't hold water. This is like saying that automobiles are gimmicks and are no good because some people drive 70 mph in a 20-mph zone. Not all drivers are idiots and neither will all persons who own reverb units misuse them.

3. If the work of engineers is so sacred, do you also advocate that preamps should have no tone controls lest the engineer's work be altered the slightest bit? What is to prevent the same Joe Doakes from upsetting the engineer's balance with a treble control? Isn't it better to say that each type of control should have a purpose and none should be condemned because of one person's opinion.

DAVID OVERSON
Pittsburgh, Pa.

There is no objection to the use of properly controlled reverb as long as it does not "gimmick up" a performance and add distortion. The listener is still the final judge, and what controls he uses and how he uses them are up to him.—Editors.

CENTER SPEAKER FOR STEREO

To the Editors:

The addition of a center speaker for 2-channel stereo by the bridging technique was proposed by Steinberg and Snow in 1934 and elaborated upon by Snow and this writer. In spite of the age of this idea it is still not broadly understood.

For example, one writer of a popular article wrote, "To maintain the original listener-focal area orientation, the speakers have to be toed-in as the listening angle increases..." This is true but the same writer goes on, "...since balanced stereo can be heard only in the focal area." This is only partly true. The

toe-in is correct but for a different reason. As Snow (1953) expressed it, the toe-in reduces the shift of the virtual sound source for different listener locations. Thus the reason or purpose of toe-in is to *widen* the listener area, which makes the writer's reason correct if it is interpreted to mean a widening of the focal area. In practice it has been found this focal or listening area is the full width of the speaker array.

The purpose of a wide speaker array is thus seen to be three-fold, widening the listener area, widening the listening angle, and improving localization.

If the flanking speaker separation is sufficient to give optimum listening area and optimum listening angle, there will be a hole in the middle or a requirement for a bridged center speaker which, when fulfilled, accomplishes the third purpose of improving accuracy of localization of sounds.

Another widely misunderstood factor in stereo is the subject of "polarity." Snow points out that in stereo "—the channel spacings are so wide that only very low frequencies can be considered at other than random phase—" and with random phase, polarity has no meaning. If signals were "in-phase," polarity reversal would cause cancellation, but if phase is random, polarity reversal has no average effect on the sound; the center speaker may be switched from sum to difference on a true stereo recording and the difference is barely liminal when listening to the center speaker only, and subliminal when listening to all three speakers.

PAUL W. KLIPSCH
Klipsch and Associates, Inc.
Hope, Arkansas

The article referred to by Mr. Klipsch above is "Adding a Center Speaker for Stereo" by Heuly which appeared in our August, 1961 issue.—Editors.

OBSOLESCENT DOCTORS

To the Editors:

Mr. Ed Bukstein's article on "Electrical Activity of the Human Body" in your August issue was most interestingly authored.

A feeling of great pity overwhelms me for my colleagues in internal medicine who are shortly to be replaced by electronic computers which will diagnose the ailment and prescribe the indicated remedy. Before long, a kit will be available I am sure to replace these obsolescent diagnosticians.

We surgeons, however, are not worried. We may have to swallow our pride and permit an electronic device to tell us *where* to do the cutting, but I doubt
(Continued on page 14)

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Again you benefit from proved B&K techniques! This up-to-date, obsolescence-proof, professional instrument is designed for maximum use today and tomorrow. Provides multiple-socket section to quick-check most of the TV and radio tube types the *true dynamic mutual conductance way*—plus simplified switch section to check new tube types in Dyna-Quik emission circuit. Also includes provision for future new sockets.

Makes test under set-operating conditions. Checks each section of multi-section tubes separately. Checks for *all* shorts, grid emission, leakage and gas. Makes quick “life” test. Exclusive adjustable grid emission test provides sensitivity to over 100 megohms.

Makes complete tube test in seconds. Checks average set in a few minutes. Discovers weak tubes that need replacement. *Satisfies more customers. Sells more tubes. Saves call-backs. Insures your reputation.*

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Each Crossfire element has a predetermined impedance, at each frequency, which determines its degree of energy absorption. This impedance, governed by the taper and spacing of the dipoles, decreases with the distance from the feed point. Each successive element therefore absorbs a larger percentage of the available energy.

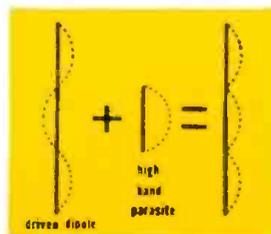
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More working elements provide more picture power! This is the key to the remarkable performance of the Crossfire.

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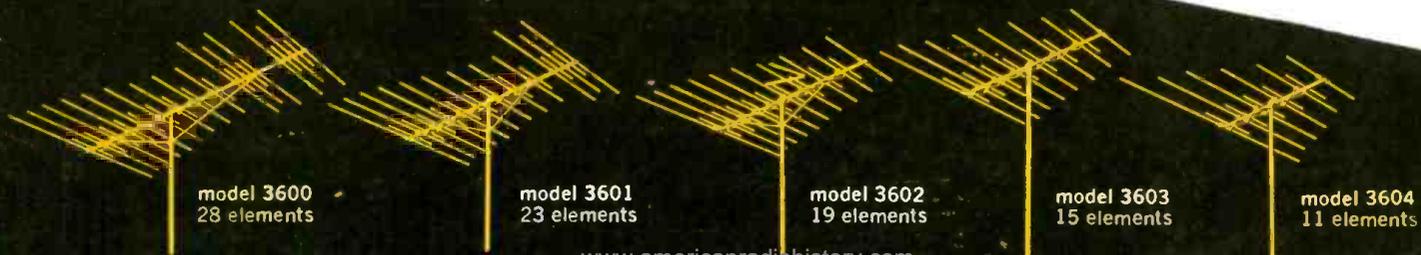


... And the Crossfire is Gold!

The Crossfire's performance is matched only by its beauty. Channel Master's exclusive E*P*C Process gives the antenna a lustrous golden coating that enriches its appearance and protects it for years against corrosion.

Channel Master's E*P*C Process is *not* anodizing! The disadvantage of anodizing is that the anodized film is an electrical insulator, and must be removed by *abrasion* wherever metal-to-metal contact is required. Therefore, anodized antennas have no surface protection on the very parts that need it most!

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model 3600
28 elements

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19 elements

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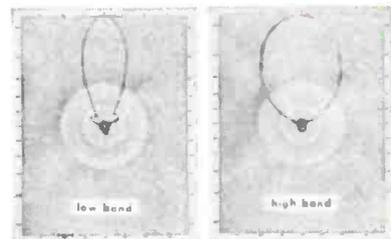
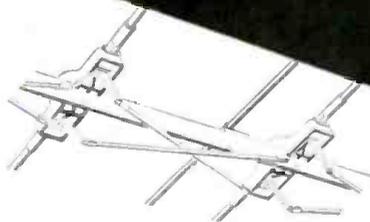
model 3604
11 elements

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Transposed Feed Line Means Cleaner Gain!

Extremely high front-to-back ratios are accomplished by a Transposed Feed Line, from which the Crossfire gets its name. This feed line is transposed between each successive pair of elements. As a result, the radiations from each pair of adjacent elements are self-cancelling because they are 180° out of phase. This carefully engineered system is so efficient that the Crossfire needs no parasitic reflector element.

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The Crossfire is the only antenna you can sell with full confidence that it will outperform anything your customer is now using!

For still more power... add the new

CHANNEL MASTER JETRON

Antenna-mounted transistorized signal amplifier and set coupler
Most effective...most dependable...lowest noise figure!



Power supply (with built-in 4-set coupler) is conveniently located in the home. Compact, only 5" x 3 3/4" x 1 3/4".

model 0020

* Patent Pending

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model 3605
7 elements

The Professional Series
TRANSVISION TV CHASSIS

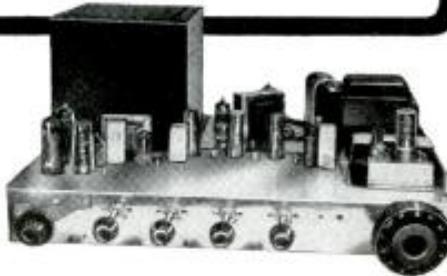
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Designed for the perfectionist seeking maximum performance!

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Designed for all types of Custom Installation, Walls, Bookcases, Cabinets, etc. Complete line of accessories facilitate custom installation.



Top view of "Professional" Chassis with controls in horizontal position.

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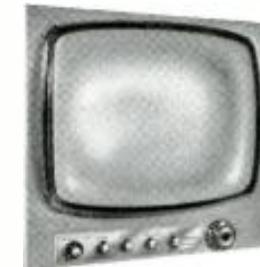
All Parts are premium quality. RCA, Sylvania tubes, Allen-Bradley resistors, Cornell-Dubilier condensers. ALL PARTS Guaranteed for FULL YEAR!

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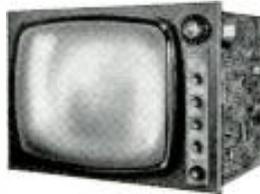
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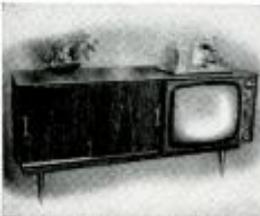
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if many patients will permit the apparatus to do it, at least until the stage of the electronic art is reached where such things as flop-over on our video screens is licked.

It is horrible to contemplate what might happen in the event a tube became gassy or acoustic feedback developed in the surgical unit.

A word of encouragement to the internists. They might take comfort in the thought that they may perpetuate themselves by repairing the machines!

PAUL B. JARRETT, M.D.
 Practice Limited to Surgery
 Phoenix, Arizona

We feel sure it will be a long time before the diagnostician will be rendered obsolete by computers. However, the computer and other electronic devices can be extremely helpful in making a correct diagnosis. See the article "Advances in Medical Electronics" in our November issue.—Editors.

SUPER-POWER U.H.F. TUBES

To the Editors:

In your editing of our article "Super-Power U.H.F. Tubes" in the October issue to fit your space requirements, two points were covered in such a way as to leave a misleading impression. They are as follows:

1. The first paragraph notes that the tubes are capable of "... hundreds of kilowatts of average power output, ..." and the title states they are "u.h.f." tubes. To completely fulfill these statements the characteristics of the RCA-2054 must be included in addition to the RCA-7835. The type 2054 can produce 5 million watts of pulse power, 300 kilowatts of average power, at 400 mc. This is actually within the u.h.f. range. The characteristics shown in the article for the 7834 are for frequencies up to 300 mc. This frequency represents the top limit of the v.h.f. band (or the bottom limit of the u.h.f. band).

2. In the section entitled "Design Philosophy," the last sentence of the last paragraph is misleading. The statement, "For short-pulse service, 1800 amps at 1.3 volts is used ..." seems to imply that this lower heater power is applied to the thoriated-tungsten filamentary cathodes. The cathodes for short-pulse service are an entirely different material, matrix-oxide, as explained in the original paper. Thoriated-tungsten would not get hot enough to emit electrons under the conditions of reduced filament power described.

R. E. REED
 A. C. TUNIS
 Electron Tube Div.
 Radio Corp. of America
 Lancaster, Pa.

Thanks to Authors Reed and Tunis for amplifying the two points mentioned above. Strictly speaking, the typographical errors on our cover and contents page referring to the tubes as "v.h.f." types were not errors at all if the 7835 tube is referred to. However, the design philosophy was to produce a superpower u.h.f. tube.—Editors. ▲

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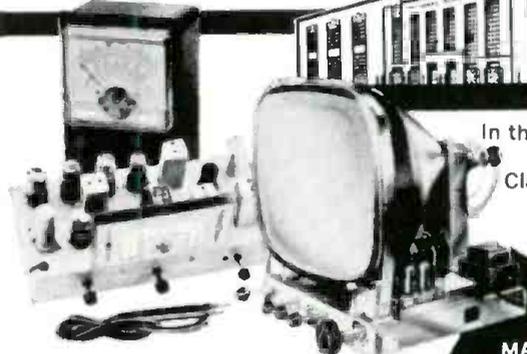
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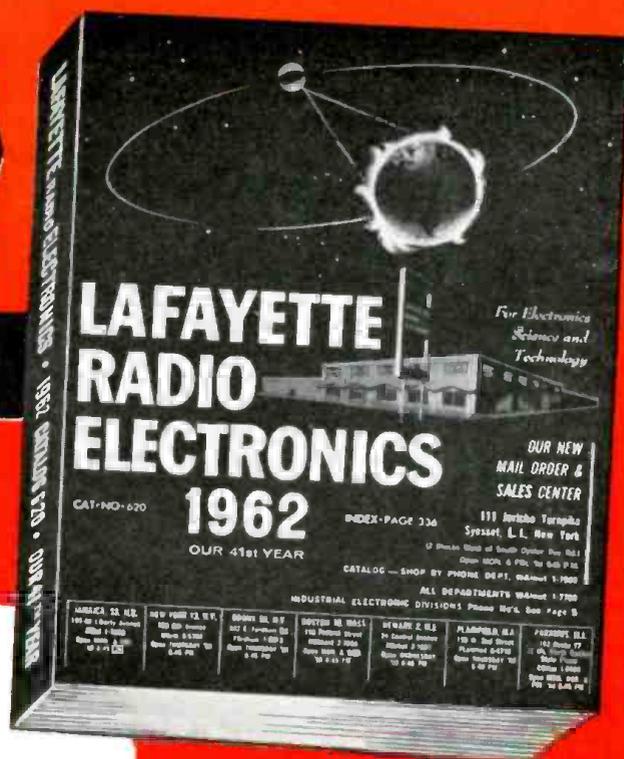
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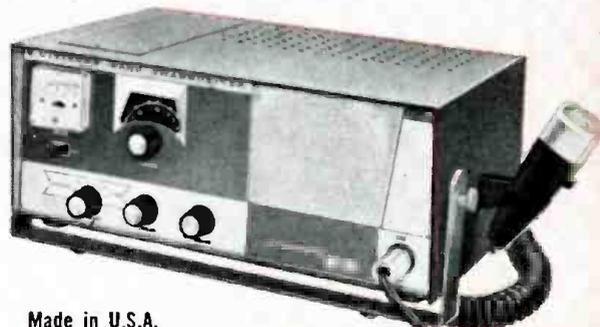
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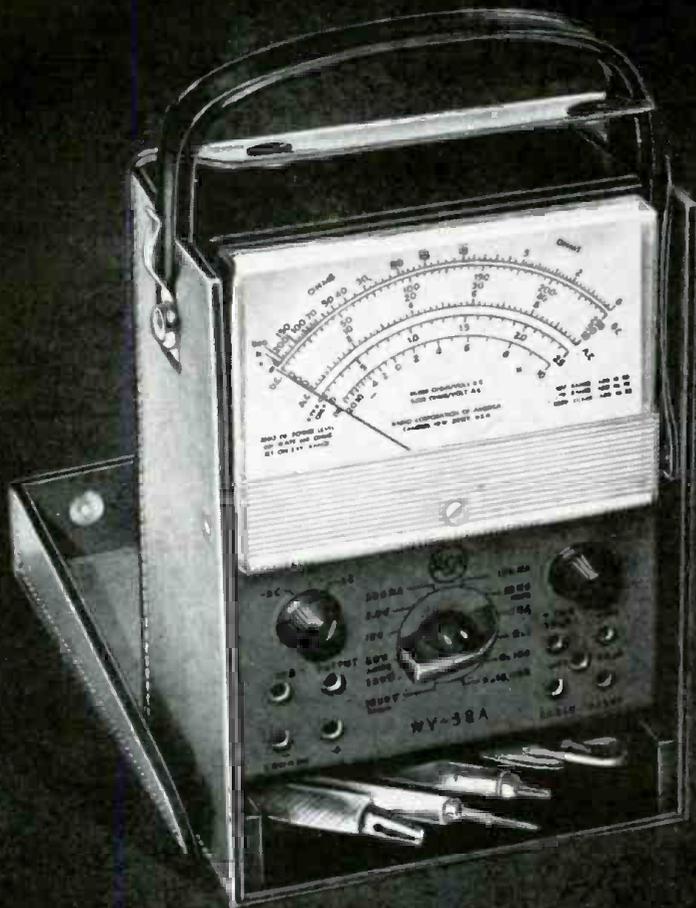
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Audio Test Report

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Miracord "Studio H" Automatic Turntable
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Fisher XP-4 Speaker System

Miracord "Studio H" Automatic Turntable

For copy of manufacturer's brochure, circle No. 58 on coupon (page 120).



THE NEW "Miracord" 10H record changer (referred to as the "Studio H" automatic turntable by its importer, Benjamin Electronic Sound Corp.) is one of that recent category of record players which combines the convenience of record-changer operation with the performance heretofore associated only with separate turntable and tonearm systems. The "Miracord's" claim to that title is by virtue of such features as a 7-pound, 11 $\frac{3}{8}$ -inch-diameter non-magnetic turntable, a hysteresis-synchronous motor, and a high-quality tonearm with low tracking error.

The "Studio H" has three distinct modes of operation. First, it can be used strictly as a manual player. The record is placed on the turntable, the arm is lifted by hand, and manually positioned on the desired portion of the record. The motor starts automatically as soon as the arm is lifted from its rest. After the record is played, the arm returns to rest automatically and the motor shuts off. The only respect in which this mode of operation differs from completely manual systems is in the trip action, which cannot be disabled and which therefore prevents the manual starting of the play near the end of the record.

A second mode is what might be termed a "semi-automatic manual player." The record is placed manually on the turntable and a button corresponding to the record diameter is pressed. The motor starts, the arm automatically lifts and is lowered on the lead-in grooves, and the record is played as described before. Automatic indexing is

provided for 7", 10", and 12" records. The operation of the push-buttons is exceptionally light (almost a feather touch) yet completely positive. If the removable center spindle is inverted, the record repeats indefinitely. A "Stop" button enables the player to be stopped, and the arm returned to rest at any time. The same effect can be had by simply picking up the arm by the finger lift and returning it to its rest, which shuts off the motor.

Finally, the "Studio H" can be used as a conventional record changer. A special spindle is inserted in the center of the turntable for this mode of operation. The appropriate button is pushed and the unit functions as in semi-automatic play except that after each record the next one drops gently into place and is played. After the last record the unit shuts off.

The tonearm is, for all practical purposes, the equivalent of a good-quality separate arm. It is long (8 $\frac{1}{2}$ ") and designed for minimum tracking error. The arm is parallel to the record surface and because of its length, the angle of the

stylus to the record surface changes only slightly over a stack of records. Tracking force is adjusted by a sliding counterweight, and no springs are used. A clever and foolproof means is provided to set stylus force to any value from 2 to 8 grams. A weight with a calibrated scale is inserted into the counterweight end of the arm and the counterweight is adjusted for a balanced condition. When the weight is removed, the tracking force is set to the pre-determined value.

The arm is metal with a removable plastic shell. To prevent hum pickup in the cartridge, a metal shield is fitted into the shell so as to surround the cartridge, and is grounded to the arm proper. The usual record-changer adjustments for indexing position and arm weight are provided.

The rumble level of the turntable was measured at -35 db relative to a velocity of 7 cm./sec. at 1000 cps. It was almost all lateral rumble, with vertical components well below that level. This rumble level is slightly better than the NAB broadcast turntable requirements and is not audible under ordinary listening conditions. The flutter was only 0.1% r.m.s. and wow was too small to be measured with our equipment (less than 0.01% r.m.s.). The speed was approximately 1% fast on all four settings (16, 33, 45, and 78 rpm), and was constant with varying record loads and with line voltage variations from 85 to 140 volts.

The arm, with a correctly installed cartridge, has a tracking error of less than 1 degree over a 2" to 5" record radius, rising to 3 degrees at a 6" radius. Any cartridge whose stylus is $\frac{3}{8}$ " to $\frac{7}{16}$ " from its mounting centers should prove satisfactory. Tracking force is limited chiefly by the cartridge, since as little as 2 grams will operate the changer mechanism.

Mechanically, the "Miracord Studio H" is a smooth performer, with the usual record-changer clicks during the change cycle but low noise at other times. It handles easily and with a feeling of precision engendered by the evident craftsmanship and fine finish on its operating controls and working parts. On our sample (an early production unit) the arm mechanism shut off after dropping the last record in a stack before playing it, but this presumably is not typical. (*Editor's Note: We actually checked several later samples of this changer and found that they operated properly.*)

The "Miracord Studio H" sells for \$99.50. It is available, as the "Studio Model," with a four-pole induction motor, for \$79.95. ▲

Fairchild "Compander"

For copy of manufacturer's brochure, circle No. 59 on coupon (page 120).

IT is an accepted fact that neither tape nor disc recording techniques can handle the full dynamic range of most musical programs. The limiting factors are noise at low levels and distortion or over-cutting at high levels. Even broadcasts of live music must be

amplitude-limited to prevent over-modulation of the transmitter. As a result, some degree of level compression or limiting is universally used, with either manual or automatic techniques. Most listeners are so used to compressed programs that they are completely un-

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Grad FRANK LEENKNECHT works in missile field for Convair Astronautics, San Diego, Calif., and as Transmitter Engineer for Station KDEO as a sideline.



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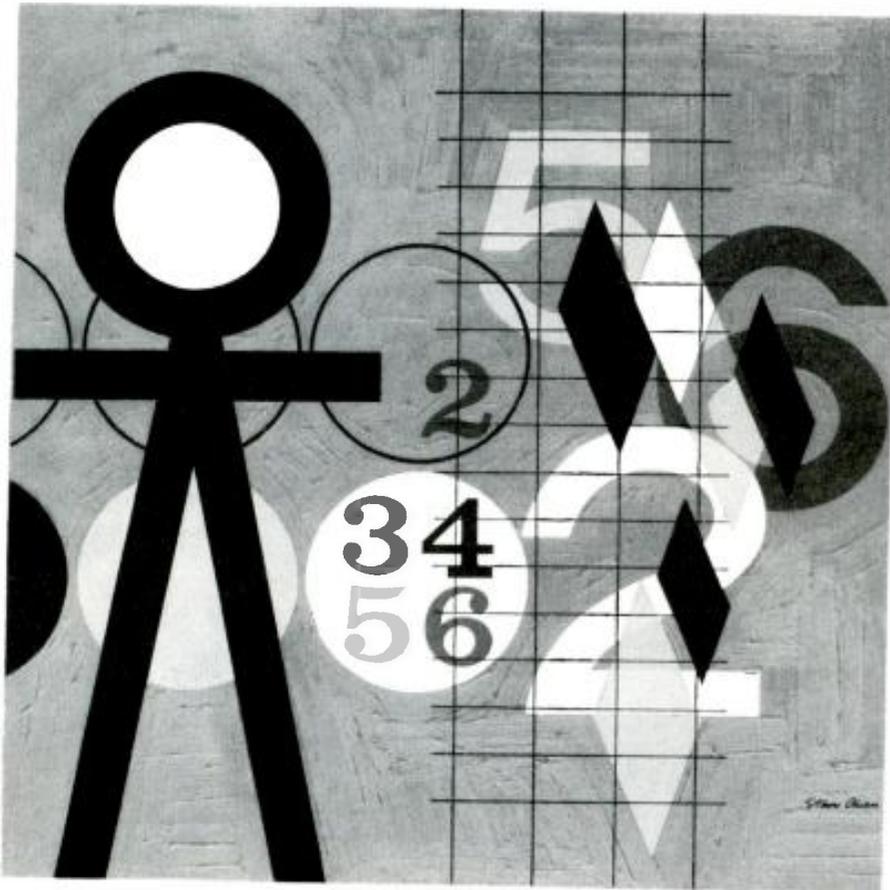
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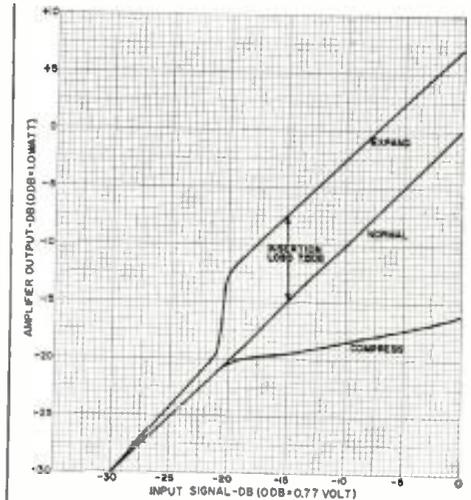
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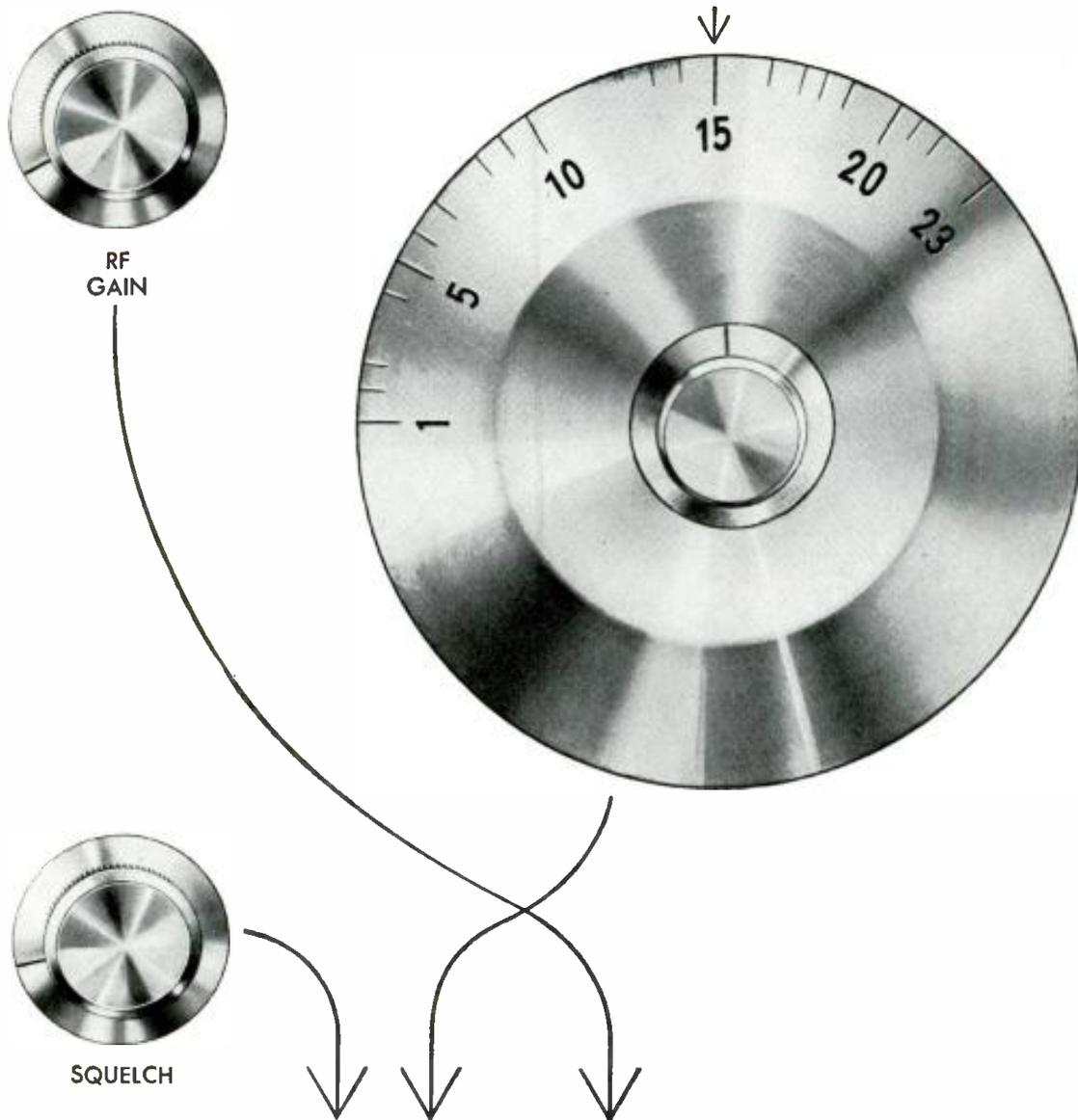


aware of the existence of the problem.

One method of overcoming the effects of compression is by use of a volume expander in the reproducing system. The expander increases the gain of the amplifier as the signal level increases. If the expansion curve is the inverse of the compression curve, it is possible (in theory at least) to re-create the original dynamics of the program. Expanders have been used for years, but have never been very popular in home music systems. They tend to be bulky, complex, and expensive and can contribute appreciable amounts of distortion.

The new Fairchild "Compander" is a fresh approach to this problem. It is a passive device, without transistors or tubes, and requires no power source. By its nature it cannot introduce non-linear distortion or hum into a system. The "Compander" is basically a simple resistive divider, in which one resistance is a photo-sensitive resistor. It is enclosed in a small tube with a lamp which is excited by the output of the power amplifier. As the amplifier output increases, the lamp glows brighter and the resistance of the control element decreases. In "expand" operation, the control resistance is in the series arm of the divider, which is placed in the signal path between the program source and the power amplifier input. Increasing signal levels cause the division ratio of the divider to decrease, which still further increases the amplifier output; hence the expansion. The amount of expansion is limited to the initial insertion loss of the divider, which is reduced to near zero at full expansion.

This is a somewhat over-simplified explanation of the operation of the "Compander." The lamp circuit has a rapid attack time (about 10 milliseconds), but takes nearly a second to decay. A threshold control adjusts the level at which expansion occurs. Neon lights glow to indicate the beginning of expansion, as well as showing the presence of full expansion. Two separate expander systems are located in the compact package (8 $\frac{3}{16}$ " x 5" x 2 $\frac{5}{16}$ "), for stereo operation. A switch on the "Compander" panel selects either expander operation, normal unexpanded operation, or compressor operation. As a compressor the control element is connected as the shunt arm of the divider,



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reducing the gain as levels increase.

The insertion loss of the "Componder" (and thus its maximum expansion) varies from 5 to 8 db as the load resistance is reduced from 470,000 ohms to 47,000 ohms. The source impedance can be anything from 100 ohms to 100,000 ohms, so it can be placed in the pickup circuit or in a preamplifier output without affecting its performance. We tested the "Componder" by driving it from a 600-ohm audio generator and coupling it to a power amplifier, with the input loaded down to 47,000 ohms to get maximum expansion. The curve of the output/input characteristics shows both expansion and compression modes, as well as the straight-through operation of the "Componder." Notice that as an expander, the effect is that of positive feedback, so that the gain suddenly flips from the lower to the upper value. The level at which this occurs can be varied over wide limits with the dynamic sensing controls. At the most sensitive setting, it takes place with less than .25 volt from the amplifier output, which is less than 4 mw. on the 16-ohm speaker terminals. In compressor operation, the threshold is the same, but here the feedback is negative and there are no abrupt level changes. The available compression is about 20 db.

The "Componder" has no inherent frequency limitations, but external cable capacitance must be kept to a minimum. A pair of three-foot cables is supplied and should be used in the output of the "Componder." In our lab set-up, we

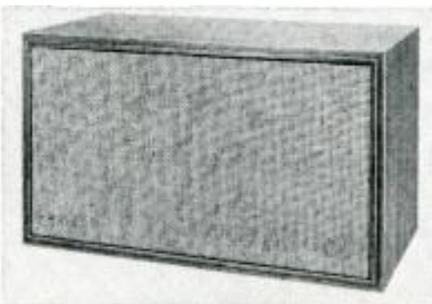
used some 8 feet of shielded cable, which resulted in a slight high-frequency loss. If the recommended cables are used, the Fairchild specification of ± 1 db flatness should be realized. With the full 20 db of compression in use, the time constant of the lamp circuit appears to reduce the effective compression at the low and high frequencies, giving the effect of a boost at these frequencies. No significant harmonic or IM distortion could be detected.

In listening tests, we inserted the "Componder" in the tape-monitor jacks of a preamplifier so that it could be used on all types of program material. It did a very effective job on orchestral music, where the 8 db of expansion definitely contributed to realism. On solo instruments or voices it was less satisfactory, since the sudden increase of level, unmasked by a complex program, was quite apparent. It is likely that the minimum expansion of 5 db would be more natural for most listeners. As a compressor, the "Componder" proved to be completely satisfactory. Its rapid attack and slow decay made its presence most inconspicuous, yet it enabled increased enjoyment of low-level background music without loss of the softer passages. It is possible to adjust the threshold controls so that music is only slightly compressed, but the commercials which come through at higher levels are "cut down to size," so to speak.

The Fairchild "Componder" sells for \$75.00. ▲

Fisher XP-4 Speaker System

For a copy of manufacturer's brochure, circle No. 60 on coupon (page 120).



THE Fisher XP-4 is a bookshelf-size, three-way speaker system with several unusual design features. Like

most of the better compact speakers, it has a woofer with a very compliant cone suspension and a long linear cone excursion, which depends on the enclosed air volume to provide most of its restoring force. The physical design of the woofer is unique, since it uses no basket or similar device to position the cone relative to the magnet structure.

The six-pound magnet assembly is rigidly fastened to the rear and sides of the cabinet. The cone rim is bonded to the front panel of the enclosure, and a compliant spider holds the voice coil in the correct alignment. In essence, the entire cabinet acts as the basket. A
(Continued on page 96)



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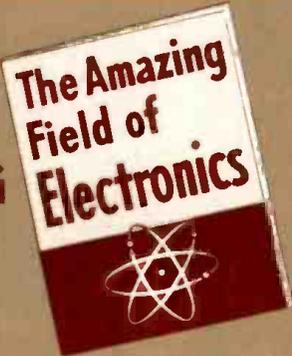
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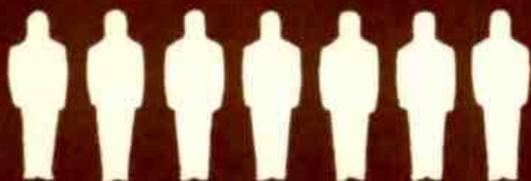
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"THE FINEST JOB I EVER HAD" is what Thomas Bilak, Jr., Cayuga, N. Y., says of his position with The G. E. Advanced Electronic Center at Cornell University. He writes, "Thanks to NRI, I have a job which I enjoy and which also pays well."



BUILDING ELECTRONIC CIRCUITS on specially-designed plug-in type chassis, is the work of Robert H. Laurens, Hammonton, N. J. He is an Electronic Technician working on the "Univac" computer. Laurens says, "My NRI training helped me to pass the test to obtain this position."



"I OWE MY SUCCESS TO NRI" says Cecil E. Wallace, Dallas, Texas. He holds a First Class FCC Radio-telephone License and works as a Recording Engineer with KRLD-TV.



MARINE RADIO OPERATOR is the job of E. P. Searcy, Jr., of New Orleans, La. He works for Alcoa Steamship Company, has also worked as a TV transmitter engineer. He says, "I can recommend NRI training very highly."



FROM FACTORY LABORER TO HIS OWN BUSINESS that rang up sales of \$158,000 in one year. That's the success William F. Kline of Cincinnati, Ohio, has had since taking NRI training. "The course got me started on the road," he says.

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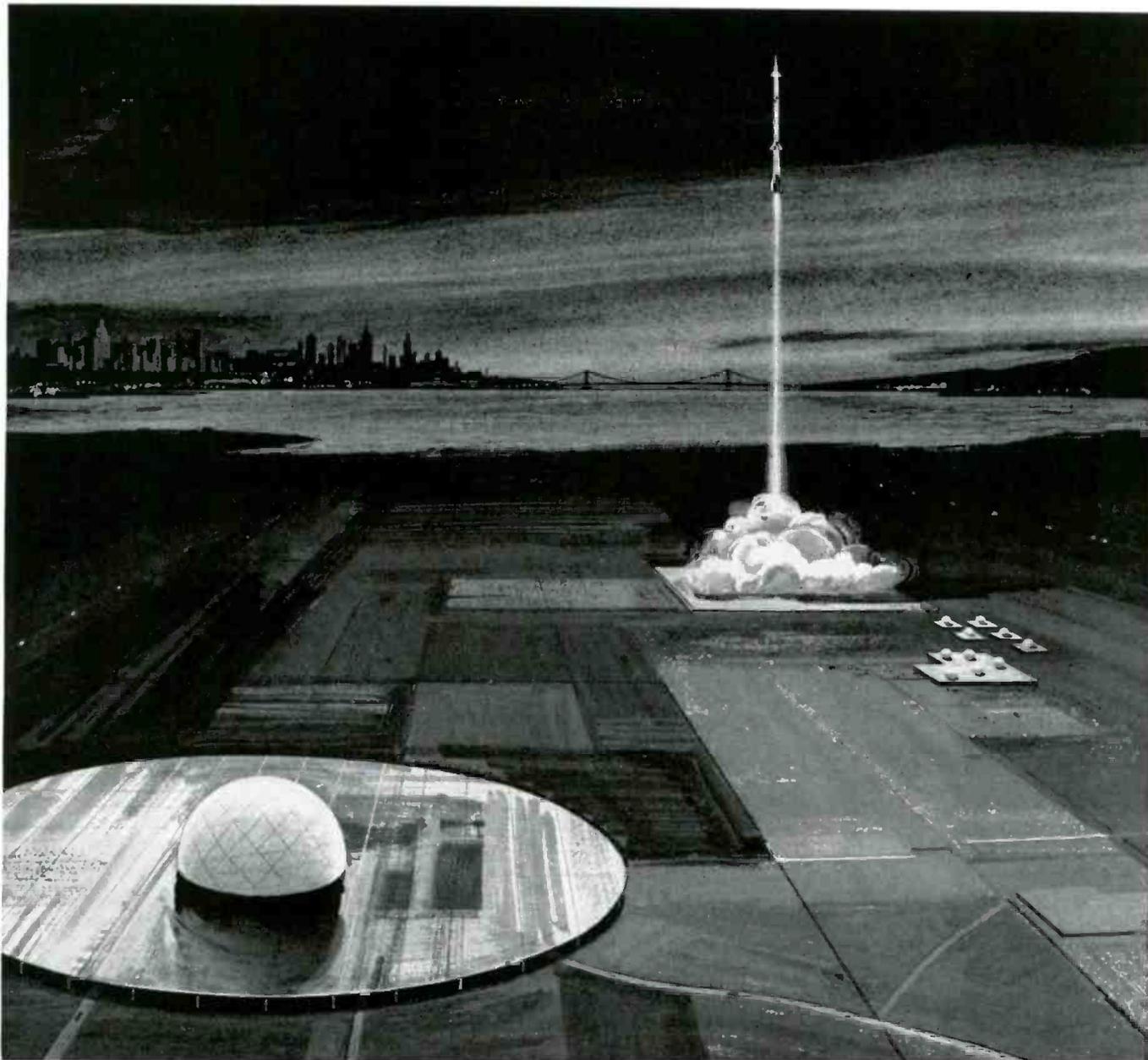
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heads from harmless decoys that may be included to confuse our defenses.

The system tracks the ICBM or IRBM, then launches and tracks the Nike Zeus missile and automatically steers it all the way to intercept the target. The entire engagement, from detection to destruction, would take place within minutes and would span hundreds of miles.

Under a prime Army Ordnance contract with the Western Electric Company, Bell Laboratories is charged with the development of the entire Nike Zeus system, with assistance from many subcontractors. It is another example of the cooperation between Bell Laboratories and Western Electric for the defense of America.

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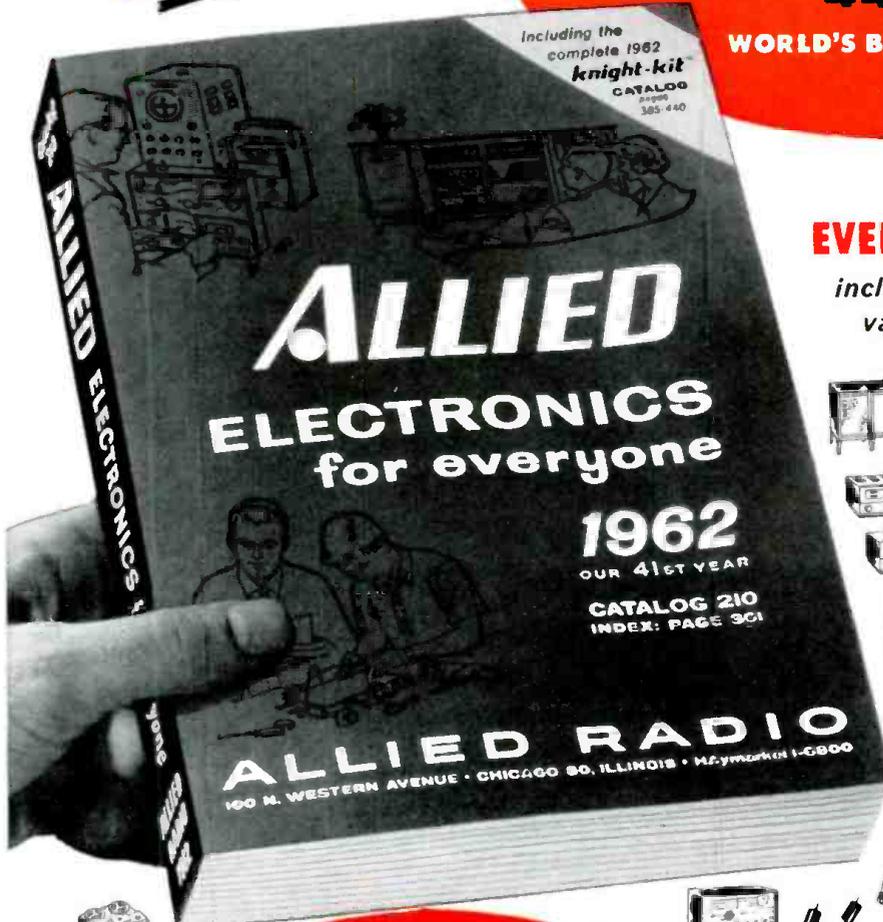
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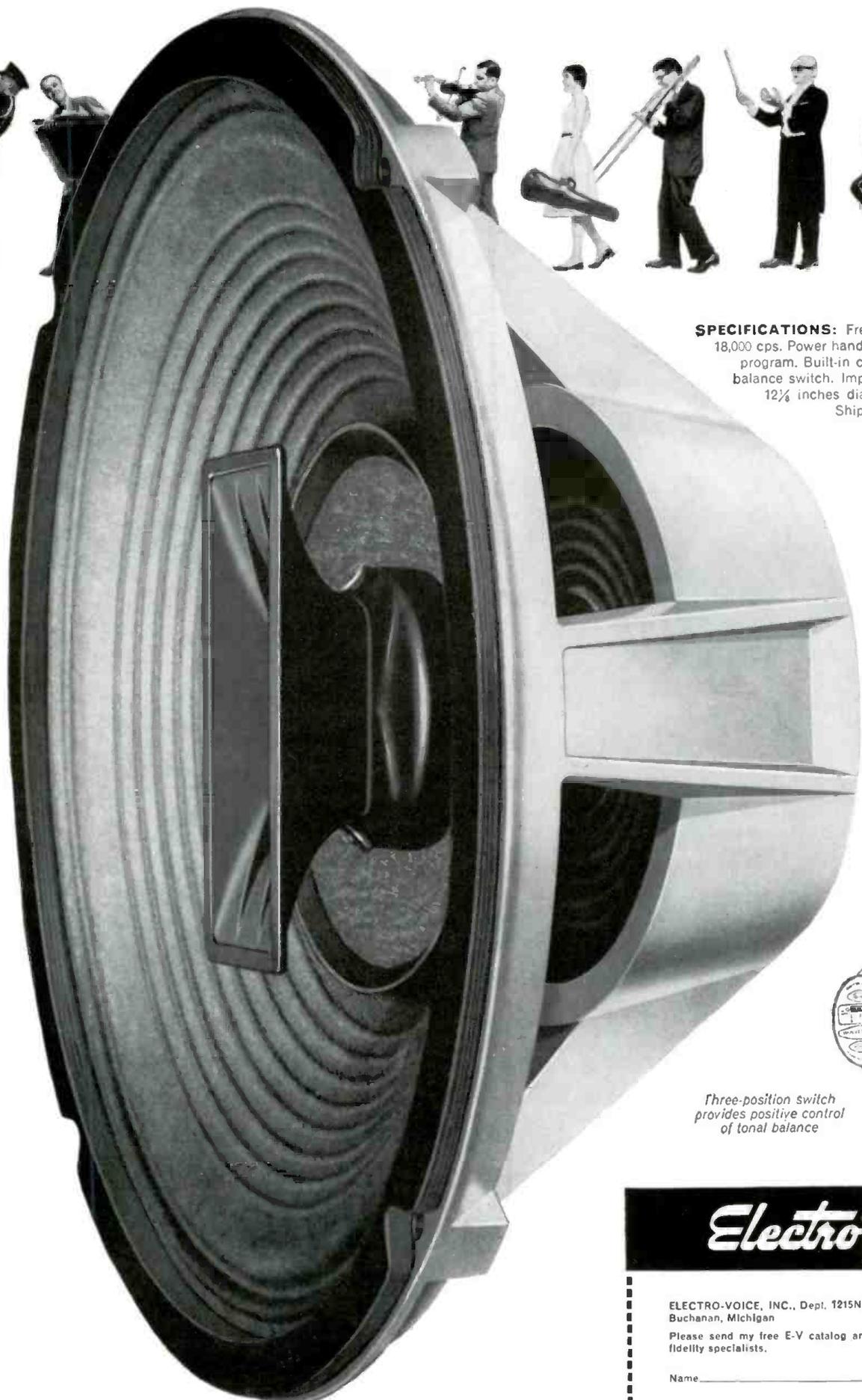
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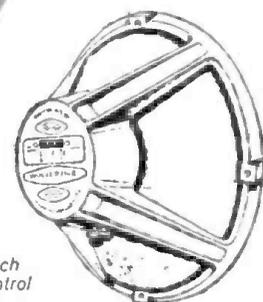
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Multiplex reception.

(Patent Pending)

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The MX99 is self-powered, provides entirely automatic stereo/mono operation and includes low impedance cathode follower outputs to permit long lines. An indicator lamp turns on when the station selected is broadcasting multiplex stereo. A separation of 35db between channels is typical across the entire audio spectrum. An over-all gain of unity is provided from input to output on both stereo and mono.

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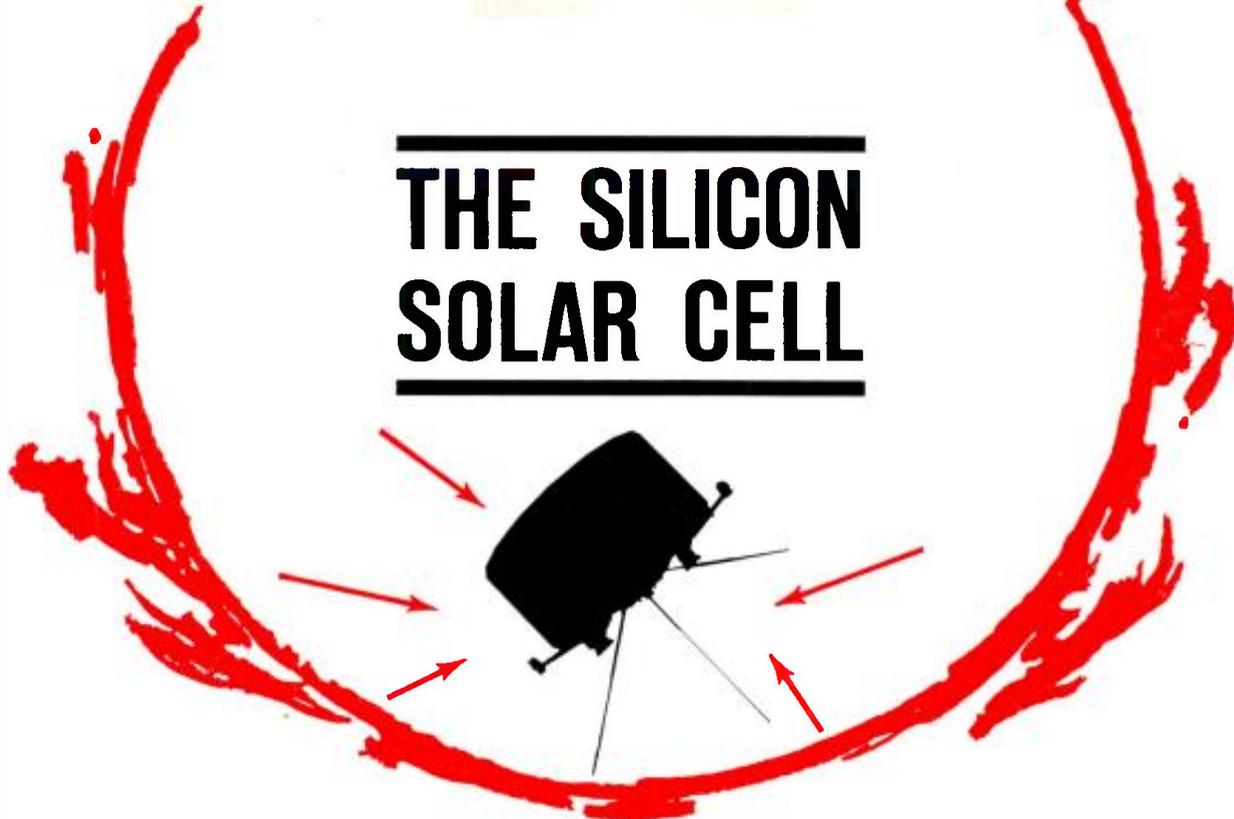
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THE SILICON SOLAR CELL



By W. R. BARON / Manager, Astro-Power Div., International Rectifier Corporation

A primary power source for the space age, this device makes possible direct, instantaneous, and efficient conversion of the sun's energy into useful electric power.

EDITOR'S NOTE: The silicon solar cell discussed below should not be confused with the selenium photovoltaic cell. The more expensive silicon solar cell is far more efficient in converting light to electricity. Silicon cells, currently being manufactured by Hoffman Electronics Corp. and International Rectifier Corp., were originally developed by Bell Telephone Laboratories.

WE ARE now living in the space age and the era of the semiconductor. One of the many thousands of different components used in satellites and space vehicles is the silicon solar cell, a product of the semiconductor industry. In addition to its sophisticated role in space travel (Fig. 2), the silicon solar cell has many industrial and commercial uses—some as yet unexplored—which are fulfilling man's dream of direct, instantaneous conversion of the sun's energy into useful electrical power.

This ability to convert light energy directly to electrical energy is worthy of considerable attention, especially since the cell has no moving parts, has great simplicity and reliability in operation, indefinite life expectancy, is extremely light in weight, mechanically strong, and can withstand humidity, shock, vibration, and a wide range of operating temperatures. Although other materials, such as selenium, are capable of converting light to electricity, silicon cells are capable of the highest electrical output and efficiency.

Not all silicon solar cell applications are as glamorous as those of satellites and space vehicles, and the cells are finding increased use in industrial and data-processing systems for light detection, response, and movement.

The sun gives us light and life and this fact has been recognized in various ways throughout the history of man. The energy received by the earth from the sun reaches fantastic proportions and, even with the considerable losses due to the atmosphere surrounding the earth, the solar energy falling on less than .01% of the earth's surface is approximately equal to present total world power consumption. By means of the silicon solar cell, solar radiation can be converted directly into electric power without an intermediate heat cycle.

At the present moment, economic and geographical considerations do not make this a practical proposition for converting large amounts of power to supply industrial and domestic needs and, in this respect, the application is at present limited to small power demands of up to approximately 100 watts continuously.

In the early days of development, a

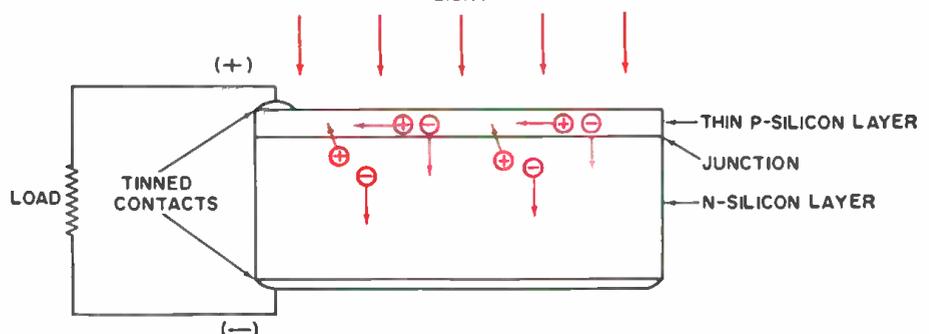
cell conversion efficiency of 6% (ratio of electrical output to total illumination energy input) was worthy of acclaim, but now cells with conversion efficiencies of 12% and 13% are in regular production at *International Rectifier Corporation*. This improvement in efficiency is a remarkable achievement when one considers that the theoretical maximum conversion efficiency is only a little more than 20%.

Operating & Manufacture

The cell is manufactured from silicon, a metallic semiconductor which is a material intermediate between an insulator (such as glass) and a conductor (such as copper or aluminum). Chemically it is second only to oxygen as the world's most abundant element.

A finished silicon solar cell appears as a rectangular wafer of silicon, dark blue-gray in color, about .020 inch thick and usually 1 cm. x 2 cm. (about .4" x

Fig. 1. The composition and the basic operation of the silicon solar cell.



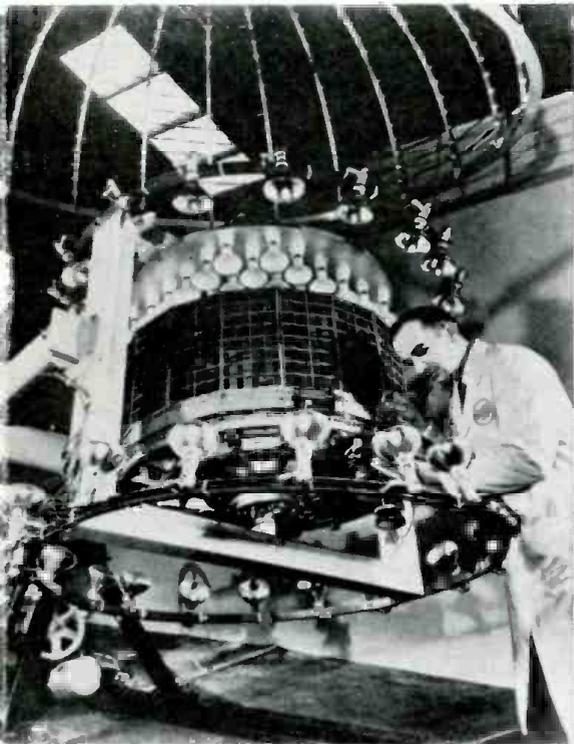


Fig. 2. The U.S. weather-eye satellite, "Tiros," was equipped with more than 9000 silicon solar cells. This represents one of the largest arrays of solar cells launched into orbit. In the illustration, a technician is taking measurements of the output of the solar cells prior to the launching of the weather satellite.

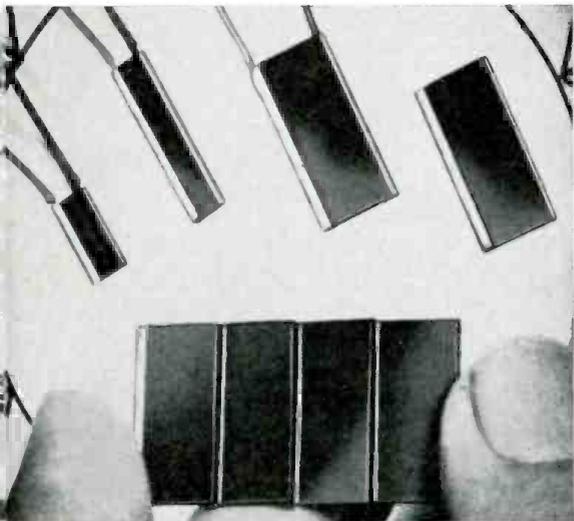
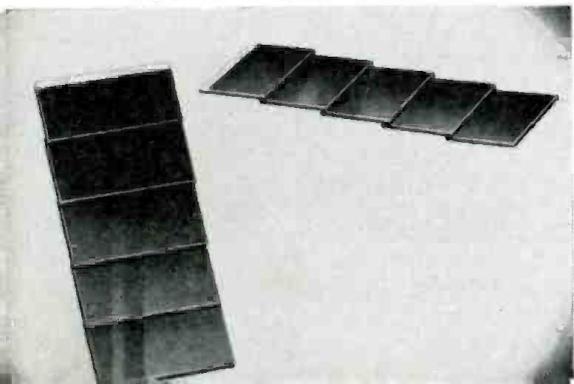


Fig. 3. Rugged, high-efficiency silicon solar-cell module (bottom) and unmounted cells.

Fig. 4. Cells may be equipped with extremely thin, optically coated coverglass to provide optimum reflection properties and high thermal emissivity. This technique is recommended for space-vehicle use.

Fig. 5. Shingled solar-cell assemblies.



.8") in size (Fig. 3). In processing, the cell undergoes a very complex manufacturing procedure, starting with the chemical refining and purification of silicon—often to impurity levels of 1 part per billion, the growing of a single crystal from the molten silicon or "melt" at a temperature approaching 2000 degrees C, cutting the crystal into wafers, formation of the junction or active layer, and finally connecting wires to the unit. In all, it passes through some forty different processes before the final cell is "born" and involves approximately twenty-five different chemicals during the process.

The cell consists of two layers of silicon, one of which is "impure" as compared to the other—but impure in a special chemical and molecular way. One layer contains a controlled chemical "impurity" rich in electrons (*n*-type silicon) and the other layer contains an impurity deficient in electrons (*p*-type silicon). These two layers are in intimate contact with each other and the junction formed between them exhibits the interesting property of a strong built-in electric field which contains the electrons in the *n* silicon and the holes in the *p* silicon, thus forming a barrier between the *n* and *p* layers. Photons of light are absorbed through the very thin *p* layer into the barrier region. There they liberate electrons and holes, the built-in electric field displacing the electrons to the *n* side, making it nega-

cycle within a furnace, a thin layer of *p*-type (positive) silicon is formed on the top of the wafer by allowing a doping material to react with the silicon wafer under intense heat in excess of 1000 degrees C.

As the *p* layer is formed in a gaseous atmosphere it completely covers all surfaces of the wafer. It is, therefore, removed from the back and all edges of the wafer to leave only the active side covered. The front collector and the back are then plated and tinned to provide solder points for assembly and connections. Each cell is finally tested for electrical output in carefully controlled temperature conditions under a calibrated simulated sunlight source and graded according to the measured conversion efficiency.

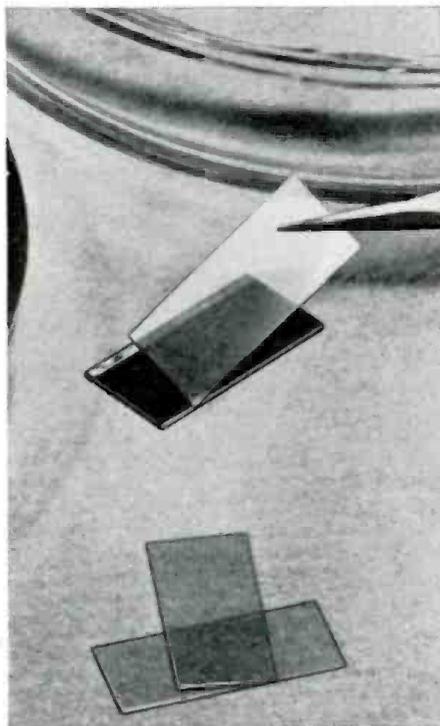
As the active area of the cell plays a very important part in the energy conversion, the contact on the *p*-layer side is usually in narrow strip form along one edge to present the maximum cell area for illumination and power conversion. In addition to a single front contact or collector strip, cells are now being manufactured with a number of secondary collectors protruding from the main or primary collector strip. The purpose of these is to afford better collection of the current from the active cell area and thus to increase the conversion efficiency or power output. These cells are called "gridded cells" because the collectors form a grid network over the top or active area of the cell.

Characteristics

Many factors influence the conversion efficiency of the cell, including the intensity of the light source, the spectral content or light wavelength, and its angle to the cell surface (angle of incidence), cell operating temperature, and the characteristics of the external electrical circuit.

It is interesting to note that the spectral content and intensity of sunlight on earth (air mass = 1) are different from those in space (air mass = 0) due to the filter effects of cloud, vapor, and air smog within our atmosphere. The electrical output from a given cell is about 15% greater in space compared with measurements made on earth.

In addition, the cell itself does not show a uniform response to all wavelengths of light shining on it. The com-



positive, and the holes to the *p* side, making it positive and causing a voltage to appear across the cell terminals. Connection to an external circuit causes current to flow and the direct conversion of light into electrical energy is obtained. See Fig. 1.

With present manufacturing techniques, a thin wafer of *n*-type silicon is first cleaned with acid, then, in a carefully controlled time and temperature

COVER STORY

OUR cover shows an important application of silicon solar cells, over 9000 of them in all, in providing the power to charge the storage batteries in "Tiros," our weather observation satellite. This satellite was developed by RCA for NASA. Below the satellite is a typical module consisting of a large number of interconnected silicon solar cells. A number of these modules may be used to supply the total power requirements of a space vehicle. To the left is a large single crystal ingot that has been grown from molten silicon. Wafers cut from this mother crystal are processed into silicon solar cells.

(Photos courtesy RCA and International Rectifier Corp.)

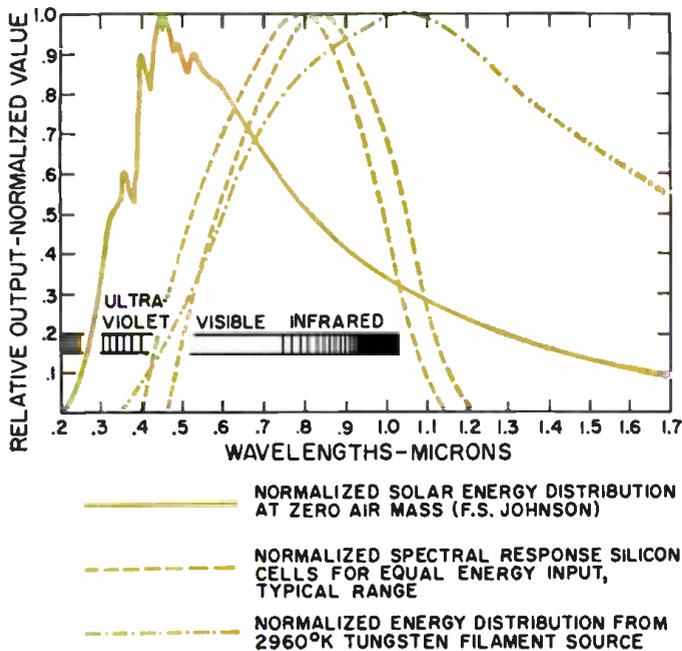


Fig. 6. Relative solar radiation spectral distribution compared to tungsten filament lamp radiation and cell response.

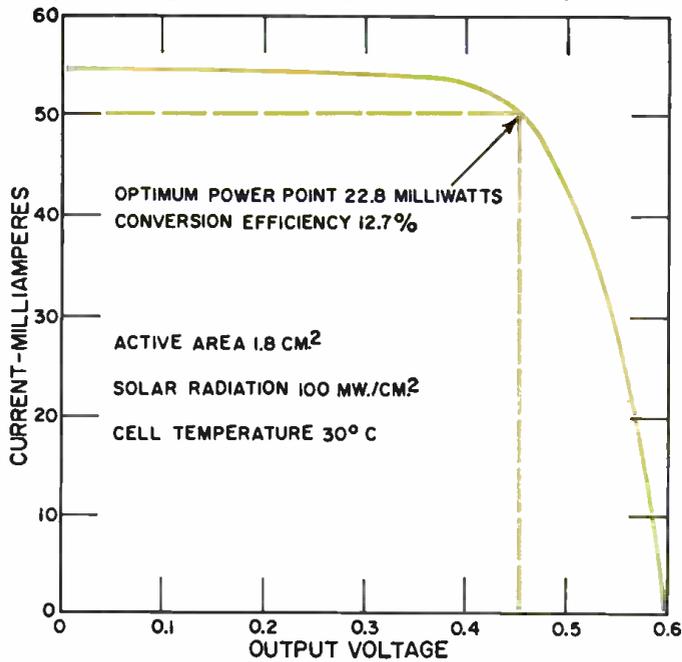


Fig. 8. Voltage-current output characteristics of high conversion efficiency silicon cell, showing optimum power point.

parison in Fig. 6 shows the spectral or wavelength content of sunlight compared to a tungsten filament lamp and the response curve of a typical silicon solar cell. From this it can be seen that the cell will only accept and convert to electrical energy that portion of the light energy embraced within the cell response curve. As would be expected, the output from the cell also depends on the intensity of the light shining on it. This is shown in Fig. 7 and, as can be seen, the short-circuit or maximum available current is a linear function of the light intensity.

The electrical output of a cell follows the typical curve shown in Fig. 8. The power output is the product of the voltage and the current at that voltage and is usually a maximum at only one point on the curve. This is the power point

at which the largest-area rectangle fits under the voltage-current curve of the cell.

Silicon solar cells suffer adversely from the effects of increasing cell operating or environmental temperatures. The power output from the cell decreases approximately .6% per degree centigrade increase in cell temperature. See Fig. 9. It is therefore vitally important in any application of these devices to ensure adequate control of the cell operating temperature.

In space, improvement in the control of cell operating temperatures can be achieved by cementing extremely thin cover glasses over the front of the cells. Typical cover glasses are about five thousandths of an inch thick. See Fig. 4. These cover glasses have special optical filters deposited on their surfaces

and are designed to decrease the transmission of the unwanted portion of the sunlight energy, *i.e.*, the energy outside the response of the solar cell. This has the effect of reducing the temperature rise of the cell under operating conditions, a most important point in the design of satellites where maximum power output is required for a minimum number of solar cells due to weight and structural considerations.

Silicon solar cells can be used singly or in groups and although the present standard commercial size is 1 cm. x 2 cm., they are also available in a wide variety of other sizes to meet special needs. For example, they can be supplied as small as .020 inch x .100 inch and as large as about .8 inch (2 cm.) square. They are also available as made-up sub-assemblies or shingles in a mul-

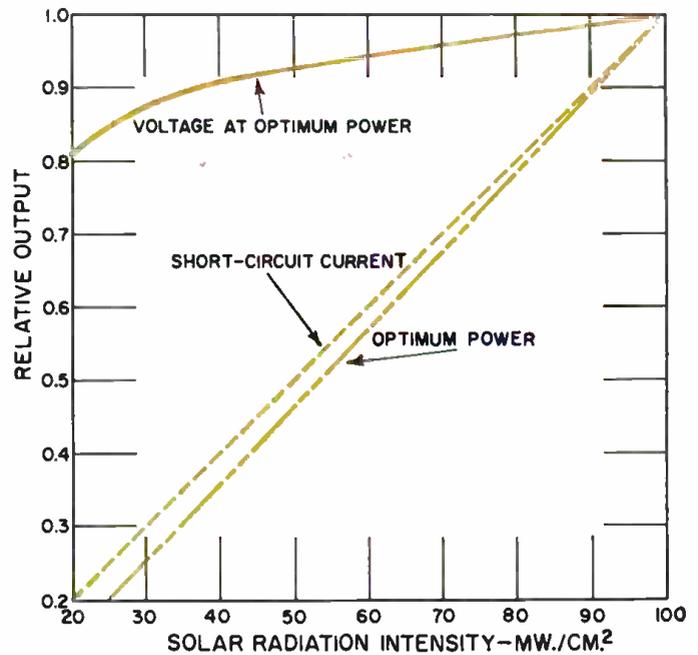


Fig. 7. Silicon-cell output versus solar radiation. 100 mw./cm.² intensity occurs with clear, bright, mid-day summer sun.

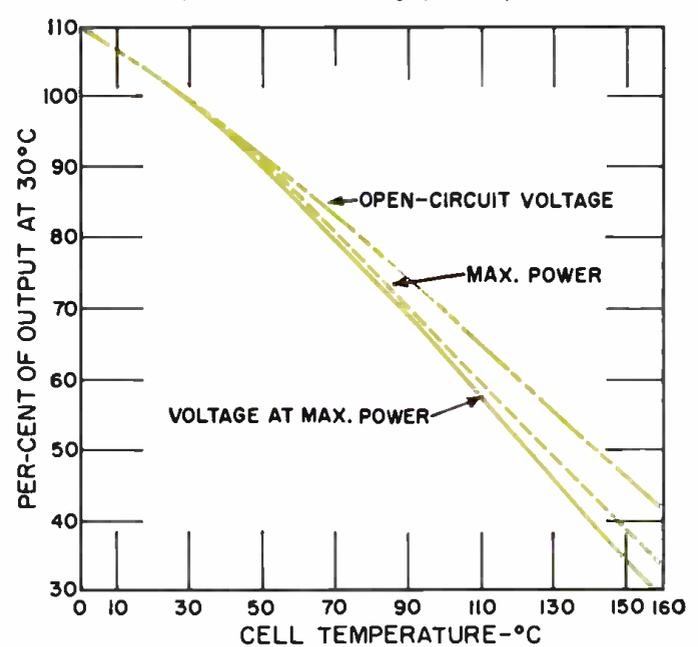


Fig. 9. Output of the silicon solar cell as a function of the cell temperature. Output is reduced with a rise in temperature.

titude of different cell configurations.

Cells can be connected in series to increase the voltage output and in parallel to increase the current output. Power output depends not only on the number of series/parallel cells used, but on the utilization of the space available for the cells as well. The shingling or overlapping cell method of series connection shown in Fig. 5 is very popular for large assemblies because it provides the highest output from a given area and is also a convenient subassembly for manufacturing purposes. A typical shingle of five average cells will give an output of approximately 2 volts at 40 ma. with optimum illumination. In such a series string the cell with the lowest output will determine the current available, hence great care must be exercised in selecting the cells to ensure accurate matching of their output characteristics.

Another type of cell gaining popularity is the gridded cell mentioned previously and shown in Fig. 10. Here the active surface has a network of collectors to assist the current flow. The effect of these extra collectors is to increase the electrical power output of a given cell beyond that available from a non-gridded cell, raising the conversion efficiency by 1% or so under given light and load conditions.

Applications

Silicon solar cells are finding increased and varied applications throughout industry, but by far the most glamorous role is to provide the power requirements of satellites and space vehicles. In such applications the solar cells are used to charge storage batteries and supply power during that portion of the orbit which is in sunlight, the storage battery providing continuity of power supply for the instrumentation, transmitters, and telemetry system during periods of darkness when the cells are inoperative. Solar-cell systems with peak-power outputs up to 250 watts have been designed and manufactured. A typical module for such an application is shown in Fig. 11. A number of these modules are used to provide the total power required.

Our weather-observation satellite, "Tiros," shown in Fig. 1 has a total of 9260 silicon solar cells to keep its nickel-cadmium storage batteries charged. Banks of 80 cells are connected in series and mounted on printed circuit boards for ease of assembly.

Silicon cells are also used extensively

to "read" punched tape, punched cards, and film. Here the cards pass between a bright light source and the cell read-out unit. These cells are extremely small with an active area per position of approximately .01 square inch and are spaced to correspond with the alignment of the card holes or information to be read.

A typical 8-position read-out is shown in Fig. 12 with over-all dimensions of only .676 inch long, .2 inch wide, and .025 inch thick. Movement of the punched card produces impulses of light upon the segments of the read-out unit and these are converted into electrical impulses which can be arranged to sort, print data, and convert information for accounting, statistical, and analysis purposes. This can be done very rapidly indeed as the read-out units have a response time of less than 20 μ sec.

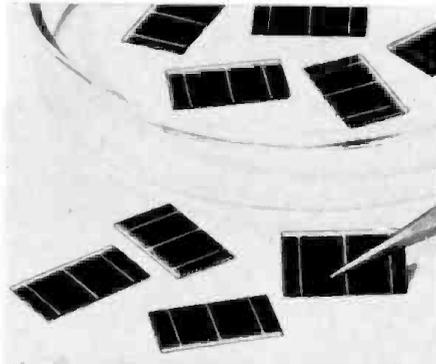


Fig. 10. "Gridded" solar cells. The central grid collection strips assist current flow and increase the power output.

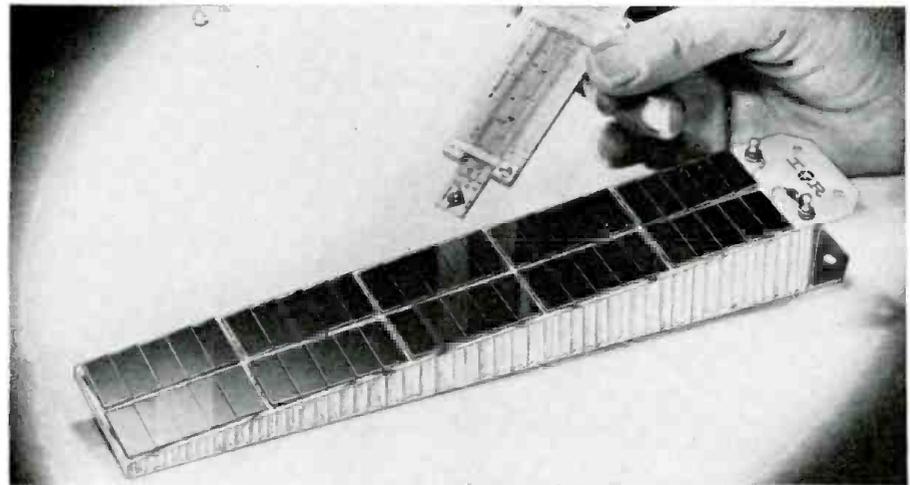


Fig. 11. This space-vehicle power-supply panel contains many interconnected cells.

Fig. 12. Eight-position fast-response read-out made from silicon cells.

Other typical uses for the cells include power supplies for remote and unattended radio stations, lighthouses, beacons, and telephone repeaters in sunny areas (such as the Polar Regions), and a machine to automatically change dollar bills into coins.

The advent of the transistor radio which requires only a small operating power, provides a ready application of silicon solar cells when the receiver is operated on a sunny beach. By using 10 or 12 cells connected in series, most transistor radios can be operated from bright sunshine. Light-controlled toys, automatic street-lighting controls, machine-tool control and positioning devices, level indicators, analogue-to-digital encoders, servomechanisms, gyrocompasses and other navigational aids, automatic door operators, tone and signal generators, light-operated burglar alarms, emergency radios and communications, modulated light-beam communications, vending machines all provide possible uses for these cells.

For these applications, the rugged simplicity, high output levels, indefinite life, and non-aging characteristic make the use of silicon cells attractive.

In common with other semiconductor devices the cost of the silicon solar cell has decreased considerably since its introduction nearly eight years ago. The cost of the cells varies with quantity and quality, but single cells of medium conversion efficiency (8%) are available for as little as \$4 each which, when spread over even a short lifetime, shows an energy cost figure less than we now pay for conventional chemical batteries.

The estimated 1961 market for solar cells is approximately \$2-million—most of which will have come from the spacecraft makers, but industrial and commercial uses are increasing at a very rapid rate. For example, the market for read-out devices nearly doubled during 1960 and is expected to duplicate this record in the current year.

The broad range of applications previously mentioned, coupled with present market trends, indicates continuing and increasing expansion in the industrial and commercial market for silicon solar cells. ▲

STEREO FM MULTIPLEX ADAPTER CIRCUIT

By W. R. COURTNEY / Chief Engineer, J. W. Miller Co.

Construction information on a simple stereo adapter that can be home-built using readily available parts.

CONSTRUCTION of a home-built FM stereo adapter has not been too convenient before this because of the unavailability of some of the special filters and transformers required. The circuit shown below, however, uses readily available coils and transformers, obtainable at electronics parts dealers who distribute Miller products.

The adapter unit is connected to an FM tuner at a point following the detector stage, but ahead of the de-emphasis network. Most recent FM tuners make this connection point available by means of a "multiplex output" jack. At this point we have a composite signal made up of the detected audio component of the main channel (left plus right, or L+R signal), a double-sideband suppressed-carrier signal (left minus right, or L-R signal) centered at 38 kc., and a 19-kc. pilot subcarrier.

All three of these components are amplified by the first triode section of the 12AU7 and they appear at the plate output circuit of this stage. The tuned circuit T_2 is a low-pass filter with a cut-off between 15 and 19 kc. This circuit permits only the L+R signal to pass on to resistor R_{10} . Tuned circuits T_3 and T_4

comprise a bandpass network that allows the sidebands of the L-R signal, from 23 kc. to 53 kc., to be applied to resistor R_{12} and the two crystal detectors.

The 19-kc. pilot subcarrier is amplified by the second triode section of the 12AU7. Then it is applied to transformer T_5 and the 6C4 oscillator stage. The output of the 6C4 is tuned by means of transformer T_6 to twice the input frequency, which is 38 kc., the frequency of the suppressed subcarrier that produces the L-R sidebands. The 38-kc. signal is then applied by way of the secondary winding of T_6 to the crystal detectors along with the L-R sidebands.

After detection a positive L-R signal is obtained from detector CR_1 , and a negative L-R signal is obtained from detector CR_2 . When these signals are combined with the L+R signal through matrixing resistors R_{11} and R_{10} , the result is a cancellation of the R portion at the output of CR_1 , and a cancellation of the L portion at the output of CR_2 . This leaves only the L signal at the upper output terminal and only the R signal at the lower output terminal.

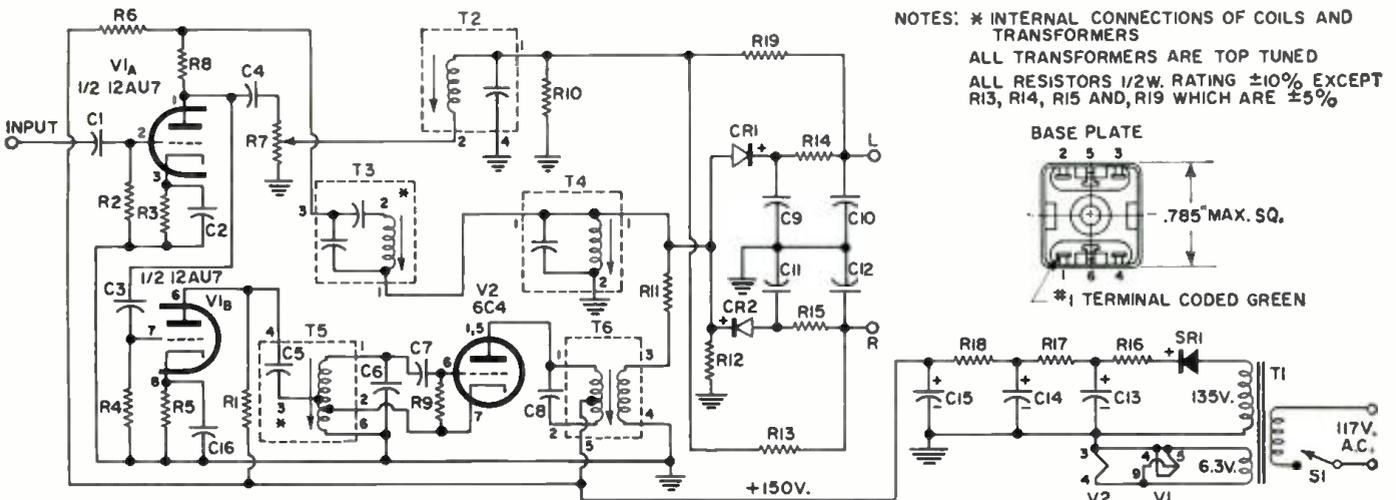
To align the adapter, turn it on, allow it to warm up, then proceed as follows. Connect a v.t.v.m. between either L or

R output terminal and ground, and apply sufficient 19-kc. signal from an audio oscillator connected to the input terminal to produce a reading of .1 volt. Now adjust T_5 until a flicker is observed on the meter. This voltage variation indicates the point of synchronization and is the correct adjustment for this coil. Next adjust T_6 for maximum meter reading.

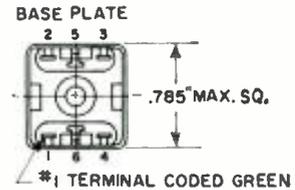
The oscillator is then disabled by shorting out the grid coil in T_5 . Adjust the audio generator to 27 kc. and peak T_1 for maximum v.t.v.m. reading. Then set the generator to 67 kc. and adjust T_2 for a null or minimum meter reading. Tuned circuit T_2 is normally adjusted by the manufacturer so that it need not be aligned. Now remove the short from T_5 .

Finally, tune in a stereo broadcast. If a steady beat note is heard, indicating that the oscillator is not locked in with the 19-kc. transmitted pilot signal, simply touch up T_5 to eliminate the beat. Control R_8 may then be adjusted for the desired stereo separation. If the stereo broadcast station is transmitting a suitable test signal or if a stereo signal generator is available, then both R_8 and T_2 can be adjusted exactly for proper L and R outputs and the correct separation. ▲

Complete circuit diagram, including power supply, for the FM stereo adapter that uses easily obtainable parts.



NOTES: * INTERNAL CONNECTIONS OF COILS AND TRANSFORMERS
ALL TRANSFORMERS ARE TOP TUNED
ALL RESISTORS 1/2W. RATING $\pm 10\%$ EXCEPT R_{13}, R_{14}, R_{15} AND R_{19} WHICH ARE $\pm 5\%$



- R_1 —47,000 ohm, $\frac{1}{2}$ w. res.
- R_2 —470,000 ohm, $\frac{1}{2}$ w. res.
- R_3 —1500 ohm, $\frac{1}{2}$ w. res.
- R_4 —100,000 ohm, $\frac{1}{2}$ w. res.
- R_5 —3300 ohm, $\frac{1}{2}$ w. res.
- R_6 —33,000 ohm, $\frac{1}{2}$ w. res.
- R_7 —50,000 ohm pot.
- R_8, R_{10}, R_{11} —10,000 ohm, $\frac{1}{2}$ w. res.
- R_9 —220,000 ohm, $\frac{1}{2}$ w. res.
- R_{12} —27,000 ohm, $\frac{1}{2}$ w. res.
- $R_{13}, R_{14}, R_{15}, R_{19}$ —75,000 ohm, $\frac{1}{2}$ w. res. $\pm 5\%$
- R_{16} —47 ohm, $\frac{1}{2}$ w. res.
- R_{17}, R_{18} —470 ohm, $\frac{1}{2}$ w. res.
- C_1 —.1 μ f., 400 v. capacitor
- C_2 —.05 μ f., 400 v. capacitor

- C_3 —180 μ f. mica capacitor $\pm 10\%$
- C_4 —1 μ f., 200 v. capacitor
- C_5 —300 μ f. capacitor (part of #1354 trans.)
- C_6 —.01 μ f. mica capacitor
- C_7, C_{10}, C_{11} —.001 μ f. disc ceramic capacitor
- C_8 —.0015 μ f. mica capacitor
- C_9, C_{12} —100 μ f. disc ceramic capacitor
- C_{13}, C_{14}, C_{15} —40/40/40 μ f., 150 v. elec. capacitor
- C_{16} —.005 μ f. disc ceramic capacitor
- T_1 —Power trans. 135 v. @ 50 ma., 6.3 v. @ 1.5 amps (Triad R-30X, Stancor PA8421, or equiv.)
- T_2 —Low-pass filter (J. W. Miller #1351)
- T_3 —Bandpass filter series element (J. W. Miller #1352)

- T_4 —Bandpass filter shunt element (J. W. Miller #1353)
- T_5 —19 kc. locked oscillator coil (J. W. Miller #1354)
- T_6 —38 kc. output trans. (J. W. Miller #1355)
- Note: T_3 through T_6 are brand-new parts which may not as yet be listed in electronic parts jobber catalogues. They will be available on order from companies handling the J. W. Miller line.
- CR_1, CR_2 —1N60 crystal rectifier
- SR_1 —140 v., 200 ma. silicon rectifier (International Rectifier 2E4 or equiv.)
- S_1 —S.p.s.t. switch
- V_1 —12AU7 tube
- V_2 —6C4 tube



RELIABILITY

SPACE-AGE REQUIREMENT

THE notion of reliability as it has come to influence our technology is generally thought to be quite new, about the age of space satellites and other sophisticated equipment that requires ultra-reliability. Actually, Oliver Wendell Holmes had reliability on his mind in his poem "The One-Hoss Shay." This is a fine picture of what would actually happen with each part as reliable as the next: a thing that fortunately does not happen in fact. Ben Franklin's "For Want of a Nail," however, written a couple of hundred years ago, is an excellent example of hitting that nail on the head. One tiny defective component in a multi-ton missile has indeed caused the whole project to fail.

Rhymed or otherwise, reliability is now a part of the technician's and engineer's vocabulary and, for better or worse, we have reached the technological point where as much time is often spent to improve reliability as is spent to produce the equipment.

The reliability technician and engineer have taken their places with other specialists and have already developed a language of their own—a language seldom understood by "outsiders." This article will attempt to clarify "reliability" by definitions and illustrations.

Reliability Defined

"Reliability" is simply the probability that a device or piece of equipment will perform as required. The only catch to this statement is the word "probability." It has quite literally built an empire.

Using a weapon as an example, we can go back in history to the cave man and a boulder. This rock, if delivered on target, was 100% reliable—one part, and not a moving one at that, with no interconnections, no power source inside, nothing required as output except its weight and hardness. This state of affairs

Air Force Minuteman intercontinental ballistic missile being launched from Cape Canaveral. The goal is to make the missile as reliable a weapon as possible, approaching that of the first weapon, the caveman's rock. If delivered on its target, this weapon was 100% reliable, having no components that were subject to any type of a failure.



lasted until the advent of the bow and arrow, a superior weapon in all respects—except in the matter of *reliability*. The bow, the arrow, or the string could break. Any component failure meant total failure. Notice that all these events need not happen simultaneously, just as a wheel giving way on Holmes' shay would make one late for prayer meeting as surely as if it went to pieces all at once.

Right here we can mention the nemesis of the builder of complex systems—from bows and arrows to Minuteman missiles—the product rule. In essence, this inexorable rule says that the *reliability* of a series of components must be multiplied to find *total reliability*. Say our Cro-Magnon hunter has a rather poor bow which will work 8 out of 10 pulls. We assign it a *reliability* of 80%. The arrow, coincidentally, is just as reliable, as is the string. So what is the reliability of Mr. C's weapon system? Not 80% as we might like to think, but $.8 \times .8 \times .8$, or only 51%! Our cave man, not being trained in the science of reliability engineering would be stunned; both by the realization that his bow and arrow misfired every other time, and by a boulder lobbed by a less sophisticated but more reliably armed adversary.

A bow and arrow man watching the fight might resolve to do one of several things: leave the country, switch to rocks, carry spare bows and arrows, or improve the ones he had. Carrying spares, which the reliability engineer calls redundancy, would work. Its drawbacks are cost, weight and bulk, and inconvenience. So forward-looking warriors—and manufacturers—choose to improve their equipment.

Need for Reliability

Today we don't have much trouble with our bows and arrows. Automobiles, radios, and TV sets, however, are not

Table showing product rule for reliability.

Number of Components	Total Reliability with Component Reliability of		
	99 %	99.9 %	99.99 %
100	37 %	90 %	99.1 %
250	8 %	78 %	97.4 %
500	1 %	60 %	95.2 %

ELECTRONICS WORLD

By D. S. HALACY / *Motorola Semiconductor Products Inc.*

Frequently as much time is spent to improve electronic component reliability as to produce the equipment itself.

100% reliable. To most of us, this is a nuisance, made the more irksome by whisperings of "planned obsolescence." But many users of equipment must have high degrees of reliability for various reasons.

Telephone circuitry must function well or the companies providing this service would spend all the profits doing maintenance work. Uncle Sam must have defenses almost as reliable as the boulder, even if the boulder comes to cost like uranium. Space vehicles and many less exotic equipment are so complex and fast operating that individual failure rates must be fantastically low.

A good topical example of reliability in action (or not in action) is the missile programs currently in progress. The reliability designer's dilemma is one of degree: build a simple missile that is light but only 90% reliable, or build one that will operate perfectly every time. Even assuming that the 100% figure were possible, the missile would still not reach the target—it would not get off the ground because of its weight. A compromise is obviously in order and, as a talking figure, let us say the designers decide on 99.7% as the goal for over-all reliability.

It would seem that an individual component reliability of 99.9% would surely suffice to give us the 99.7% over-all figure. But using the product law, we find that 500 components, each 99.9% reliable, results in a total reliability of about 60%. Even 99.99% individual reliability yields only 95% when it is subjected to the product law. See table on opposite page.

Remembering the product rule, and reflecting on the fact that there are not 500 but thousands of parts in a missile, many operating in series, it is understandable that a transistor reliability of 99.9993% is the goal set by *Motorola Semiconductor Products Division of Autonetics' Minuteman Project*. Other firms are shooting for goals ranging as high as 99.9994% for simpler components like capacitors.

To illustrate a little more vividly what this means, the example has been used

that a device with a failure rate of 0.0007% would last, on the average, 15,000 years before failure. A transistorized Noah's Ark would still have a long life ahead of it. This quantitative statement should give rise to a question which leads us to another term in the reliability equation—that of time. Most reliability figures are given per 1000 hours, although some experts contend that this is a meaningless qualification. MTBF, the mean time between failures, is another expression of reliability. For the Minuteman this MTBF is 7000 hours, about the same as operating 30,000 TV sets for a year before one failed!

Failure Rate

This leads us to another term, that of *failure rate*. In our case of 99.7%, the failure rate, or probability of failure, would be:

$$100\% - 99.7\% = 0.3\% \text{ failure rate.}$$

While at first inspection a reliability of 99.7% is not particularly impressive, a popular soap having approached that figure long before the age of electronics, attainment of such a goal is a marvel, if not a miracle.

Confidence Level

There is another term we must learn and that is *confidence level*. Boiled down,

this simply means the consistency with which the desired reliability figure has been demonstrated. Since all reliability, no matter how good, is not a guarantee but a probability, demonstrating 99 successes out of 100 times, sets the 99% figure only for a very low confidence level. It is necessary to test and retest, or test simultaneously with many batches of parts to reach a confidence level as respectable as 60%, the figure set for many of the Minuteman components.

Quality Control

It is one thing to build a reliable product and something else to prove this reliability. This need for such testing gives rise to the Quality Control Department, a group whose testing includes highly sophisticated statistical methods and whose lexicon is studded with terms like "Monte Carlo," "chi-square," "AQL," and "4-dimensional matrices."

Although there are those who decry the whole reliability idea as a "cult" that can wreck the economy, reliability is surely with us to stay, at least until an ultra-reliable missile war puts us back in leopard skins, with rocks for weapons. An example of the importance of reliability is the spending of \$20-million by *Autonetics* for reliability studies of Minuteman components. ▲

Statistical reliability studies being made for parts used in Minuteman missile.



SIMPLE SYNC SERVICING

By WAYNE LEMONS

A few stubborn faults need elaborate testing—but most sync troubles will yield to this quick v.t.v.m. method.

EVERYONE, at one time or another, probably has trouble finding sync-circuit faults. Not everyone likes to use the scope for servicing this part of the receiver, although that instrument offers many advantages. After all, the path to profits is to make repairs in the quickest way, which is not necessarily the most sophisticated way.

This story is for those who prefer not to use the scope. Nearly everyone has a v.t.v.m. This instrument and maybe a little "cut and try" is all you need to make short work of all sync problems but the most unusual ones.

The secret of all troubleshooting is to narrow down or localize the fault to a few possible components. This applies to sync servicing too. To begin with, the cause of a sync fault can lie either in the sync stage (or stages), or it can be ahead of this circuit, in the video stages. Which is it? If you have no obvious clues, it is necessary to "prove" one circuit; that is, to determine that the sync stages are either defective or not defective. If you can prove that one of these sections (sync or video) is not defective, then you can concentrate on the other.

It is sometimes said that the v.t.v.m. is practically useless in sync circuits, that only the scope will do. This just isn't so! A sync circuit performs or fails to perform because of correct or incorrect voltages. What is more logical than using a v.t.v.m. to check voltages? Admittedly, the instrument has limitations in sync troubleshooting—but they are not as serious as one is often led to believe. Triode sync clippers almost always have fairly low d.c. plate voltages. (Most multi-grid sync tubes are essentially triode or pentode clippers.) Pentode clippers usually have low d.c. screen voltages. These low voltages allow the tubes to saturate easily so that clipping and limiting is realized.

The most common sync troubles, aside from tubes, include open coupling capacitors (no sync), leaky coupling capacitors (bending, tearing, instability), and open or changed-value resistors. What else is there? As far as major causes go, there is one more, which we'll discuss later on.

Now how do you check a capacitor that is suspected of being open? There is probably no quicker way than to shunt it with a good one. How about a leaky capacitor? Suppose, for example, that you suspect leakage in C_1 of Fig. 1. Simply leave the end of the capacitor

in the circuit that has "B+" voltage on it and disconnect the other end. Connect your v.t.v.m. (a medium d.c. range is a good start) from this dangling end to ground, as shown. If you get a steady reading with the set on, the capacitor is either leaky or shorted and must be replaced. A word of caution: tune the set to an inactive channel. If you are getting reception, arriving sync pulses will sometimes cause the v.t.v.m. to read even though a coupling capacitor is good.

Now for resistors. For these, measure plate and screen voltages in the sync stage or stages. In doing so, watch out for the voltage readings given on schematics and make sure you are using them properly. The plate voltage may be considerably higher when you're on channel than it is when you're off. This is because the "sync drive" biases the grid of the sync clipper more negatively when the set is operating on channel, causing the tube to conduct less and drop less voltage across itself. So, when comparing with schematic readings, make sure you note the conditions under which they were taken and the conditions under which you are taking readings.

If a plate voltage seems high, you probably have a defective resistor in the network that supplies it. In Fig. 1, for example, R_2 may be open or R_2 could be off value. Reduced voltages can also be traced to changes in these resistors.

This leaves only one common source of sync-circuit faults not yet covered: improper filtering. Note that the "B+" line to the sync clipper in Fig. 1 has an extra electrolytic filter, C_3 , to keep the ripple here low. Obviously this can be shunted with a good electrolytic and the effect can be observed.

Sometimes, however, this shunting will temporarily heal the defective capacitor—and you are not quite sure, then, that it was bad after all. You can

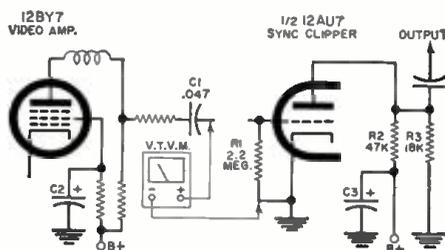
get around this possibility by using the a.c. function of your voltmeter to read ripple. If you have an instrument that reads peak-to-peak volts, connect it between the "B+" line and ground. If the meter reads more than 1 or 2 volts, you need additional filtering. (If the ripple is more than 3 volts, peak-to-peak, install a new electrolytic even though a sync fault is not yet apparent. The capacitor is going bad and you are going to have to replace it in a few weeks anyhow. It will be less troublesome to do it now.)

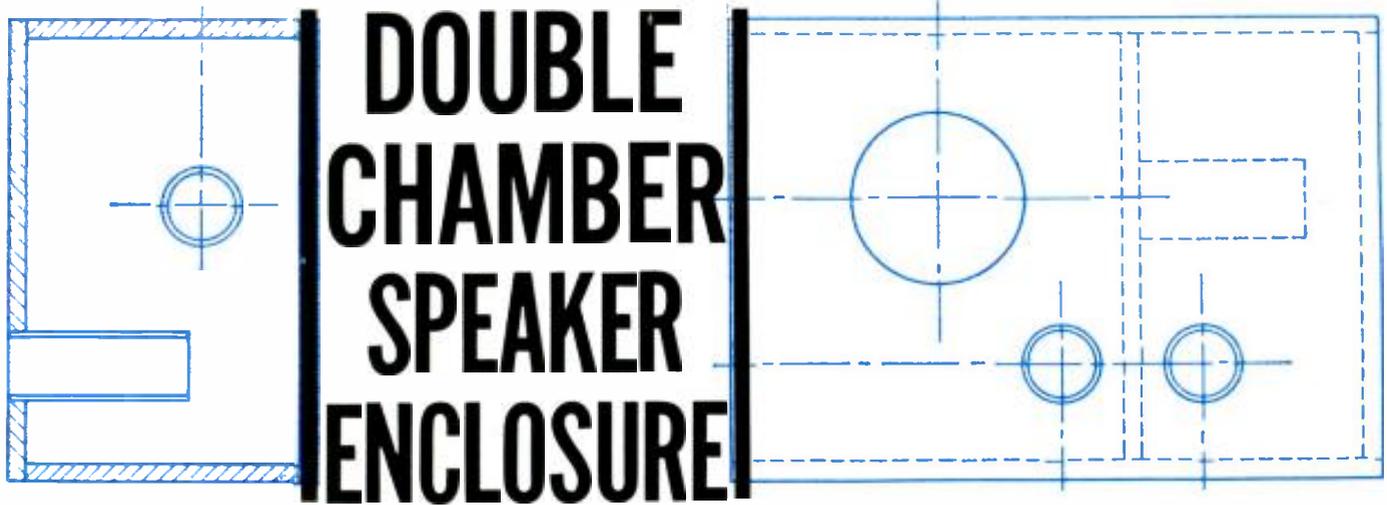
Suppose you have checked out the sync circuit and it "proves" OK. You now look for the trouble in the video circuit. For example, insufficient a.g.c. voltage may be responsible for the fact that your sync circuit is being driven too hard. Check the a.g.c. with the v.t.v.m., or use a substitute d.c. bias voltage and watch for improvement. The video signal may have "holes" in it due to inadequate bypassing of the a.g.c. line or of the screen of the video amplifier. Shunt the a.g.c. line with a .5- μ f. capacitor and see if there is improvement. The bypass for the video-amplifier screen filter (C_2 in Fig. 1) may be shunted with a 10- μ f. electrolytic. Excessive leakage or shorting in such filters, of course, reduce the d.c. voltages.

This covers most trouble spots in the video chain except for the video detector, which can be checked if the amplifier is cleared. When semiconductors are used in this application instead of tubes, remember that they often develop excessive reverse leakage. Use an ohmmeter to test. Disconnect one lead from the diode and measure it in both directions. Resistance should be low (say less than 500 ohms) in one direction and high (over 500,000 ohms) in the other. A defective diode that may read as low as 2000 ohms in the reverse direction could disturb sync action without having any other obvious effects on the picture or sound.

The outlined methods are not guaranteed to show up every single sync-related fault you will ever come across. But they will find the overwhelming majority of them, and quickly. Sync problems are least difficult if you don't waste time guessing and worrying about them. Start to localize the trouble immediately with the methods described. It's a lot like learning to fly. You're told, "Fly the airplane; don't let it fly you." For sync circuits it's, "Master the trouble; don't let it master you." ▲

Fig. 1. Popular triode clipper, with input from video amplifier. Test for leaky coupler, a common defect, is illustrated.





By *GEORGE L. AUGSPURGER*

Construction details on an experimental enclosure that will extend the bass response of almost any good 8-inch loudspeaker down to a usable 35 cps.

THIS enclosure will extend the bass of almost any good 8-inch loudspeaker to a usable 35 cps. With a good, high-efficiency speaker installed, performance in the very low bass region is excellent. The design is easy to build and dimensions are reasonable. The proportions lend themselves to a variety of styling treatments. It is, to put it briefly, a pretty interesting little box.

What Is It?

Basically, a double-chamber (or double-tuned) enclosure differs from the usual reflex configuration by having two tuned chambers instead of one. The idea is not new. Variations of the double-tuned reflex have been used by the *BBC* and *Quad*, among others. Considerable freedom in design is possible and results can also vary, depending on just what you are trying to do.

The configuration shown in the photographs is different from any other I've seen. It was worked out to allow maximum flexibility in experimentation while

trying to find out just how far the bass response of a standard 8-inch speaker could be extended.

How It Works

A normal reflex enclosure is matched to the characteristics of a specific loudspeaker or group of loudspeakers. It is essentially a Helmholtz resonator tuned to a suitable low frequency (35-70 cps) where the speaker, without help, can't move enough air to maintain uniform bass response.

At its resonant frequency, the reflex enclosure inverts the phase of the sound from the rear of the loudspeaker, adding it to that produced by the front of the cone. The enclosure also loads the speaker acoustically, reducing cone movement and distortion.

But above and below this resonant frequency, the reflex enclosure unloads its driver. As a consequence, if the resonant frequency is set too low, mid-bass response is weak and the speaker can be overloaded in this range. If the resonant

frequency is set too high, deep fundamental tones are lost and the speaker is easily overloaded by low-frequency signals.

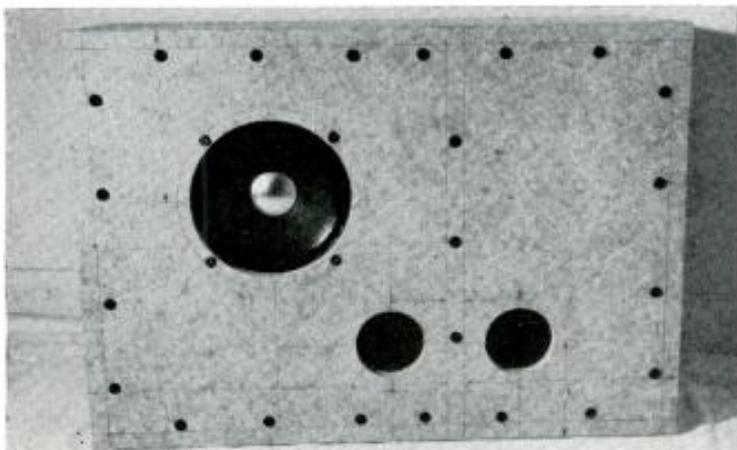
In contrast, the double-chamber enclosure is tuned to *two* frequencies about an octave apart. The higher frequency gives acoustic loading in the mid-bass region, and the lower frequency maintains loading down to a suitable low-frequency limit.

The photos show the experimental enclosure built to house an 8-inch loudspeaker. The interior design and dimensions are shown in Fig. 1.

In this design, the larger chamber (in which the loudspeaker is mounted) is tuned to 70 cps. Its volume is about 1.8 cubic feet. The combined effect of two ducted ports is used to tune the chamber. One port is placed in the partition between the two chambers and the other exhausts outside.

Below 70 cps, the first chamber starts to unload the speaker and air moves freely through the port in the partition.

Front panel of the unfinished double-chamber enclosure.



Finished version of enclosure constructed by the author.



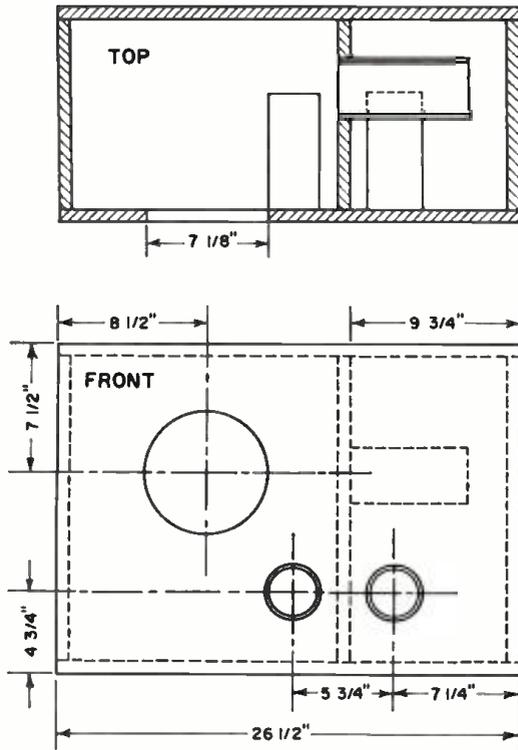


Fig. 1. Construction details of enclosure. Three-quarter-inch particle board is employed along with three 7 1/2" long 2 3/4" inside diameter cardboard mailing tubes.

As far as the speaker is concerned, the partition ceases to exist. Then, near 35 cps the combined volume of both chambers reacts with the two outside ports to establish the lower system resonance.

Effect on Impedance

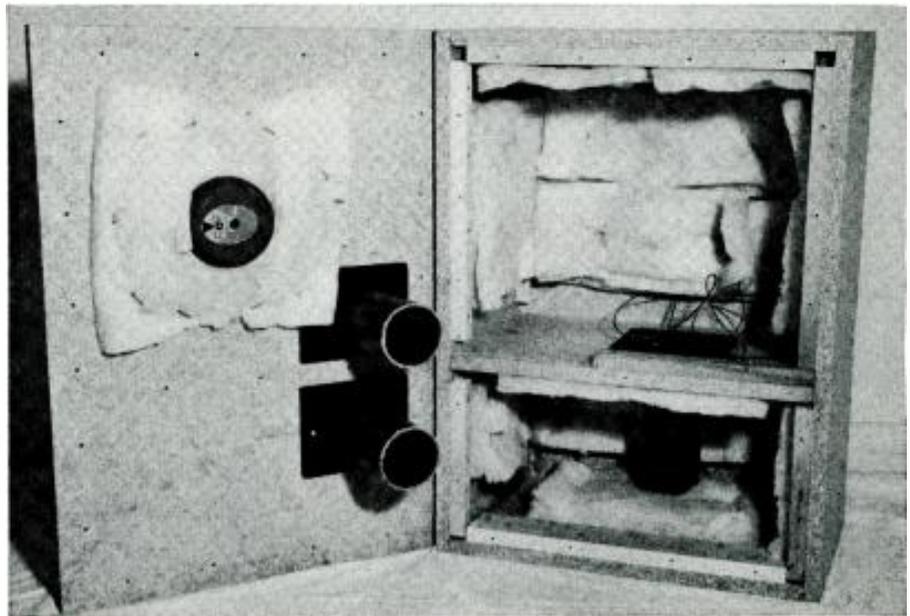
By spreading reflex action over a band of about two octaves, the double-tuned enclosure eliminates the need for close matching to a particular loudspeaker.

To verify this, the experimental enclosure was tried with three 8-inch loudspeakers having free-air cone resonances of 39, 56, and 70 cps respectively. Impedance curves were run in each instance and these are shown in Fig. 2. Instead of the double-peaked impedance curve of a reflex system, there are three peaks and two dips. The dips at 35 and 70 cps indicate the two system resonances and they show up quite clearly on all three curves.

It's important to remember that impedance curves are useful only if you know what they are related to. A smooth impedance curve does not necessarily have any connection at all with smooth response. There have been a number of recent articles pointing with pride to smooth impedance curves achieved by stuffing a reflex port with an old Angora sweater or gluing a layer of thick felt to the speaker cone suspension.

This approach is a little like trying to improve the performance of a car by keeping your foot on the brake. It runs smoothly no doubt, but you've thrown away most of the power in the process.

The nice feature about a good reflex system is that the levelling-out of impedance is a result of acoustic loading on the speaker cone. This acoustic loading in-



Interior of the enclosure, shown here in a vertical position. Three ducts are used.

creases efficiency while lowering distortion—a most worthwhile combination.

In the case of the experimental double-tuned enclosure, there is only one frequency at which some additional resistive damping might be desirable. Note the upper impedance peak which lies between 85 and 105 cps, depending on the speaker installed. In some cases, this peak will correspond to a slight boominess in reproduction. Fortunately, the cure is simple—tack a layer of damping material immediately behind the speaker. A single thickness of one-inch glass wool or a couple of layers of burlap will do nicely.

This bit of resistive damping is a good precaution against mid-bass boom and it

goes directly to the fundamental problem without noticeably affecting the efficiency of the system below 70 cps. The damping layer is clearly shown in one of the photographs.

Bass Performance

Fig. 4 shows free-field response curves of the experimental enclosure with a JBL LE8 and a JBL D216 installed. This leads us to issue a word of caution: I have a distrust of published "response curves" because no little squiggly line can possibly delineate the listening quality of a loudspeaker system. Consequently, if you must look at curves, please try to find out as much as possible about how they were made before comparing them. And then don't believe everything you see until you have a chance to hear the systems in question. Enough said!

The curves in Fig. 4 were run with the experimental enclosure lying on its back on a 12-foot-square platform on top of a building. A calibrated microphone was suspended 6 feet from the speaker 45 degrees off-axis.

The system was driven by 8 volts of pure sine-wave signal from a standard McIntosh 60-watt amplifier. There was no attempt to change the damping factor of the amplifier to get a better curve.

Now the JBL D216 is an extremely efficient 8-inch speaker with a very light cone assembly. The LE8 is a less efficient unit featuring a rather elaborate long-throw cone suspension. It is designed to deliver full-range response in small bookshelf enclosures.

Yet, although these are two quite different units, the curves of Figs. 2A and 2B are almost identical below 200 cps. This is further indication that the heavy acoustic loading and reflex action of the double-tuned enclosure are primary con-

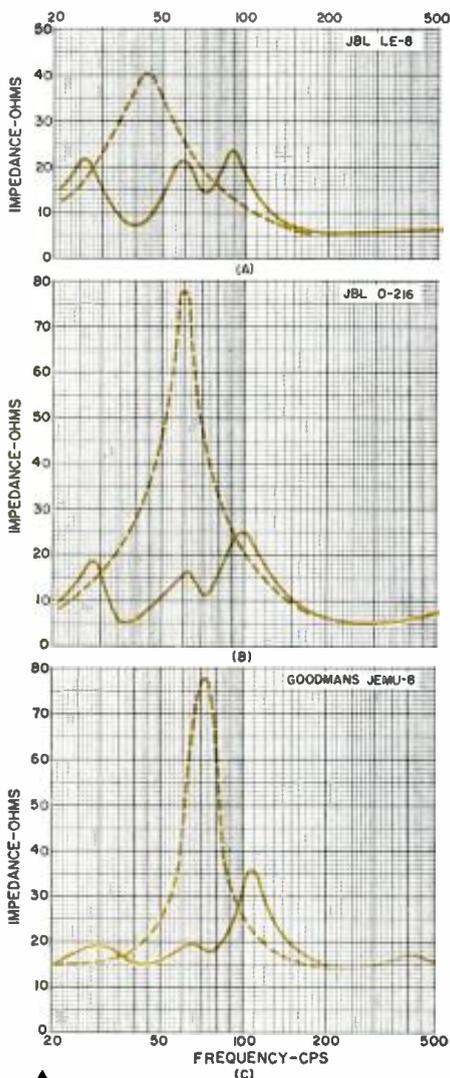


Fig. 2. Impedance curves of three of the loudspeakers used in the enclosure. The dashed curves are the impedances measured in free air, while the solid curves show the impedances of the three speakers when they were mounted in enclosure described. Two Jim Lansing and one Goodmans 8" loudspeakers were employed for these tests.

Fig. 3. Response and harmonic distortion of (A) JBL D-216 and (B) JBL LE-8 loudspeakers in the double-chamber enclosure. Power input was 15 watts in both cases.

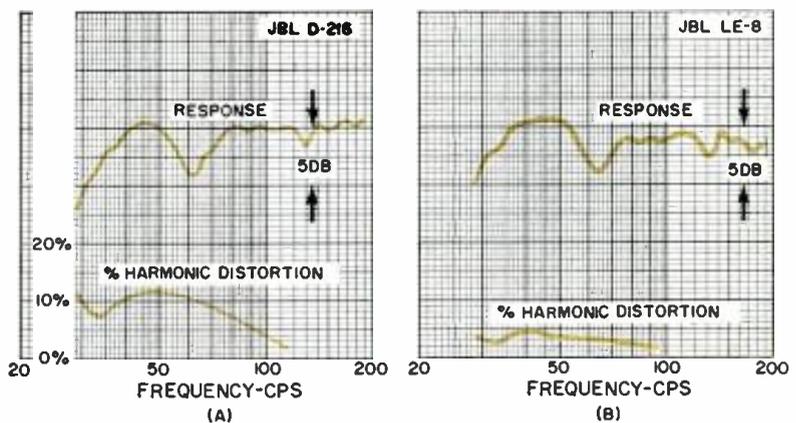
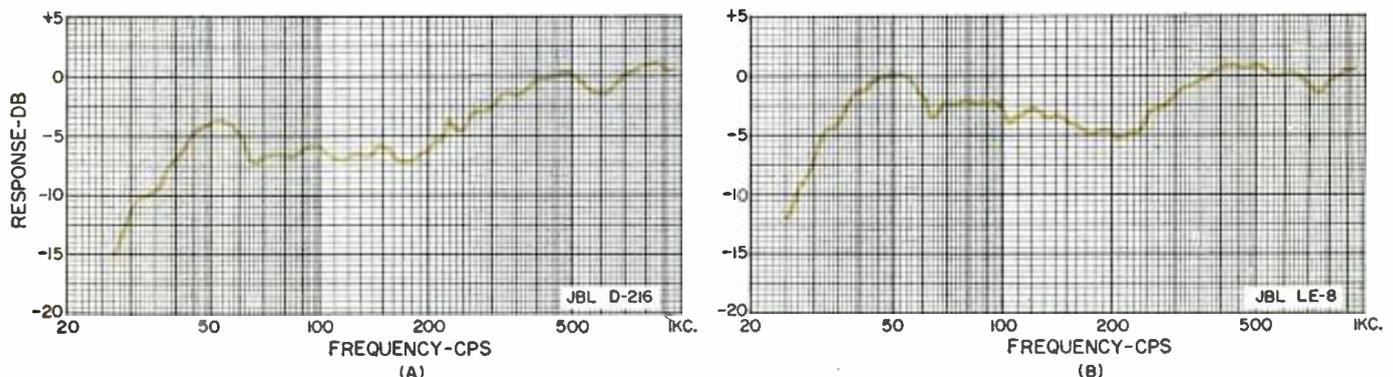


Fig. 4. Free-field response of two of the 8" loudspeakers used in the experimental enclosure. The loudspeaker whose acoustic response is shown in part (B) of the figure is about twice as expensive as the speaker whose response is shown at (A).



trolling factors in the bass response of the system.

Also note that even though the system is radiating into a 180-degree solid angle, both speakers maintain substantial output to about 32 cps. This is particularly impressive considering that we are talking about 8-inch speakers.

The main difference between the two speakers' performance lies above 200 cps. The LE8 is flat within about 5 db from 32 to 1000 cps. The D216, being the more efficient speaker, climbs gradually about 6 db up to its midrange level. This, incidentally, points up a common misconception about long-throw loudspeakers. Other things being equal, the less efficient speaker does *not* have more bass—it has *less* midrange.

Since the bass response of a speaker system in a room generally extends lower and is more efficient than outdoors, it is a toss-up as to which of the two speakers tested will have the smoothest bass under normal listening conditions.

In the double-tuned enclosure, the D216 has a crisp, firm bass characteristic. Bass is not particularly prominent until a really low fundamental comes along.

The LE8 in this enclosure has a more robust, rich bass which some people will prefer. In all honesty, however, this is really a case of gilding the lily since it will deliver comparable performance in smaller, less complicated enclosures.

Bass Distortion

Trying to coax 35 cps out of an 8-inch speaker doesn't accomplish much unless

it is an *honest* 35 cycles. If the output turns out to be mostly frequency doubling, far better to restrict the bass range to a more orthodox limit.

Fortunately, in the experimental system the lack of distortion at very low frequencies is even more surprising than the extension of frequency response.

Fig. 3 is a graph of response and distortion of the two systems below 200 cps. Fig. 3A is the D216 in the double-tuned enclosure while Fig. 3B is the LE8 in the same enclosure.

Again the tests were made outdoors. This time the speaker system was placed vertically against the wall of a building and the microphone was placed three feet away on-axis. The signal was a pure sine-wave and the speaker was driven by a standard 60-watt *Dynaco* amplifier. Again, there was no adjustment of the amplifier's normal damping factor.

For the distortion measurements, the speakers were deliberately overdriven. Eleven volts were fed to the D216. This represents 15 watts into 8 ohms. Why 8 ohms when the D216 is rated at 16 ohms? You must understand that the rated impedance of any loudspeaker is just a convenient figure to use when hooking it up to an amplifier. Its measured impedance will wander all over the place at various frequencies. *JBL*, like many other speaker manufacturers, uses an average impedance rating, that is, the measured impedance of a 16-ohm unit can be expected to vary from, say, 6 to 60 ohms at different frequencies.

So far so good. But the heavy acoustic

(Continued on page 72)

Semiconducting Synthetic Diamonds

Methods have been discovered at the General Electric Research Laboratory which make it possible for the first time to produce semiconducting diamonds. Such diamonds are extremely rare in nature, accounting for less than 1 per-cent of natural diamonds, but these diamonds can now be grown at will using a high-temperature, ultra-high-pressure process. In the photo a piece of semiconducting diamond is being held in a fixture so that its electrical characteristics can be tested.

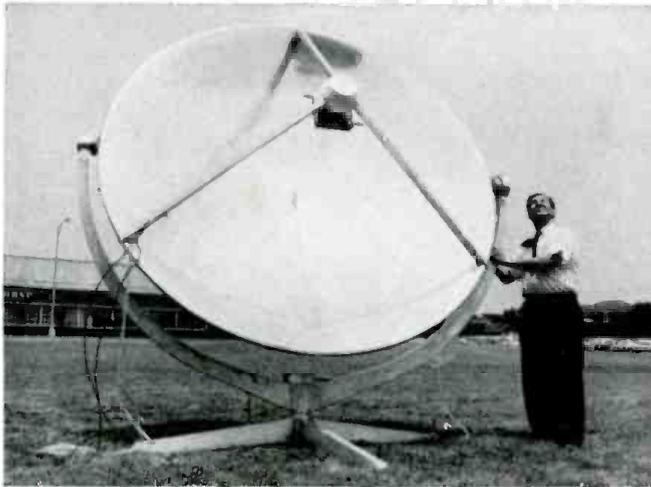


RECENT DEVELOPMENTS IN ELECTRONICS



Infrared Motion Picture

These are frames from an infrared motion picture made from the display tube of an electronic infrared scanner by engineers of the ITT Federal Laboratories Div. The pictures, showing a man waving his arms, were taken at night using only the natural heat emanation from his body. The white fringe at the bottom of the pictures is beach sand which retained heat from the sun. The image is in a relief pattern because the system was designed to emphasize point sources of heat.



Sun-Powered Electric Plant

Prototype of a self-contained 50-watt power plant and irrigating unit has been built and tested by Westinghouse and the University of Wisconsin. The unit converts sunlight into electricity by means of a thermoelectric generator. The power generated drives an electric motor having a water pump connected directly to it. The device, designed for people in underdeveloped areas of the world, can sustain individual families or villages by irrigating the land they live on and supplying household water needs.

High-Speed Tape Terminal Unit

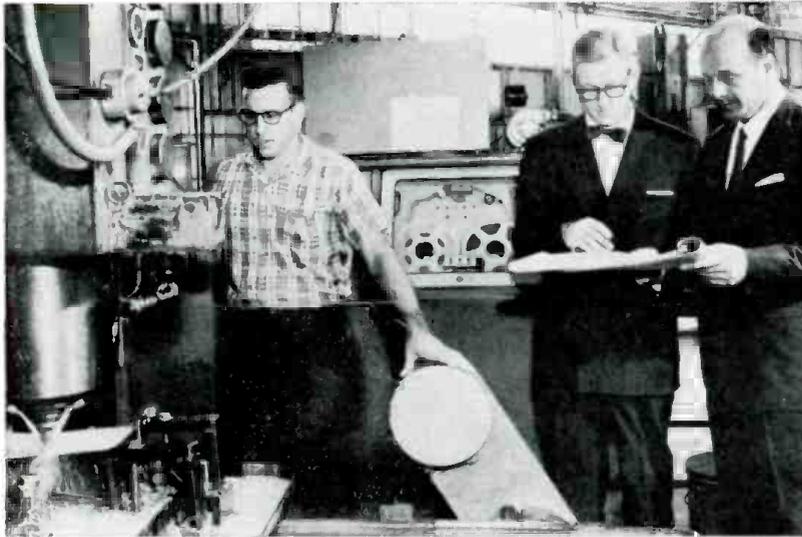
Newly developed RCA magnetic tape terminal units have been installed at San Francisco and Kansas City to speed Social Security data from the California city to an RCA 501 computer at Kansas City over standard telephone facilities. Speed of transmission is 3000 times faster than by teletypewriter.





◀ Closed-Circuit TV for Banking

A clerk at the recently expanded St. Paul Federal Savings & Loan Association of Chicago places a signature record card before a closed-circuit television camera (in cabinet), which takes a picture and relays it to one of ten TV monitors located at teller stations throughout the bank, including walk-in and drive-in windows. The closed-circuit system, designed by Dage, facilitates communication of ledger records, account balances, and payment records from any of three TV cameras to key departmental locations.



◀ Tape-Controlled Machine Tools

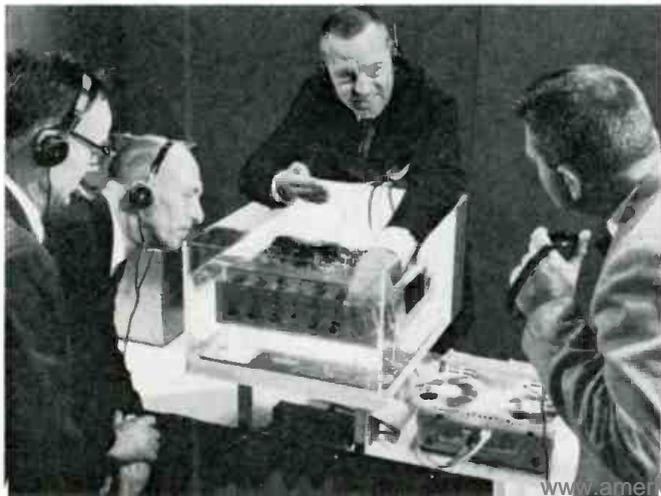
A profiler at Rohr Aircraft Corp. automatically mills out an engine-mounting box beam from a steel forging under the guidance of computer-generated numerical instructions. Checking over the drawing which originated these instructions prepared by a "Univac" solid-state computer are Rohr and Remington Rand executives. The operator now has little more to do than feed tape instructions into his machine. The new programming system applies high-speed computer techniques for automating production machinery and is especially suited to small- and medium-sized metal-working concerns. The system uses a part-programmer's manuscript, a simple statement of manufacturing information prepared from an engineering drawing of the part. Cards are punched from this manuscript and fed into the computer where they are interpreted. Punched cards used to control the machine tools are then produced automatically by the computer.

Computer-Directed Power Generators

A digital computer control system that directs the outputs of generators supplying electricity to 3½ million persons was placed into operation recently by the Philadelphia Electric Co. Developed jointly by Minneapolis-Honeywell and the utility, the computer "tells" 34 turbine-generators what share of the total power requirements each is to produce for most economical operation. The computer also calculates the amount of power exchanged with interconnected utility systems.

Submersed Hi-Fi Amplifier

Technician shown below is demonstrating the high dielectric strength of a "Freon" solvent by actually operating a hi-fi amplifier submersed in solvent bath. The liquid also helps cool electrical components of amplifier because of its high heat-transfer characteristics.



Not only living things, but metal parts, castings, and other manufactured objects can be examined internally. The equipment used and how it works.

AT ABOUT the same time that Marconi was experimenting with radio waves, a German scientist named Roentgen discovered x-rays, another kind of electromagnetic radiation. While less striking, perhaps, than developments in radio communications and radar, recent advances in x-ray techniques have multiplied the uses of x-ray for industrial purposes. Improvements have been made in traditional x-ray fields and, in addition, new applications have been found.

Although many of the rules are the same for x-ray as for other types of electronic equipment, radio technicians usually need help in adapting their

knowledge to the maintenance of x-ray apparatus.

Most people associate x-ray with its use in hospitals and doctors' offices for such things as detecting broken bones, diagnosing tuberculosis through chest x-ray, treating cancer, and fluoroscoping the stomach. Dental x-ray is also familiar.

The industrial use of x-ray has increased as a result of improved apparatus that permits the non-destructive examination of welds and castings of even the thickest steel, and portable equipment provides a convenient means of checking pipelines, bridges, and other construction projects on the spot. In

addition, x-ray spectrosopes and x-ray diffraction apparatus have opened up new avenues in basic research.

The method of locating a defect in a casting with x-ray is not very different from finding a break in a bone. An x-ray beam is directed through the casting and detected on the far side, usually by means of photographic film. For a beam of given intensity, the amount of radiation reaching the film in a given time depends on two factors: the kind of material used for the casting and its thickness. If the casting is uniform throughout, the developed film will be of uniform density. However, an air bubble, being less dense than the

By JOHN R. COLLINS

INDUSTRIAL X-RAY APPARATUS

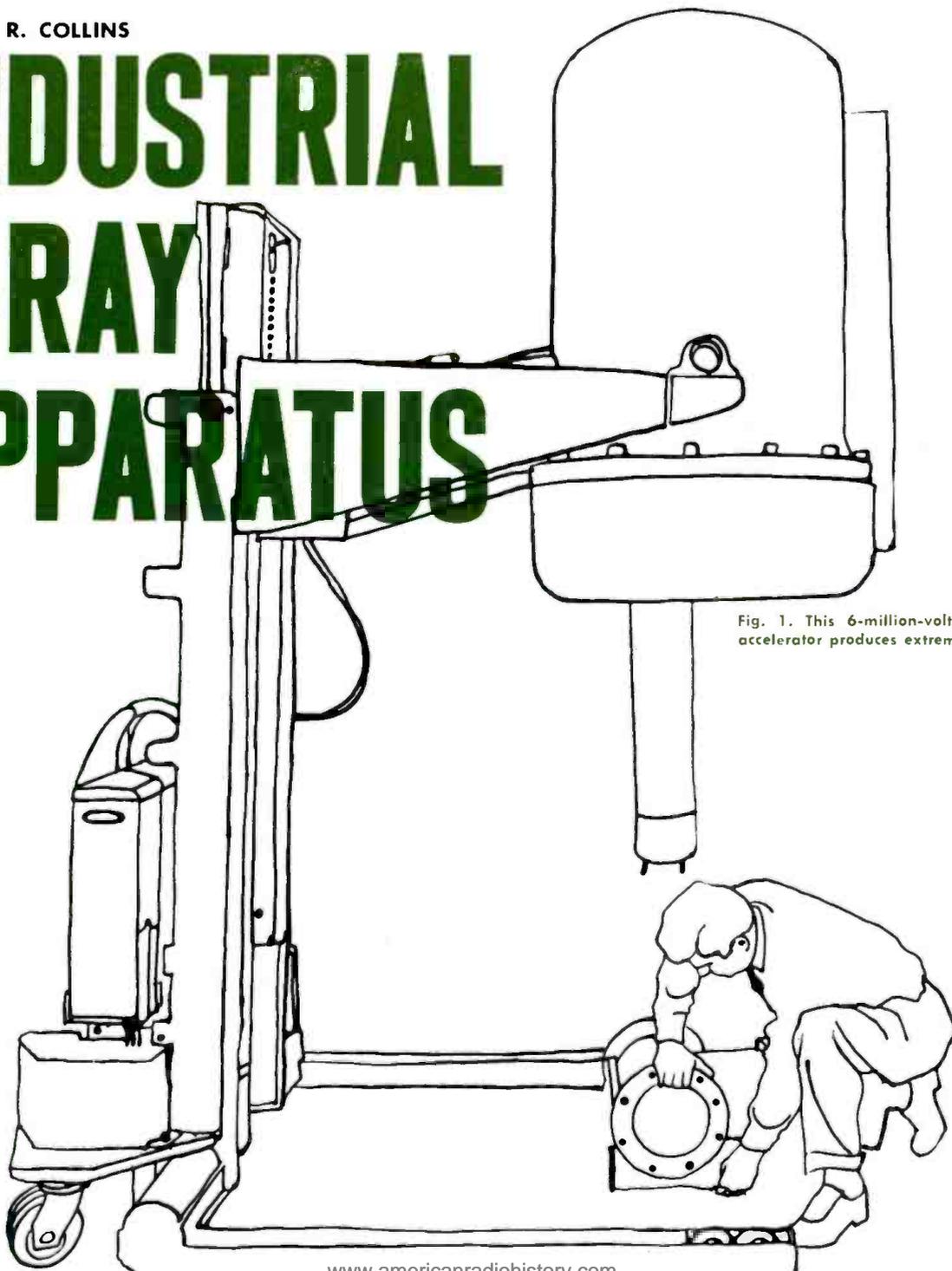


Fig. 1. This 6-million-volt Van de Graaff accelerator produces extremely "hard" rays.

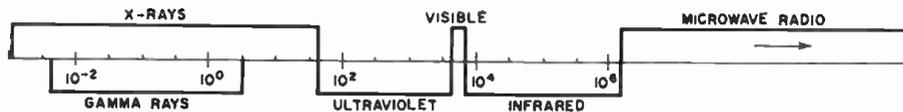


Fig. 2. Place of x-rays in electromagnetic spectrum. Wavelengths are in angstrom units.

steel, would permit more radiation to pass and would show up on the film as a dark spot. Similarly, any foreign matter having absorbing qualities different from steel and any irregularities in thickness would be displayed on the film as dark or light areas.

The process of producing x-ray photographs is called radiography. Micro-radiography concerns the x-raying of small objects, where the detail is too fine to be seen by the unaided eye, and the picture must either be enlarged or examined with a low-power microscope. The technique has been used for such diverse purposes as distinguishing between natural and cultured pearls, examining biological specimens (*e.g.*, insects, leaves, seeds) and in metallurgical laboratories for determining minute discontinuities and the separation of metals making up alloys.

Fluoroscopy is the same as radiography, except that the image appears on a fluorescent screen instead of a photographic film. It is fast and inexpensive, but lacks fine detail and does not provide a permanent record. It is most useful, therefore, for a fast examination for gross defects—like finding hairpins in candy bars.

General Theory

X-rays are a form of radiant energy having properties similar to visible light. Because of their extremely short wavelength, however, they are able to penetrate materials that absorb or reflect visible light. They are produced by collisions between electrons traveling at high speed and some form of matter.

Fig. 2 shows the place occupied by x-rays in the electromagnetic spectrum. Since they are far shorter than even the shortest radio or radar wave, it is inconvenient to measure their wavelength in meters. The usual standard of measurement is the angstrom unit, equal to 1/100,000,000 centimeter. The wavelength of visible light ranges from about 4000 to 7500 angstrom units. The wavelengths of x-rays vary from under 100 angstrom units to a tiny fraction of 1 angstrom unit.

The wavelength is related to the speed the electrons are traveling when they strike matter. So-called *soft* x-rays have relatively long wavelengths and are produced by moderate accelerating potentials. They have little penetrating power and have difficulty in escaping from the x-ray tube. *Hard* x-rays are produced by higher accelerating potentials. Extremely hard x-rays, such as those produced by Van de Graaff accelerators (Fig. 1), can readily penetrate many inches of steel.

You will notice that *gamma* rays cover much the same range as x-rays (Fig. 2). They have the same characteristics and are distinguished from x-rays by their source rather than by nature,

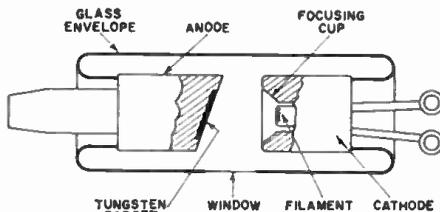


Fig. 3. The cut-away view shows the elements in a stationary-anode x-ray tube.

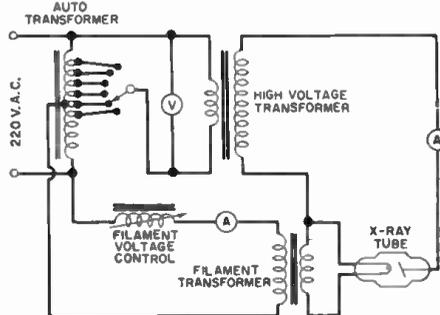


Fig. 4. Basic, high-voltage, x-ray circuit. Tube itself serves as rectifier.

being emitted by radioactive substances. Some *gamma*-ray sources are natural, such as radium; others, like cobalt-60, are artificially produced and do not occur in nature.

X-Ray Tubes

The principal features of an x-ray tube are shown in Fig. 3. It has a cathode to emit electrons and an anode to attract them. The electrons are concentrated in a narrow beam by the focusing cup and directed against the target on the anode. Their velocity is determined by the voltage applied to the anode. The sudden stopping of the electrons on striking the target causes x-rays to be produced.

Only about 1 per-cent of the energy resulting from the impact of the electrons on the target is given off in the form of x-rays, the rest being wasted as heat. Excessive heat can readily melt the tube and it is necessary to dissipate it efficiently. Tungsten is used as the target material not only because of its high melting point (3370 degrees C) but also because it has a high atomic number (74), and elements with the highest atomic numbers are most efficient in producing x-rays. The tungsten target is mounted on a copper base, a good heat conductor, which is brought out to external radiating vanes. In many tubes, oil or water is circulated through the anode to carry off heat.

A further aid to heat dissipation is the rotating-anode tube (Fig. 5). The anode is a large disc of pure tungsten with a beveled edge, connected to a motor. The electron beam is directed against the beveled edge while the disc rotates at high speed. The effect is to

increase the area of the target and to lessen the chance of overheating. It permits the use of a smaller focal spot and higher accelerating potential without damaging the tube than would be possible in a stationary-anode tube.

X-rays do not travel from the target in a single beam. Instead, they are scattered and, like light rays, "illuminate" a considerable area. To prevent scattered radiation from endangering operating personnel and others, x-ray tubes are encased in shockproof metal enclosures lined with lead. An aperture is provided through which the x-rays can emerge in the desired direction.

Tubes for low-intensity or soft x-rays are made with special windows to permit the radiation to escape with little loss. A window is usually either an exceptionally thin area in the glass or an insert of beryllium metal. Beryllium has the characteristic of being transparent to x-rays, just as clear glass is to light.

The high voltage applied to an x-ray tube is expressed in peak kilovolts (rather than r.m.s.) and is abbreviated k.v.p.

Circuits

An elementary circuit for an x-ray machine is shown in Fig. 4. Basically, it is simply a power supply designed to furnish the filament and plate voltages needed to operate the x-ray tube. The principal components, other than the x-ray tube, are an autotransformer, a high-voltage transformer, a filament transformer and, sometimes, a rectifier unit with one or more rectifier tubes. The autotransformer (so called because both primary and secondary are combined in a single winding) permits the 220-volt source to be varied in steps over a considerable range. The voltage thus selected becomes the input to the high-voltage transformer, which supplies plate voltage for the x-ray tube. In this way the plate voltage can be adjusted by adjusting the autotransformer.

The filament voltage for the x-ray tube is furnished by a low-voltage step-down transformer which provides from 4 to 12 volts at a few milliamperes. The secondary winding of the stepdown transformer is heavily insulated from the primary and from the iron core so that the high voltage to the x-ray tube will not get back into the supply lines of the machine.

The filament voltage is controlled by an adjustable iron core and coil in the primary circuit of the filament transformer. When the core is inserted all the way in the coil, its inductive reactance is high and a large part of the supply voltage is dropped across the coil instead of the transformer primary. When the iron core is withdrawn, the voltage drop is almost all across the transformer primary. A knob on the control panel usually provides this adjustment.

When only moderate power is handled, it is usual to employ self-rectification, in which the x-ray tube itself acts as a rectifier. The high voltage is applied directly to the x-ray tube, and the

anode becomes alternately positive and negative with respect to the cathode during each half-cycle. When the anode is positive, the electrons emitted from the cathode are attracted to it and there is current flow in the tube. When the anode is negative, the electrons are not attracted to it and there is no current flow. Self-rectification is common in portable, bedside, and dental units.

X-ray machines of greater power usually employ rectifier tubes to prevent the inverse voltage from being applied to the anode. The rectifier circuit and its operation are conventional. A rectifier tube absorbs little of the power that it handles, so the heating problem encountered with x-ray tubes is not present. More efficient circuits use four rectifier tubes for full-wave

handling. The control unit (right) is housed in a steel case and is connected to the power unit by means of a multi-conductor cable. The x-ray generator and tube are encased in a shockproof and radiation-proof steel tank weighing 55 pounds. The high voltage can be varied continuously from 30 to 100 k.v.p.

Some portable units employ *gamma* radiation from cobalt-60 instead of x-rays. Other materials (radium, thulium-170, iridium-192, cesium-137) are sometimes used, but cobalt-60 is popular because of its high-power continuous radiation. Cobalt-60 is produced in unlimited quantities by exposing cobalt to radiation in a nuclear reactor. Its characteristics are subject to change with age. Its half-life is 5.3 years, indicating that the original intensity de-

beam cannot be varied to suit the requirements of a particular job.

Maintenance

X-ray circuits are relatively simple and straightforward. Most difficulties result from the exceptionally high voltage and heat. While maintenance procedures will vary with individual units, certain principles are common to all and can be used for general guidelines.

It is good practice to check the operation of an x-ray machine whenever the x-ray tube has to be replaced. As far as possible, the circuit is examined without connecting the high voltage. Whenever the high voltage is on and the x-ray tube is operating, the technician must be especially careful to avoid exposure to radiation. This means keeping clear of the active beam and also making sure that all shielding is in place. Furthermore, when it is necessary to check an operating machine, it is good practice to observe the one-hand-in-the-pocket rule to minimize the chance of having the body form part of a circuit for the high voltage. Some x-ray machines use an arrangement of capacitors to aid in building up the high voltage; when these are encountered, care must be taken to discharge them before touching the high-voltage circuit, even when the machine is not operating and is disconnected.

Arcing in the high-voltage section, a problem familiar to all television technicians, is even more of a problem in x-ray since the high voltage is many times greater than in television. Arcing may appear in a cable insulator, a socket, or in a rectifier tube. It can trip a circuit breaker, and the trouble may be attributed to a defective x-ray tube unless the cause is discovered.

An examination of the tube to be replaced will often uncover a defect in the equipment or the way it has been operated. Early failure may be due to any one of a number of causes. If the tube seems otherwise in good condition but is filled with oil, the trouble may be a puncture, probably caused by overload, excessive voltage, or instability. A cracked or broken tube would suggest careless handling. Filament burn-out would indicate a check of the filament boost circuit. Target damage would point to work overloads, such as too long or too heavy an exposure, or an excessive number of exposures without time to cool. Stationary molten spots on the target of a rotating-anode tube would indicate that the motor or motor-control circuits are faulty.

A check may show that it is necessary to advance the filament voltage of the x-ray tube to a higher value than specified to obtain a certain current in the x-ray tube. When this occurs it may indicate a loss of emission in the rectifier tubes which, in turn, limits current flow in the x-ray tube. The remedy is to operate the rectifiers at a higher filament voltage or (usually) to replace them.

Most other checks are routine circuit-tracing that any good radio or TV technician can handle without difficulty. ▲

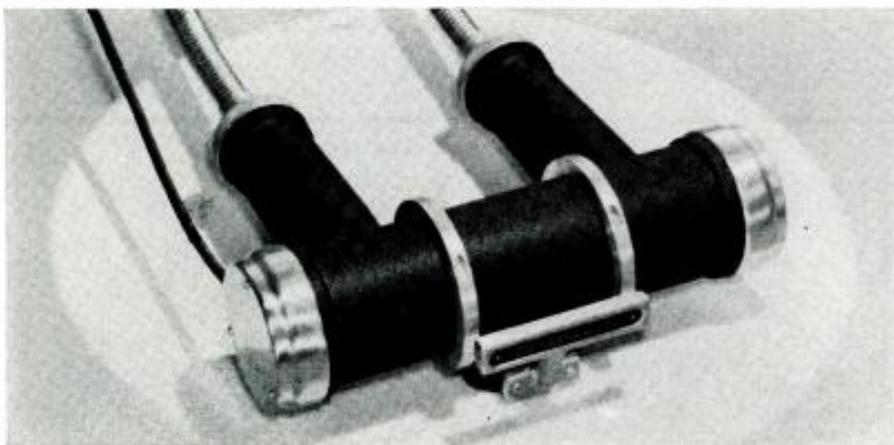


Fig. 5. A rotating-anode x-ray tube that can handle a high voltage of 100 peak kilovolts, made by Machlett Laboratories. It is suitable for general diagnostic service.

rectification, in order to utilize the inverse voltage.

Unlike other electron tubes, the operating voltages of x-ray tubes are adjusted for each individual job. When the voltage is increased on the filament, the effect is to cause more electrons to be emitted. This is equivalent to providing greater illumination, and the process can be visualized as increasing the brightness. The variations in the intensity of rays passing through the subject is not changed, however, so contrast remains the same. Since x-rays, like light rays, travel in diverging straight lines, the brightness can also be increased by moving the tube closer to the subject. Numerically, the variation is inverse with the square of the distance, so brightness is increased four times by reducing the distance by one half.

Increasing the anode voltage increases the penetrating power of the x-rays. However, it also results in a decrease in contrast, so the kilovoltage is not increased beyond the point needed to achieve the necessary penetration.

Portable Equipment

Special lightweight equipment that can be moved readily from place to place is valuable for use around airplane factories, shipyards, and similar places to inspect welds, joints, and parts during construction. The apparatus shown in Fig. 6 is made in two pieces for easy



Fig. 6. Portable x-ray apparatus of this type is common in industrial radiography.

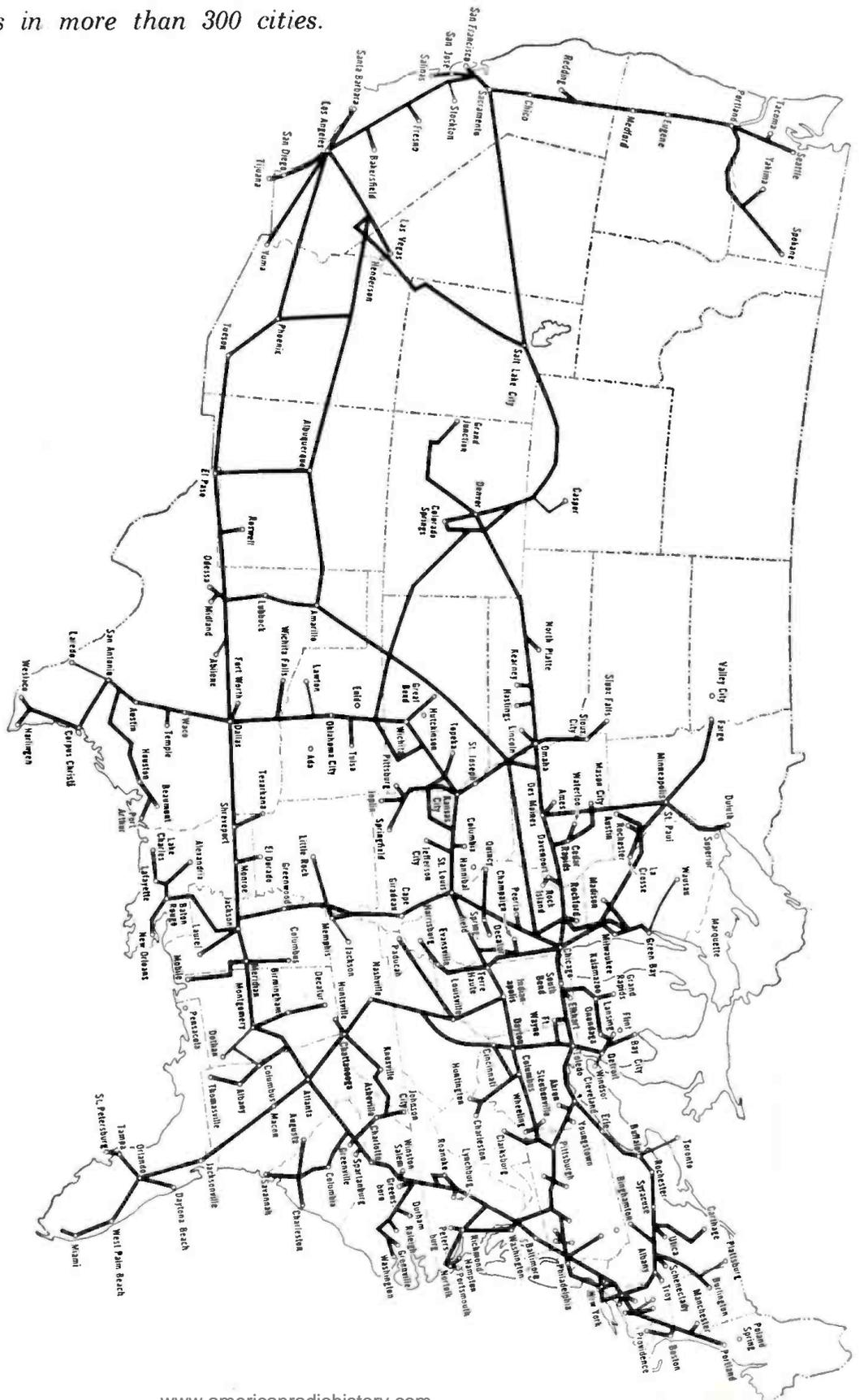
clines to one half in that period.

Gamma-ray radiographic equipment is contrived so that the cobalt-60 capsule can be remotely withdrawn from its protective canister, exposed for any desired time, then drawn back into the shielded container. It is effective for x-raying even the heaviest castings when exposed for a sufficient period. About 15 minutes is normally needed to x-ray a 6-inch steel casting.

Gamma-ray apparatus has the advantage that no power supply is needed and it is therefore easily portable. The chief limitation is the fact that, unlike x-ray apparatus, the intensity of the

COAST-TO-COAST TV IS 10 YEARS OLD

Today's 93,000-mile network carries programs via microwave radio relay and coaxial cable to some 500 television stations in more than 300 cities.



Coast-to-coast television became a reality a little more than ten years ago. On Sept. 4, 1951 an audience estimated at over 40 million viewed the first live telecast broadcast across the nation—President Truman's opening of the Japanese Peace Treaty Conference in San Francisco. The event was made possible by a transcontinental microwave radio relay system built by American Telephone and Telegraph Co. The program was fed simultaneously to 94 TV broadcasting stations in 52 cities.

At present, a program could be transmitted to some 500 TV stations and viewed at the same time in more than 300 cities across the land. Today, microwave radio relay and coaxial cable—in addition to supplying thousands of circuits for telephone conversations and other transmission—provide some 93,000 miles of television circuits as shown on the above map.

The pioneering transcontinental microwave route initially offered only one TV pathway and 180 voice circuits. Today there are 12 coast-to-coast TV circuits over microwave and coax cable. The latest type of microwave system, recently added to one section of the transcontinental route, can transmit as many as 11,000 telephone conversations or 12 television programs at the same time.

A microwave link will also serve for future space communications. An orbiting satellite will serve as microwave relay station in the Bell System's space communications experiments planned for next year.

transistorized citizens band converter/

By T. C. SOWERS

A printed-circuit 2-transistor converter for the car's broadcast radio that permits it to pick up CB signals.

THIS article will describe the circuitry, construction, and operation of a transistorized converter for mobile reception of the 11-meter Citizens Band. The converter is crystal-controlled, constructed on a printed-circuit board, and has a built-in power supply.

This transistorized converter will work equally well with 6- or 12-volt automotive battery systems. The only necessary connection to the auto radio is a short piece of coaxial cable from the converter to the antenna jack of the radio. The regular broadcast antenna may be used with the converter but a whip of the proper length will give much better results.

The printed-circuit board is not difficult to make and the constructor should not encounter any problems if he follows the simple instructions given in this article. The entire converter was designed with the Citizen Bander in mind who wants the experience of building some of his own equipment. The project will give the builder experience with transistor circuitry, making printed-circuit boards, and the satisfaction of constructing a useful piece of gear.

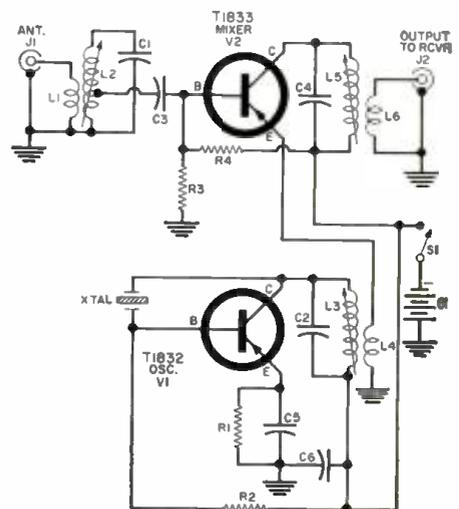
The converter oscillator stage is crystal-controlled with a 26.3-mc. third-

overtone crystal and uses the car broadcast receiver as a tunable i.f. amplifier. The Citizens Band channels are selected by using the normal tuning knob on the auto receiver. Channel 1 is found near 660 and Channel 23 near 1000 on the receiver dial. The entire Citizens Band covers slightly less than .3 mc., therefore only one-third of the radio dial is used to tune the complete band. The converter may also be used with the auto radio for receiving the 10-meter amateur band. To receive this band requires changing the crystal to a 28-mc. third-overtone type and adjusting the slugs in the mixer and oscillator circuits. The auto receiver will tune 28.5-mc. at 500 and 29.5-mc. at 1500 on the dial.

Those who have an old auto radio available and have made or can make the a.c. conversion will find that, if used with the transistorized converter, it makes an ideal Citizens Band receiver for the start of a base station. The coaxial cable is the only necessary connection to the receiver, as was the case with the mobile installation.

The Circuit

The ready availability and the grati-



- R₁—1000 ohm, ½ w. res.
- R₂—470,000 ohm, ½ w. res.
- R₃—5600 ohm, ½ w. res.
- R₄—82,000 ohm, ½ w. res.
- C₁, C₂—10 µf. disc ceramic capacitor
- C₃, C₄—0.005 µf. disc ceramic capacitor
- C₅—27 µf. disc ceramic capacitor
- C₆—0.01 µf. disc ceramic capacitor
- J₁—Coax connector (Amphenol SO-239)
- J₂—RCA phono jack
- S₁—S.p.s.t. slide switch ("on-off")
- B₁—9-volt battery (Argonne BA-2, RCA-VS312)
- Xtal.—26.3 mc. third-overtone crystal
- V₁—"p-n-p" transistor (Philco MADT T1832)
- V₂—"p-n-p" transistor (Philco MADT T1833)
- I₁—3½" x 2¼" x 1½" chassis box.
- I₂—Crystal socket (National CS-7)
- L₁—2 t. #28 en. wound over ground end of L₂.

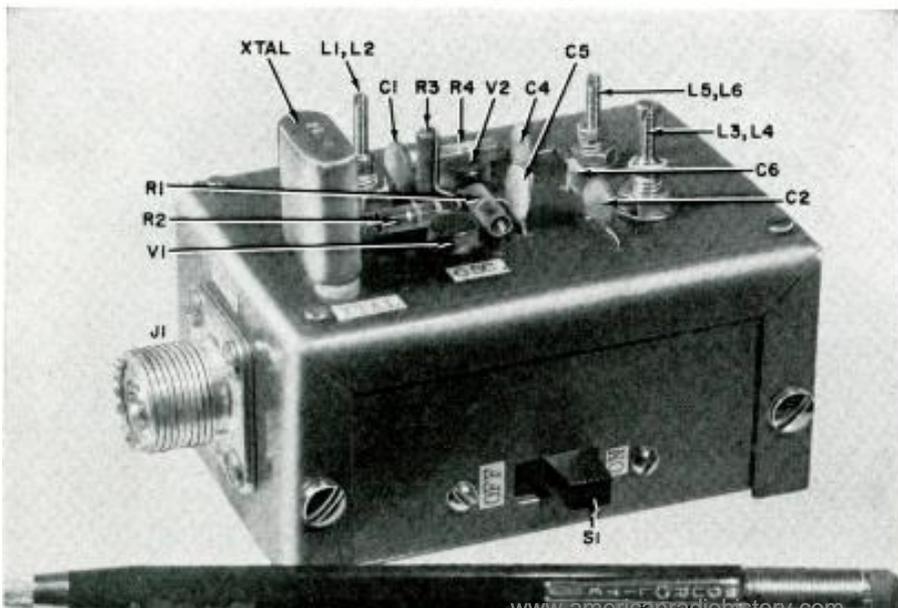
Use small strip of plastic tape between windings.
 L₂—25 t. #28 en. wound on ¼" Cambridge Thermionic coil form No. PLS6-2C4L/0. Tap 8 t. from ground end.
 L₃—Same as L₂, but without tap.
 L₄—Same as L₁, over ground end of L₃
 L₅—1 mc. coil (Cambridge Thermionic Type LSM)

L₆—35 t. #36 en. scramble wound on L₅. Leave ¼" space below L₅ and wind to cover approx. 3/16".

Note: Coils L₂ and L₃ are both closewound. The tap on L₂ is made by twisting ¼" of coil wire at the appropriate place for the tap. The twist is then stripped by holding twist in a match flame and finishing with fine steel wool or emery paper. After stripping, the twist can then be solder tinned.

Fig. 1. Circuit of the CB converter. The entire Citizens Band is tuned over about one-third of the car set's tuning range.

Entire converter is built into a 3½" x 2¼" x 1½" chassis box as shown.



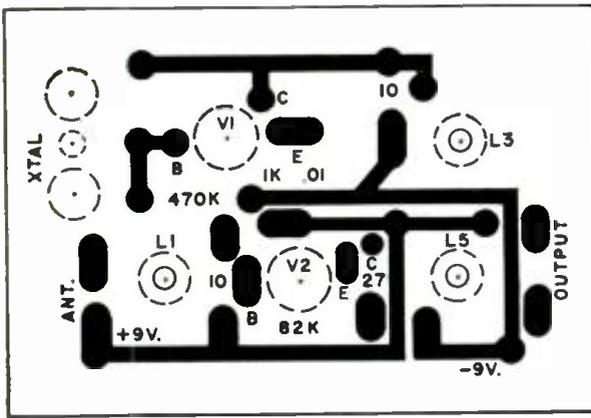
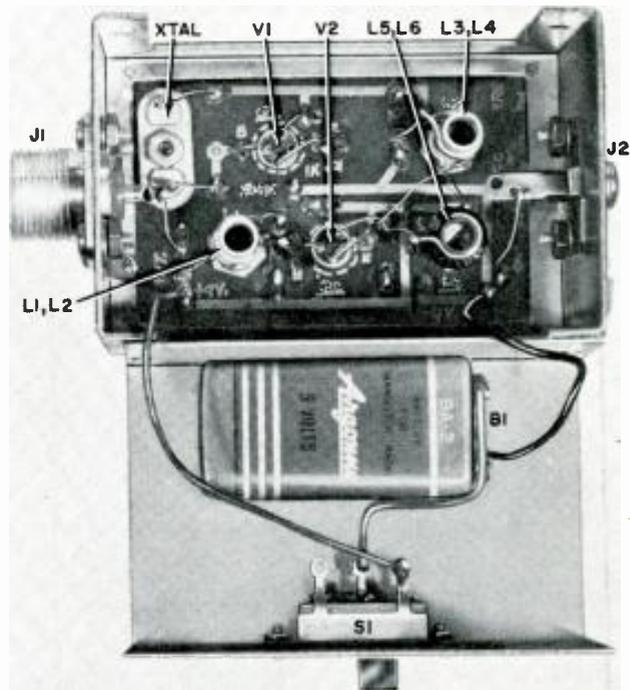


Fig. 2. This is a full-size template for the printed wiring board used by the author. A few of the parts values have been indicated to show the relative placement of the parts. Location of the coils as well as the emitter (E), base (B), and collector (C) terminals of the transistors have also been indicated. If the constructor does not wish to use the printed-wiring technique, more conventional point-to-point wiring may be used.



Chassis box has been opened up in this view in order to show underside of the printed board and the location of battery.

fyng decrease in the price of good high-frequency transistors, such as the Philco MADT types, make it possible for the amateur and experimenter to use these devices in high-frequency communications circuitry. The Philco MADT units will oscillate at well over 500 mc. and are being used in TV tuners and converters in the 420-mc. range. The transistorized converter described here uses two of the MADT transistors—the T1832 as an oscillator and the T1833 in the mixer stage.

The oscillator circuit is a transistorized version of the popular Pierce oscillator. The frequency of oscillation is determined by the values of L_3 and C_2 which comprise the collector tank circuit. Exact control of the frequency is maintained by the crystal in the base-collector circuit of V_1 . Crystals of the third-overtone type are used in the oscillator portion of the converter. Emitter stabilization is provided by resistor R_1 from emitter to ground.

The mixer circuit is conventional, utilizing injection voltage from the oscillator. The injection for the mixer is taken from L_2 by the link coupling of L_4 . L_4 is two turns of #28 wire wound over the ground end of L_2 .

From the schematic diagram of Fig. 1 it can be seen that the signal appearing at the antenna is link-coupled from coil L_1 to L_2 . The signal is then fed to the base of transistor V_2 from the tap on L_2 . A portion of the oscillation voltage is link-coupled by L_4 from L_2 to the emitter of V_2 and mixed with the incoming signal. The collector circuit of the mixer transistor is tuned by L_5 and C_1 to the frequency of the auto radio. This signal is then link-coupled through L_6 and transferred by coaxial cable to the antenna jack of the auto radio.

The circuit board, which is used in place of a chassis, should be made first.

There are many techniques and processes for making printed-circuit boards but the one to be described is probably the easiest for those without previous experience in this type of construction. No one should encounter difficulties if instructions are followed closely. Many of those constructing this converter will find that the making of printed-circuit boards opens up a whole new field for future construction projects.

The etchant used is not dangerous, but some care must be exercised to avoid staining your hands or the kitchen sink. Follow the instructions on the bottle and never attempt the etching process in a metal pan of any type. The author always uses a glass or plastic dish as the etchant will affect most metals and this will tend to weaken the solution. The four things you will need for the job are: (1) copper-clad laminated board $2\frac{1}{8}$ " x 3" cut from 3" x 4" piece—#MS-512; (2) tape resist $1/16$ " x 320"—#MS-735; (3) ball-point liquid resist tube (black)—#MS-728; and (4) a 6-ounce bottle of etchant—#MS-729. Although the materials for the printed-circuit board made by the author were purchased from Lafayette Radio (the catalogue numbers are theirs), other large electronics parts dealers also handle suitable materials for making printed circuits.

Two methods for laying out the circuit board are described in this article. The first method, which is the simpler, involves tracing Fig. 2 onto the copper while the second method involves placing the components and applying the resist tape and ink point-to-point.

The first method consists of taking the $2\frac{1}{8}$ " x 3" copper-clad board with the copper side up and placing a piece of carbon paper on top. Place Fig. 2 over the tracing paper and keep the 3 pieces together with cellophane tape.

The diagram of Fig. 2 is drawn to scale and may be used as a template.

Trace all holes for transistors and the crystal socket, then make the small dots representing the component connections. Run a single line for all connecting bars from dot to dot, as shown in Fig. 2. Trace small circles at points shown for mounting the three coils. Any printing that is to appear on the board may be lettered with a sharp pencil. If the printing is clear, it will etch well with the rest of the board. After the tracing is completed, apply the $1/16$ " resist tape for all connecting bars and use the ball-point pen for applying resist ink for small dots on the ends of the connecting bars. Use special care in applying the resist ink from the ballpoint tube. The dots should be neat and not touching each other as the etchant will only clean away copper that is not covered.

The second method is described for the benefit of those who may want to make the circuit board larger or smaller than that shown in Fig. 2. Starting with the basic board, drill holes and temporarily mount transistors, coils, and the crystal socket. Apply the resist tape and dots point-to-point, following Fig. 2 as closely as possible while still permitting enough space for mounting resistors and capacitors.

After the resist tape and dots have been applied, press the resist tape firmly with the head of a small nail, being careful not to smear any of the printing that was made on the board with the carbon tracing. When the resist ink is dry, the board is ready for etching.

Pour etchant solution into a suitable glass or plastic bowl and immerse the circuit board, copper side up. Agitate the circuit board slowly from time to time using a small wooden stick. The circuit board should be removed several

(Continued on page 94)

ELECTRICALLY OPERATED SWITCHES

By KENNETH BRAMHAM

Ranging from simple circuit breakers to electronic networks, they may use relays, vacuum tubes, thyratrons, or transistors. Characteristics of the various types.

ELECTRICALLY operated switches are the most important components in industrial and accounting electronics today. The familiar circuit breaker and the most elaborate "electronic brain" are both electrically operated switches. The circuit breaker must switch off a circuit when its current reaches a given maximum; the "electronic brain" must perform a multitude of switching operations to search for information, add, store new information, and finally switch on the correct electromagnet to operate a typewriter key or high-speed printer.

Vacuum tubes, soft tubes (thyratrons), relays, and transistors are all used as electrically operated switches. Each has its own characteristic advantages and disadvantages to make it more suitable for some applications than others. All have in common the ability to switch a much greater current than the input current controlling the switching. This of course is the equivalent of amplification.

An ideal switch responds instantly to its control voltage, has infinite resistance when "off," and no resistance when "on." In a practical switch these ideal conditions are never realized, but some of them may be approached closely at the expense of others. In every switch appli-

cation, the relative importance of each ideal condition must be considered and the most suitable type of switch selected. Compromises must often be made, as in the many cases where low contact resistance is sacrificed to gain switching speed. Concessions may be necessary in order to use one type of switch throughout an installation for the sake of standardization. In some cases, concessions are made merely to allow the words "transistorized" or "electronic" to appear in the advertising.

Plotting the control voltage or current, and the voltage or current being switched, enables us to compare the characteristics of different switches. Fig. 1A shows this graph using control or input voltage V_i and the voltage across the load V_L , for an ideal switch. Both input and output graphs are identical in time and shape, but not in amplitude. (Ideal amplitudes are not practical to portray, as the input voltage would be extremely small.)

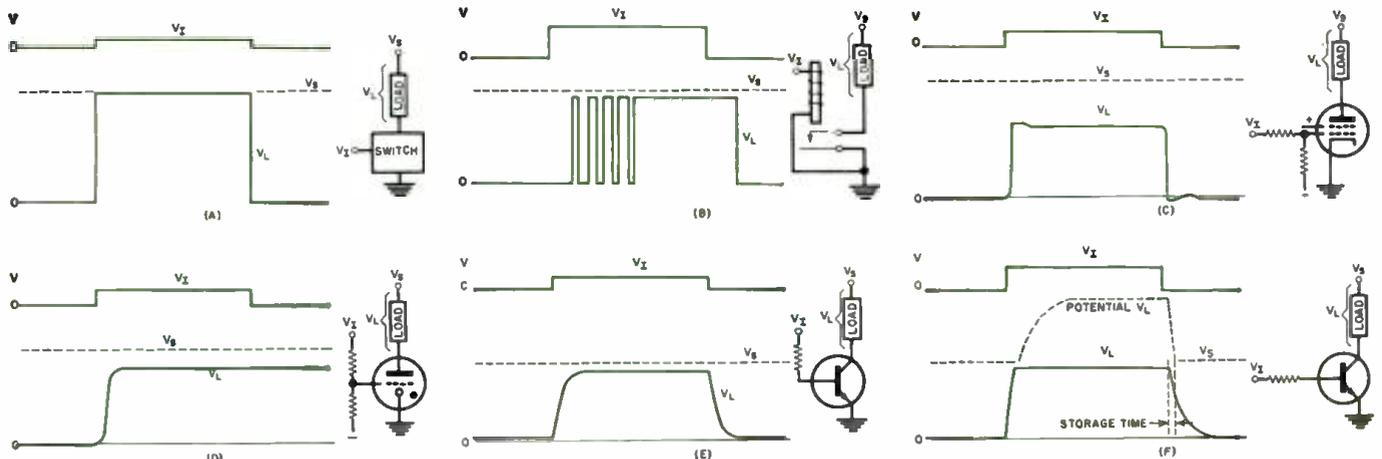
Taking a "telephone type" relay as our first example and assuming the input voltage to be suitable for the relay coil, we see the resulting input-voltage and load-voltage graphs in Fig. 1B. There is a time lag due to electrical and mechanical factors after the input voltage is applied until the output contacts

close. First, the inductance of the coil does not allow an immediate surge of current; the current in the coil, building up the magnetic field, is opposed by the back e.m.f. generated in the coil. The current in the coil and field build up exponentially until a steady state is reached, and then the current is determined by the resistance of the coil wire and the input voltage across it. Mechanical delay is introduced by the mass of the moving parts (armature and contact assembly) and the friction of the pivot bearings.

The total delay in this type of relay is from five to ten milliseconds to the first time the output contacts close. Now the energy due to momentum in the moving parts must be absorbed if the contacts are to remain closed; but, as all this energy is not absorbed, the contacts bounce open before being closed again by the field. This happens four times in our example, each time for a shorter open period, as the bounce distance decreases, until finally the output contacts come to rest.

Once the contacts are at rest, virtually the full supply current is available at the output. This is shown in the graph by the load voltage (V_L) being almost equal to the supply voltage (V_s). The contact resistance is negligible for most applica-

Fig. 1. Simplified input and output voltage waveforms for six common switches, showing differences in response of the output circuit to similar inputs. Waveforms have been drawn to heighten distortion and other output characteristics.



tions—providing the contact surfaces are in good condition. In use, a layer of oxide may form on the contacts and gradually increase the contact resistance, reducing the available output. Correct choice of contact material for the current and voltage to be handled, plus occasional cleaning, will overcome this problem in all but very low voltage circuits.

When the input voltage falls to zero, a time lag is again seen on the graph of Fig. 1B. First the energy in the magnetic field must be dissipated and then the mechanical factors must be overcome. The electrical portion of this delay can be varied over a wide range by introducing different circuits across the coil to slow the rate of energy dissipation in the coil. The mechanical factors are less predictable, being dependent on such matters as spring tension, lubrication, and temperature.

Other relay types have characteristics slightly different from the one shown. All have delay to a greater or lesser degree, and almost all but the mercury-wetted types exhibit a certain amount of contact bounce.

Vacuum tubes used as switches have an advantage over relays in speed and sensitivity. No mechanical parts are involved and inductance is negligible but, because of this, the circuit capacity (which can be neglected in the relay) now becomes the limiting factor in switching speed. Because grid (input) current is not needed in most applications, sensitivity is very high. For example, a voltage change of only 4 volts ($-5v.$ to $-1v.$) and negligible current will switch a 6AU6 from cut-off to deliver 10 ma.

The voltage-time graph of a typical vacuum-tube switch is shown in Fig. 1C. Although the input is again a square wave, the output has become slightly distorted, and it does not cover the full range of available current. The inter-electrode capacity of the tube, plus the capacity introduced by wiring, combine with the plate and load resistances to introduce slight delay in the output. If this delay were constant over a wide frequency range, all the frequency components in the output would be delayed equally and delay—but not distortion—would be the result. As this is not the case (unless special peaking circuits are employed), the delay varies across the frequency range and the result is a distorted output.

The plate resistance reduces the available output well below the level of the supply voltage and causes heat to be dissipated in the tube. This heat dissipation leads to a size problem, as large tubes must be used to handle currents of more than a few milliamperes. Against this, we have the advantages of speed and safe, reliable operation at relatively high voltages.

Thyratrons (multi-element, gas-filled tubes) are slower-acting than vacuum tubes, but have the advantage of lower resistance once they are switched on. A typical graph for a thyratron switch is shown in Fig. 1D, where some delay and a slight rounding out of the V_o curve are noticeable when the tube is switched on. This delay and distortion is due primarily to two characteristics of the tube, the inter-electrode capacity and the time taken to ionize the gas. The ionization phenomenon starts in the region between cathode and grid when the grid is made positive and spreads rapidly through the tube in an "avalanche," comparable to the breakdown of a zener diode. The low-pressure gas that, in its normal state, is an insulator, becomes a conductor when ionized to close the switch circuit. Gas pressure and the type of gas used determine the ionization time, which may be a fraction of a microsecond or several microseconds.

The most obvious difference between the thyratron and other switches is the "switch-off" characteristic. Once the tube has fired, the grid has no further control over the tube: the only way to restore it to an "off" condition is to remove the anode voltage for sufficient time to allow de-ionization. This may

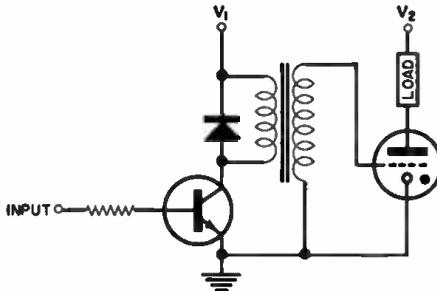


Fig. 2. A combination transistor and thyratron switch used to couple systems that have different supply voltages.

be from 1 to 10 milliseconds, depending on gas type, pressure, and temperature.

A switch that can be turned on but not off by its control element may seem to have very little use but, in fact, it is quite practical for many applications. Only a short pulse on the grid is needed to switch the thyratron on for an indefinite time; this can be used to advantage where a "hold" function is needed. To duplicate this effect and hold other types of switches "on," a flip-flop circuit must usually be used. This requires a minimum of two switch components. In another mode of operation, the thyratron plate is supplied from an a.c. or pulsating d.c. source that switches off the tube on each cycle and on again only when a voltage is present at the control grid.

Transistors, like vacuum tubes, are used both as signal amplifiers and as switches. The same transistor type may sometimes be used for either purpose but it is more likely that "steep-slope,"

special-purpose tubes or transistors would be used for switching applications. The requirements of a signal amplifier are that the output shall follow changes of input voltage or current very closely, while the switch requires only two states of output: "off" and "on."

Two basic switch conditions are used in transistor circuits, the low-level switch and the saturated switch. To simplify these conditions, the low-level switch can be regarded as being supplied with just the right amount of input drive current to give the required output current, while the saturated switch's input is overdriven. If, for example, the *beta* (current amplification factor) of a transistor is 20 and the required output is 200 ma., the low-level switch circuit would be supplied with 10 ma. to the transistor base in a grounded-emitter circuit. The same transistor used as a

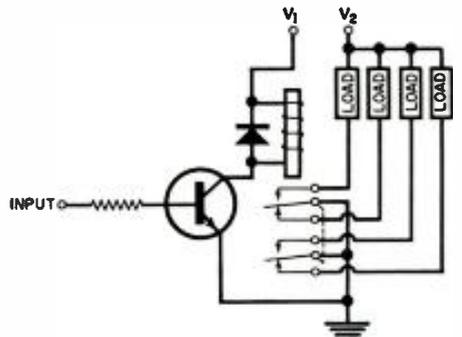


Fig. 3. Common office-machine combination. Transistor switch controls relay which, in turn, switches multiple loads.

saturated switch would be supplied with about 20 ma. to the base, twice the amount needed.

At first glance, it may seem that we are wasting the potential gain of the transistor by saturating it. There are, however, advantages to offset the reduced gain. First we have the advantage of reliability and non-critical circuitry. The output current is limited only by the load. Variations in transistors or input circuitry must be quite large to have any great effect. Another advantage is faster switching to give a much shorter rise time, although a delay is introduced in the switch-off conditions due to "storage time" (the time needed by a semiconductor to become unsaturated).

The input and output voltage-time graphs for an unsaturated switch are shown in Fig. 1E and those for a saturated switch in Fig. 1F. The improved rise time and the delay due to storage time are seen in comparing these graphs. The broken-line graph in Fig. 1F shows the unsaturated state that would exist if the output voltage (V_o) across the load were not restricted by the supply voltage (V_s) and the same input current were supplied to the base. This unsaturated curve is useful in determining the saturated values of rise and fall time and

(Continued on page 87)

By JOHN T. FRYE



Industrial Sampling

"HEY, MAC, what's so interesting about that booklet you're reading?" Barney asked his employer. "You've been goofing off with it for an hour while I sweat away here at the service bench paying the rent."

"Keep right on, Einstein; you're doing fine," Mac said as he took off his glasses and rubbed his eyes wearily. "This reading is heavy going because I don't know exactly what I'm doing. This morning the manager of that new defense plant west of town called me in and asked my advice about antennas for microwave communication equipment the plant intends to use in connection with some test work they're undertaking. It's a weird set-up. The whole thing is very hush-hush. In fact, I gather I was being consulted instead of a commercial communications engineer solely because of security reasons. I was told the frequencies to be used, the distances to be covered, the power of the transmitters, and the shapes of the transmitting antenna patterns required—that was all. I'm permitted to discuss the matter with you and no one else. You're to talk about it to no one except me."

"Just call me Zipper-mouth Barney, but why get tangled up in this in the first place? It's a long way from our work."

"That was my first reaction, too; but then I remembered an article called 'From TV Service To Industrial Electronics' that James T. Mendel authored in the September, 1961 issue of *ELECTRONICS WORLD*. In this article Mendel strongly urged qualified TV technicians to go into the field of industrial electronics. He argued the pay was better in the long run, there were more fringe benefits, the technician was under less constant pressure, and the work was more varied and challenging."

"You agree?"

"It would be presumptuous to agree or disagree without knowing more about industrial electronics than I do. But Mendel's article made me want to know more about the pasture on his side of the fence. That defense plant is chock-full of electronic gadgets, and this might be a toe-in-the-door for us."

"Then you do think we ought to get into industrial electronics," Barney insisted.

"I've always thought we should have a deep interest in all sorts of electronic equipment—you know that," Mac answered; "but quitting radio and TV service work entirely and taking a job as an industrial electronics technician is something else again—especially when, as in my case, this would mean changing from operating my own business to working for someone else. And incidentally, since you have such a soft-hearted, lenient employer, it's not much different with you."

"Soft-hearted like Simon Legree!" Barney scoffed. "I think it would be nice if we could do some of both."

"Exactly what I have in mind," Mac replied. "There're several comparatively small factories in this area using more and more electronic devices. Automation and its hand-maiden, electronics, is becoming quite a thing with these little plants. They have to use this equipment to compete price-wise with larger concerns, but they don't have enough of the equipment to warrant the full-time service of a qualified commercial electronics technician. They try to get by with the help of the plant maintenance personnel. These boys can take care of a simple trouble, such as replacing a bad tube; but they're lost when there is a serious breakdown in the electronic equipment—just as we should be lost if confronted with a tough job in their respective fields. When these men can't solve the problem, the plant manager has to call for help wherever he can get it—usually from the manufacturer of the device. That quite often means a long and costly wait during which, at best, the plant is deprived of the use of the device, or, at the worst, a whole production line may be shut down."

"And you're thinking that if he could just call us in and we could get the thing going again *my pronto*, it would be a great help to the plant manager, and it would mean money in our pocket and industrial electronic experience in our head."

"You're getting brighter all the time," Mac complimented. "I've been nosing around the past few weeks, and I'm confident we can get quite a bit of this work if we can handle it. An old school friend of mine is plant manager of that big relay and control factory on the far side of town. Of course this is a big factory, and they take care of their own equipment; but he gave me a lot of useful information on how the electronic equipment in their plant is handled. They have a complete electronics division within their maintenance group. This division is headed up by a college-trained engineer, but none of the technicians in the group are college-trained. Instead, an educational program is carried out right in the factory to train the technicians to handle the peculiar problems encountered in the manufacture of relays and controls. This electronics unit designs and builds electronic equipment, writes up installation and service manuals on it, and maintains the equipment."

"Where do they get these technicians?"

"Some come from our field; others come from the armed forces where they have received electronic training. My friend reports both groups are able to use their highly specialized training as a foundation for quickly acquiring the new knowledge needed in industrial electronics."

"You say they design and build a lot of their electronic equipment. Is this a usual practice in a large plant?"

"Yes. For industrial electronics to do the maximum job of which it is capable in a factory, many of the devices have to be tailored to the peculiar needs of that factory. Of course there are many counting, measuring, and sensing devices of universal application that can be bought ready for application; but there are many other cases where one of these devices must be modified to do a particular job or a completely new electronic apparatus must be built to do that job. I think this is an area in which we could be of great service to our small factory clients."

"You lost me," Barney admitted.

"I mean that if we really bone up on the electronic devices available for industrial application and if we familiarize ourselves with the operations in each of these small factories we serve, we should be able to (a) suggest where a piece of commercial electronic gear can be put to good use in the factory, or (b) design an electronic gadget of our own to do a particular job. In short, we could provide our clients with at least some of the advantages of having their own full-time electronics technician."

"I'm all for it," Barney said enthusiastically. "I'm not ready to give up radio and TV servicing yet—not with millions of sets that need servicing every year; but I'd like to know more about other branches of electronics and gain some experience working with various kinds of electronic devices. This scheme of yours would permit us to continue being our own boss in a field where we *know* we can make a living; yet we

(Continued on page 97)

MODULATED 10-KC. CALIBRATION OSCILLATOR

By RONALD L. IVES

Complete construction information on an accurate test oscillator that is able to provide tone-modulated check points on amateur and communications receivers.

CRYSTAL-controlled calibration oscillators have been regarded as a necessary part of most communications receivers for more than a decade and crystal calibrators of one sort or another are included in the armamentarium of almost every advanced electronics technician and engineer.

Unfortunately, the lowest frequency for which a crystal is commonly available is 100 kc. Although crystals for lower frequencies can be ground, they are extremely large and costly as the world supply of "optical quality" quartz crystals in the larger sizes is distinctly limited.

Because low-frequency crystals are not readily available, most needs for low-frequency standards are met by use of a relatively high-frequency crystal, which drives a chain of submultipliers—usually multivibrators, to produce the desired low frequency. The most common arrangement of this kind uses a 100-kc. crystal oscillator to drive a 10-kc. multivibrator, giving a 10-kc. output.

Many of the published circuits using this principle employ three triodes, one as a crystal oscillator and the other two as a multivibrator. This arrangement can be made to work, but is likely to "skip," giving an output of 9 or 11 kc.; and injection of an audio tone, to permit definite signal identification, is extremely difficult. Additional difficulty is sometimes experienced when the multivibrator "backfires" into the crystal oscillator circuit, altering its frequency.

All of these difficulties can be eliminated rather easily, using fairly conventional circuitry, so that a compact and dependable 10-kc. calibration oscillator, with optional audio modulation, can be constructed with standard components. The functional block diagram of this calibrator is shown in Fig. 1. The completed unit is shown in the photographs.

Basic Circuit

The functions of the various blocks in Fig. 1 are as follows: the oscillator produces an accurate 100-kc. sine wave. The submultiplier converts this into a 10-kc. square wave. The output tube isolates this square-wave circuit from the output load and permits insertion of an identifying audio tone, which is produced in the modulator.

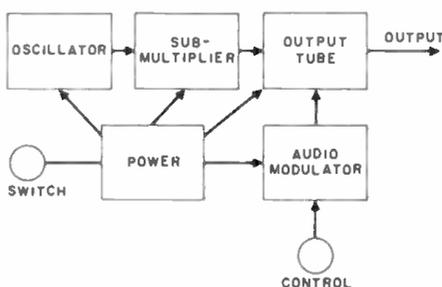


Fig. 1. Block diagram of calibration unit.

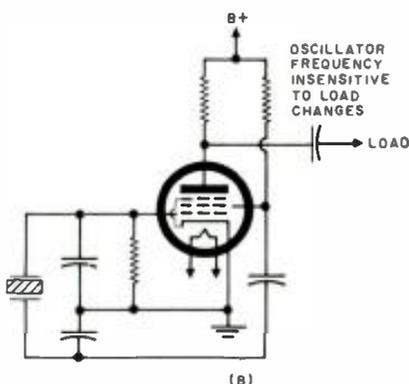
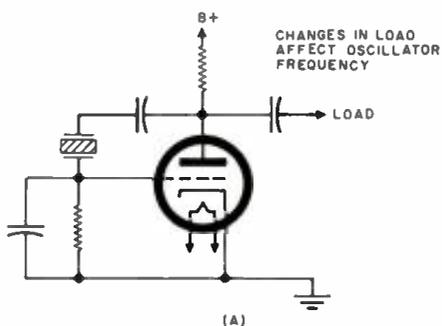
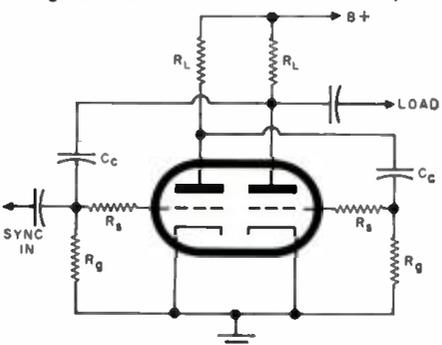


Fig. 2. Oscillator circuitry as described.

Fig. 3. The basic multivibrator circuitry.

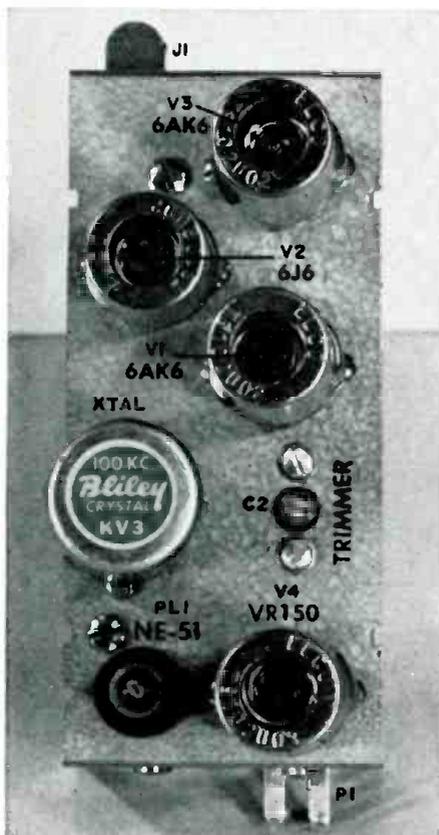


Circuitry of the oscillator is so chosen that changes in the output load or injection of pulses at the output (from the submultiplier) do not affect the oscillator frequency. In a conventional Pierce oscillator (Fig. 2A), any change in the load characteristics or any pulse applied to the plate of the tube, as from a driven multivibrator, will have a definite adverse effect on the frequency stability. In consequence, isolation of the oscillator from the load is desirable. This can be done by use of a buffer amplifier or a cathode-follower, an effective isolation method that unfortunately requires another tube. A simpler and equally effective isolation method is by use of electron coupling, as shown in Fig. 2B.

Here the oscillator consists of the grid, screen grid, and cathode of the pentode, while the output is taken from the plate, which is coupled to the oscillator only by the electron stream in the tube. This method of coupling isolates the oscillator from the effects of changes in the load and from pulses externally applied to the plate circuit. Similar circuits are recommended by crystal manufacturers for use with precision calibration crystals.

The submultiplier here used is a symmetrical multivibrator, the circuit of which is shown in Fig. 3. Free-running frequency is determined principally by C_c and R_s , but the plate resistors, R_L , have a minor effect as does the plate voltage. Any coupled device, such as a synchronizing input or a load, becomes a part of the frequency-controlling circuit and must be compensated for by adjusting the other constants. If the load is inductive, or if it injects any sort of signal into the multivibrator, undesired outputs at spurious frequencies may result. It is for this reason that an output tube, which also permits injection of audio modulation, is desirable. The function of the series grid resistors, R_s , is to improve the waveform, producing more rapid rises and hence more useful harmonics.

The basic circuit of the output tube and audio modulator is shown in Fig. 5. The output tube is a conventional pentode amplifier with audio injection via the suppressor grid. The modulator proper is a conventional neon oscillator, with an output shunt capacitor, C_c , added to attenuate the higher audio harmonics.

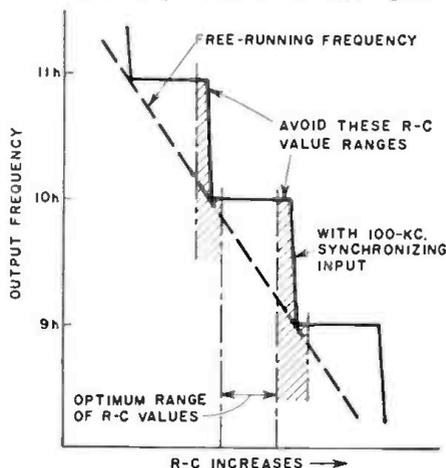


Top view of the calibration oscillator.

Because both frequency and power output are sensitive to changes in plate voltage, a regulated "B" supply is desirable with a calibrator of this type. A conventional 150-volt regulator tube performs this function satisfactorily.

By combining these elements, a consistently dependable calibration oscillator is produced. The circuit is shown in Fig. 6. Constants shown are those which worked consistently, but those in the crystal oscillator and output tube circuits are not at all critical. Five percent components are essential in the submultiplier circuit so that it will run at the desired frequency and these are suitable only because the multivibrator is controlled by the crystal oscillator, through the synchronizing coupling (C_1). Without this synchronization, the

Fig. 4. Behavior of submultiplier with and without sync input as constants are changed.



error in output frequency would be a direct function of the errors in the component values.

Construction

Construction is fairly simple and straightforward, as all frequencies involved are relatively low and there is no problem of critical lead dress. It is essential, however, that the oscillator be adequately shielded, to prevent interference with receivers as far away as several hundred feet or more.

A suitable enclosure for this calibration oscillator is an aluminum shield case approximately $2\frac{1}{4} \times 2\frac{1}{4} \times 5$ (LMB 108). All electronic components are mounted on the ends and face of the cover, and the base (also supporting the sides) is fastened to the chassis. Sockets used for V_1 , V_2 , and V_3 are Vector turrets, Type 8M12T, with S-7 shield shells. Pre-wiring of these, before mounting on the case, simplifies assembly greatly.

The output connector is made from a Weatherhead right-angle fitting (designed for automotive gas lines), to which has been added a miniature microphone connector (Switchcraft 5501-MP). This takes a shielded output cable, which is necessary to confine the calibrating signals.

Construction is facilitated if all holes

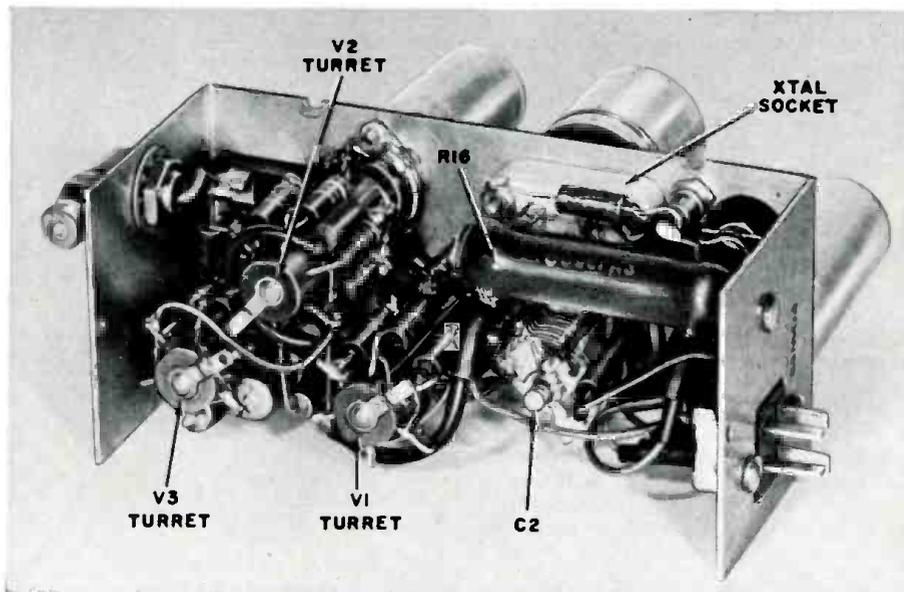
of V_2 to terminal 1 of V_3 . Next mount the turret for V_1 and connect coupling capacitor C_1 from terminal 5 of V_1 to the junction of C_3 , R_3 , and R_6 on the V_2 turret. This wiring and assembly procedure, using pre-assembled and pre-wired turrets and a definite order of installation, eliminates most "packing factor" problems and minimizes the number of tricky soldered connections.

Now, working toward the front of the chassis, mount all other components except the power input plug and R_{10} . Complete all possible wiring at this stage then mount and wire the power input plug and, finally, mount R_{10} and complete the plate wiring of the calibrator.

Wiring will be facilitated if a small tie-point is placed between the crystal socket (Millen 33102) and the socket for V_3 (Johnson 147-610). Insulation of the V_3 socket from the chassis by means of a $\frac{1}{2}$ " rubber grommet eliminates connection polarity problems. Other construction details can be seen in the photographs.

Testing

When wiring is completed and has been checked for errors, the calibrator is ready for testing. With all tubes and the crystal inserted in their sockets, connect power and let the calibrator warm



Inside view showing the turret-socket construction employed by the author.

are drilled in the case before any equipment is mounted and all possible components are mounted on their respective turrets and pre-wired before the turrets are bolted in place. The output connector is mounted first, followed by the tie-point for the output capacitor, then the turret for V_3 . The output circuit can now be completed by connecting the output connector to the tie-point and the output capacitor (C_{10}) from the turret to the tie-point.

Connect two wires to each filament terminal of the turret for V_2 , then mount the turret. Connect one wire from each filament terminal to the filament terminals of V_3 and connect the coupling capacitor, C_1 , from terminal 2

up for a few minutes. Output should be very close to 10 kc. and should be a symmetrical square wave.

To align the output exactly, remove V_2 from its socket so that the output is the amplified output of the crystal oscillator. Beat this with WWV as received in any convenient manner and adjust C_2 for zero beat. Although an audible zero beat is adequate for most purposes, a true zero beat, as measured on an oscilloscope, is a bit better as few of us can hear beats below about 70 cycles.

Replace V_2 in its socket and beat the output with a series of broadcast signals picked up on any convenient receiver. If all is working well, zero beats will be noted at each standard broadcast station

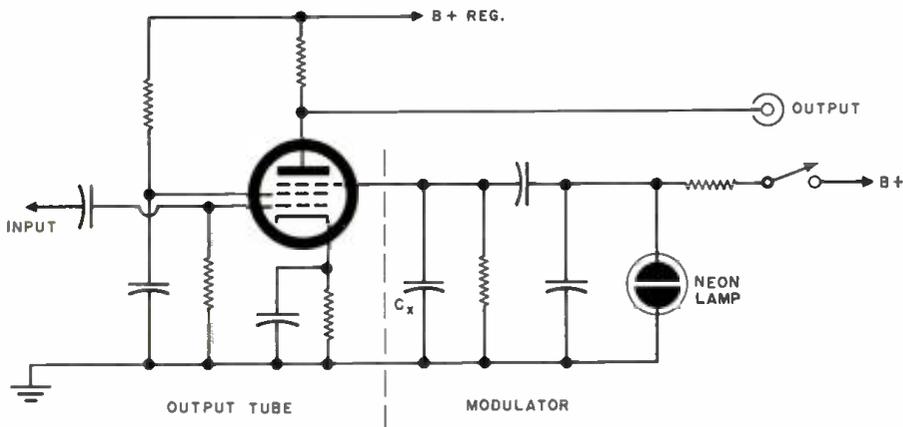


Fig. 5. The basic circuit arrangement of the output tube and the audio modulator.

and no further adjustment is necessary.

If deviant beats are noted, check for a resistor or capacitor in the submultiplier (V_2) whose value is off. Deviant beats are usually due to asymmetry in the square-wave output and this can be corrected by changing the value of C_6 slightly. Due to the injected synchronizing signal from the 100-kc. oscillator, the submultiplier will tend to "pull in" at 10 kc. through a wide range of RC values in the V_2 circuit, as shown in Fig. 4. This property of the multivibrator makes it possible to use components of medium precision to produce a high-precision output. As indicated in Fig. 4 and as demonstrated by experiment, the

free-running speed of the multivibrator should be about .95 of the desired synchronized speed.

The audio modulator, consisting of a neon lamp PL_1 and an RC network (R_{11} , C_{11} , C_{12} , and C_{13}), inserts an audio tone into the calibration signal when desired for identification purposes. The operating frequency, with the constants shown, is 350 cycles, with the higher harmonics suppressed by shunt capacitor C_{11} .

The 350-cycle modulating frequency was chosen because audio modulation "spreads" the calibration frequency by the audio frequency doubled, producing, in this case, a bandwidth of 700 cycles. Quite obviously, some other frequency

can be chosen, simply by altering the RC constants in the neon oscillator circuit, as frequency is an approximate function of $1/RC$.

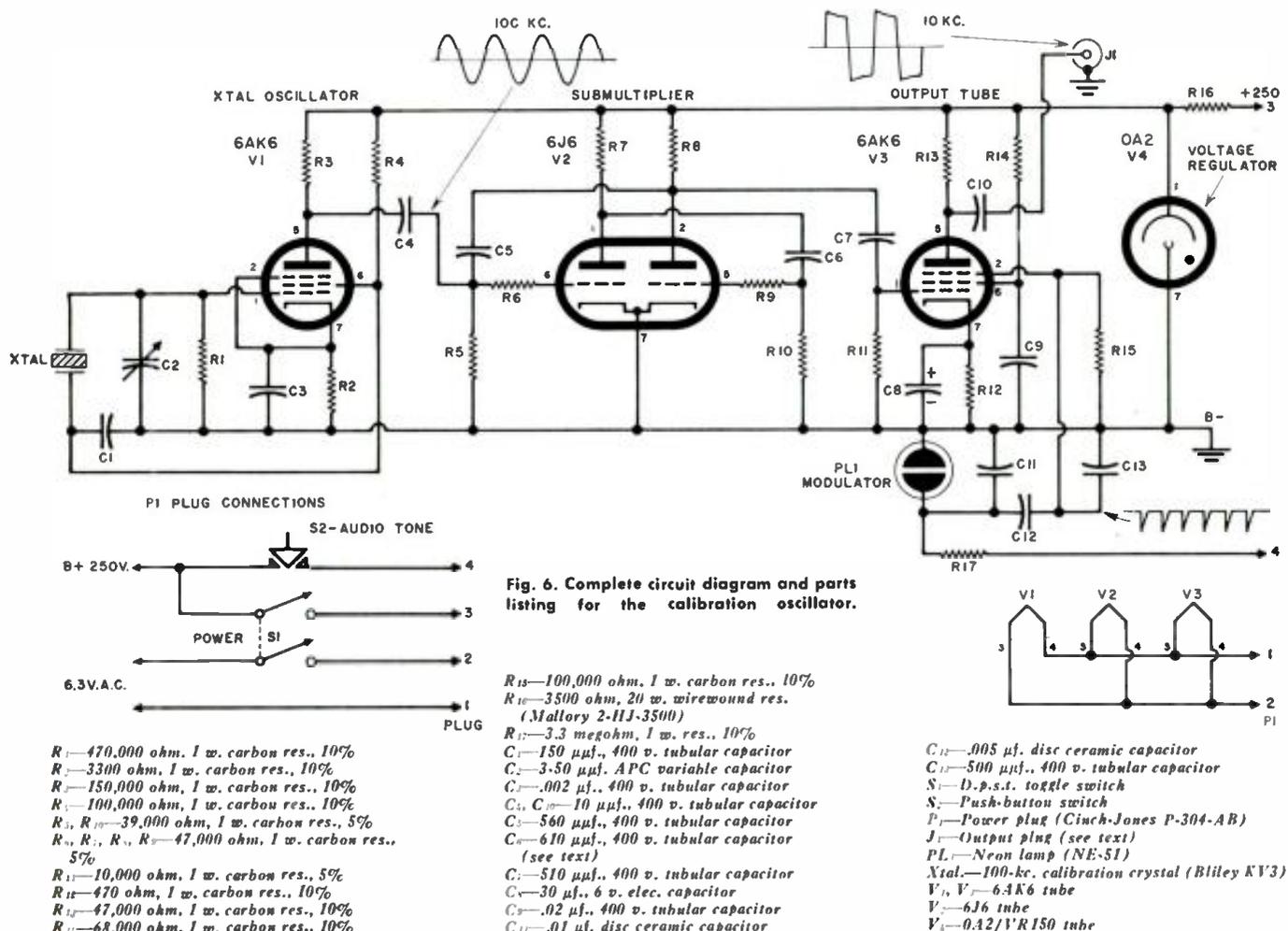
Raising the modulation frequency, however, broadens the calibration signal and if the audio frequency, either fundamental or strong harmonics, exceeds 5000 cycles, a 10-kc. calibrator will give a continuous tone in the receiver, irrespective of tuning, and will not be very useful.

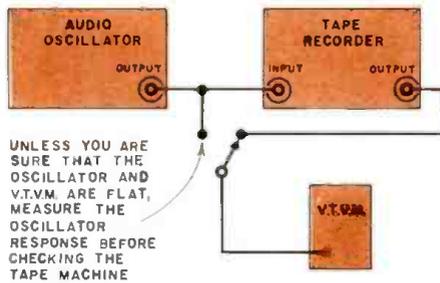
Regulated plate voltage is used throughout this calibrator so that switching transients and line noise will not enter the signal circuit and produce undesired deviant frequencies. With the regulation method shown, an electric drill can be operated from the same socket as the calibrator power supply without producing any changes in the output signal.

Coupling of the calibrator output to the receiver input should be very loose to prevent both interaction of circuits and overloading of the receiver, as the calibrator has a strong output at all frequencies up to about 50 mc. The circuit and constants shown in Fig. 7 appear satisfactory for most applications.

The control circuit shown in Fig. 6 is ideal for most installations. Here the toggle switch turns on both the plate and filament supply of the calibrator while the audio tone, used only for signal identification, can be inserted at will

(Continued on page 71)





UNLESS YOU ARE SURE THAT THE OSCILLATOR AND V.T.V.M. ARE FLAT, MEASURE THE OSCILLATOR RESPONSE BEFORE CHECKING THE TAPE MACHINE

Fig. 1. Measuring the record-playback frequency response of tape recorder.

EVEN the simplest tape machine is a complex instrument and a variety of tests are required to assure that all is well; just one hitch can defeat the entire purpose of the machine. The most frequently used tests are covered in this article in general terms. It is desirable to consult the service manuals for specific instructions.

Tape recorder testing is not merely part of diagnosing and repairing faulty machines. When faithful reproduction is

expected of a tape recorder, performance checks are also part of the preventive maintenance that guards against "so-so" operation.

Inasmuch as certain tests are interdependent, an appropriate testing sequence may reduce one's work. To illustrate, one cause of poor treble response is improper azimuth. To have a correct picture of frequency response it is first necessary to be sure that azimuth is correct. Before checking azimuth one may wish to check vertical head alignment, because moving the head up or down will probably disturb azimuth. To illustrate further, treble response is also related to bias current and equalization. If frequency response is checked first and proves reasonably flat, this probably obviates the need for bias and equalization tests. On the other hand, this is not necessarily true, because compensating defects are possible, although unlikely; thus too little bias might be offset by too little treble boost in recording.

Before making any tests it is advisable to let the tape machine warm up for at least 15 minutes.

Record-Playback Response

The heads should be cleaned and demagnetized as the first step in frequency-response testing.

A speedy and effective check of record-playback response is to take a wide-range phono disc and A-B the tape against the record. Significant peaks and holes in response will be apparent.

An instrument check of record-playback response requires an audio oscillator and a v.t.v.m., as shown in Fig. 1. A v.o.m. may also be used if it has good frequency response. The oscillator and v.t.v.m. should each be flat within 1/2 db over the audio range. Barring this, the response measurement should be corrected for known errors of these instruments. Record a series of frequencies at constant amplitude over the audio range and measure the playback output. Record at least 20 db below maximum permissible recording level, as evidenced by the record-level indicator, otherwise the great amount of treble boost in recording will saturate the tape at high frequencies, causing a seeming loss of treble.

The recorded frequencies should be

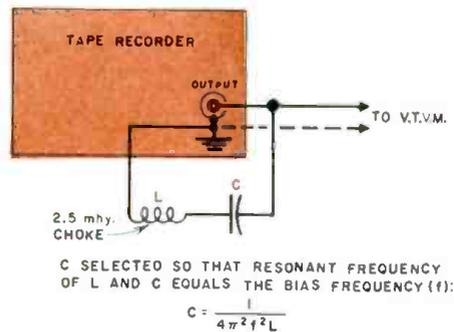


Fig. 2. Connecting a trap for bias signals across the output of a tape recorder that uses separate record and playback tape heads.

no more than an octave apart. A comprehensive test that will reveal any significant peaks or dips employs 10-cycle intervals from 20 to 100 cycles; 100-cycle intervals to 1000 cycles; and 1000-cycle intervals thereafter. A reasonably good picture of response at a saving in time can be had with these frequencies: 30, 50, 100, 200, 500, 1000, 2000, 3000, 5000, 8000, 10,000, 12,000 and 15,000 cycles.

The problem of frequency identification arises when the same head is used for record and playback. List the frequency sequence on paper and "mark" several key frequencies by turning the oscillator on and off rapidly at the start of each key tone. The key tones, serving as milestones, are preferably 100, 1000, and 10,000 cycles. In playback, several rapid, wide swings of the v.t.v.m. pointer will identify the key tones.

A machine with separate record and playback heads may present this problem: sometimes enough bias voltage is radiated to the output jack to obscure the audio signal. If so, shunt the bias frequency to ground through a series-resonant trap, as shown in Fig. 2. Given the oscillator frequency and using a 2.5 mhy. choke, the value of the capacitor is determined from the formula:

$$C = \frac{1}{4\pi^2 f^2 L}$$

In the case of a stereo machine, check record-playback response of each channel under two recording conditions: (1) with the other channel on and (2) with the other channel off. Response on one channel may change appreciably when the other is turned off, because of ac-

TESTING TAPE RECORDERS

By HERMAN BURSTEIN

Summary of the various tests used to check the performance specifications of a tape recorder.

companying changes in bias current.

Playback Response

Although the record-playback test proves response to be flat, this is no reason to omit the test of playback response. It can and does happen that a serious error in playback is compensated by suitable record equalization, yielding flat over-all response.

Playback response is checked by playing a standard test tape, such as the *Amper* 5563, at 7.5 ips and measuring the output signal with a v.t.v.m. The output must be simultaneously fed into a monitor amplifier and speaker (often present in the tape machine) so that the frequency announcements are heard.

If the output jack is preceded by tone controls, turn them to the position designated "flat" by the manufacturer. If there are outputs both before and after the internal power amplifier, measure response at the earlier location.

Equalization

To measure playback equalization, feed a very small signal into the playback head via its ground lead, which is temporarily lifted from ground, as shown in Fig. 3. Signal amplitude is measured at the output of the playback amplifier. Keep the input signal sufficiently low so that the maximum output signal (at the bass end) does not exceed 2 volts. A voltage divider at the input, as shown in Fig. 3, is advisable.

At high frequencies the output signal will be less than 100 millivolts, which may require a sensitive v.t.v.m. for clear and accurate measurement. If the v.t.v.m. is not sensitive enough, increase the input signal above 500 cycles and make a corresponding correction in the output measurement.

To measure record equalization, the technique of Fig. 4 is commonly employed. First, disable the oscillator by removing the oscillator tube. Temporarily disconnect the ground lead of the record head and place it in series with a 100-ohm resistor to ground. Feed constant-level signals from an audio oscillator into the tape recorder and measure the output voltage across the 100-ohm resistor. At 1000 cycles, the input signal should be about 15 to 20 db below maximum permissible recording level.

If the v.t.v.m. is not sensitive enough to give a clear reading, a 1000-ohm resistor can probably be safely used to provide a larger voltage output. The resistor must be less than one-tenth the impedance of the head plus other circuit elements (plate resistance of the driving tube and the "constant-current" resistor) in the audio range.

Azimuth

To adjust the gap of the playback head for maximum treble response, play a standard alignment tape bearing a prolonged high-frequency tone, such as 7500 or 10,000 cycles. Tilt the playback

head alternately to the left and right until maximum output is indicated by a v.t.v.m. connected to the output jack. Beware of "false peaks" which may occur on either side of the much larger true peak.

Some alignment tapes bear two tones. The lower frequency is used for preliminary adjustment of azimuth and the higher one for fine touch-up.

Azimuth alignment should be checked on both channels of a stereo head. Sometimes the two gaps are not exactly colinear and optimum alignment cannot be achieved simultaneously on both channels. It is then necessary to effect a compromise alignment, which results in about the same treble loss on both channels.

If the tape recorder has separate record and playback heads, the playback head is aligned first. The record head is adjusted for maximum output while simultaneously recording and playing back a signal of 10,000 to 15,000 cps.

Bias Current

Bias current can be checked by measuring the voltage across the record head and comparing this with the voltage specified in the service manual. However, this technique may lack the desired accuracy because bias current depends upon the impedance of the head, which varies with bias frequency and also with differences in inductance from one head to another of the same brand and type. A preferable method is to measure the voltage across a 100- or 1000-ohm precision resistor placed in series with the ground lead of the record head. Application of Ohm's Law indicates current.

In some recorders having a vu meter, the latter can be switched to indicate whether bias current is correct. Usually the meter is connected via a variable calibrating resistor to a resistor between the record head and ground. The calibrating resistor is set by the manufacturer so that zero vu corresponds to correct bias. From time to time it may be necessary to adjust the calibrating resistor itself on the basis of an alternate measurement of bias current.

For machines having separate record and playback heads and a bias control, the usual method of checking and adjusting bias is as follows. Adjust bias current to obtain maximum output when simultaneously recording and playing a specified frequency, usually 1000 cps at 7.5 ips. Sometimes the procedure calls for increasing bias current until output falls 1/2 db below the maximum. This tends to minimize the effect of slight changes in bias current upon treble response and distortion.

At a tape speed of 15 ips, one might indulge in the luxury of adjusting bias on the basis of minimum harmonic or IM distortion. Use a high recording level for sharp definition of the proper bias. A machine intended for 15-ips operation typically has variable recording equalization, which must then be adjusted for flattest response. Below 15 ips, the bias for minimum distortion causes excessive treble loss.

Distortion in the bias waveform produces noise in recording. Check for obvious distortion by placing an oscilloscope across the record head. Some tape oscillators include a balance control for minimum distortion. Adjust this control for least noise when simultaneously "recording" and playing a virgin or bulk-erased tape, but with no signal input and the record gain control at minimum.

Beat notes between harmonics of the audio signal and the bias frequency may occur if the latter is too low. But if the bias frequency is too high, the erase head may do a poor job. To check whether the bias frequency is at the

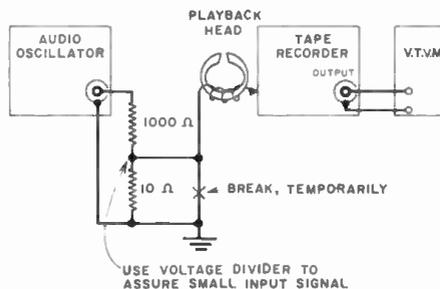


Fig. 3. Measuring the playback equalization.

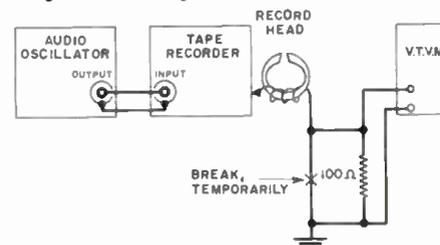


Fig. 4. Checking the record equalization.

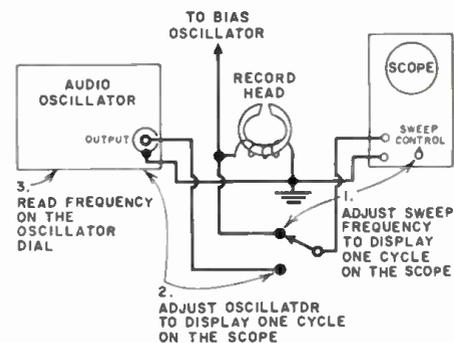


Fig. 5. Setup for measuring bias frequency.

optimum value specified in the service manual, follow the procedure of Fig. 5. Connect an oscilloscope to the record head to display one cycle of the bias waveform; keep the sync control low. Then connect the scope to a signal generator and adjust the frequency of the latter until one cycle is again displayed on the scope. The dial reading of the generator is the bias frequency. If an audio oscillator is used and cannot reach the bias frequency, do the following: obtain a four-cycle display at the record head, obtain a one-cycle display at the oscillator, and multiply the oscillator dial reading by four.

Vertical Head Alignment

The gaps of the record and playback
(Continued on page 99)

a **U.H.F.** *nuvistor tuner*

By AARON E. ZIMMERMAN, Sr. Engr., F. W. Sickles Div., General Instrument Corp.

A miniature triode that can oscillate at ultra high frequencies and renewed interest in this band have prompted reconsideration of front-end circuitry.

THE u.h.f. television band is once more the subject of comment in newspapers and magazines. This renewed interest has been fostered by the fact that the Federal Communications Commission is actively considering action to promote use of the band, including the possibility of transferring all television transmission to this frequency range. In fact, the agency is now carrying out air tests in New York City to evaluate u.h.f. transmission and reception in a metropolitan area and make comparisons with v.h.f.

With such prospects in mind, *General Instrument's F. W. Sickles Div.* has reviewed its past experience in u.h.f. tuner design. Out of this effort has come a new unit. No reasons were found for radical revision of the basic circuitry already developed. However, since that past effort, *RCA* announced the nuvistor. This device opened a way to overcome the major deficiency of exist-

ing u.h.f. tuners. A cooperative effort between the two manufacturers resulted in the development of a special u.h.f. nuvistor triode and a modification of the tuner to use the new device.

The Tuner Circuit

The design (Figs. 1 and 2) consists of two high- Q , end-tuned, coaxial transmission lines as r.f. preselectors and a vacuum-tube oscillator using another end-tuned, coaxial, transmission line. Tuning is accomplished by ganged, variable, air-dielectric capacitors (the three sections of C_1). The input is matched to a 300-ohm balanced impedance. Coil L_1 couples signal to the first preselector line. An interstage shield between the two preselectors has a hole in it, through which signal is coupled from the first to the second. A portion of loop L_2 , which lies parallel to the second preselector, then applies r.f. signal to the crystal mixer, a 1N82A diode.

Note that a small portion of the wire that makes up inductance L_2 projects through the shield into the oscillator compartment. Oscillator injection energy is picked up in this way, and also applied to the mixer, in common with the r.f. signal. The network at the output of the mixer, consisting primarily of C_2 and L_3 , is a tuned, unbalanced output for feeding a 43-mc. amplifier. While this output is at the intermediate frequency of the TV receiver, it is not fed directly into the i.f. strip. It is customary to couple it into the receiver's v.h.f. tuner which, in its u.h.f. position, is set up to serve as an added i.f. amplifier.

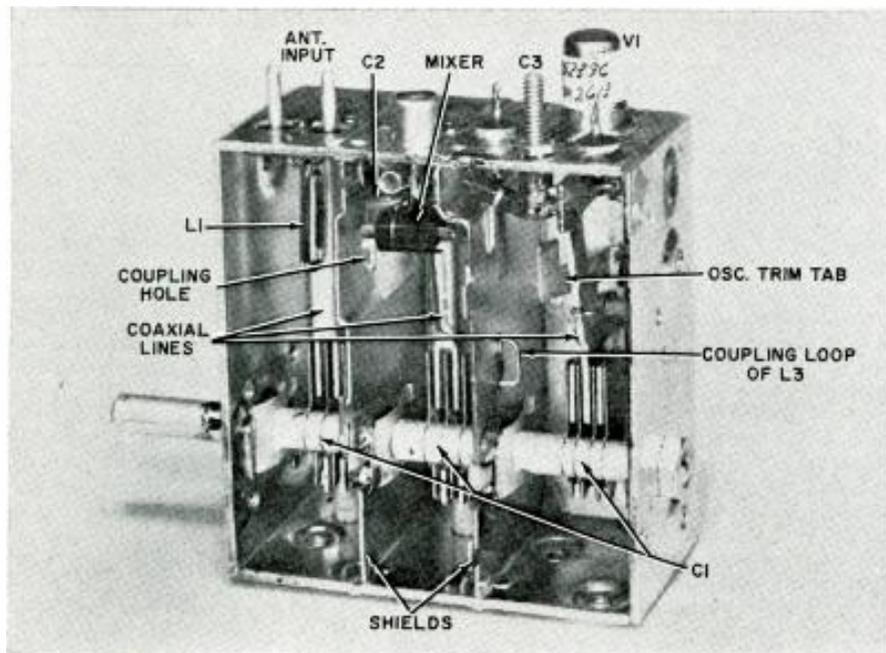
The means for controlling bandwidth differ somewhat from those used in lower-frequency r.f. amplifiers that are more commonly encountered. Three factors affect this characteristic and are used in combination to obtain the desired response. The coupling between antenna loop L_1 and the first preselector line is one of these. The size and location of the hole in the shield between the two preselectors is another factor. Finally, there is the coupling between the second preselector and L_2 , which is used to bring r.f. signal to the mixer diode.

The Tube Problem

Until recently, the oscillator tube in practically all u.h.f. tuners was in the -AF4A series. Transformer-powered receivers use the 6AF4A, while the 2AF4A (or B) and the 3AF4A (or B) are used in 600-ma. and 450-ma. series-heater circuits respectively. Although performance of these vacuum tubes, which were designed specifically for the job, was otherwise satisfactory, they exhibited one serious drawback: life in use is relatively short, with frequent replacement being required.

In March of 1959, *Radio Corp. of America* announced the nuvistor. In construction and appearance, this device is considerably different from the tubes normally found in TV sets. Internally, the elements are concentric cylinders supported in an open-ended, cantilever

Fig. 1. Inside view of the tuner "cradle" or subchassis shows most major components.



construction. They are mounted on a ceramic plate through which the tube pins pass. The ceramic plate is brazed to the metal envelope that houses the nuvistor. Seated in its socket, a typical nuvistor was slightly more than half an inch high and less than half an inch in diameter. In addition to its small size, the nuvistor offered the promise of being very rugged and having considerably longer life than conventional tubes.

The first versions available for experimental use included triodes that could operate at frequencies as high as the v.h.f. band. The original nuvistor, which had five pins protruding from its base, could not be made to oscillate at frequencies high enough to cover the u.h.f. band. This failure was due to the considerable inductance of the lead pins in the plate and grid circuits, which accounted for a large part of the oscillator inductance. The effect of each of these pins in tuning the circuit was reduced by shunting each one with the inductance of another lead.

Specifically, an additional pin was brought out from the grid and both were connected in parallel to the tuned oscillator line. An additional pin was also brought out from the plate and connected across the original plate pin to the plate bypass capacitor, C_5 . However, this was not as easy to accomplish as it may sound.

The small size of the nuvistor has already been indicated. The addition of two more pins to the tube meant that it was necessary to insert two more contacts in an already compact socket. The five-contact socket used for the original nuvistor was made of a mica-filled, phenolic material. With the reduced spacing between contacts that resulted from the use of seven pins, this insulating material was no longer satisfactory. Another was needed that could be molded to the desired tolerances and still provide the low dielectric constant and low-loss properties needed at ultra-high frequencies. The search ended with the only material available that meets these requirements: polychlorotrifluoroethylene, Kel-F.

The experimental type number assigned to the nuvistor during development was 15239, with suffix letters designating refinements added as work was in progress. (At this writing, RCA is offering experimental samples to manufacturers as type No. 15239G.—Ed.) Other advantages are offered by this u.h.f. triode in addition to its high life expectancy, which is several times that of the tubes it replaces. Its power consumption is low. Its rugged construction withstands shock and vibration very well. These two characteristics, in addition to its small size, are particularly important in portable receivers. In any type of receiver, its metal envelope and metal guide pins acting as grounds provide another advantage: the need for a separate tube shield is eliminated.

Other Considerations

The problem of keeping all extraneous inductance to a minimum is not confined to the nuvistor. For example, a

ceramic disc capacitor (C_2) is connected between the diode mixer and ground. This is a special unit in that ribbon leads are used in place of the wire leads normally found on such a unit. A special capacitor was also designed for use in the oscillator plate. Two wide, metal tabs provide a common connection from one side of this component for the two plate pins of the tube. The metal body of this capacitor is soldered directly to the tuner chassis, providing the shortest possible connection for the other side.

Other special measures are taken to obtain the desired performance characteristics and also to maintain them at the critical frequencies involved after the tuner has been subjected to use. The chassis cradle, for example, has been cadmium plated for protection against corrosion. Silver plating is used on the r.f. preselector lines and the oscillator line to provide high- Q elements. This results in circuits exhibiting low loss and low noise figures.

Alignment will not usually be necessary on this tuner. However, if it should be required after service in the field, the general procedure to be followed is similar to that used on a broadcast receiver. In each case, one is dealing with a continuously variable, superheterodyne device that uses ganged, air-dielectric capacitors.

The first step is to adjust the low-end oscillator trimmer (C_1 in Figs. 1 and 2) for an oscillator frequency of 505 to 510 mc. with C_1 set for maximum capacitance (plates closed). With an inter-

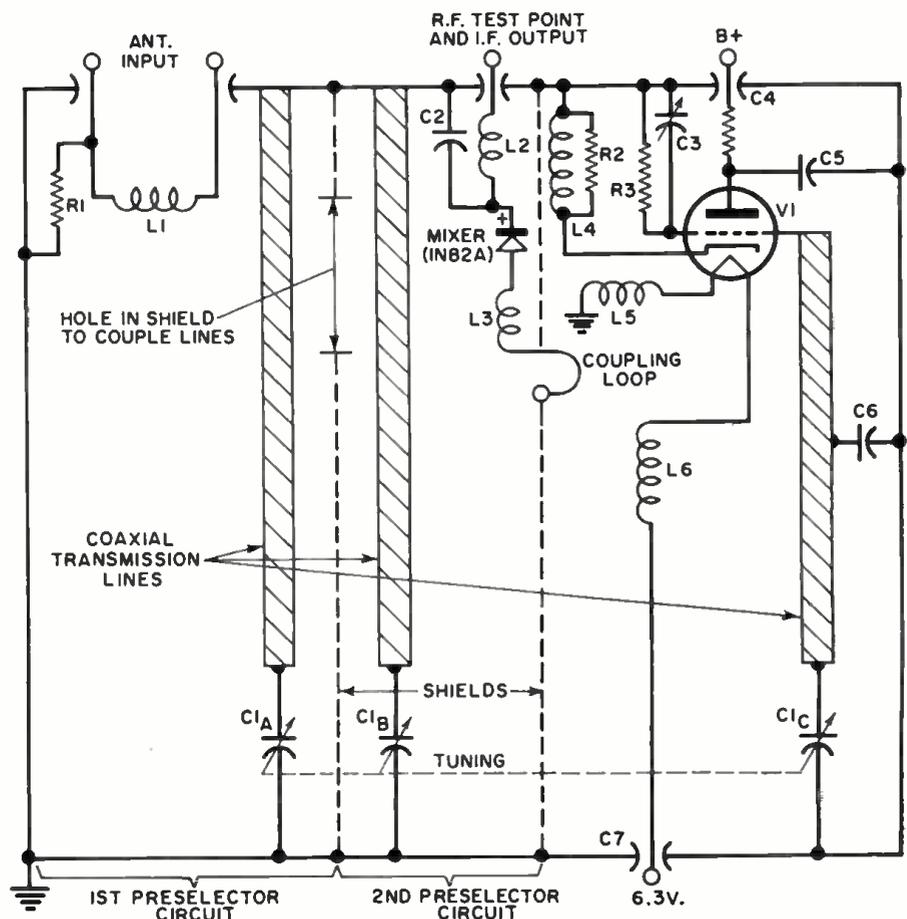
mediate frequency of 43 mc., this corresponds to an r.f. setting of 462 to 467 mc. for the low end of the band. The lowest u.h.f. broadcast frequency, on channel 14, is 470 mc.

C_1 is then rotated to minimum capacitance. The position of the oscillator trim tab, shown in the photograph, is then manually adjusted for the proper high frequency of 939 to 945 mc., corresponding to an r.f. setting of 896 to 902 mc. The highest frequency to be received, on channel 83, is 890 mc. With these first two adjustments completed, the end points for oscillator frequency are correctly established.

There is also a trim tab for each of the r.f. preselector lines. If it is necessary to re-adjust for acceptable band-pass, the adjustment is made with these tabs while the tuning capacitor is left in minimum-capacitance position. Starting in this same position, tracking may be checked and corrected by rotating the tuner slowly toward the low end of the band. Wherever deviation is noted, adjust the rotor blades in both preselector sections to bring tracking in line. Note that the oscillator blades are never adjusted. Doing so would change dial calibration substantially.

When it becomes necessary, the alignment procedure is not unduly elaborate or difficult. The reliability of the nuvistor and the measures taken to keep the entire tuner design relatively trouble-free should both contribute to minimizing the incidence of service problems in general. ▲

Fig. 2. For convenient reference, the tuner schematic follows actual layout closely.



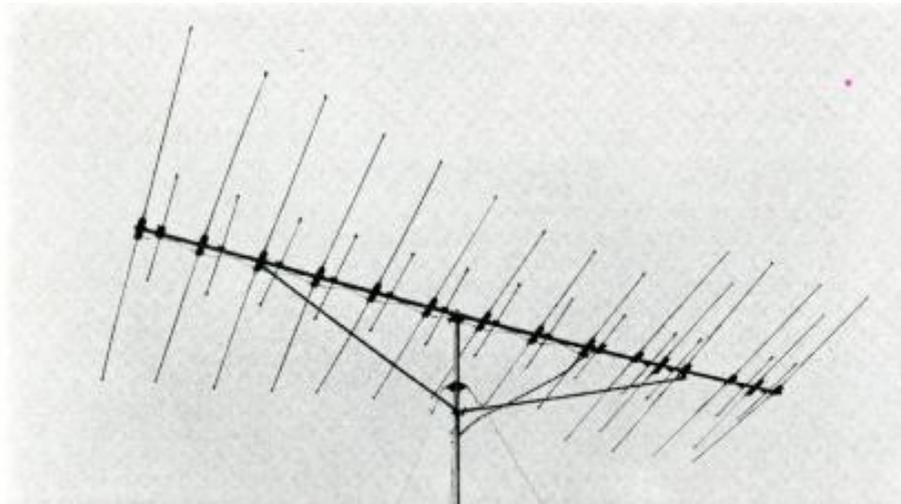


Fig. 1. Deluxe model of "Crossfire." Other available versions use fewer elements.

A NEW BROADBAND TV ANTENNA

By HAROLD HARRIS / V.P. Engineering, Channel Master Corp.

Proportional energy absorption by many elements permits high all-channel gain, sharp directivity.

MANY difficulties beset the engineer who would design a high-performance TV antenna for all-channel, v.h.f. use. Foremost among these is the manner in which channels have been allocated. They exist from 54 to 216 mc., encompassing a frequency ratio of 1 to 4. Furthermore the range, instead of being continuous, is divided into two, separated bands. This pattern of distribution is discouraging when one recognizes that antennas, because they are inherently frequency-selective devices, operate best over limited bandwidths.

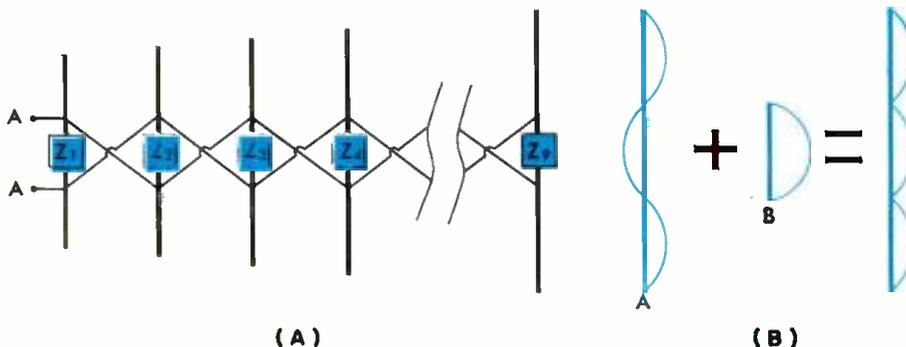
High-efficiency, broadband designs, in one way or another, rely on a multiplicity of elements to obtain operation at all frequencies. This generally means that, at any given frequency, most of the elements are contributing little to the performance, with one or a few doing most of the work. Also, as a result of the compromises that are made, frequency

response is erratic, being good at some frequencies and poor at others, and antenna impedance may vary greatly on different channels.

A Channel Master research team, under the direction of Chief Engineer Harry Greenberg and including Project Engineer Charles Liu, sought to overcome these problems and to achieve effective dual-band operation with higher gain and higher front-to-back ratios than were realized heretofore. The result was the "Crossfire" design, which incorporates many noteworthy features.

The most elaborate version of the "Crossfire" appears in Fig. 1, with the forward portion of the antenna pointing to the right. From the rear of the antenna to the feedpoint, we find 18 elements in all. Actually, these are 9 dipoles, each with an associated, shorter parasitic element. From the feedpoint to the front of the antenna, the elements constitute a "director group." This re-

Fig. 2. The driven elements of the "Crossfire" (A) may be regarded as parallel impedances across the interconnecting harness. Addition of a high-band parasitic element (B) enhances harmonic-mode operation of a dipole cut to a lower band.



finement, which does not exist on all models, is not our main concern. Of principal interest are the 9 dipoles, which are interconnected with a single harness.

An obviously interesting feature of the system is the fact that it is front fed. Also, all 9 dipoles are driven elements, which are connected in parallel with the 2-wire feedline running from the transmission line. This feedline itself is transposed between each successive pair of elements. The antenna is so designed that, at any particular frequency, many elements are simultaneously active. This phenomenon is related to the use of the principle of "proportional energy absorption" on both bands. Finally, despite the high front-to-back ratios, the antenna does not employ a reflector element.

The key to the high gain is the fact that several dipoles rather than one function at any given frequency. This was obtained, in part, by departing from the conventional practice of making active elements individually resonant at particular channels or frequency ranges. Instead elements were designed so that their interaction at any given frequency would produce the desired result: the signal-gathering abilities of several active elements are combined. To accomplish this feature, in turn, great care was exercised in adjusting the impedances of the individual elements and maintaining critical impedance relationships at all frequencies.

To better illustrate the importance of

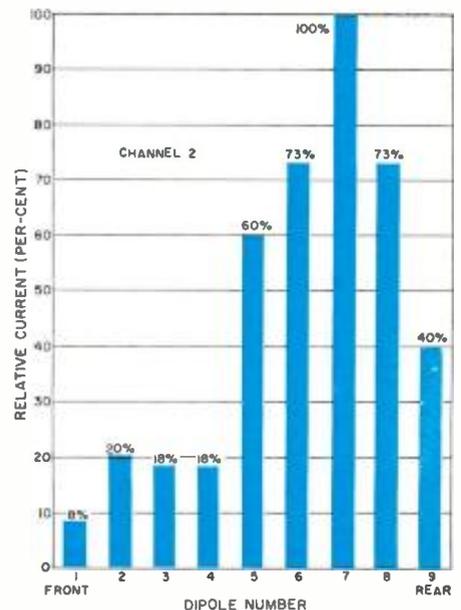


Fig. 3. Relative absorption of current in the 9 driven elements on channel 2.

impedance, we resort to the valid principle of reciprocity. That is, antenna operation during transmission rather than reception will be described; performance characteristics and patterns are identical in transmission and reception. In Fig. 2A, each driven element is represented as an impedance at a particular frequency and the elements, numbered beginning at the front of the

(Continued on page 100)

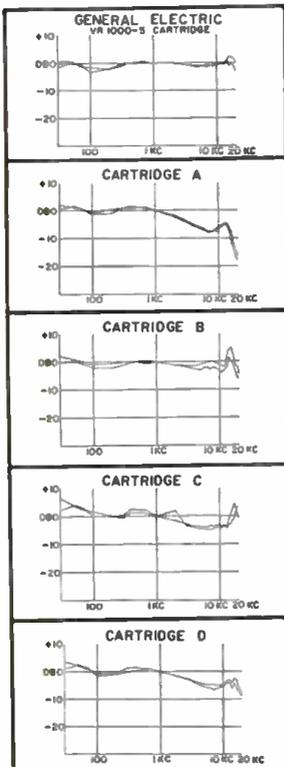


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Specifications for General Electric VR1000-5 .5 mil Diamond Stereo Cartridge (Also available with .7 mil diamond stylus, for record changers that track from 3-7 grams vertical force). **Application:** Professional-type turntable and tone arm, or any quality changer that tracks below 4 grams vertical force. **Recommended Tracking Force:** 1-3 grams. **Lateral Compliance:** 6×10^{-6} cms/dyne. **Vertical Compliance:** 9×10^{-6} cms/dyne. **Frequency Response:** 20 -20,000 cycles per second ± 3 db. **Recommended Load Resistance Each Channel for Flat Response:** 47K ohms. **Output:** 1 millivolt per cm/sec. minimum. **Separation between Channels:** 25-30 db per channel at 1000 cycles. Channel balance at 1000 cycles 2 db or better. **Resistance:** 1100 ohms per channel, nominal. **Inductance:** 400 mh, per channel, nominal. **Shielding:** Triple mu-metal. **Mounting Centers:** Standard $\frac{1}{2}$ " mounting centers. All measurements taken from RCA Victor stereo test record no. 12-5-71. Audio Products Section, Decatur, Ill.

GENERAL  ELECTRIC

CAPACITOR LEAKAGE PROBLEMS

DURING recent years, there have been vast improvements in the design and construction of all types of capacitors. Nevertheless, a recent examination of the records of one of the nation's largest TV servicing agencies reveals that the major cause of TV set failure, exclusive of tube defects, is the result of one or more faulty capacitors. In fact, capacitors were involved in over 63 per-cent of such cases. With a hundred or more capacitors in the modern TV receiver, this result should not be too surprising.

Some capacitors short; others open. These are easy to find. The real headaches and lost time are the result of leakage, which may be anywhere from slight to appreciable. The causes of leakage are varied. In tubular types, they include such imperfections as tiny, conductive particles in the dielectric; carbonization of portions of the dielectric resulting from repeated arc-overs; poor connections; and a number of other effects already familiar to the modern technician. In ceramic types, when the dielectric or silver-film plates crack or break, the capacitor will show a significant reduction in capacitance. This effect, instead of helping, further confuses and complicates troubleshooting.

Leakage is conveniently considered equivalent to having a d.c. resistance connected across the capacitor, the ohmic value of this resistance depending, of course, on the degree of leakage. Yet this degree is not the only factor that determines effects on circuit action. In some circuits, high leakage (a low leakage resistance) of 1000 ohms will cause no noticeable trouble. In other circuits, slight leakage, such as the equivalent of a high leakage resistance of 1000 megohms, may produce considerable woe. Such possibilities do nothing to simplify the matter of detection.

What Leakage Does

Let's consider the effects of various degrees of leakage in different circuit applications by citing specific examples. For instance, what is the result of a large leakage (low resistance) of 1000 ohms? If it occurs in bypass capacitor C_1 of Fig. 1, which is across a 100-ohm cathode resistor, it would cause very little disturbance. In fact, it would very

likely go unnoticed. The effective resistance in the cathode circuit would be about 91 ohms—an unimportant drop from the original 100. But introduce this same amount of leakage in a plate-to-grid coupling capacitor, like C_1 in Fig. 1, and serious disruption results. The effect in capacitors C_2 and C_3 would also be serious, but less severe.

All of this may seem quite elementary, so let us consider the condition of slight leakage, a subject on which all

technicians do not agree. What result would a leakage of one megohm have in a cathode-bypass or plate-bypass capacitor? The adverse effect would be small. In a plate-to-grid coupling application, however, it might be almost as detrimental as a short circuit. And what of a really high leakage resistance, in the order of 100 megohms? Assume this occurred in a plate-to-grid coupling capacitor. Many technicians would say this amount is insignificant. Actually it can disrupt the circuit seriously.

Observe the example in Fig. 2. The plate voltage of 300 v.d.c. from the preceding stage is dropped across the leakage resistance (100 megohms) of capacitor C and the 2 megohms of grid resistor R in series. A simple calculation shows that only about 6 volts is dropped across the grid resistor. But this positive drop cancels out most of the normal bias, dropping it from -8 to about -2 volts. The change is usually enough to cause unmistakable trouble.

But let's go one step further. Assume a fantastically small leakage, say 1000 megohms, in this same capacitor. Also assume the same circuit except that normal grid bias is -2 volts. Now we get a positive drop in the grid resistor of only .6 volt, reducing bias from -2 to -1.4 volts. This should not cause trouble, you might say. But consider a critical circuit, such as a video amplifier. The change could cause sync clipping and unstable sync action. Thus, even an extremely high leakage resistance should not be ignored, especially when one is involved in a difficult, puzzling job.

Testing for Leakage

Too many technicians, even those who know better, still rely on ohmmeter tests for capacitor leakage. High resistances, still low enough to cause trouble, often will not show up. Besides these instruments apply very low voltages to the component during the test. Leakage that may show up under the stress of the higher voltage used in the actual circuit may not even take place with the ohmmeter's potential applied.

These difficulties are easily overcome, however, by taking a voltmeter reading in the circuit. The instrument is used on a low d.c. scale, on which it should

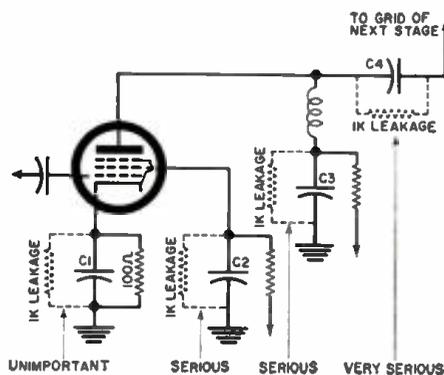


Fig. 1. Position and use of the component in the circuit determines whether the effects of leakage will be serious.

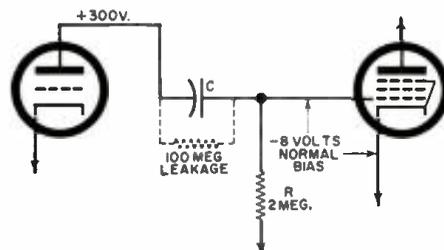


Fig. 2. Leakage in interstage coupling unit may disrupt bias in second stage.

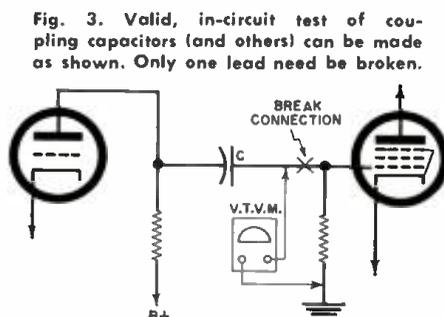


Fig. 3. Valid, in-circuit test of coupling capacitors (and others) can be made as shown. Only one lead need be broken.

A large amount may be unimportant, but a small amount may be serious. How to test and tell the difference

have a high input resistance. A v.t.v.m. is obviously recommended. The exact set-up for the test will depend on the circuit arrangement, but Fig. 3 is a general guide. Connections from the low-voltage side of the capacitor are severed and the positive v.t.v.m. lead is connected to this end, the other to circuit ground. If there is leakage resistance, it will form a series circuit with the meter's resistance across which the "B+" will be dropped. With input resistance and the value of "B+" on the capacitor's high side known, it would be possible to calculate leakage resistance from the instrument reading.

It is not always necessary to break the connection. If the circuit allows, as in the case of Fig. 3, one would merely have to remove the second tube from its socket. Although this method is more convenient, it is usually less sensitive; for the meter is shunted by the grid resistor, and total resistance is thus reduced.

When the meter probe is first touched to the capacitor, the needle will jump, but it should return to near zero promptly if the capacitor is sound. If the pointer fails to return close to zero—the capacitor should be replaced.

Often it is desirable to test a new capacitor before installing it in a critical circuit. For an effective check, connect the capacitor across a portion of the circuit that will provide a voltage equal to the working voltage of the component. One end of the capacitor is simply connected to the appropriate, positive potential. The positive lead of the d.c. v.t.v.m. is connected to the other end, and the negative lead from the instrument goes to ground or "B-." In effect, this sets up a condition similar to that of Fig. 3.

Erroneous Readings

Often a technician misleads himself with the manner in which he makes measurements. This frequently happens when he is taking bias readings at the grid of a stage. Such measurements tend to be closely related to the phenomenon we are discussing here. For example, note the relationship in Fig. 2, where capacitor leakage affects bias appreciably. Many technicians, lacking service data for the specific equipment

under consideration, will measure bias by taking a reading from grid to chassis. In some circuits, such as the one in Fig. 4A, a correct reading will be obtained.

In other cases, the method will not

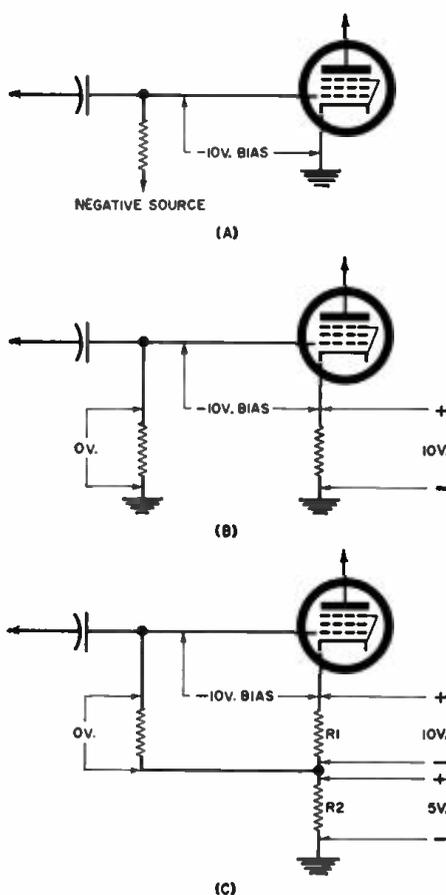
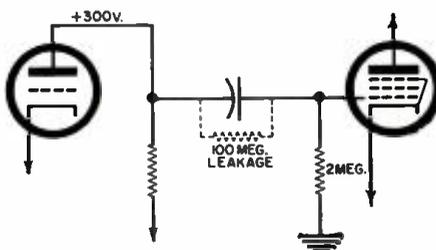


Fig. 4. While grid-to-ground readings may reflect actual bias (A), there are many cases (B, C) where this is not so.

Fig. 5. Circuit in which loading of low-resistance voltmeter may falsify reading.



work. In Fig. 4B, however, there is a 10-volt drop. Thus, although there is no significant drop across the grid resistor, leaving the grid virtually at ground potential, there is a grid-cathode bias of -10 volts that does not show up in a reading taken from grid to ground, across the grid resistor. The grid-cathode reading reflects actual working conditions. Another example that may mislead appears in Fig. 4C. The actual bias is -10 volts, obtained across the upper cathode resistor, R_1 . A reading from grid to chassis would yield 5 volts, which is misleading. The technician might begin a hunt for trouble where none exists. The best procedure is to consult service data for the equipment whenever it may be obtained and, when it is not available, to stop and think before plunging ahead.

Mention has been made of the preference for a v.t.v.m. over a v.o.m., even if the latter has a 20,000-ohms-per-volt rating. A review of the differences in readings obtained in high-impedance, critical circuits is worthwhile. Consider the circuit of Fig. 5. Assuming leakage resistance across the capacitor to be 100 megohms and normal voltage across the 2-megohm resistor to be zero, voltage at the grid of the second tube will be 6 volts positive. If a grid-to-ground reading is taken at the second tube with the v.t.v.m., the instrument will shunt down the grid resistance somewhat. As a result of this loading, the voltage will drop somewhat, but it will still be well above 5 volts. This is close enough to permit correct interpretation of what is happening. When the v.o.m., used on its 5-volt scale, is shunted across the grid resistor, ohmic value drops to approximately 100,000 and the measured potential is only .3 volt.

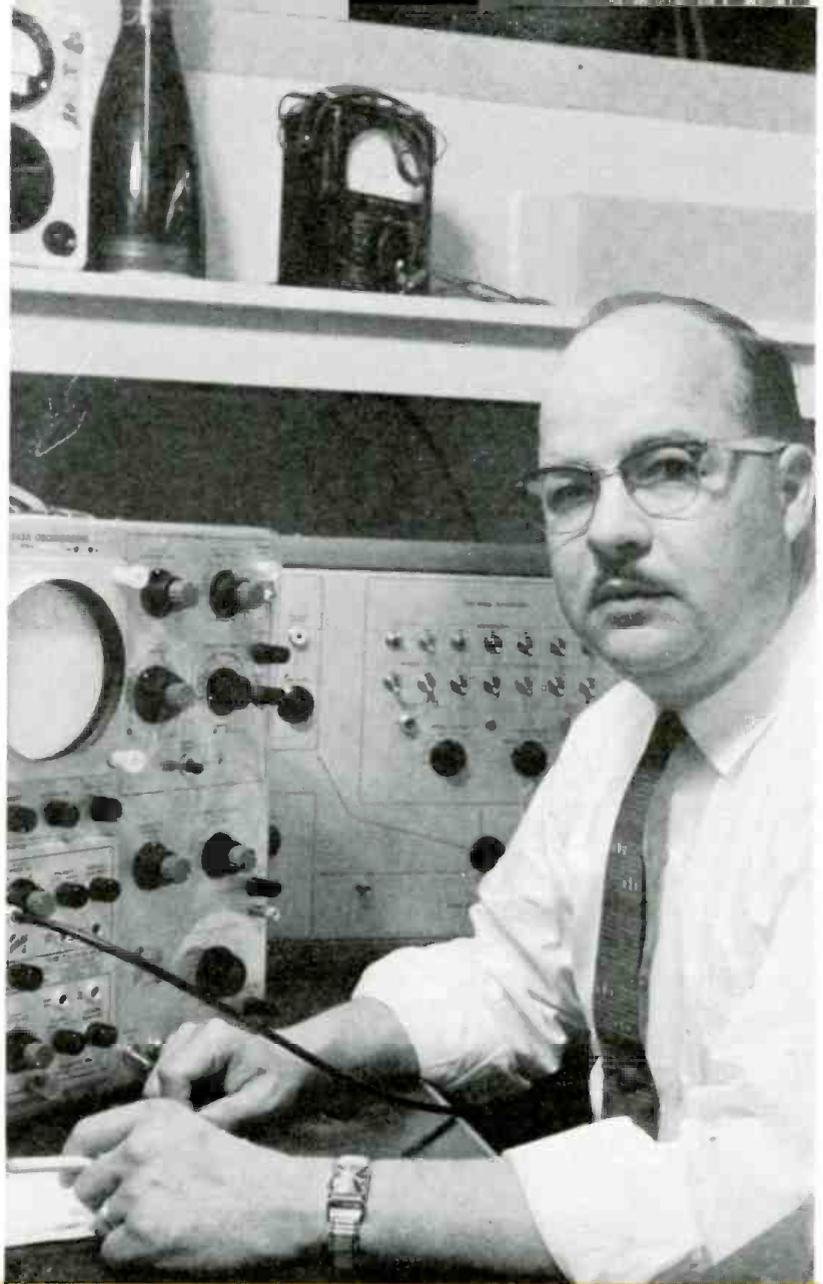
Suppose leakage resistance in the capacitor were 1000 megohms. The actual grid voltage would be .6 volt. A v.t.v.m. reading would show over .5 volt, which is still respectable. The v.o.m. reading would be .03 volt. Conclusion: stick to the v.t.v.m., with its high input resistance on low-voltage scales, for leakage tests, as you should do in any low-voltage, high-impedance circuits. You can trust your test instruments only if you know which ones are to be trusted and when. ▲



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“I am indeed grateful to CREI for my success. Since enrollment in a CREI Home Study Program in Electronic Engineering Technology, I have progressed from a Junior Technician to a recognized and licensed Senior Engineer. My present title is Field Support Manager and my salary has increased by a factor of four (4).”

*Mearl Martin, Jr., SENIOR ENGINEER
Field Support Manager, Tektronix, Inc.,
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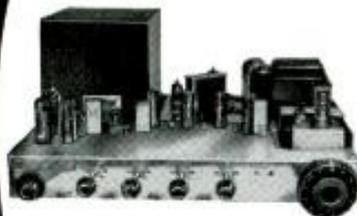


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IMPEDANCE MATCHING IN AUDIO CIRCUITS

By JOEL H. LEVITT

Some misconceptions on the optimum values of load impedances that are employed in audio amplifiers.

MANY people have the mistaken notion that a load impedance should always equal the impedance of the source driving it, since maximum power is then delivered. The confusion arises for two reasons: (1) maximum load power may be an irrelevant or even undesirable condition, and (2) the matching condition does not hold for non-linear circuits, such as an audio output stage.

Consider a 117-volt power generator matched to its load. The power delivered to the load will be the maximum that this generator can supply, but the power dissipated in the generator will be equal to the load power ($I^2 R_g = I^2 R_L$). We would have an efficiency of only 50%. Since efficiencies over 90% are essential to the power industry, generator output resistances are made much smaller than those of expected loads.

Cross-Coupled Inverter

Now, let's consider the often-used circuit of Fig. 1 which is part of the popular "cross-coupled phase inverter." Cathode-follower V_1 , which behaves as an equivalent resistance $r_{p1}/\mu_1 + 1$ works into R_K , in parallel with $(r_{p2} + R_L)/(\mu_2 + 1)$. It is not difficult to choose R_K and R_L so that $r_{p1}/(\mu_1 + 1)$ is matched. If we do this, as many people do, we get intolerable distortion. This has been pointed out with regards to cathode-followers but some people still insist on "matching."

A general rule here is that the highest gain and the lowest distortion from any vacuum-tube amplifier circuit—plate-loaded or cathode-follower—is obtained when the *minimum* power is drawn. Note that we are discussing signal

power not d.c. power. Thus we want V_1 to work into a load impedance many times greater than its equivalent impedance. The correct design approach here is to make V_2 a much lower g_m tube than V_1 ($g_m = \mu/r_p$) and to make R_L and R_K both as large as d.c. conditions will allow.

Output Matching

Let us now turn our attention to a power-output tube driving a loudspeaker through an output transformer. If the tube were completely linear, as it is for very small signals, we could represent it as having a constant open-circuit output voltage and a constant resistance r_p , and distortion would be no problem. Efficiency would be less than 50% but this would not be improved by any other impedance ratio since 50% is the ideal maximum for any class A amplifier.

However, because the tube is not linear, we have two problems. First we must find the load that will absorb maximum power and then we must consider distortion and find whether the optimum compromise load is a little bit higher or lower than this. Laborious trial and error calculations, using tube characteristics curves or experimental power output and distortion vs load-resistance measurements, show that the optimum load may be anywhere from a small fraction of the plate resistance (for pentodes) to several times the plate resistance (for triodes).

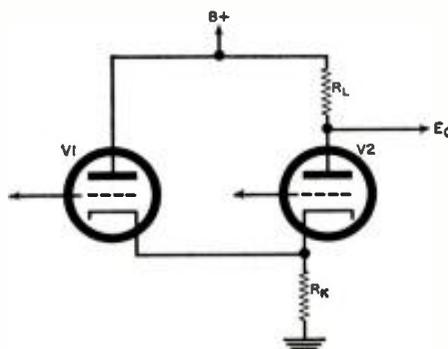
For pentodes an approximate recommended value of load is $R_L = .9E_b/I_b$ where E_b is the plate-to-cathode voltage and I_b is the plate (not total) current. For triodes $R_L = E_b/I_b - 2r_p$ is a reasonable value. For triodes or pentodes E_b is chosen as high as possible and I_b is as large as plate dissipation allows. An exception is the unusual triode for which the high plate current $I_b = \frac{1}{4}(E_b/r_p)$ is allowable in which case $R_L = 2r_p$ is recommended. (Do not forget that universal design equations of this type are only rough approximations.)

Another useful approximate rule is to double the optimum load to get the plate-to-plate impedance for push-pull operation. Happily, popular power tubes have their optimum loads tabulated by the tube manufacturer, making the job easy for the user.

REFERENCE

1. "Radiotron Designer's Handbook," Fourth Edition, pages 556-557. ▲

Fig. 1. Partial schematic diagram of frequently used cathode-coupled phase inverter.



Calibration Oscillator

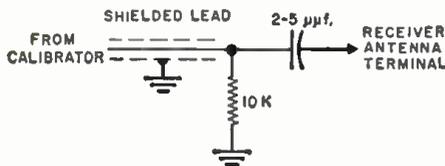
(Continued from page 57)

by pressing the push-button. With this circuit there is a short warm-up interval after the calibrator is turned on and before it can be used. If "instantaneous" use is desired, the filaments should remain heated continuously and the plate voltage alone should be switch-controlled.

Calibrators of this general type have an average tube life exceeding 3000 hours of operation. Neon lamp life is nominally 10,000 hours and actually much greater. All other components, except the crystal, are substantially immortal. Service life of a lightly loaded crystal is finite but very long so the crystal should not cause problems.

Extensive testing of this calibrator shows that it is a very dependable and consistent performer—well worth the three evenings and \$30.00 invested in its construction. ▲

Fig. 7. Coupling calibrator to a receiver.



VOLUME EQUALIZATION

By RONALD L. IVES

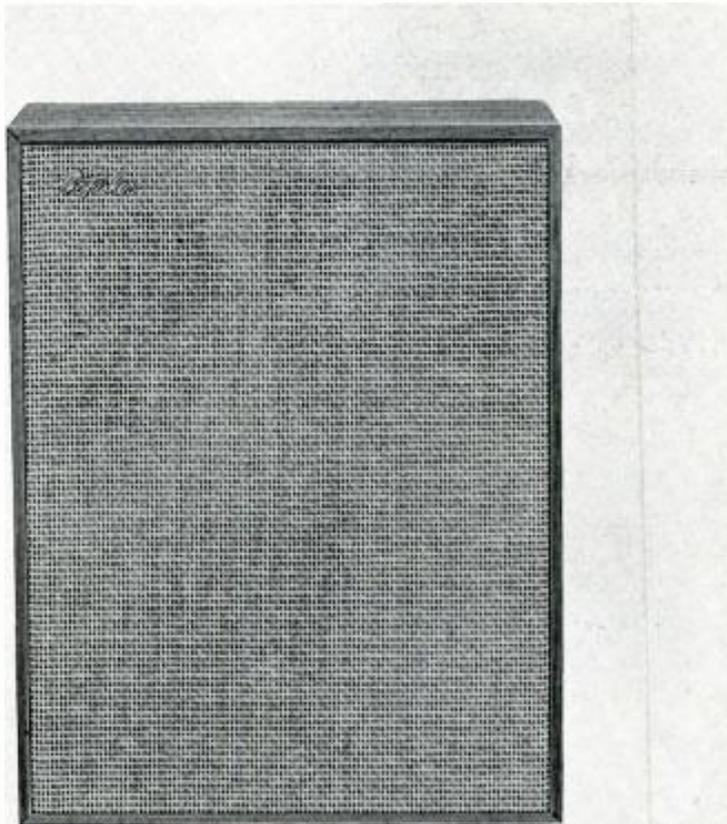
IN MOST communications receivers, insertion of the headset plug disables and silences the loudspeaker. Unfortunately, in many receivers, the volume control adjustment suitable for headset operation is entirely too high for speaker operation. In unhappy consequence, if a signal is tuned in, using the headset, and the plug is then pulled—to put the signal on the speaker—the resultant volume blasts you out of the shack and gives the neighborhood a jolt.

This annoyance can be eliminated quickly and inexpensively by inserting a "T" pad in the speaker line. This is a standard, commercially made attenuator which is so designed that the circuit impedance remains constant at all settings, while the signal transfer is manually variable from zero to maximum. Impedance of the "T" pad selected should match that of the output transformer secondary, which should also be that of the speaker.

Suitable "T" pads for this application are available from Mallory ("T" series), Clarostat ("CIT" series), and IRC ("TP" series). All will handle at least 10 watts of audio. Clarostat also manufactures a miniature "T" pad, Series CIT43, which has a rating of 4 watts.

In operation, the signal is tuned to optimum value using the headset. Then the headset plug is pulled and the speaker volume adjusted to a comfortable level by means of the pad control. Thereafter, through a wide range of signal strengths, any signal adjusted to comfortable volume on the headset will also be at a satisfactory listening level when switched to the speaker. ▲

December, 1961



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Double-Chamber Enclosure

(Continued from page 43)

loading of the double-chamber enclosure keeps the impedance of the speaker so low through the bass range that it really seems fairer in this case to call it an 8-ohm system for purposes of calculating rated power.

Now 11 volts (whether you agree that this represents about 15 watts or not) into a D216 produces an awfully loud noise. At 35 cps, even though the speaker was outside, all the windows in the building were rattling and the floor was vibrating perceptibly.

Yet, at this intensity the total harmonic distortion did not exceed 11% at any frequency above 30 cps. At 35 cps, the distortion actually dropped to 7% because this is the frequency at which the reflex action of the enclosure is most effective.

But if the low distortion of the D216 is impressive, take a look at the graph for the LE8 in the double-tuned enclosure, Fig. 3B. Again, 11 volts were required to produce the same intensity at 200 cps. Again, it seems legitimate to call this 15 watts of sine-wave power.

Notice that the distortion of the LE8 under these conditions is less than 5% at any frequency above 30 cps. At 35 cps, the total harmonic distortion is only 2%!

Once more, I want to point out that in this test the speaker was making a very loud noise. At any normal listening level, the performance of the LE8 is at least this good in a simple small vented enclosure. But for special applications such as electronic organ or string bass reproduction, the LE8 in a double-chamber enclosure makes an efficient, yet compact, system of truly outstanding bass performance.

What About Highs?

High-frequency reproduction is not affected by the enclosure, of course. But the exceptional bass possible from the double-chamber enclosure prompts the use of a high-quality 8-inch speaker having clean highs as well. A good high-efficiency speaker, such as the JBL D216, Electro-Voice SP8-B, or Altec 755C, will have good response up to 3000 cps or so before serious peaks and dips appear.

A good high-efficiency tweeter is therefore recommended to balance the full bass brought out by the enclosure. The finished system shown in one of the photographs uses a D216 crossing over to a JBL 075 ring radiator at 2500 cps. Considering size and money invested, the performance of the system is superb.

Construction

The exact dimensions of the double-chamber enclosure are not critical. The

main chamber should be 1.8 to 2 cubic feet in volume and the smaller chamber should be between .9 and 1 cubic foot. The dimensions shown in Fig. 1 are convenient and can be used for either a horizontal or vertical unit.

The two outside ports can be located on any surface. In the finished enclosure shown in the photograph, the ports are located on the bottom rather than the front of the cabinet.

The enclosure must be solidly put together of 3/4" stock. Particle board ("Novaply," "Timblend," etc.) is recommended because of its comparatively high density. Whichever panel you make removable for installation of the speaker, use plenty of screws to hold it in place. Note the "bank vault" appearance of the unit in the photos.

The interior surfaces of the main chamber should be liberally lined with glass wool or similar absorptive material. It is not necessary to line the second chamber, but it won't hurt to use the remaining scraps of padding here.

The drawings show three port tubes of circular cross-section. These are actually heavy cardboard mailing tubes with inside diameters of 2 1/2" and lengths of 7 1/2". If it is easier to build wooden tubes of rectangular cross-section, they will work just as well. The cross-sectional area of each tube is 6 square inches. Inside dimensions could thus be 2"x 3", 1 1/2"x 4", etc.

Any Questions?

Q. Can I install a 12-inch speaker?

A. Not in the enclosure shown. Why would you want to?

Q. What causes the "hole" at 65 cps?

A. Interaction between the two chambers which I was not able to foresee when I made the original design. The hole is only about 3 db deep and unnoticeable in listening tests, but it can probably be smoothed out by making the second chamber a little smaller in relation to the first, and then re-adjusting the lengths of the three port tubes.

Q. How good is the performance of a cheap 8-inch speaker in this enclosure?

A. A husky speaker in the \$8.00 to \$15.00 class can be expected to perform quite well down to about 40 cps in the double-chamber enclosure. But you naturally won't be able to get powerful bass with the low distortion afforded by better speakers.

Q. Will this design be made available commercially?

A. As far as I know—no. The general public is willing to accept an 8-inch speaker in a bookshelf enclosure, but once the cabinet grows to 3 or 4 cubic feet, people install a 12- or 15-inch speaker no matter what the experts say.

Q. Some of your statements sound pretty far-fetched for an 8-inch speaker. Aren't you really exaggerating a little?

A. No. ▲

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Technical BOOKS

"101 KEY TROUBLESHOOTING WAVEFORMS FOR SYNC CIRCUITS" by Robert G. Middleton. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 122 pages. Price \$2.00. Soft cover.

This newest volume in the author's "101" series pinpoints trouble in sync stages by relating distorted waveforms to specific component defects. For each of the troubles there is an oscillogram plus a complete text description of the symptoms, as well as voltage and resistance changes, evaluations of tests, and troubleshooting procedures to be followed to clear up the fault.

The text is practical, down-to-earth, with all extra verbiage and frills eliminated in the interest of providing the technician with fast answers to his service problems.

* * *

"OSCILLATOR CIRCUITS" by Thomas M. Adams. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 118 pages. Price \$2.95. Soft cover.

This is a basic explanation of how oscillator circuits work and is the first in a projected series on circuit fundamentals. The text covers crystal, Hartley, Colpitts, tuned-plate tuned-grid, electron-coupled, phase-shift, and blocking oscillators, plus multivibrators and thyatron saw-tooth generators.

A unique feature of this text is the use of four-color diagrams to indicate circuit action during successive half-cycles or quarter-cycles. Each electron current is identified and discussed in detail so its path can be followed through all parts of the circuit.

* * *

"TELEVISION AND RADIO REPAIRING" by John Markus. Published by *McGraw-Hill Book Company, Inc.*, New York. 558 pages. Price \$8.95. Second edition.

This is a revised and up-dated version of the author's 1953 book and includes several new chapters to cover recent advances in the state of the art such as printed circuits, transistors, selenium and germanium rectifiers, wire-wrap connections, remote-control devices, clock-radio timers, etc.

Like the earlier volume, the text is based on the assumption that the reader has had no previous experience in television or radio but is of average intelligence and electronically oriented. Emphasis is on simple, practical procedures and how-to-do-it information which can be applied to actual receiver circuits right from the start.

Entirely suitable for home study, the book also includes information on tools and components with which the reader may or may not be familiar.

* * *

"TELEVISION TUBE LOCATION GUIDE" by Sams Staff. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. Price \$1.25. Soft cover.

This is the eleventh volume in this publisher's series of service handbooks designed to eliminate the necessity for removing the TV chassis for preliminary diagnosis. The layout diagrams show the location, type number, and function of all tubes in the various chassis covered.

In addition to the information about tubes, the volume includes data on fuses in the receivers covered. This book also contains the combined index for Vol. 9 through 11, covering receivers produced from 1958 to 1961.

* * *

"MICROWAVE FERRITES" by P. J. B. Clarricoats. Published by *John Wiley & Sons, Inc.*, New York. 255 pages. Price \$8.00.

This volume is intended for microwave engineers and designers and serves as a guidebook and introduction to the microwave properties of ferrites. Since this represents the first unified source of information on developments in this field, those concerned with the uses and behaviour of ferrites in the microwave region will find this book invaluable.

The text material is divided into six chapters dealing with an introduction to the field, the general properties of ferrites, microwave behaviour of ferrites, loss mechanisms

in ferrites, propagation through ferrites and ferrite-loaded waveguides, and microwave components employing ferrites.

Since the text is written for engineers, no concessions have been made to those without the requisite mathematical and engineering background.

"PLASMAS AND CONTROLLED FUSION" by David J. Rose & Melville Clark, Jr. Published jointly by MIT and John Wiley & Sons, Inc., New York. 474 pages. Price \$10.75.

The text, by two nuclear engineering professors at MIT, is prepared for students at the graduate level and covers the principles underlying plasma physics and controlled fusion. Prerequisites include a moderate knowledge of atomic physics, differential equations, electricity and magnetism, and thermodynamics.

The first twelve chapters cover plasma physics, hydromagnetics, and elementary gaseous electronics in association with transport and electromag-

netic theories. The last four chapters deal more specifically with the controlled fusion problem, including experimental and theoretical approaches, and methods of eventual energy recovery.

"ESSENTIALS OF RADIO-ELECTRONICS" by Morris Slurzberg & William Osterheld. Published by McGraw-Hill Book Company, Inc., New York. 696 pages. Price \$10.00. Second edition.

In the authors' earlier volume published in 1948, the emphasis was on radio. Now some 13 years later the text has been expanded considerably to include the burgeoning field of electronics.

The text material is written at an intermediate level and since mathematical treatment has been kept to a minimum, the book is suitable for home study as well as classroom use.

The book is divided into sixteen chapters covering an introduction to radio, vacuum tubes, AM detector circuits, tuning circuits, r.f. amplifier circuits, a.f. voltage-amplifier circuits, power-

amplifier circuits, vacuum-tube oscillators, power supplies, audio units and hi-fi reproduction, AM and FM receiver circuits, transistors, transistor amplifiers, transistor receiver circuits, and test equipment. Nine appendices containing useful reference material make this self-contained volume doubly helpful to the student.

"A GUIDE TO FORTRAN PROGRAMMING" by Daniel D. McCracken. Published by John Wiley & Sons, Inc., New York. 86 pages. Price \$2.95.

This is a workbook for those interested in learning how to use a computer in the solution of problems in science and engineering without the necessity for learning details of computer operation.

Written as a basic text for use in courses in engineering, science, or mathematics, the book can also be used by the individual to amplify and/or clarify other Fortran programming manuals or texts. Graded exercises and answers

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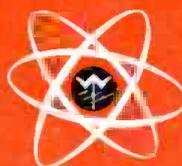
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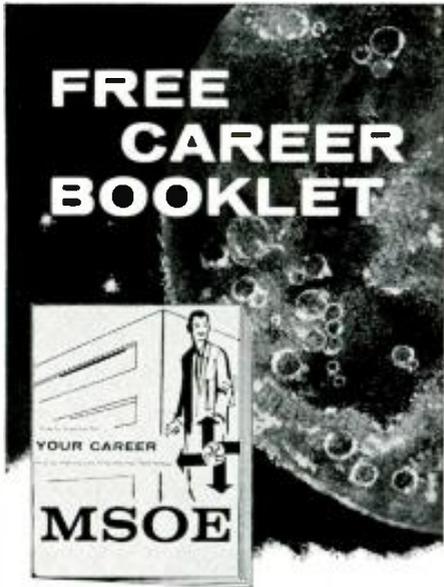
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have been included along with eight case studies illustrating practical applications of the technique.

"SENSORY COMMUNICATION" edited by Walter A. Rosenblith. Published by MIT Press and *John Wiley & Sons, Inc.*, New York. 824 pages. Price \$16.00.

This volume represents the contributions of 42 participants in the International Symposium on Principles of Sensory Communication held July 19 through August 1, 1959 at Endicott House, Massachusetts Institute of Technology. Drawing on the experiences of an international group of life scientists, physical scientists, and communications and computer engineers, the symposium considered the problems of interest to those working in the field of telephone communication, radio, television, and photography.

This volume is a distillation of the group's deliberations.

"ABC'S OF TAPE RECORDING" by Norman H. Crowhurst. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 92 pages. Price \$1.50.

This is basically a primer for the new or prospective owner of a tape recorder. The language is non-technical and the explanations of the applications and operation of the machine are simple and lucid. We do, however, take issue with the author when he flatly states that open-reel type machines are "older models" and that cartridges are characteristic of "more modern machines," citing *RCA* and the *CBS/3M* as examples

of such units. In this the author is a bit premature, to say the least, since the *CBS/3M* machine is not even on the market.

The text is elaborately illustrated with line drawings and photographs of actual equipment. The six chapters deal with the components basic to all tape recorders, how to choose a tape recorder, how to use it, simple things that can be done with a recorder, practical applications, and advanced uses for such equipment. A glossary of terms is also appended.

"COLOUR TELEVISION" by P. S. Carnt & G. B. Townsend. Published for "Wireless World" by *Iliffe Books Ltd.*, Dorset House, Stamford Street, London SE1, England. 480 pages. Price 86 s./9 d. postpaid.

This book describes the British version of our NTSC color-TV system with emphasis on the 405-line version but also taking into account the differences among the 405-525-, and 625-line systems. In this way the authors have eliminated the threat of obsolescence since the standards for color TV have not been officially established in Europe.

A thorough working knowledge of black-and-white television theory is prerequisite and although, on the whole, the treatment is non-mathematical, a familiarity with mathematical processes and procedures would prove helpful.

There is a section prepared specifically for service technicians as well as chapters on circuit theory and practical color-TV circuits. ▲



JANUARY 9-11, 1962

Eighth National Symposium on Reliability & Quality Control. Sponsored by PGRQC, AIEE, ASQC, and EIA. Statler-Hilton Hotel, Washington, D.C. Program information from E. F. Jahr, IBM Corp., Dept. 351, Owego, N.Y.

JANUARY 18

Transformer Testing. Sponsored by N.Y. Metropolitan Chapter of Institute of Environmental Sciences. U.S. Testing Co. Laboratories, Hoboken, N.J. For program information contact Carl Hanne-mann, 214 E. 105th St., New York 29, N.Y.

JANUARY 23-27

Third Annual ERA Convention & Management Conference. Sponsored by Electronic Representatives Assn., Hollywood Beach Hotel, Hollywood Beach, Fla. Details from ERA headquarters, 600 S. Michigan Ave., Chicago 5, Ill.

FEBRUARY 7-9

1962 National Winter Convention on Military Electronics. Sponsored by PGMIL and I.A. Section of IRE. Ambassador Hotel, Los Angeles. Details from IRE Los Angeles Office, 1435 S. La Cienega Blvd., L.A., Calif.

FEBRUARY 9-11

Pacific Electronic Trade Show. Shrine Exposition Hall, Los Angeles. Information on exhibits and program available from PETS, 2216 S. Hill St., Los Angeles 7, Calif.

FEBRUARY 27-MARCH 1

Symposium on Application of Switching Theory in Space Technology. Sponsored by Lockheed Aircraft Corp. and AFOSR/General Physics Div. Contact Dr. J. P. Nach, c/o Lockheed, Sunnyvale, Calif. for details.

MARCH 1-2

Eighth Scintillation and Semiconductor Counter Symposium. Sponsored by PGNS, AIEE, AEC, NBS. Shoreham Hotel, Washington, D.C. Program information from Dr. George A. Marton, RCA Labs, Princeton, N.J.

MARCH 14-16

Twelfth Annual Conference on Instrumentation for the Iron & Steel Industry. Sponsored by Instrument Society of America. Hotel Roosevelt, Pittsburgh, Pa. Details from H. M. Gravatt, Allegheny Ludlum Steel Corp., Research Lab., Brock-ridge, Pa.

ELECTRONIC TERMINOLOGY

By **WILLIAM A. PLICE**

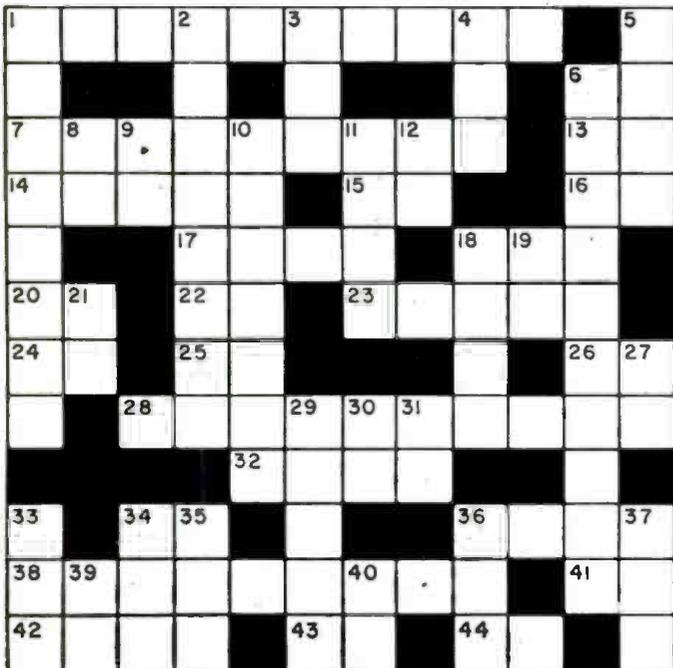
(Answer on page 98)

ACROSS

1. Degree of movability—critical in performance of speakers.
6. Frequencies usually handled by a tweeter (abbr.).
7. A horn baffle matches the _____ of the speaker to the room.
13. Approximately 52 weeks (abbr.).
14. An important component of the stereo illusion.
15. A type of hookup wire (abbr.).
16. Semiconductor used in modern power supplies (abbr.).
17. Delayed sound waves.
18. Musical notation directing a slowing of tempo.
20. Distortion caused by one frequency modulating another.
22. The base metal of the cathode in a vacuum tube (Chem. symbol).
23. Any unwanted or unrelated component of the program.
24. Chemical symbol for sodium.
25. A two-way radio service (abbr.).
26. Thoroughfare, for short.
28. Process intended to compensate for changes made in transmission or recording (pl.).
32. Small receiving antenna.
34. Frequencies present on each side of the carrier in AM transmission (abbr.).
36. Electrical element of a speaker.
38. Science of sound.
41. A few bits of this material may someday replace tubes in an amplifier (Chemical symbol).
42. Usually the frequencies below 260 cps.
43. Lightest inert gas (Chemical symbol).
44. Standard form of output transformer employs a _____ in the primary (abbr.).

DOWN

1. Distortion occurring when maximum input is reached.
2. An additional boost given to frequencies in the 3000 to 5000 cycle range.
3. The "Gem State" (abbr.).
4. Signal given as a direction.
5. An equalization curve.
6. Type of motor used in high-quality turntables.
8. 1/1000 of the basic inductance unit.
9. Early hi-fi experimenters built rigs from modified _____ amplifiers.
10. 1/10 of a bel.
11. Level indicator used in some recorders.
12. Hookup wire type (abbr.).
18. The Record Industry's trade group (abbr.).
19. Equals.
21. Small unit of current (abbr.).
27. Musical notation directing repetition from the sign.
29. Larger end of a horn.
30. This agency is responsible for the mail service (abbr.).
31. Drive motors for recorders are only fractional _____ (abbr.).
33. The broadcasters en masse.
34. Distress signal.
35. Wire or bar used for power or ground.
36. Reciprocal of a sine (abbr.).
37. Fifty-four (Roman numerals).
39. Calcium (Chemical symbol).
40. Power, according to Ohm's Law.



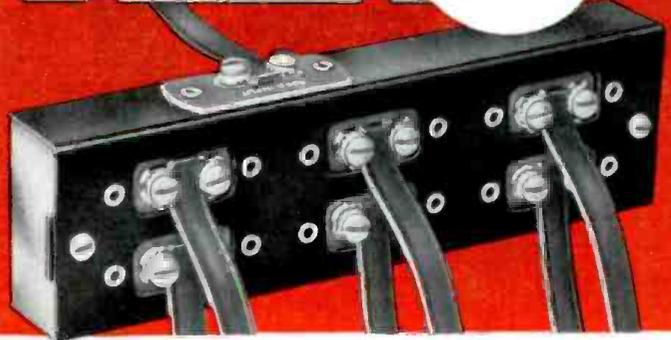
December, 1961

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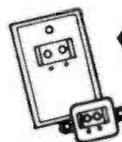
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COMPONENT & TUBE TRENDS IN GREAT BRITAIN

By PATRICK HALLIDAY

A rundown of some of the items shown in London at the largest electronic component show ever held in Europe.

THE largest component show ever staged in Europe, held in London recently, pinpointed the international tie-ins in the component industry. Many of the 250 British component, semiconductor, and tube firms represented now have close financial or technical links with their counterparts in the United States. The importance of this European market is indicated by the figure that, in Britain alone, more than seven million electronic components are manufactured daily.

For the TV and radio consumer industries, several new transistor and u.h.f. tuners were noted. One compact u.h.f. tuner by *Cydon* uses two triodes, the first as a grounded-grid r.f. amplifier, the second as a grounded-grid self-oscillating mixer (single-tube self-oscillating mixers are very popular in Europe for FM radio). The three u.h.f. tuned circuits consist of short Lecher sections tuned by a slow-motion ganged capacitor over the range 470-790 mc. TV tuners generally have swung rapidly away from rotary "detent" knob controls and there is now great emphasis on push-button mechanisms, usually providing four channels per receiver. Motorized tuners also seem to have come to stay, often in conjunction with remote control.

In the past, the series-cascode circuit has been almost universal in European TV tuners but the trend is toward more neutralized-triode and tetrode amplifiers. A new beam-triode (PC97) by *Mullard* features frame-grid construction with only the active area of the plate in close proximity to the grid to give the unusually low grid-plate capacitance of .5 $\mu\text{f.}$; this technique is similar to that of the 6ER5 tube. Another TV tuner innovation is an *Ediswan* TV frequency converter tube with the mixer section designed for connection to the receiver a.g.c. line.

Among recent European domestic tubes shown was the ELL80 (*Brimar*), a miniature double-pentode output suitable for stereo equipment either as two single-ended output tubes or as a 6-8 watt push-pull output stage. Another new output tube for stereo is the triode-pentode type ECL86. *Mullard* has described an inexpensive high-fidelity unit with total harmonic distortion well under 0.1 per-cent at 10 watts, using for each channel a single high-slope pentode (EF86) followed by two ECL86 triodes as phase-splitter and the two pentode sections as an "Ultra-Linear" output stage.

Garrard, whose phono equipment is well-known in the U.S., has a new, very slim auto-changer requiring only $4\frac{3}{8}$ " mounting space above and $2\frac{7}{8}$ " below the motorboard.

Silicon rectifiers have not thus far been widely used in British TV receivers mainly because of their low p.i.v. for the 240-volt standard line voltage. *Lucas* has a new 330-ma. unit rated at 800 p.i.v. for this application. Several firms, including *Hughes International*, featured silicon variable capacitors for remote tuning and "signal seeking" circuits.

In the transistor field, new releases tumbled over one another. Emphasis now seems to be on the epitaxial types in which a layer of semiconductor material is built up by the deposition of a gas at high temperature onto a seed crystal at lower temperature. An *S.T.C.* display showed an interesting unit containing three epitaxial transistors delivering an r.f. output of 9 watts at 10 mc. with 50% efficiency, compared with 5 watts at 5 mc. with 45% efficiency of corresponding double-diffused transistors.

Eddystone, makers of ham and other communications receivers, showed for the first time an entirely transistorized high-performance communications receiver covering 500 kc. to 30 mc. in six

ranges. It uses 12 transistors and 6 diodes; the r.f. amplifier, mixer, and oscillator being h.f. alloy-diffusion transistors now readily available in Britain. With bandpass crystal filter and operating from 12-volt batteries, the price tag is in the region of \$360.00. Other receivers in this exhibit go down to 10 kc. and up to 1000 mc.

The hybrid TV receiver with transistors for a few functions such as sync separation has already arrived on the British market and the gradual extension of transistors in TV rather than all-transistor models has been forecast for the mass market.

The panel space taken up by most meters is a problem well-known to all designers of amateur and commercial equipment. A new series of small rectangular meters, taking little more than one square inch of panel space, was shown by *M.I.P.* The edgewise mounting of the movement provides a very clear scale for such a small meter.

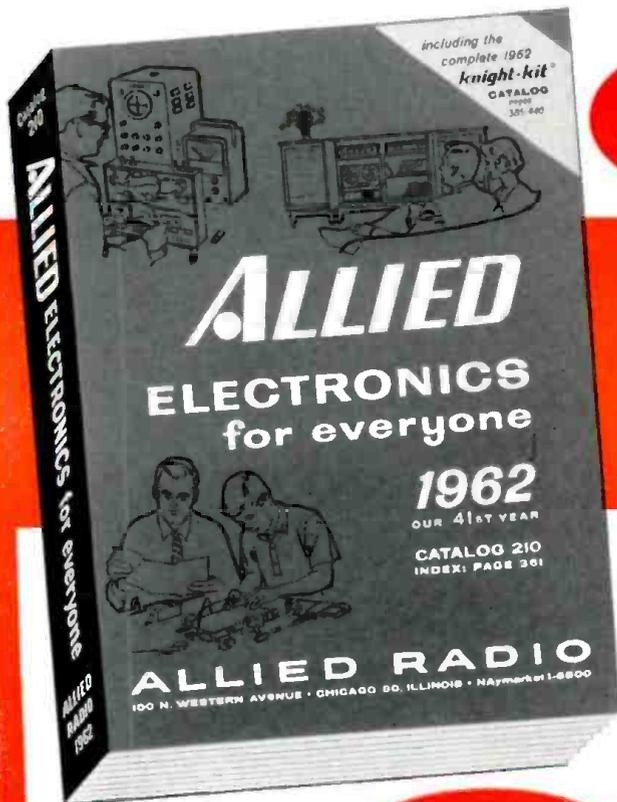
Among the myriad small components, this visitor was impressed by the many new miniature trimmers and fixed capacitors as well as by the promise of more reliable miniature switches. Recent techniques for plating switch contacts with a layer of gold, rhodium, or palladium only a few millionths of an inch thick should take these components off their present low rating in the reliability stakes. Some of the types shown are said to retain their performance even after more than one million operations.

A good deal of research into solid-circuit micro-miniaturization is going on in government and industrial research centers. Some of the progress being made in the formation of resistive and capacitive circuit elements by successive vacuum evaporation onto thin glass substrates was also exhibited at the component show.

A tiny *Mallory* mercury-cell battery has been developed for use in radio pills, swallowed by the patient to transmit information on the intestinal tract. It has a capacity of about 37 ma.-hours and measures only $\frac{1}{2}$ inch in diameter and $\frac{1}{8}$ inch high.

At high power, *English Electric* has introduced tunable klystron u.h.f. TV transmitting tubes capable of 10 kw. output with an efficiency of 40%. For two-way mobile v.h.f. equipment, *Mullard* has medium-power transmitting tubes up to 85 watts output which take less than one second to heat up fully. These use either short, coated ribbon cathodes of large cross-section or else a number of thin oxide-coated wires connected in parallel. ▲





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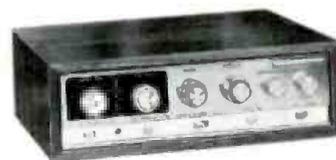
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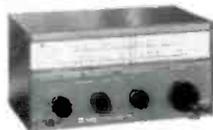


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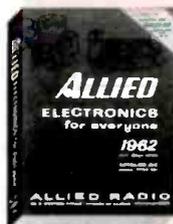
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TELEPHONE BOOSTER AMPLIFIER

By HAROLD REED

Designed for persons with a hearing impairment, this compact and portable transistorized unit includes several novel features.

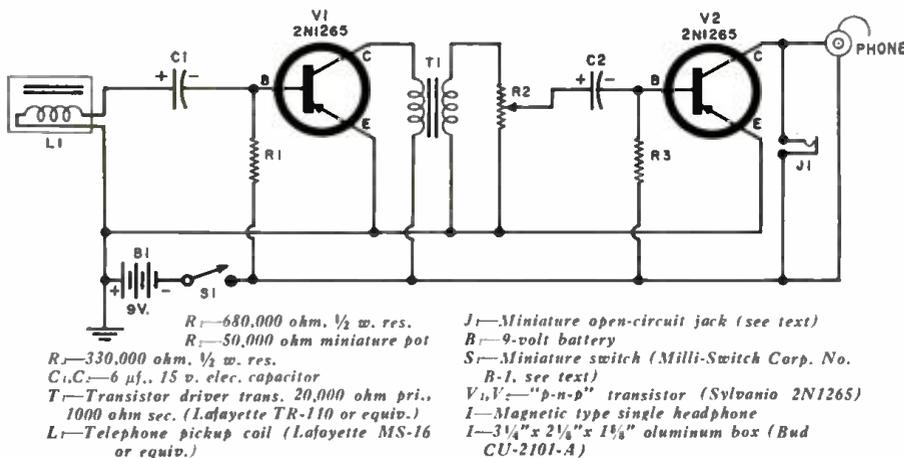


Fig. 1. Schematic diagram of the two-stage telephone booster amplifier.

straightforward. See Fig. 1. Signal from the telephone pickup coil is fed to transistor *V₁*, which is transformer-coupled to a second transistor, *V₂*. A volume control is connected between these two stages. The booster headphone is in the collector circuit of the second transistor. Power is obtained from a 9-volt battery, *B₁*. *S₁* is a miniature switch which disconnects the battery from the transistorized circuit when the receiver is hung on the hook.

Construction Details

The booster is constructed in a 3¼” x 2¼” x 1¼” aluminum box. A thin aluminum strip is secured to the bottom of the box by small machine screws. The telephone pickup coil is cemented to this

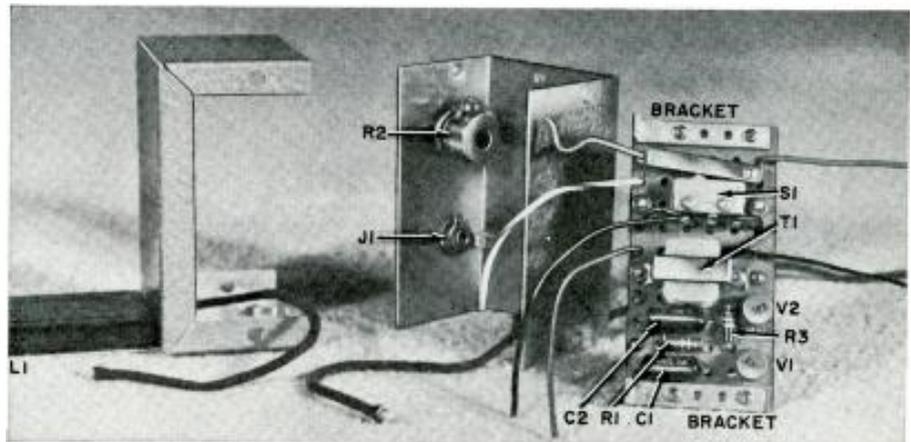
VOICE amplification of incoming telephone communications is certainly not new, however some novel features are incorporated in this version of a telephone booster which should be of interest to electronic technicians and constructors. The following desirable features have been included in this unit.

It can be used on different phones, making it possible for a person with a hearing impairment to be accommodated on both main and extension phones. It is compact—offering portability with ease and having no long wire to contend with. There is no power switch to be operated as the unit is turned off automatically. Although battery life will be long, there is no point in leaving the unit operating continuously, hence the cut-off feature.

A miniature output jack is provided for connection to the high-impedance input of a power amplifier or recorder, thus the booster can also be used for speaker operation or tape recording. Nothing is attached to the telephone. At first it was planned to provide an arrangement whereby the booster headphone could be clipped over the telephone receiver. This idea was discarded since it resulted in hearing in one ear only, whereas by using the telephone receiver normally for one ear and the booster headphone for the other ear, an increased hearing facility is provided. This also avoids attaching anything to the telephone—which is frowned upon by the telephone company.

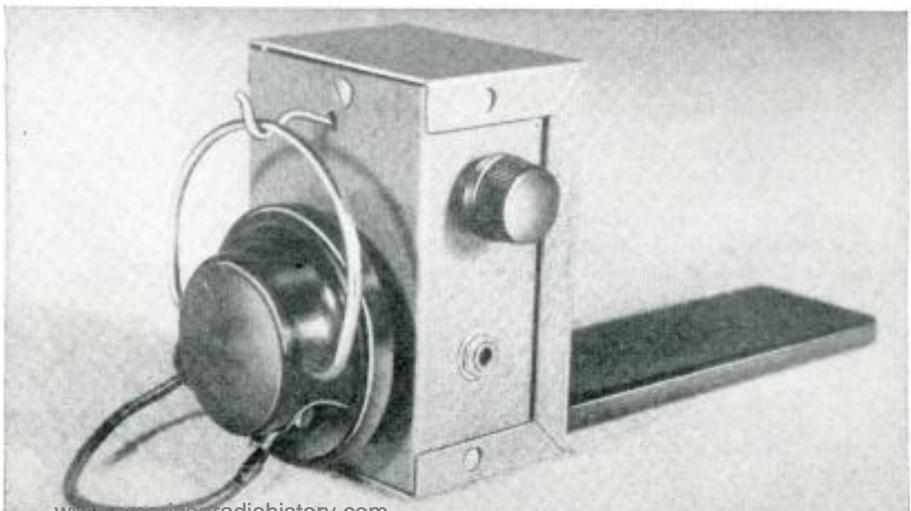
The Booster Circuit

The circuit itself is quite simple and



The phenolic board with its components mounted and wired, is ready to be attached to the box section next to it by the two brackets. The volume control and output jack are already mounted on box section while the pickup coil is attached to cover.

The booster amplifier is shown here completely assembled and ready to use. For battery replacement, which will not be often, box sides are pressed in and pulled out.



strip, as can be seen in the photographs. It should be noted that the outer section of the box faces toward the pickup coil. This is done so that the inner portion of the box may be removed easily for battery replacement.

The miniature switch specified in the parts list just happened to be on hand. There are other units of this type available that can be used just as well. An actuator arm was devised for the switch from a $\frac{3}{16}$ " x $\frac{3}{16}$ " x $1\frac{1}{4}$ " piece of brass. A hole drilled in one end accepts a stiff wire that is solder-sweated to the brass. The other end of the wire is fashioned into a hook on which the headphone can be hung. The arm is pivoted at the switch end and rests on the actuator button of the switch. The weight of the headphone on the arm produces sufficient pressure to operate the switch. When the weight of the headphone is removed, the switch returns to normal in which position the switch contacts close, connecting the battery to the circuit.

The single headphone is a surplus item. It was fitted with a wire band made from a shower curtain hook, available at variety stores. The wire has sufficient spring to remain secured in place. This is for hanging the phone on the wire hook but, also, the wire is fashioned so it will slip over the user's ear, making it unnecessary to hold the headphone when engaged in long conversations or when taking notes.

All small parts, except the volume control and output jack, are mounted on a piece of phenolic board measuring 3" x $1\frac{1}{2}$ ". Wire leads of the parts are pulled through holes in the board and soldered on the opposite side. The switch is also attached to this board near the top. A thin metal strap holds the battery to the board behind the switch and transformer. The small output jack is insulated from the box with fiber washers.

To use the booster it is only necessary to slip the pickup coil under any telephone, lift the headphone off the hook, and adjust the volume control for the level desired. The phone may be hand-held or hung on the ear.

The constructor can make the following modifications. The switch and actuator arm, although desirable, need not be used. The miniature volume control is available with an attached switch which can be used instead. Also, if the booster is constructed for a person with a considerable hearing loss, the volume control can be eliminated entirely and a small toggle or slide switch employed for battery cut-off. However, in making tests with persons having a moderate hearing loss there were complaints that speech reception was too loud without the volume control. If it is not intended to use the device for speaker operation or tape recording, the output jack will not be required.

The cost of this booster is low. The transistors were purchased for 49 cents each, the transformer was 89 cents, and the pickup coil \$1.95... which all adds up to a lot of convenience for little money. ▲

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Memory Unlimited

I JUMPED into the first railway compartment which seemed empty: my eyes fell on a book left on the seat opposite by a previous passenger.

I took it up absent-mindedly and ran through the first lines. Five minutes later I was reading it as eagerly as a clue to a hidden treasure. I learned that everyone's memory is capable of fantastic feats; that an ordinary person if he has taught himself to control the way in which his brain stores impressions can memorize accurately long and complicated lists of facts after reading them over only once or twice. I thought I would test the truth of the statement.

I took a timetable out of my suitcase and began reading quietly in the manner prescribed, the names of about one hundred railway stations. I observed that, after reading them over a few times, I could recite the whole list off with hardly a mistake. With a little more practice I found I had committed them so completely to memory that I could remember them in the reverse order and even pick out one station from the list and say which number it was, and what were the names of the towns before and after it.

I was astonished at the memory I had acquired and spent the rest of my journey on more and more difficult experiments in memory, and reflecting how this new control I was achieving over my mind would materially help me to a greater success in life. After this, I worked hard at this wonderful memory system, and within a week I found I could recall passages from books and quote them with ease; names, addresses and business appointments were remembered immediately; and in four months I had succeeded in learning Spanish.

If I have obtained from life a measure of wealth and happiness, it is to that book I owe it, for it revealed to me the workings of my brain.

Three years ago, I had the good fortune to meet its author, D. U. Borg, and I promised him to propagate his method, and today I am glad of this opportunity of expressing my gratitude to him.

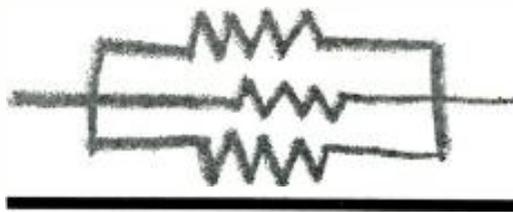
I can only suppose that others wish to acquire what is, after all, the most valuable asset towards success in life.

Borg's address is: D. U. Borg, c/o Aubanel Publishers, 14 Highfield Road (Rathgar), Dublin 6, Ireland. Apply to him for his little book, "The Eternal Laws of Success." (Postage 5¢ for a postcard to Ireland by surface mail). It is free to all who wish to develop their memory.

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PARALLEL RESISTANCE SHORTCUT



By A. K. QUINN

Simple arithmetic replaces cumbersome calculations for determining needed shunts, finding other values.

AS THE SERVICE shop owner often puts it, "How can I find the value of a blasted resistor which, in parallel with some other blasted resistor, will give me the value of a blasted resistor I need but don't have on hand?" More plainly, suppose you need but don't happen to have a 500-ohm resistor. Nor do you have a pair of 250-ohm units to put in series or a pair at 1000 ohms each to shunt.

Trying to find a series pair from a random collection is not the toughest job in the world, but looking for a parallel pair is another matter. You already know what resistance you want, R_1 , but the trouble is that you are looking for two unknowns, R_1 and R_2 . From those on hand you pick a likely (you hope) resistor for R_1 , and use the parallel resistance formula to derive R_2 . But you don't have the latter value in the shop either. Trying several possible combinations in this way with the formula is a messy, time-consuming business. However, there is a short cut, based on simple arithmetic, so easy that you can work out several possible parallel combinations quickly before looking for suitable resistors.

To find the first resistor, R_1 , simply multiply desired value R , by any simple number. To find the matching value of R_2 , divide R_1 by a number that is one less than the first number chosen. If you want 500 ohms, for example, multiply that value by, say, 5. This gives 2500 ohms for R_1 . Dividing 2500 by 4 now gives you 625 ohms for R_2 . A multiplier of 7 and a divisor of 6 gives you another pair, 3500 and 583. Using 4 and 3 yields 2000 and 666. You now have several possibilities before checking your stock.

Tolerances being what they are, converting your answers to the nearest standard values will give little trouble. In the last pairing cited, for example, suppose you shunted a 2000-ohm resistor across a standard, 680-ohm unit. You would theoretically have 507 ohms instead of 500. Is this error of slightly more than 1 per-cent significant in the light of available tolerances and actual requirements? Also, while the use of simple, whole numbers as factors is convenient, you can get as fancy as you like.

You might use 7.5 and 6.5 as factors, for example, to get more possible pairs.

So far, so good; but there is still more to the basic technique. Suppose you have such a limited resistor assortment on hand that you can't find a parallel pair, even now, and you have to try it with three units in shunt. Let's say you need 60 ohms. You have multiplied by 7 to give you 420 ohms for R_1 (which you have) but you can't find a matching R_2 . You take your second factor (7 minus 1 equals 6) and split it up into any two numbers that add up to it. For example, 4 and 2 make 6. Divide each of these new numbers separately into R_1 . The two answers will be the values for R_2 and R_3 . In this case, $420/4$ gives you 105; and $420/2$ gives you 210.

Sure enough, 420 ohms, 105 ohms, and 210 ohms in parallel will come down to 60 ohms exactly. Using standard values, 430, 100, and 220 would provide 59.3, less than 2 per-cent off. This method can be extended for any number of parallel units. If it is not practical to do so, neither should it be necessary.

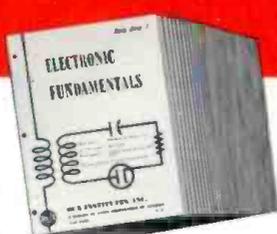
Finally, a variation of the method works wonders in reverse; that is, when you start out with a number of resistors and wish to determine what they will come to in parallel. It is much simpler than using the reciprocal formula. (Oh, those least common denominators for large numbers!) Assume you want to know what four resistors, whose ohmic values are 540, 270, 180, and 90, will come to in parallel.

First divide each resistor's value into that of the largest one in the group. You quickly find that $540/540=1$, $540/270=2$, $540/180=3$, and $540/90=6$. You add up your four quotients as follows: $1+2+3+6=12$. Now divide the highest value by this sum. This division, $540/12$, gives you an answer of 45 ohms. If you don't think this works, you can test it for yourself by working out a combination in the recommended manner and trying the same set of values with the reciprocal formula. What you accomplish will be more than the confirmation of this method's validity by getting the same answers both ways. You will also find out why this method is easier. ▲

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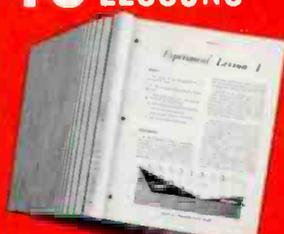
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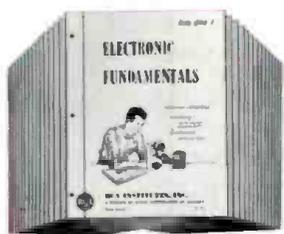
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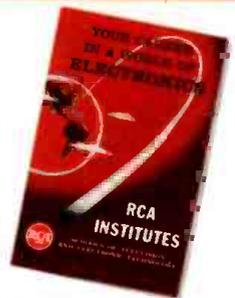
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Electrical Switching
(Continued from page 53)

the storage time. Note that it is also possible to *overdrive* the switch "off," by applying a negative input voltage. In this way, storage and fall time are reduced.

Voltage limitations of transistors usually require that only transistors, or transistors and relays, be used throughout a system. It is sometimes necessary to couple two systems that use different switch components and work from different supply voltages. Special circuits are used to couple these systems without damaging the lower-voltage system. One such circuit is shown in Fig. 2, where a transistor switch is used to trigger a high-voltage thyatron. The transistor switch load is a step-up transformer, suppressed with a diode to prevent damage to the transistor from the kickback voltage; the output pulse from the secondary fires the thyatron. A very common combination, shown in Fig. 3, is the transistor switch used to control a relay. The relay, in turn, may be used to switch several circuits which would otherwise each require a heavy-current transistor or tube-switching circuit.

Temperature sensitivity is a disadvantage of transistor switches that must be overcome to achieve reliability. Heat

generated in the transistor, due to the voltage drop across it while it is switched on, can cause the junction to fuse; while heat from the surrounding air can cause the switch to turn on even though the control pulse has not been applied to the base. A heat sink (a chunk of copper or aluminum) fastened to the transistor will conduct away the heat generated in the transistor. Careful circuit design must be used to prevent any sudden variations in the wattage dissipated by the transistor that the heat sink may not be able to handle, even though it is capable of handling the average dissipation. Correct biasing gives protection during the "off" time and prevents heat runaway.

The switches described are the ones most frequently used in automation and computer systems today. There are other switches, not described, that are being used to an increasing degree as new techniques are developed. Among these is the magnetic amplifier, used for years in heavy current and servo control systems and now finding new applications with the development of ferrites and multi-aperture cores. Esaki diodes and avalanche transistors are also taking over some of the work now done by older switch types. As each new switch is developed, it should take over where it is best suited, reducing the number of compromises made when a switch is selected, and increasing the reliability and efficiency of the systems of the future. ▲

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FOUR CONVENIENT PURCHASE PLANS

named president and chief executive officer of *Ampeex Corporation*, succeeding **GEORGE I. LONG, JR.** who has resigned.

MERLE W. KREMER has been named vice-president of the electronic tube division of *Sylvania Electric Products Inc.*



In his new capacity, Mr. Kremer assumes full responsibility for the operation of the division and will also continue as vice-president and general

manager of the firm's parts division. He has been with the firm since 1955 and has maintained headquarters in Warren, Pa. since 1960.

He succeeds Matthew D. Burns, senior vice-president, who has been assigned to assist the president in corporate and interdivisional activities.

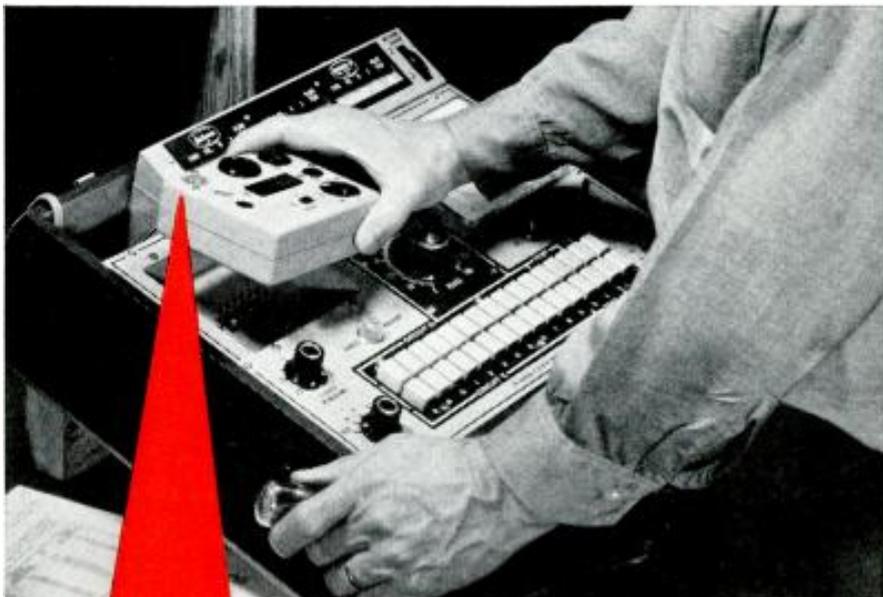
SANGAMO ELECTRIC COMPANY is building a 65,000-square-foot addition to its Pickens, South Carolina plant and will transfer the capacitor production now located at Marion, Illinois to the new location. The Marion plant will be closed. In addition, the firm announced that construction has started on a new 150,000-square-foot plant in Walhalla, S.C. for the manufacture of certain types of single-phase electric meters now produced at the company's plant in Springfield, Illinois... **DELCO RADIO DIVISION** has broken ground for a new semiconductor manufacturing building in Kokomo, Ind. The new 150,000-square-foot facility is expected to be completed by May 1962...

MILLER-STEPHENSON CHEMICAL COMPANY, INC. has moved its headquarters to larger facilities at 16 Sugar Hollow Road, Danbury, Conn... The acoustical engineering firm of **LEWIS S. GOODFRIEND AND ASSOCIATES** has moved into new offices and laboratories located at 48 Notch Road, Little Falls, N.J... **GENERAL PRECISION, INC.** has consolidated its Washington operations in new offices at 808 Seventeenth St., N.W. and re-located its Boston offices to 166 Bear Hill Road, Waltham... **AIRTRONICS, INC.** has dedicated its new plant at 5221 River Road, Bethesda, Maryland. It is one of the few manufacturing plants in the metropolitan area specifically designed and built to meet government regulations for handling classified projects... Construction has started on a 40,000-square-foot addition to **MINNEAPOLIS-HONEYWELL'S** inertial guidance facility at St. Petersburg, Fla. It is scheduled for completion January 1962... **HAZELTINE CORPORATION** has built a 50,000-square-foot warehouse and production facility adjacent to its manufacturing plant in Greenlawn, Long Island, New York.

KENNETH A. HATHAWAY, treasurer of EP & EM and a well-known figure in the electronic industry for more than 30 years, died recently in Chicago at the age of 66... *Jensen Manufacturing Company* has promoted **KARL KRAMER** to the post of manager commercial sound products and **EUGENE G. VAN DEVEER** as

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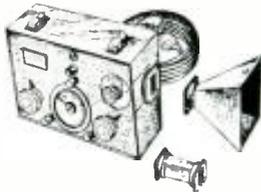
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1N1551	1	amp.	100	volts	.80
1N1552	1	amp.	200	volts	.95
1N1553	1	amp.	300	volts	1.10
1N1450	5	amp.	100	volts	1.00
1N1451	5	amp.	200	volts	1.25
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1N1456	25	amp.	300	volts	4.50
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1N1466	75	amp.	100	volts	10.00
1N1467	75	amp.	200	volts	11.00
1N1468	75	amp.	300	volts	12.50
1N05V7	150	amp.	50	volts	16.50
1N1474	150	amp.	100	volts	17.00

X-BAND POWER LEVEL TEST SET, TS-36/AP

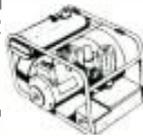


Brand new, in original packaging, with accessories. Measures 10 to 30 dbm. 8700-9500 mc.

PRICE \$14.95 each

Brand new power unit, PE182C. Lightweight; approx. 56 lbs. Output 7 volts DC at 3.5 amp and 550 volt DC, 200 mil. Governor controlled with filter. Driven by Jacobsen single cylinder 2 cycle 1 h.p. engine. Units are complete with set of tools, spare parts and manuals. Dim.: 16 3/4" wide, 18 1/2" long, 10 7/8" high. Over-seas packaged.

Shipping weight: 90 lbs.



PRICE \$39.95 each

SELENIUM RECTIFIER

full wave
input 12-24-36 volt
will handle approx. 1/2 amp D.C.
1 3/8" dia.; 3 1/4" long



PRICE \$1.00 ea.

POWER TRANSFORMER

output 12-24-36 volts
input 100 volts, 60 cycle, single phase
will handle 2 1/2 amps
steel case hermetically sealed
3 1/2" long x 2 3/4" wide x 4 1/8" high;
weight: 3 1/4 lbs.



PRICE \$2.95 ea.



MINOR SWITCH

10 position, 3 pole with stepper coil and reset coil 6-12 volts D.C. off-normal non-bridging wiper approx. dimensions: 4" long x 4 1/2" high x 1 5/8" wide; weight: 1 lb.

PRICE \$9.95 ea.

NAVIGATION SPECIAL! Radio Compass Receiver RS/ARN7

frequency 100 to 1750 KC

PRICE \$17.50



Loop LP21 LM

PRICE \$12.50



Control Box C4/ARN7

PRICE \$7.50



Indicator 181A

PRICE \$4.95



NO C.O.D.'S. REMIT FULL AMOUNT WITH ORDER.

C & H SALES CO.

2176 E. Colorado St. - Pasadena 8, Calif.

manager of the export division . . . **ROBERT H. BEISSWENGER** has been named general manager of *Jerrold-Philadelphia . . . Cadre Industries Corp.* has appointed **JOSEPH H. GIBBS** to the post of commercial sales manager . . . **RICHARD F. POST** has been named head of the military and industrial products department of *Aircraft Radio Corporation . . . ROBERT E. HOUSE has been appointed executive vice-president and **HERBERT N. GOLDMAN** vice-president of engineering of *Semicon, Inc. . . . RICHARD B. SABIN is the new advertising and sales promotion manager of *Eldon Industries, Inc. . . . Melpar's Applied Science Division* has named **DR. BERNARD FRIEDLAND** to the post of senior staff consultant . . . *Assembly Engineers, Inc.* has appointed **C. R. POSSELL** to the post of chief engineer . . . *Instruments for Industry, Inc.* has promoted **LAWRENCE I. ALGASE** to director of engineering. He was formerly chief engineer of the firm . . . **WALTER A. MAINBERGER**, former manager of the electronic systems department of *National Co., Inc.*, has been named technical assistant to the vice-president for technical operations at *Dunn Engineering Corp. . . . O. B. HANSON*, pioneer radio and TV broadcasting engineer, died recently at the age of 67. He retired in 1959 as vice-president, engineering serv-**

ices, of *RCA* but continued to serve as a consultant. He was with *RCA, NBC*, and predecessor companies for approximately 38 years.

NEIL P. WHITNEY has been appointed president of *Aircraft Radio Corporation*, a wholly owned subsidiary of *Cessna Aircraft Company*.

He joins the Boonton, New Jersey firm after serving as general manager of the parent company's industrial products division. He has been with the organization since 1948 following his release from the Quartermaster Corps where he served during World War II.

DAVID R. HULL, former president of *EIA*, has been elected to the Board of Directors of *Globe-Union Inc. . . .* The appointment of **ROBERT W. CARR** to the post of manager of product development has been announced by *Shure Brothers, Inc. . . . FREDERICK WALZER is the new quality and reliability manager of the *Allen B. Du Mont Laboratories . . . Radio Receptor Company, Inc.* has made four key staff appointments: **M. MICHAEL***

Frequency Quiz

By **JOE TERRA**

(Match terms in first column with definitions given in the second column.)

- | | | |
|---------------------|-----|--|
| 1. Beat | () | A. Frequency in a woofer-tweeter loudspeaker at which both speakers receive equal power. |
| 2. Carrier | () | B. The lowest frequency component of a complex electrical signal. |
| 3. Center | () | C. Portion of the TV color signal which carries the finer details of the transmitted image. |
| 4. Critical | () | D. Produced in a superregenerative detector stage to prevent oscillation during reception of strong signals. |
| 5. Crossover | () | E. In superheterodyne reception, a frequency resulting from the combination of the received frequency and the locally generated frequency. |
| 6. Cut-off | () | F. Pulsation of amplitude resulting from the combination of two waves of different frequency. |
| 7. Field | () | G. In TV, 30 frames per second and 525 lines per frame. |
| 8. Frame | () | H. Resting frequency of an FM transmission system. |
| 9. Fundamental | () | I. Lowest resonant frequency of an antenna or circuit. |
| 10. Half-power | () | J. Variable capacitor characteristic. |
| 11. Image | () | K. Audio amplifier frequency which is equal to the square root of the product of the two half-power frequencies. |
| 12. Intermediate | () | L. Frequency of the original unmodulated radio wave produced by the transmitter. |
| 13. Intermodulation | () | M. Frequency in a filter at which rapid, if not complete, attenuation takes place. |
| 14. Mean-carrier | () | N. In TV, the number of times per second that the picture area is completely screened. |
| 15. Mid-band | () | O. A radio signal appearing as an unwanted component in the output of a receiver. |
| 16. Mixed highs | () | P. In sound recording, the changeover frequency from constant-amplitude recording to constant-velocity recording. |
| 17. Natural | () | Q. Assigned frequency of an FM station from which deviation takes place in step with the audio signals impressed. |
| 18. Quenching | () | R. In TV, the number of complete downward sweeps of the scanning element per second. |
| 19. Scanning | () | S. Highest frequency at which radio waves directed to the ionosphere will be reflected back. |
| 20. Straight-line | () | T. The two values of frequency on the sloping shoulders of an amplifier response curve. |
| 21. Transition | () | U. Sum and difference frequencies generated in a non-linear element. |

(For correct answers, see page 96)

MOSS, director of reliability; WILLIAM BOREN, manager of finance; JOHN FELTMAN, director of materiel; and ALBERT SIKORSKY, manager of government relations . . . *The Bendix Corporation* has announced the appointment of JACK D. KOSER and J. A. OGLE to special areas of long-range planning. Both are former military officers . . . *Acoustic Research, Inc.* has announced the promotion of ROY F. ALLISON to the post of plant manager . . . PROF. A. R. VON HIPPEL, director of the Laboratory for Insulation Research at MIT, has been elected vice-president in charge of fundamental materials research of *U.S. Sonics Corporation* . . . ROY L. ASH has been elected president of *Litton Industries, Inc.* He was one of the founders of the corporation . . . CARTIS F. KOEFOD has been named instrumentation tapes sales manager for the magnetic products division of *Minnesota Mining and Manufacturing Co.* . . . GRAFTON P. TANQUARY, director of marketing for the components group of *Litton Industries, Inc.*, has been named chairman of the RF Transmission Components Section of the EIA. . . The appointment of R. E. WHIFFEN as general manager of the *Bendix Products-Aircraft Division* has been announced by the corporation . . . *ACF Electronics* has named A. C. SUGALSKI to the post of manager of professional employment . . . ALFRED J. GIRARDOT, JR. has been promoted to the post of director of marketing for the Semiconductor Division of *Hoffman Electronics Corporation*.

JOSEPH P. FOLEY has been named vice-president of marketing, a newly created position at *Bay State Electronics Corporation*, Boston.



In his new position, Mr. Foley will be responsible for all sales, sales promotion, and marketing with particular emphasis on implementation of the corporate marketing plans, including expansion by acquisitions.

Prior to joining the firm, he was marketing manager at the electronics division of *Van Norman Industries* and, earlier, sales manager of the electronics division of *Baldwin-Lima-Hamilton Corp.*

EDWARD A. JOYNER has been appointed to the newly created position of sales promotion manager for the *Amphenol Distributor Division*.



He was formerly Chicago District sales manager for the division and in his new post will be responsible for a training program to familiarize management, sales, and purchasing personnel of industrial distributors with the firm's products and policies. He will also have a liaison responsibility for division advertising and other sales promotion activities. ▲

INVITATION TO AUTHORS

Just as a reminder, the Editors of *ELECTRONICS WORLD* are always interested in obtaining outstanding manuscripts, for publication in this magazine, of interest to technicians in industry, radio, and television. Articles covering design, servicing, maintenance, and operation are especially welcome. Articles on Citizens Band, audio, hi-fi, and amateur radio are also needed. Such articles in manuscript form may be submitted for immediate decision or projected articles can be outlined in a letter in which case the writer will be advised promptly as to the suitability of the topic. We can also use short "filler" items outlining worthwhile shortcuts that have made your servicing chores easier. This magazine pays for articles on acceptance. Send all manuscripts or your letters of suggestion to the Editor, *ELECTRONICS WORLD*, One Park Avenue, New York City 16, New York.



PERSONAL Messenger

- No license required—may be used at once!
- Meets FCC requirements for use with licensed Citizens' Band stations, too!

This is the new "Personal Messenger"—a superbly engineered 2-way crystal-controlled transceiver so compact it fits in your hand—so flexible it can be used in thousands of applications! 11 transistors and 4 diodes—superheterodyne receiver with exclusive tuned R.F. amplifier gives you twice the sensitivity and more than 40% more range than units with conventional circuitry! Powerful two-stage transmitter delivers more power output than similar units with the same rated input! Unmatched audio intelligibility and razor-sharp voice reproduction—automatic noise limiter—automatic volume control—positive squelch control—elastic hand strap—operates on penlight or rechargeable nickel-cadmium batteries. **\$109⁵⁰**

ILLUSTRATED AT LEFT—The Viking "Messenger"—maximum legal power Citizens' Band crystal-controlled transceiver. Excellent receiver sensitivity and selectivity—highly efficient transmitter punches your signal home! Built-in squelch—AVC—ANL. With tubes, push-to-talk microphone and crystals for 1 channel. **FROM \$134⁹⁵**



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Manufacturers of the world's most widely used personal communications transmitters

TAPE RECORDER TERMINATION

Once in a life-time opportunity to purchase production parts and spares for operating equipment from one of the largest PROFESSIONAL TAPE RECORDER MANUFACTURERS!

STOCKS LIMITED

Shipments will be made in order of receipt.



DRIVE MOTORS

BODINE NCI-33 induction drive motor, 115 v., 60 cy., .45 A., 340/1080 RPM, 1 1/2" dia by 3 1/2" long. Rear shaft: 7/8" long. Front shaft: 1 1/2" long and ground for 7 1/2 and 15 ips tape speed. Guaranteed rebuilt, like new. **\$17.50**

Same, except **BRAND NEW**, with unground shaft. **\$17.50**

FASCO reeling and rewind motors. Can be used in conjunction with above drive motors, 115 v., 60 cycle, 3 1/2" dia by 1" long. Shaft: 2 1/2" long and finished for standard reel lock. Best quality available for professional use. Completely rebuilt, like new. **\$9.50**

BODINE NCI-42 reeling and rewind motors, 115 v., 60 cycle, 1/30 HP, 1400 RPM, 2 3/4" square body by 4 3/4" long and finished for standard reel lock. Tapped plate on bottom for mounting. Rebuilt, like new. **\$9.50**

PLEASE ADD \$1.75
Per motor for postage and handling.

SPECIAL Motor starting capacitor for above drive and other motors, 2 x 5 mfd at 330 VAC. With mtg bracket. **\$1.75**

EXTRA SPECIAL . . . REEL LOCKS

Bright plated, standard NAB reel locks. Will center and lock 101 1/2" or larger, reels or will retain 7" reels. Most secure center compression locking devices with top knob. Per pair. **\$3.50**

PHIL-TROL SOLENOID. Ideal for mechanical braking, 17.5 ohms, 24 VDC, long stroke, 2 1/2 lb. in. pull. **\$2.00**

TERADO Series 6000. Miniature plate relay (3" dia x 1 3/4" long), SMDT, hermetically sealed, 7-pin miniature base, 5000 ohm coil, 1 amp contacts, 1 ma. **\$2.25**

PROFESSIONAL TAPE RECORDER HEADS

BT-1 Full track erase	\$10.00
BT-3 Full track record	10.00
BT-5 Full track playback	10.00
BT-2 Half track erase	8.00
BT-2B Lower half track erase	10.00
BT-4 Half track record	8.00
BT-6 Half track playback	6.00
BB-3 Stereo record (stacked)	12.00
BB-5 Stereo playback (stacked)	10.00
SP-1 Sync-pulse	30.00
Michigan Mag. stacked stereo records	6.00
Michigan Mag. stacked stereo playback*	6.00

*Supplied with mtg. brackets.

"VU" METERS

2 3/4" by 2 1/2" rectangular, with clear plastic escutcheon, 500 micro-amp basic movement with standard 2-color "VU" scale. Requires 2 1/2" mtg. hole. **\$5.95**

2 for **\$11.00**

MINIATURE 1 1/4" square, clear plastic escutcheon, 500 micro-amp basic movement with 2-color calibrated "VU" scale, 1" mtg. hole, threaded case for single nut mounting. **\$7.95**

2 for **\$15.90**

WESTON model 882 illuminated DB meter, 4 1/2" rectangular case, 0 DB = 0.639V. New price 41.00. Special. **\$24.50**

California residents add 4% sales tax. Terms: Cash with order or 25% deposit, balance C.O.D. All prices FOB Los Angeles. Minimum order \$5.00.

H. D. STERN CO.

3000 S. Main St., Los Angeles 7, Calif.

MINE DETECTOR AN-PRS/3

Portable Device for locating metallic objects buried in the ground. This is the most recent type, extremely sensitive. Presence of metal will be indicated on meter or phones. Special circuit eliminates false responses. Exc. oper. cond.—60 Lbs. **39.95**

NEW BATTERIES 5.00

FIELD TELEPHONES—EEB-A. Dependable phone system over miles of wire—Recond.—OK—PAIR **23.95**

GAS ENGINE GENERATOR—Output variable from 0-24VDC at 30 Amps. Voltmeter, Ammeter, self contained gas tank—Used—Gd. Cond. **49.95**

GAS ENGINE GENERATOR—Output 550 VDC, 220 Mils. and 6.3V—5 Amp. Like New—50 Lbs. **29.95**

SCR 522. W/All tubes—Gd. Cond. **24.95**

BC 1306—TRANSCIVER—3800—6500 KC. M.O. and Crystal Control—New—W/All tubes. **29.95**

RCA GEIGER COUNTER WF15A—10 Geiger tubes—List \$750. Closeout Special W/Batteries—New **99.50**

VACUUM TUBE MEGOHMMETER—CALN—60089-A. 4X4X4 10,000 Megs. Battery operated—Like new. **29.95**

REX RADIO, 84 Cortlandt St., N.Y. 7, N.Y.



At its 1961 convention held in Chicago, the National Alliance of Television and Electronic Service Associations elected new officers, welcomed 18 new affiliates since the preceding convention, settled some internal problems, and advanced a good deal of other business.

New officers include Ralph J. Woertendyke, president; John H. Stefanski, secretary general; and C. Nelson Burns, treasurer. Regional vice-presidents are Irving Toner (eastern), T. R. Nabors (east central), B. R. Moon (west central), and Patrick Barr (western). Regional secretaries are George Carlson (eastern), John Graham (east central), Earl Steffes (west central), and Leslie A. Quigley (western).

The internal problems stemmed from differences of opinion that finally took the form of charges and counter-charges among individuals and affiliated groups within the national body in a number of letters, bulletins, and other publications. With feelings running high, the executive council decided to air the strife completely on the floor of the general directors' assembly at the start of the convention, but with the doors barred to outsiders. Insider Mac Meoyer, a past NATESA president, reports that an effort was made not only to eliminate existing differences but to prevent recurrences: "All charges were resolved to the satisfaction of all parties involved . . . our assembly did not partake of the figurative banquet of crow. . . There was no figurative blood-letting and no scars left. . . I also sincerely feel that all individuals involved have been exonerated of the charges levied against them."

Out of this incident came a constitutional amendment setting up machinery, through divisional officials and the executive council, for reviewing communications deemed to be harmful or unjust, for the issuance of restraining orders, and for suspensions where there is no compliance with orders.

Progress reports were delivered on 33 subjects including pay-TV, wholesale practices, caddy thefts, and the all-industry panel. The spring directors' conference was set for April 28-29, 1962, at the Americana Hotel in Miami, Fla., with TESA-Miami hosting.

Be-Kind-to-Distributors Week

President Charles McBroom of the North Carolina Federation of Electronic Associations has been throwing reverse English at his members, of late, in the NCFEA "Printed Circuit." Instead of

helping them duck their own responsibilities with the sometimes overdone practice of dumping their woes on the shoulders of everyone else, he is taking them to task for their own deficiencies. His latest subject is the charges levied against that favored scapegoat, the distributor:

"The Distributor Sells to the Public—Of course, it's okay for you to buy electrical and plumbing supplies (from distributors), but *your* distributor shouldn't do this. Why not? Where will the public buy the odd tubes now in their sets? Certainly not from you because you refuse to stock them. You don't have the stock because you laughed when the distributor's man talked to you about inventory control.

"Your distributor also urged you to stock and sell Citizens Radio—most of them even offered an extended billing policy so you wouldn't have your money tied up—but you weren't interested. You have forced your distributor to sell this gear to the public. Admit the truth. *You* made the situation you're complaining about."

For those who would bypass the distributor with a co-op buying scheme, McBroom has this to say: "The supply of parts is the smallest of the distributor's problem. *You* cause the biggest portion of his work. Who do you depend on to know about and stock test equipment . . . to finance this equipment? . . . Do you pay him in full, on time, every month? . . . Your distributor is working and planning right now . . . figuring how much money he will have to borrow to take care of you next year. Tell me, Mr. Co-op Promoter, how do you go about not paying *yourself* on time?"

Coincidence or not, other re-appraisals of the distributor-dealer relationship and the matter of dealer loyalty to a co-operative distributor appear in the NATESA "Scope" and the bulletin of the Alameda County TV & Radio Association of California. Both remind readers that co-operation is a two-way street and that they also have some obligations in the matter.

Color Prospects

In a speech to Chicago dealers, RCA President John L. Burns stated that his company's color-TV production lines are operating at high capacity with heavy back orders, that dealer orders virtually doubled over last year, and that Chicago sales, in actual dollars, "were substantially greater for color than they were for black-and-white." Furthermore, he foresees a color TV market for

RCA "surpassing in volume and profitability our greatest years in black-and-white." In terms of receiver and equipment sales, broadcasting—and service—he foresees, by 1970, a dollar volume for color alone that will exceed the present volume for the entire industry.

Is this just some more pie in the sky for service? Possibly not. For many years to come, at least, color will continue to be more expensive and more involved, in the eyes of the public, than monochrome TV. Set owners may become hesitant about do-it-yourself experimentation and reluctant to look for the cheapest service call. The unwillingness to gamble with an expensive, quality product bodes well for shops with good reputations.

Paid Association Executives

To become big, you have to think big. Many associations have reached the stage of growth at which they must grapple with the problem of having their affairs properly managed by individuals, however dedicated, whose first duties are to their own businesses. The North Carolina group mentioned earlier is wondering whether it can continue to "depend on our elected officers to do the terrific amount of detail work required without some compensation. In the past many officers have accomplished the work of the federation at the sacrifice of their own personal activities and frequently at a financial loss to their businesses.

"Those who are unable or unwilling

to spend of their time should be willing to contribute financially to help build a strong federation for their own good." In short, NCFEA is considering a constitutional amendment to set up the salaried position of executive secretary: a paid administrator who could devote unstinting effort, without worry about personal sacrifice, to advancing the aims of the group.

Tube Pricing Policy

President E. Russell Goode of the Television Service Association of Michigan, in a recent issue of "TSA News," has his say on the much-discussed matter of whether service dealers should insist on list prices for receiving tubes or fight to get back the lost business by offering discounts. His starting point is "the tremendous loss of over-the-counter tube sales in the past two years."

"Discount merchandising is an accomplished fact in the Detroit area and most other large cities in the United States," he states. "Whether you approve or disapprove of this concept," he adds, "it is here to stay."

Many Detroit dealers, says Goode, have tried discounting for trial periods ranging to a year or more—but could not get the necessary volume to justify continuation nor could they see enough profit to allow a consistent advertising program." This result is particularly disconcerting since, as Goode adds, "tube sales are the logical leads to the service customer." He has no easy answers. ▲

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BUY NOW AND SAVE!!

OVERTONES: 10 to 30 Mc... Tol. .005%... \$2.50
 AMATEUR & NOVICE Fundamental... Tol. .005%
 HC-6 Herm. Sealed... \$2.50
 HC-6—6 Meters (5th Overtone)... \$3.75
 MARINE FREQ. HC-6 (Herm. Sealed)
 Tol. .005%... \$3.50

ALL MARINE FREQ.—FT-243, DC-34 Hold Tol. .005... \$2.00
 POLICE, C.A.P., CD, MARS, Tol. .01%... \$1.89
 CITIZENS BAND—11 METERS—.005% Tol.
 26.965 to 27.225 MC, 3rd Over. Herm. Seal. or
 FT-243... \$2.50
 13.4825 to 13.6125 MC, 2nd Harm. Herm. Seal. or
 FT-243... \$2.50
 6741.25 to 6806.25 Kc, 4th Harm. FT-243 only... \$2.00

SPECIAL! STOCK CRYSTALS

\$1.19

FT-243 Holders 5700 KC to
 8700 KC in steps of 25 KC's

SEND FOR FREE CATALOG

DC-34 Hold. 1690 KC to 4440 KC steps of 10 KC, ea. 79c

NOVICE BAND FT-243 Fund. ea. \$1.49

80 Met. 3701-3748—Steps of 1 KC. FT-243
 40 Met. 7150-7198—Steps of 1 KC. FT-243
 Dbl. to 40 Met. 3576-3599. Steps of 1 KC. FT-243
 15 Met. 5276-5312—7034-7083 Steps of 1 KC. FT-243

FT-243—2 Meters (Steps of 1 KC) \$1.19
 FT-243—6 Meters (Steps of 1 KC) \$1.19
 FT-243—From 3000-4000 \$1.19
 FT-243—From 1005-2999 (Steps of 5 KC) \$2.39
 FT-243—.005% Tol. From 3000-8750 \$2.39
 FT-243—.01% Tol. From 3000-8750 \$1.89
 FT-241 SSB Low Xtals 370 to 540 KC
 (Steps of 1.852 and 1.388) \$.69
 FT-241 SSB Matched Pairs \$2.39
 FT-241—AN/TRC-1-721.167 KC-1040-625
 (Steps of 1.042 KC—Except 1000 KC) \$.96

Include 5c per crystal postage. (U.S. only). Calif. add 4% tax. No C.O.D.'s. Prices subject to chg. Ind. 2nd choice, sub. may be necess. Min. Order \$2.50

Open Friday Evenings until 9 P.M.

"The House of Crystals"

U. S. CRYSTALS, Inc.

1342 S. La Brea Ave. Los Angeles 19, Cal.

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UP TO 100
 1-YR. GUARANTEED
 TRU-VAC TUBES
 TO QUANTITY BUYERS!

Now quantity buyers get a FREE assortment of individually-boxed, regular stock TRU-VAC tubes with each order.

PLACE YOUR ORDER TODAY!
 GET UP TO 100 TUBES FREE!
 Here's how this FREE offer works!

15 FREE TUBES	With Order of	\$25
25 FREE TUBES	With Order of	\$50
50 FREE TUBES	With Order of	\$100
100 FREE TUBES	With Order of	\$500

LOOK! 1,000 USED TV'S
 Costly, famous make console models with little or no tube replacement! Perfect for resale, or as your own second set! 16", 17" and 19" screens—none shipped smaller! Sets shipped FOB, Harrison, N.J.

\$16.95
 As is

1-yr. guaranteed Radio & TV Tubes

35¢

\$33 PER 100 TUBES
 Any Tube Not Listed Also Available at 35¢ Each!

Factory Used or Factory Second Tubes!
 TRU-VAC will replace FREE any tube that becomes defective in use within 1 year from date of purchase!

ALL TUBES INDIVIDUALLY BOXED!
 CODE DATED & BRANDED "TRU-VAC"

Partial Listing Only... Thousands More Tubes in Stock!

6AC7	6BG6	6BY5	6D6	6D7GT	7A5
6AF4	6BM6	6BZ6	6DE6	6SF5	7A6
6AT7	6BQ6	6BZ7	6DC6GT	6SF7	7A7
6AM4CT	6AS5	6C4	6DF6	6S07	7A8
6AM6	6AT6	6C8B	6E5	6SM7	7B4
6AK5	6AU6CT	6C8B	6E8	6S7	7B5
6AL5	6AUSCT	6C8CG	6F6	6SK7	7B6
6AM8	6AUS	6CF6	6H6	6SL7	7B7
6AN8	6AV5CT	6C7	6J4	6ST7	7B8
6AQ5	6AV6	6C8	6J5	6SR7	7C4
6AQ6	6AW8	6C8B	6J6	6T4	7C5
6AQ7	6AX4GT	6CL5	6J7	6T8	7C6
6AR5	6AX5CT	6CM6	6K6CT	6U5	7C7
6AU6	6BK5	6CM7	6K7	6U8	7E5
6B8	6B7	6CT	6N7	6V6GT	7E6
6BA6	6BL7GT	6CQ8	6Q7	6W6GT	7A4, XXL
6BQ6	6BN6	6CR6	6S4	6X4	7E7
6BQ6CT	6BQ6CT	6C56	6S7	6X5GT	7F7
6B8	6BD6	6C57	6S8CT	6F8	12A7
6B8E	6BR8	6CUS	6S9	6Y6	12AX4GT
6BF5	6B8E	6CUG	6S7	7A5	12AX7

6W4GT 30c

7N7	12AZ7	12Q7	25Z6GT
7Q7	12BA	12R5	27
7S7	12BA6	12SA7	35A5
7K6	12B7	12S7	35B5
7X7	12BD6	12SK7	35C5
7Y4	12BE6	12SN7CT	35W4
7Z4	12BF6	12SQ7	35Z5
12A8	12BM7	12V6GT	36
12AB5	12BL6	12W6GT	38
12AD6	12BR7	12X4	39/44
12AF6	12BQ6	14A7/12B7	41
12AQ5	12BY7	14B6	42
12AT6	12CA5	14Q7	43
12AT7	12CWS	17AX4	50A5
12AUG	12D4	17D4	50B5
12AUV	12E5	19AU4CT	50C5
12AV6	12F8	19B6GT	50L6
12AV7	12K5	19J6	56
12AX4GT	12K7	19T8	80
12AX7	12L6	24A	84, 6Z4, 11Z3

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Below Listed prices do not include dnd Add Additional \$5.00 Deposit on tube sizes to 20" on 21" and 24" tubes—\$7.50. Deposit refunded immediately when dnd is returned prepaid. (Luminized tubes)—\$4.00 extra.

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Citizens Band Converter

(Continued from page 51)

times for checking and then re-immersed. The entire etching time will run from 20 to 30 minutes, depending on the strength of the solution. When all the excess copper has been dissolved, remove the board from the etchant and rinse well in clear water. Do not leave the board in the etchant any longer than is necessary as additional time will tend to undercut the resist ink and tape. After rinsing, remove tape and ink with a knife or razor blade and finish by polishing lightly with any good household cleansing powder. The board is now completed and if instructions have been followed closely the results should be "professional."

Mounting Components

After etching the circuit board, drill a 1/32" hole in the center of each copper dot for component leads. Drill a 5/16" hole inside the dotted circles for the body of transistors V₁ and V₂. Drill two 1/4" holes and one 3/32" hole for mounting the crystal socket. Drill 3/32" holes for coils L₁, L₂, L₃. After all the holes have been drilled, mount the coils and crystal socket. The resistors and capacitors are mounted and soldered in place next.

When soldering to printed-circuit boards use a small iron and a good grade of rosin-core solder. The transistors are the last to be put in place and soldered. Slip the transistor through from the top of the board and carefully shape the leads in place with tweezers or small pliers. The leads are long on these transistors and will have to be cut. When cutting transistor leads, place leads as far back in the cutters as possible and try to squeeze the cutters without snapping. Cut one lead at a time. After the leads are shaped and cut, solder each lead in place using a pair of small pliers on the transistor lead near the base as a heat sink. After all components have been soldered in place, recheck the circuit board by tracing the circuit of Fig. 1 to eliminate any possible errors.

For those who are not interested in making the printed-circuit board, the more conventional point-to-point wiring technique may be used.

Final Assembly

Mounting of the circuit board, power supply, switch, and input and output jacks is clearly indicated in the photographs. A rectangular opening, 1 3/4" x 2 3/4", is made in the top cover of the chassis box. The printed-circuit board is mounted over this opening and held in place with small self-tapping screws or with 2-56 machine screws and nuts. The circuit board must be mounted without grounding any of the connecting bars or input-output points to the metal. A 5/8" hole is made in the center of one end of the top cover for the coaxial SO-239 jack and a 3/8" hole drilled in the center of the other end for the RCA phono jack.

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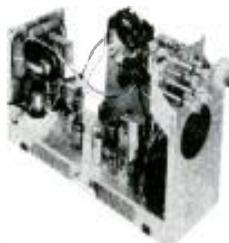
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A small "on-off" slide switch is mounted on one side of the bottom section of the chassis box. The 9-volt battery is held in place by means of several dots of Duco cement.

After the circuit board, jacks, and battery have been mounted, run the necessary wires from the battery to the circuit board and connect the input and output jacks to the designated points. The converter is now ready for preliminary adjustments.

Adjustment & Operation

Before installing the converter it will be necessary to make certain that the oscillator is operating. This test is simplified if a receiver that will tune to 26.3 mc. is available. Turn the converter on, tune the receiver to the crystal frequency, and adjust the slug in L_1 until the signal is heard. The oscillator will function when the slug is properly adjusted so that the collector tank circuit (L_2 and C_2) is resonant.

With the oscillator checked out, install the converter in the car. A short length of coax is required. It should have a phono plug on one end and an auto antenna plug on the other. Turn the auto radio on and set the dial to 800. Turn the converter on and adjust the slug in L_2 for maximum background noise in the speaker. Next, adjust the slug in L_1 for maximum noise or select a weak signal and peak the slug for maximum gain. The final adjustments are made with the slug of L_2 at the center frequency, which is Channel 11. If either extreme of the Citizens Band is favored in your locality, additional gain can be realized by peaking the coils for those particular channels.

Two of these converters have been built by the author. One is being used as a base station and the other is installed in the author's car. An r.f. amplifier was omitted for simplicity's sake and to reduce the cost of construction. Gain of the converter is 19 db at the center frequency with a loss of 1 to 2 db at either end. The ends can be peaked up by adjusting coil slugs if either end is used more than the center frequencies. Signals of S6 or better are easy arm-chair copy for the Citizens Bander. ▲



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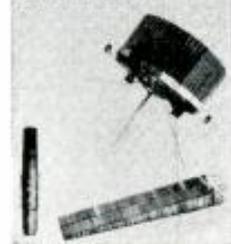
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Audio Test Report

(Continued from page 24)

cheesecloth cover protects the rear of the cone and the entire cabinet is filled with fiber glass. Fisher claims that the elimination of the basket, and consequent packing with absorbent material almost up to the cone, eliminates internal reflections which affect the smoothness of response of conventional speakers.

Middle frequencies, from 1000 to 2500 cps, are handled by a pair of 5" cone speakers packed with fiber glass. Above 2500 cps a 2" hemispherical tweeter, with a six-pound magnet structure, takes over and provides an omnidirectional 120-degree coverage. The user has a wide range of control over the response of the XP-4, since the mid-range and high-frequency speakers each has its own level control. Positions are indicated for average settings of the control knobs, which we found agreeable and which were used during our tests.

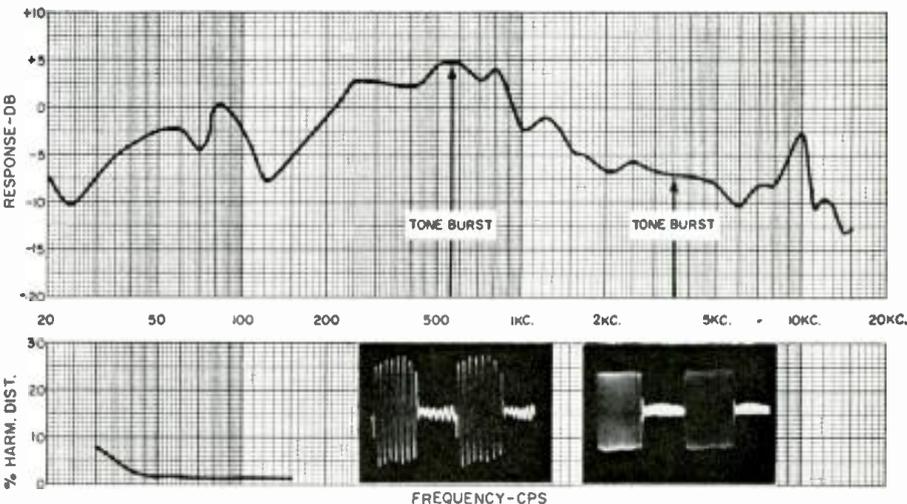
The cabinet of the XP-4, finished in oiled walnut, is extremely rigid. Rapping it with the knuckles produces a

adequately by a 15-watt amplifier, and one-watt input produces an uncomfortably loud sound level.

Transient tests, using tone bursts, confirm the excellent transient response of the XP-4, which can be inferred from its smooth and hole-free response curve. The two typical photos, taken at 560 cps and 3.5 kc., show the type of tone-burst picture we found.

In listening tests, the Fisher XP-4 acquitted itself admirably. It has no tendency toward boominess and, in common with all low-distortion speakers, seems to be lacking in bass in most program material. When any real bass is present, the XP-4 leaves no doubt in the listener's mind as to its capabilities. The ability to adjust the balance of middles and highs gives the user a worthwhile increase in flexibility, allowing him to suit his personal taste and specific room environment.

The hemispherical tweeter of the XP-4 has a very wide dispersion, with little evidence of the beaming of high frequencies usually found with cone-type tweeters or with some horns. This can also be inferred from the relatively flat response curve, which represents the average response throughout a typ-



sound reminiscent of a block of concrete. It is constructed of 3/4" plywood, with locked joints and glued construction. No screws or nails are used in its construction. The entire system weighs 50 pounds.

The XP-4 was tested in a live room, with the plotted curve showing the average of the response measurements made at eight different microphone locations. Allowing for the microphone calibration, the response is within ±7.5 db from 20 to 15,000 cps, which is very good. This is the total integrated response of the speaker throughout the room, a more realistic and less flattering curve than the usual axial pressure response taken in an anechoic chamber.

The low-frequency harmonic distortion, measured with one-watt input to the speaker, shows the XP-4 to be very clean. It has less than 2% distortion down to 40 cps, and only 7.5% at 30 cps. The XP-4, unlike some other compact speaker systems, is a moderately high-efficiency unit. It can be driven very

ical live listening room. A speaker with very directional high-frequency response can measure reasonably flat on its axis, in an anechoic chamber or out of doors, but will show an appreciable loss of highs when measured in the manner we use.

The XP-4 sounds very nearly the same at any listening angle, which is the way it should be. It is a little difficult to verbally describe its sound, since it can be tailored by the user, but it is definitely in the upper echelon of speakers.

The Fisher XP-4 sells for \$199.50. It is available in oiled-walnut, cherry, mahogany, and unstained sanded birch. ▲

Answers to Quiz on Page 90

1. F	8. N	15. K
2. L	9. B	16. C
3. Q	10. T	17. I
4. S	11. O	18. D
5. A	12. E	19. G
6. M	13. U	20. J
7. R	14. H	21. P

Mac's Service Shop
(Continued from page 54)

could be acquiring new knowledge and skills at a gait more or less of our own choosing. Later, if we decided to go into industrial electronics completely, we would have some experience under our belt and not have to start as green hands. But what have you decided about your antenna problem?"

"Yeah! Seeing you're a ham, antennas should be right up your alley. Suppose you wanted to maintain a good reliable communication circuit over a distance that was barely line-of-sight on a frequency around 900 megacycles. You want to do it with a minimum of power. For this and security reasons, you want as narrow a beamwidth as possible. What kind of antennas would you use?"

"I better explain first that my ham experience only extends up to 144-megacycle work; so nothing I say can be used against me," Barney hedged. "Off-hand, though, I'd think a high-gain beam of some sort would be in order. If I remember rightly, you can get a little better than 16 db gain over a reference dipole from a 13-element yagi. A 12-element colinear-broadside array will give you 10.5 db."

"Building and adjusting such complicated antennas at this frequency would be quite a job," Mac demurred. "What would you say to a 2-element antenna providing nearly 17-db gain with a half-power beamwidth of less than 7.5°?"

"I'd say there ain't no such animal," Barney answered promptly.

"How about a ten-foot parabolic reflector?" Mac asked as he spread open the booklet he had been reading. "This is the catalogue of Microwave Parabolic Antennas and Accessories produced by *Prodélin, Inc.* of Kearny, New Jersey. As you can see, it has complete information and pictures of their spun aluminum parabolic antennas of 4-, 6-, 8-, and 10-foot diameters."

"Hey, this is even better than you said!" Barney exclaimed. "This ten-foot job gives a gain of 27.7 db at 890-960 megacycles."

"That's gain above an isotropic source," Mac explained. "A half-wave dipole has a gain of 1.64 over an isotropic source; so you have to divide the gain figures in the catalogue by that number to arrive at the gain over a reference dipole we are accustomed to using in radio and TV work. I think this points up something we are going to have to watch in industrial electronics work: some of our radio and TV experience can be applied directly to the new problems, but there will be other cases where this experience will not apply at all or where it will have to be modified to be used. We'll have to be constantly on the alert to know which case is which."

"OK, but was that all your antenna problem?"

"No, that was to take care of a communication link between the lab and a control center at the testing range. They

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0A2	3X8	6BH6	6FS	7Z4	18BD6G
0Z4	5Y3GT	6E4	6SF7	12A8	19J8
1A7GT	5Y4G	6BK3	6SJ7	12A9S	19T8
1B3GT	6A7	6BK7	6SK7	12AT6	2A4
1N4G	6AB	6BL7GT	6SL7GT	12B7	2BRX8
2W5GT	6AB4	6BN6	6BN7GT	12A6	2SRQ4
3L6	6AC7	6BQ6GT	6BQ7	12A7	250NR
3L6	6AF6	6B07	6BS7	12A8	25L6GT
3N1GT	6AD5	6BY5G	6T4	12A7	25W4GT
1Q5GT	6AGT	6BZ6	6T8	12A4GT	25Z3
3R3	6AH4GT	6BZ7	6U8	12A7	25Z6
3X5	6AH6	6C4	6V5	12A7	2B
3T6	6AK3	6C5	6W6GT	12A7	35A5
3U4	6AL5	6C6	6W6GT	12B6	35B5
3U5	6AL7	6C8	6X1	12B7	35C5
1V2	6AM5	6CD6G	6X3	12B6	35L6GT
1X2	6AN8	6CF8	6X8	12B6	35W4
2A3	6AQ5	6CD7	6X8	12B7	35Y4
2A4	6AQ6	6CL8	7A5 XKL	12B6	35Z5GT
3BC5	6AQ7GT	6CM6	7A5	12B8T	37
3BN6	6AR5	6CM7	7A5	12B7	38/44
3BE6	6AS5	6CM7	7A7	12CA5	42
3C8	6AT6	6C6	7B8	12J5	43
3CF6	6AT8	6C6	7B4	12K7	45
3C6	6AU4GT	6DE6	7B5	12L6	50A5
3L4	6AU5GT	6DE6	7B6	12Q7	50B5
3Q4	6AU8	6F6	7B7	12A7	50C5
3B4	6AU8	6H6	7B8	12S07	50L6GT
3V4	6AV5GT	6J4	7C4	12B7	50X6
4B07A	6AV6	6J5	7C5	12B7	5B
6BZ7	6AW8	6J7	7C6	12BN7GT	57
6B8	6AX4GT	6K6GT	7C7	12B7	58
6AT8	6AX5GT	6K7	7C8	12B7	73A
6AV8	6B6	6N6	7E7	12V6GT	75
6AW4	6B6	6N6	7E7	12V6GT	75
6B7	6B6	6N7	7F7	12X4	76
6B7	6B6	6N7	7F8	12Z3	77
6B7	6B6	6N7	7F7	14A7/12B7	78
6B7	6B6	6N7	7F7	14B8	80
6B7	6B6	6N7	7F7	14Q7	84/824
6B7	6B6	6N7	7F7	14R7	117Z3
6B7	6B6	6N7	7F7	19A4GT	117Z6

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also want to have two-way communication between this control point, located at one side of the testing range, and mobile units scattered over the ten-square-mile area of the range. This is on about 150 megacycles. Just to make it tougher, they want to confine as much of the signal from the control station as possible to the test-range itself. In other words, they want an antenna pattern that has nearly uniform gain to the right, left, and straight ahead but with a deep null to the back.

"Very fortunately I had received Prodelin's two-way antenna catalogue along with the one on parabolic reflectors, and this 'Cardioid-3' ground-plane antenna looks like just the ticket. It has a 3-db gain over about a 180° arc, but the front-to-back ratio is 27 db minimum. See, this is the antenna pattern. Looks like the response pattern of a cardioid microphone, doesn't it?"

"Sure does. Say, I want to read this dope here in the back of the catalogue about how you figure the coverage in miles when you know the power input to the transmitter and the gain figures of the transmitting and receiving antennas. I see it is figured for 30, 150, and 450 megacycles and at two different antenna heights. I'll bet I could use those figures for estimating coverage on our ten- and two-meter bands. I see the charts even take a shadow-loss and are prepared for use with omni-directional, bi-directional, and uni-directional antennas. I haven't seen some of these charts in antenna handbooks."

"Lots of these commercial equipment catalogues contain a great deal more information than just sales pitches," Mac commented. "One of the first moves we can make toward getting into industrial electronic service is to acquire and study all of these catalogues we can get. Some of the electronics magazines are starting to publish good articles on the nature and servicing of various kinds of industrial electronic equipment. These articles will be 'must' reading for us from now on. I'm going to start soliciting service work from some of the small plants tomorrow; so brace yourself. It's Mac's Electronics Service from now on!"

Answer to Puzzle Appearing on page 79

C	O	M	P	L	I	A	N	C	E	F
L	I	M	P	E	D	A	N	C	E	Y
P	H	A	S	E	E	C	S	R		
P	E	C	H	O	R	I	T			
I	M	N	I	N	O	I	S	E		
N	A	C	B	A	R	D				
G	D	E	E	M	P	H	A	S	E	S
N	S	B	U	L	O	O	P	S		
A	C	O	U	S	T	I	C	S	S	I
B	A	S	S	H	E	C	T	V		

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Testing Tape Recorders

(Continued from page 59)

(or record-playback) and erase heads must span the same portion of the tape. Improper vertical positioning causes signal loss, crosstalk (particularly in the case of quarter-track stereo heads), and incomplete erasure.

Except, perhaps, in the case of mono heads and half-track stereo ones, it is not a good idea to rely on visual alignment, that is, adjusting the heads by eye so that the edge of the tape and the edge of the gap appear at the same level.

For mono and half-track stereo heads, vertical alignment can be performed with a test tape bearing a relatively low tone (such as 400 cycles) so that moderate changes in azimuth as the head is moved do not significantly affect signal output. If the tape runs from left to right, move the playback head up, then lower it until output (on the left channel in the case of a stereo head) reaches maximum. If the tape runs from right to left, lower the playback head, then raise it until output reaches maximum. If the machine has a separate record head, first align the playback head, then adjust the record head for maximum output while simultaneously recording and playing a low frequency. The erase head is aligned last by adjusting it for maximum erasure of a tape recorded at high level.

A more accurate technique is needed for quarter-track heads to avoid crosstalk. A test tape such as RCA No. 12-5-64T is useful here. The entire width of this tape is recorded except for a band corresponding to track 3, the right channel. The recorded signal is 1000 cycles at 3.75 ips and 2000 cycles at 7.5 ips. The playback head is moved vertically to achieve minimum signal output on the right channel.

Another precision technique employs "Magna-See" made by Reeves Soundcraft Corp. Starting with virgin or bulk-erased tape, record one or both channels with a quarter-track head, then immerse the tape in "Magna-See" solution. When the tape dries, the recorded tracks become visible and can be measured for proper position. If necessary, the record head can be adjusted accordingly. Where there is a separate playback head, this is adjusted afterward by positioning it for maximum output while simultaneously recording and playing a signal. The erase head can be aligned by using "Magna-See" to view the results of erasure on a previously recorded tape.

Distortion

Conventionally, tape recorders are tested only for harmonic distortion. IM tests sometimes give results that are too embarrassing to mention in print.

Harmonic distortion measurements are ordinarily made at 250 or 400 cycles at maximum permissible recording level as shown by the record-level indicator. When the indicator is a vu meter, keep in mind that on a steady signal it usually reads zero vu when the signal is about

6 db below maximum permissible level.

Signal-to-Noise Ratio

Signal-to-noise ratio is usually measured on the basis of a 250- or 400-cycle signal recorded at a level producing 3% harmonic distortion. Machines with magic-eye tubes are often calibrated so that the eye closes at 3% harmonic distortion. Machines with a vu meter are typically adjusted so that 3% distortion occurs when a steady signal is 6 db above that which produces a zero vu reading.

Using virgin or bulk-erased tape, record the signal, play it back, and measure the output level. Rewind the tape, repeat the procedure but without an input signal, and measure the output. The signal-to-noise ratio is that between the first and second measurements, expressed in decibels. The ratio takes into account the noise and hum of the tape amplifiers, hum picked up by the playback head, tape hiss, noise resulting from bias waveform distortion, and imperfect erasure.

For a playback-only tape machine, use a test tape bearing a signal recorded at the 3% harmonic distortion level. Measure the output level when playing this tape. Then play a virgin or bulk-erased tape and measure the output. Compare the first and second measurements in terms of decibels. If the tape has a signal recorded at the 1% harmonic distortion level, add about 6 db to the measured signal-to-noise ratio.

Tape Speed & Erasure

To measure tape speed, use a tape stroboscope, consisting essentially of a wheel with strobe markings, which is held against the moving tape. View the strobe bars under a 60-cycle light source and count the number of bars per minute that appear to move past a fixed point. At any tape speed, 72 bars per minute correspond to a speed error of 1%. Other errors are proportional—thus 36 bars per minute denote an error of .5%.

To check the erase head, record a low frequency at maximum permissible level on virgin or bulk-erased tape and repeat the process without signal input. Then play the tape with gain well up to ascertain how the head performs.

Wow & Flutter

Equipment for measuring wow and flutter is seldom encountered in the average service shop; therefore, this test will be discussed on the basis of the device most frequently used—the human ear. Play a tape containing a tone of 3000 cps or thereabouts—either a test tape or one recorded at moderate level on the machine under examination. At this frequency the human ear is quite sensitive to deviations from constant speed. Wow produces a quavering or sour effect, while flutter is manifest as graininess or coarseness of tone.

All the tests outlined herein will help you to judge the over-all performance of the tape recorder and determine whether or not it is operating in accordance with its manufacturer's specifications. ▲

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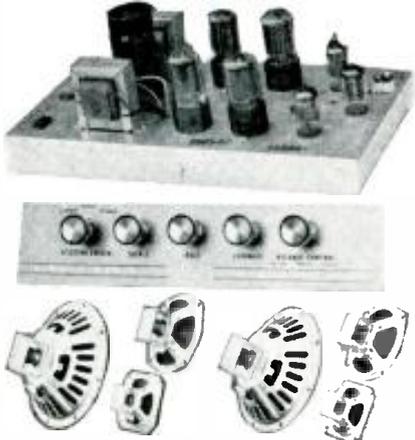
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A New Broadband TV Antenna

(Continued from page 62)

antenna, are interconnected by a transposed feedline. We will assume that a signal at the frequency of channel 2 is applied to input terminals A-A. Let us also make the assumption, which is not true in the actual case, that the impedances of all elements are equal at channel 2. It is important to recognize that, in this condition, the various elements will not absorb (and radiate) equal amounts of power.

Take as an example the case where the impedance of each element is such, in relation to the impedance of the transmission line, that each element absorbs one half the power supplied to it. Omitting reflections, element 1 would absorb one half the total power; element 2 would then absorb one half of the balance (or one quarter of the total); element 3 would thus absorb only one eighth of the total, and so on.

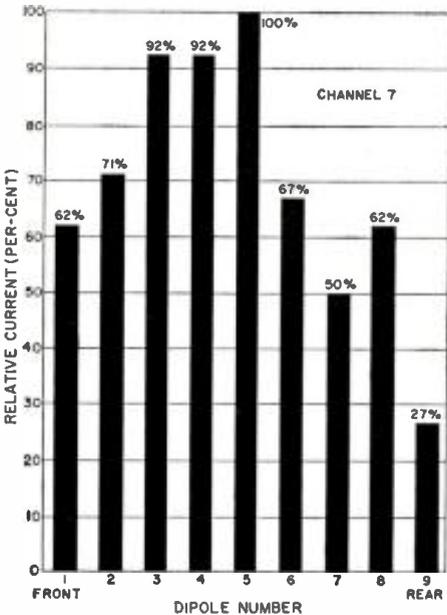


Fig. 4. Relative absorption of current in the 9 driven elements on channel 7.

Only the first few elements would be significantly active.

Since the elements (and their impedances) are in parallel across the transmission line, it is also true that any high-impedance element will absorb relatively little power, while any low-impedance element will absorb relatively more. In other words, if the impedances of elements toward the front of the antenna, such as Z_1 and Z_2 , are kept relatively high and such impedances as Z_4 and Z_5 are kept relatively low, power will tend to be distributed more evenly through the driven elements. With more elements kept active, greater gain is achieved. To maintain a uniform distribution of power across most of the array, the critical impedance values at each element were adjusted to obtain the lowest percentage of absorption in those elements nearest the feedpoint and the greatest relative absorption in those elements farthest away.

The exceptional broadband gain is due to the fact that this principle of proportional energy absorption from the transmission line was maintained for a large number of elements at all v.h.f. frequencies. Although the degree of absorption for any given element does not remain the same at all frequencies, the combined effect is always that of several active elements. For example, in the case of channel 2 (Fig. 3), element 7 is most active. However, elements 6 and 8 are also extremely active and elements 5 and 9 make substantial contribution. Each element contributes some amount of gain.

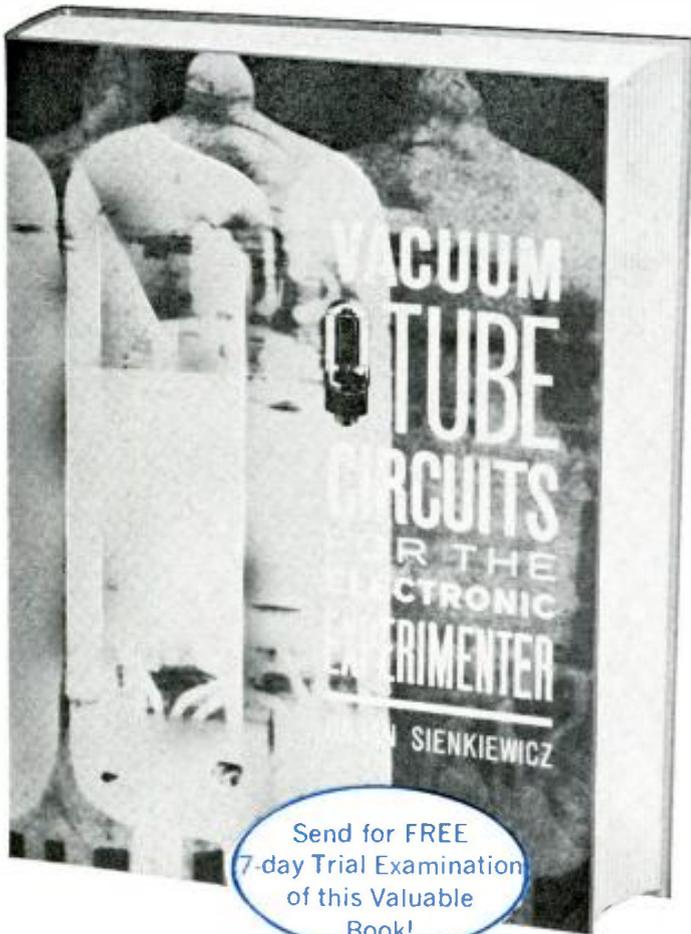
If we were to examine a similar graph for channel 6, we would find that element 1 absorbs the greatest amount of current, that dipoles 3 and 2 respectively are close behind it, and that elements 4 and 5 also show appreciable absorption. In the graph for channel 7 (Fig. 4), the pattern of absorption is still different, but note that virtually every dipole is significantly active. However, mention of channel 7 gets ahead of the story, since it is in the high v.h.f. band. The series of driven dipoles used, as illustrated in Fig. 2A, were designed for the low v.h.f. band.

For the high band, harmonic-mode operation is used. This is made possible by the fact that the high band (174 to 216 mc.) falls within the range of third harmonics of the low band (54 to 88 mc.). Element A of Fig. 2B is a half-wave dipole on the low band. Let us say that it is resonant at 60 mc. (channel 3). Current distribution is shown for the third harmonic, 180 mc., which corresponds to channel 8 on the high band. The out-of-phase half-cycle of current at this frequency tends to cancel effectiveness. If a parasitic element resonant at 180 mc. (B in Fig. 2B) is added, its strong forward current overcomes the effect of the out-of-phase component. The combined effect of dipole and parasite on the higher frequency is shown at C.

As may be noted in the photograph of Fig. 1, each driven, low-band dipole has its own associated high-band parasite. The impedance of the parasites is so high that they have virtually no effect on low-band impedance and therefore on low-band operation. The dipole system was thus developed for optimum low-band performance. Length and spacing of the parasites were then independently worked out to maintain the desired performance characteristics in the high band.

The use of a transposition type of feedline maintains phase relationships of signal in the various driven elements so that there is reinforcement in the forward direction but out-of-phase cancellation to the rear. In principle, this can provide extremely high front-to-back ratios. However, for this to occur in practice, signal amplitudes in the driven elements must be matched. Otherwise the pattern of re-inforcement and cancellation can be extremely erratic. Due to the proportional energy absorption at all frequencies, high ratios are obtained at all channels without reflectors.

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- ELECTRONIC OHMMETER—0 to 1000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms.
- DECIBELS—10 db to +18 db, +10 db to +38 db, +30 db to +58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v).
- ZERO CENTER METER—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads and carrying case. Price is \$42.50. Terms: \$12.50 after 10 day trial then \$6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER



6 INCH FULL-VIEW METER provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.

MIRRORED SCALE permits fine accurate measurements where fractional readings are important.

SPECIFICATIONS:

- 7 D.C. VOLTAGE RANGES: (At a sensitivity of 20,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500 Volts.
- 6 A.C. VOLTAGE RANGES: (At a sensitivity of 5,000 Ohms per Volt) 0 to 15/75/150/300/750/1500 Volts.
- 3 RESISTANCE RANGES: 0 to 2,000/200,000 Ohms. 0-20 Megohms.
- 2 CAPACITY RANGES: .00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.
- 5 D.C. CURRENT RANGES: 0-75 Microamperes, 0 to 7.5/75/750 Milli-amperes, 0 to 15 Amperes.
- 3 DECIBEL RANGES: -6 db to +18 db, +14 db to +38 db, +34 db to +58 db.

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Price is \$42.50. Terms: \$12.50 after 10 day trial then \$6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 70 UTILITY TESTER

FOR REPAIRING ALL ELECTRICAL APPLIANCES MOTORS * AUTOMOBILES



INCLUDED FREE
64 page condensed course in electricity. Profusely illustrated. Written in simple, easy-to-understand style.

As an electrical trouble shooter the Model 70:

- Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Switches, Thermostats, etc.
- Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistances, Leakage, etc.
- Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc.
- Leakage detecting circuit will indicate continuity from zero ohms to 5 megohms (5,000,000 ohms).

As an Automotive Tester the Model 70 will test:

- Both 6 Volt and 12 Volt Storage Batteries • Generators • Starters • Distributors • Ignition Coils
- Regulators • Relays • Circuit Breakers • Cigarette Lighters • Stop Lights • Condensers • Directional Signal Systems • All Lamps and Bulbs • Fuses • Heating Systems • Horns • Also will locate poor grounds, breaks in wiring, poor connections, etc.

Model 70 comes complete with 64 page book and test leads. Price is \$15.85. Terms: \$3.85 after 10 day trial then \$4.00 monthly for 3 months.

DID YOU EVER?

- ▶ Order merchandise by mail, including deposit or payment in full, then wait and write...wait and write?
- ▶ Purchase anything on time and sign a lengthy complex contract written in small difficult-to-read type?
- ▶ Purchase an item by mail or in a retail store then experience frustrating delay and red tape when you applied for a refund?

Obviously prompt shipment and attention to orders is an essential requirement in our business... We ship at our risk!

NO

**CONTRACT TO SIGN
CO-MAKERS
EMPLOYER
NOTIFICATION**

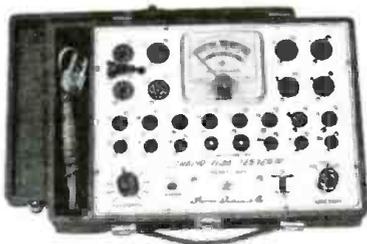
The simple order authorization included in this offer is *all* you sign. We ask only that you promise to pay for or return the goods we ship in good faith.

**EXAMINE ANY ITEM YOU SELECT
IN THE PRIVACY OF YOUR OWN HOME**

Then if completely satisfied pay on the interest-free terms plainly specified. When we say interest-free we mean not one penny added for "interest" for "finance" for "credit-checking" or for "carrying charges." The net price of each tester is plainly marked in our ads—that is all you pay except for parcel post or other transportation charges we may prepay.

SUPERIOR'S NEW MODEL 82A
MULTI-SOCKET TYPE

TUBE TESTER



Model 82A comes housed in handsome, portable case. Price is \$36.50. Terms: \$6.50 after 10 day trial then \$6.00 monthly for 5 months.

SPECIFICATIONS:

- Tests over 1000 tube types.
- Tests OZ4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

SUPERIOR'S NEW MODEL TW-11
STANDARD PROFESSIONAL

TUBE TESTER



The Model TW-11 comes housed in a handsome, portable, saddle-stitched Texon case. Price is \$47.50. Terms: \$11.50 after 10 day trial then \$6.00 monthly for 6 months.

- Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test.
- Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large-easy-to-read type.
- **NOISE TEST:** Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.
- **SEPARATE SCALE FOR LOW-CURRENT TUBES**—Previously, on emission type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

SUPERIOR'S NEW MODEL 83A

C.R.T. TESTER

**Tests and Rejuvenates
ALL PICTURE TUBES**



Model 83-A comes housed in handsome portable Saddle-stitched Texon case—complete with socket for all black and white tubes and all color tubes. Price is \$38.50. Terms: \$8.50 after 10 day trial then \$6.00 monthly for 5 months.

ALL BLACK AND WHITE TUBES
From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES
Test ALL picture tubes—in the carton—out of the carton—in the set!

Model 83A provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.

Model 83A properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

Model 83A will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus.

Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages, improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83A applies a *selective* low voltage uniformly to assure increased life with no danger of cathode damage.

SUPERIOR'S NEW MODEL 85

TRANS-CONDUCTANCE TYPE TUBE TESTER



Model 85 comes complete, housed in a handsome portable cabinet with slip-on cover. Price is \$52.50. Terms: \$12.50 after 10 day trial then \$8.00 monthly for 5 months.

- Employs latest improved **TRANS-CONDUCTANCE** circuit. Test tubes under "dynamic" (simulated) operating conditions. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured as a function of tube quality. This provides the most suitable method of simulating the manner in which tubes actually operate in radio, TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.
- **SYMBOL REFERENCES:** Model 85 employs time-saving symbols (P, A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z) in place of difficult-to-remember letters previously used. Repeated time-studies proved to us that use of these scientifically selected symbols speeded up the element switching step. As the tube manufacturers increase the release of new tube types, this time-saving feature becomes necessary and advantageous.
- **"FREE-POINT" LEVER TYPE ELEMENT SWITCH ASSEMBLY** marked according to RETMA basing, permits application of test voltages to any of the elements of a tube.
- **FREE FIVE (5) YEAR CHART DATA SERVICE.** Revised up-to-date subsequent charts will be mailed to all Model 85 purchasers at no charge for a period of five years after date of purchase.

SUPERIOR'S NEW MODEL TV-50A

GENOMETER 7 Signal Generators in One!



- ✓ R.F. Signal Generator for A.M.
- ✓ R.F. Signal Generator for F.M.
- ✓ Audio Frequency Generator
- ✓ Bar Generator
- ✓ Cross Hatch Generator
- ✓ Color Dot Pattern Generator
- ✓ Marker Generator

A versatile all-inclusive **GENERATOR** which provides **ALL** the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

The Model TV-50A comes absolutely complete with shielded leads and operating instructions. Price is \$47.50. Terms: \$11.50 after 10 day trial then \$6.00 monthly for 6 months.

SUPERIOR'S NEW MODEL 88

TESTS ALL TRANSISTORS AND TRANSISTOR RADIOS



AS A TRANSISTOR RADIO TESTER

An R.F. Signal source, modulated by an audio tone is injected into the transistor receiver from the antenna through the R.F. stage, past the mixer into the I.F. Amplifier and detector stages and on to the audio amplifier. This injected signal is then followed and traced through the receiver by means of a built-in High Gain Transistorized Signal Tracer until the cause of trouble is located and pinpointed.

AS A TRANSISTOR TESTER

The Model 88 will test all transistors including NPN and PNP, silicon, germanium and the new gallium arsenide types, without referring to characteristic data sheets. The time-saving advantage of this technique is self-evident. A further benefit of this service is that it will enable you to test new transistors as they are released!

Model 88 comes housed in a handsome portable case. Complete with a set of Clip-on Cables for Transistor Testing; an R.F. Diode Probe for R.F. & I.F. Tracing; an Audio Probe for Amplifier Tracing and a Signal Injector Cable. Complete—nothing else to buy! Price is \$38.50. Terms: \$8.50 after 10 day trial then \$6.00 monthly for 5 months.

SEND POSTCARD TODAY (NO POSTAGE NECESSARY)

Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. No interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC, INC., DEPT D-917 3849 TENTH AVENUE, NEW YORK 34, N.Y.

New Products and Literature for Electronics Technicians

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 120.

PC GRID BOARDS

1 Corning Electronic Components has recently developed two new configurations in its "Fotoceram" printed-circuit grid boards. One has new corner mounting holes while the other has the mounting holes plus a plug section useful for computer design work.



The grid boards consist of copper-clad "Fotoceram" glass-ceramic with a grid of .052-inch through-plated holes set .1-inch on center. The new boards, equipped with silicone rubber mounting groutmets, are available in 4" x 6" and 6" x 8" sizes.

MICROMINIATURE PLUG

2 Cannon Electric Company has designed a new microminiature plug which is being used to form an ingenious diode matrix by Delta Semiconductors, Inc.

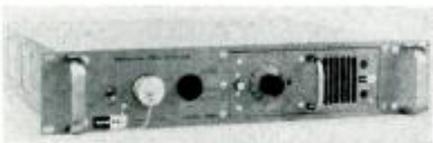
The plugs incorporate new twisted wire pin contacts which assure maximum contact surface and provide high reliability compared to welded connections. The "Micropins" are self-aligning and individually "shrouded" in the insulator for protection.

Designed to resist severe environmental conditions, the entire mated plug can be constructed as small as .395" deep (excluding terminations).

A.C./D.C. PREAMP

3 Kin Tel Division of Cohu Electronics, Inc. is now in production on a new a.c.-d.c. pre-amplifier, the Model 458 C/N.

The unit is a versatile, chopper-stabilized, single-ended, wideband d.c. amplifier which can be used as a general-purpose laboratory amplifier



or as a preamplifier. In this latter use, the unit has precision d.c. and a.c. gain positions of 100 to increase the sensitivity of the firm's digital voltmeters to 1 μ v. d.c. and 10 μ v. a.c.

Front panel controls provide four modes of operation. Output capability is \pm 45 volts d.c. into a 10,000 ohm or greater load, 35 volts peak (25 volts r.m.s.) a.c. into 1000 ohms or more.

HIGH-FIELD SOLENOID MAGNETS

4 The Magnetics Division of Harvey-Wells Corporation has designed a new type of solenoid magnet in conjunction with Prof. F. Bitter of MIT's Magnet Lab.

The Model HF-26 provides ultra-high field strengths across large working diameters with lower power requirements and utilizes a low carbon steel jacket around the solenoid as a return path to achieve a new breakthrough in high-field solenoid performance.

A 2" diameter by 6" long bore size provides ample room for samples on the order of one-half inch cube, together with any necessary low-temperature apparatus. A special steel stand facilitates easy access to the entire bore area.

SAMPLING OSCILLOSCOPE

5 Hewlett Packard Company is now offering a new sampling oscilloscope which provides calibrated, high-resolution measurement of nanosecond pulse phenomena.

The Model 185B features conventional con-



trols, direct-reading and bright-trace observation, and a standard 5" mono-accelerator CRT. The unit, when equipped with a Model 187B plug-in dual-trace amplifier, has a passband from d.c. to 1000 mc., can be synchronized up to 1000 mc., and permits full screen presentation of signals from .3 nanosecond to 100 μ sec.

TV BIAS SUPPLY

6 Sencore, Inc. is marketing a dual TV bias supply, designated as Model BE113. This supply is designed to replace batteries that are frequently used to substitute for a TV set's bias supply during alignment. The supply is also suitable for a.g.c. troubleshooting and for checking the operation of a TV receiver under conditions of different a.g.c. bias voltages.

The bias supply operates directly from the 117-volt a.c. line. It has two separately adjustable d.c. outputs which may be connected to the TV set being checked by means of the clip leads supplied. Each output is variable from 0 to 22 volts negative. By using fairly large electrolytic capacitors for filtering, the impedance of the supply is kept low and the percentage of ripple is said to be only .1%.

The supply, which the manufacturer calls an "Align-o-pak," is contained within a compact, flat metal case which measures 4 1/2" wide by 1 3/4" high by 3 1/2" deep.

DIFFUSED-SILICON TRANSISTOR

7 Texas Instruments Incorporated has announced the availability of the developmental type T1X 690 field-effect transistor, an "n"-channel diffused silicon device featuring dual gate control.

The unit is a voltage-operated amplifying device which uses the depletion regions of back-biased "n-p" junctions to control the conductive thickness of a semiconductor layer. The result is

a high-input-impedance, high-gain unit that will find application in the input stages of audio and d.c. amplifiers, switching, voltage-controlled resistances, a.g.c. circuits, voltage-controlled bandwidth amplifiers, analogue multipliers, among other uses.

POWER TRANSISTOR

8 Westinghouse Electric Corporation has developed a 10-ampere silicon power transistor with a current gain of 1000 at 2 amps and a .35-ohm saturation resistance.

The WX118 has voltage ratings up to 150 volts and a power dissipation rating of 150 watts. It is applicable in high-power, high-efficiency regulators, amplifiers, and switching circuits.



AIRBORNE RECORDER

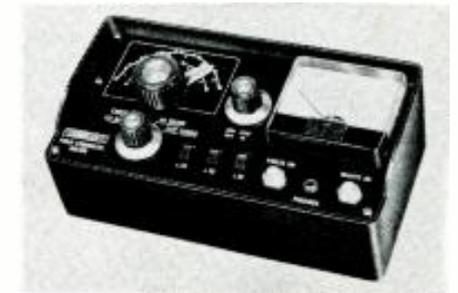
9 Westrex Recording Equipment Div. of Litton Systems, Inc. is now in production on a 13-pound airborne magnetic tape recorder that records 14 tracks with laboratory precision in missile environments.

The 2101 data recording system consists of a precision tape transport and an electronic module assembly. Choice of 14 tracks of wideband FM recording or seven tracks of wideband FM and seven tracks of direct analogue recording can be made by changing plug-in modules.

TV FIELD-STRENGTH METER

10 Sadelco Inc. is now offering a compact, portable TV field-strength meter for service applications.

The unit's six transistors are operated from a zener diode voltage-regulated battery supply. Separate tuning is provided for all v.h.f. picture



and sound carriers, which can be measured from 20 μ v. to 1 volt. It can also measure power output of low-power v.h.f. transmitters from .1 to 1.5 watts.

The instrument measures 8" x 4 1/4" x 2 1/2" and weighs 3 pounds. It comes complete with a leather carrying case.

MINIATURE CHOPPER

11 Oak Manufacturing Co. has announced the development of an improved miniature 60-cycle chopper designed for operating d.c. amplifiers for computer applications.

In compact electronic equipment, the lightweight moving element and armature reduce

audible noise and vibration due to chopper operation. It eliminates vibration in the chassis and is designed to prevent transmission of vibration to tubes in the chassis.

Nominal drive frequency and voltage are 60 cps \pm 5 cps at 6.3 volts aperiodic from 10 to 100 cps.

FAST-SWITCHING DIODE

12 Rheem Semiconductor Corporation is now offering a new silicon diode, the RD750, which provides a 5 to 1 improvement in conductance and a 2 to 1 improvement in recovery time, making possible significant design improvements in computers and other electronic systems.

Conductance of the RD750 is typically 1000 ma. at 1 volt, permitting new levels of high-current switching for applications such as thin-film computer memories. At low current levels, the voltage drop is very low, being only .65 volt at 10 ma.

POWER-TRANSISTOR TESTER

13 Hickok Electrical Instrument Company has announced development of the Model 1885 which has been designed to test transistors to 50 amperes of I_r power diodes to 5 amps forward current, and tester diodes to leakage current of 150 ma.

The new tester will measure the following



parameters: I_{cbo} , I_{cbo} , I_{cbo} , d.c. beta, input impedance, Z_{in} , output impedance H_{re} , G_m in μ hos and mhos. It will also determine alpha and collector voltages.

This fully transistorized instrument can be set up through use of the built-in roll chart or direct from transistor manufacturers' handbook specifications.

CRT REJUVENATOR-TESTER

14 B&K Manufacturing Co. has recently introduced a low-cost "compact" model CRT rejuvenator-tester as the Model 420.

The new unit tests and rejuvenates picture tubes at correct filament voltage at 2, 6, and 8 volts, including 110-degree tubes and the new 19" and 23" tubes. The instrument checks for leakage, shorts, and emission and removed interelement shorts and leakage.

There is an easy-to-read "Good-Bad" scale. The



December, 1961

unit operates on 117-volts, 50-60-cycle a.c. and measures 8 $\frac{3}{4}$ " x 6 $\frac{3}{4}$ " x 3 $\frac{3}{4}$ ". It comes in a lightweight, two-tone carrying case.

R-C ANALYZER

15 Lafayette Radio Electronics Corporation is now offering a capacitance-resistance analyzer as the Model TE-25.

The unit features a large functional dial and



easy-to-read milliammeter. Resistance and capacitance is read in four separate ranges: from 1 μ f. to 5000 μ f. and from .5 to 500 megohms. The unit will also measure the power factors of electrolytics, shorts, opens, and leaky capacitors. The d.c. voltage is continuously variable up to 600 volts. The meter has two ranges, 0-6 and 0-60 ma.

MULTIPLE SWITCHING DIODES

16 Radio Corporation of America has announced the development of multiple silicon switching diodes which are expected to simplify computer design and manufacture while extending performance and reliability.

Housed in a subminiature package the size of a match head and thinner than a nickel, the multiple units consist of two or three ultra-high-speed silicon diodes having a common cathode connection.

The new units are currently available in sampling quantities for industry evaluation.

SCOPE AMPLIFIER

17 Keithley Instruments is now in production on a new a.c. preamplifier which is designed to provide the best possible signal-to-noise ratios to oscilloscopes and recorders.

The Model 103 has a noise level of less than .8 μ v. r.m.s. between 10 and 10,000 cps. The unit lowers the microvolt measurement threshold over a bandwidth of .1 cps to 100 kc. Applications include measurement of piezoelectric crystal outputs, a.c. Hall effect studies, a.c. bridge null indicators, and investigations of i.f. noise in semiconductors.



ETV DISTRIBUTION SYSTEMS

18 Jerrold Electronics Corporation has developed a complete master antenna system for use in areas where the MPATI telecasts are being received.

The system includes a master antenna or "J-jacks" unit, plus the 503HX crystal-controlled converter. The J-jacks system permits the reception of all radio and TV signals in the area (including MPATI and FM) and functions as a flexible and expandable closed-circuit system that accommodates both video and r.f. transmissions. Thus TV broadcasts may originate at any desired J-jacks outlet and may be received at all J-jacks outlets.

TRANSISTOR TESTER

19 Heath Company is now introducing a low-cost, laboratory-quality transistor tester as its Model IM-30 kit. Designed for the servicing field and industry, the circuit features four level switches which permit instant selection of the

COLUMBIA GEMS!

COLLINS MBF TRANSCEIVER
Freq.: 60-80 Mc. 3 W. output. AM. Complete self-contained unit with speaker and built-in 110 V. a.c. DC power supply. Easily converted to 220 V. 10 or 11 meters. Excel. cond. **\$49.95**

TF-239/UP OSCILLOSCOPE
This is a portable, general purpose, lab type scope for minute fraction of its original cost which was \$2,000.00! 10 cps, SMC response. You can't go wrong. Excel. cond. **\$99.50**

I-100B ADF TEST SET For ARN-7 and SCR-269 aircraft ADF. Excel. condition. Special \$149.50
TS-251 LORAN SIG. GENERATOR Bench simulator for AN/APN-4 and AN/APN-5. Excel. **\$59.50**

AN/APN-4B LORAN RECEIVING SET FR for boats! Gives exact fix with relation to LORAN stations. Consists of indicator, receiver, mounting rack, connectors, and inverter. for 24 V. system. Excellent. ONLY **\$79.50**

TCS REMOTE CONTROL UNIT Universally speaker alone worth \$15.00! P.L.U.S.: volume control, switches, etc. Complete. Like new **\$4.95**

TDQ 50 W. AM TRANSMITTER FOR 2 METERS: Complete modular power supply. RF and mod. sections. Final uses 825-B drivers by 89-B. 115 V. 330 V. 800 cps. No conversion necessary. Good cond. Sensational buy @ **\$95.00**

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R-28/ARC-5 2 METER & AIRCRAFT RECVR.: 100-150 Mc. Excellent condition. Only... **\$22.50**
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1-3 Mc. This Recv'r is brand new! Only... **13.95**
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AN/PRC-6 FM TRANSMITTER-RECVR. 30-40 Mc. Crystal control. 50 W. 115 V., 80 cps. Contained in 8 ft. enclosed cabinet. With meter and speaker. This is a military version of Motorola Model B-1. Only **\$99.50**

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TCS SET: Complete. 12 V. Recond... **\$150.00**
TCS SET: Complete. 110 VAC... **199.50**
ARC-27 TRANSCEIVER. Excel. This month only... **395.00**
PP-109 12 V. POWER SUPPLY: Excel. cond. **99.50**
PP-112 24 V. POWER SUPPLY: Excel. Only **89.50**
PRC-6 HANDIE TALKIE: Comp. w/book. **125.00**
BC-312 RECEIVER: Excel. Our special... **89.50**
PE-110 VOLT POWER SUP. For B-100. Excel. **49.50**
SPARES! Complete spares for GRC, PRC, Equip. etc. WHAT DO YOU NEED?
R-101A ARN-6 COMPASS RECEIVER: **79.50**
SA 142 GSA-6 SWITCH BOX: With 12-100 V. Cont. Excel. **3.95**
GN-58 GENERATOR: Excellent. New low price! **35.00**
GN-175 BAG: For above generator. Only **1.00**
BC-375 100 W. XMTR. With all accessories. Like new **49.50**
AN/UPM-4 IFF TEST SET: Excel. cond. **950.00**

APR-4 TUNING UNITS
TN-18/APR-4: 300-1000 Mc. Like New. Ea. **\$35.00**
TN-19/APR-4: 475-725 Mc. Like New. Ea. **49.50**

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TN-1: 30-90 Mc. Excellent condition. Only **19.95**
TN-2: 80-100 Mc. Excellent condition. Only **19.95**
TN-3: 300-1000 Mc. Excellent cond. Only **19.95**

ORIG. CASE FOR BC-611 HANDIE-TALKIE
Leak switch, top and bottom covers. New... **\$4.95**
PP-109 THERMAL RELAY: **227.98-129.** 20c Brand new. Ea.

FACSIMILE TRANSMISSION MODULATOR: Nimitz MD-168/EX. Permits transmission of facsimile signals via air or wire. BRAND NEW **\$99.50**

RT-82, APX-6 TRANSCEIVER, 1215 Mc.
Less tubes... excellent condition **\$3.95**

MOBILE RADIO-TELEPHONE
150-170 Mc. single channel, crystal control. FM. 5 V. input; out, 25 W. Consists of transmitter, receiver, antenna, connecting cable and other accessories. Mfg. by West Coast Elect. Good condition. Only **\$24.95**

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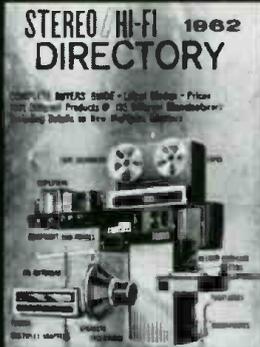
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The 1962 edition of the **STEREO/HI-FI DIRECTORY** is the complete buyers' guide to over 1300 component listings! Get specifications, prices, and performance data on:

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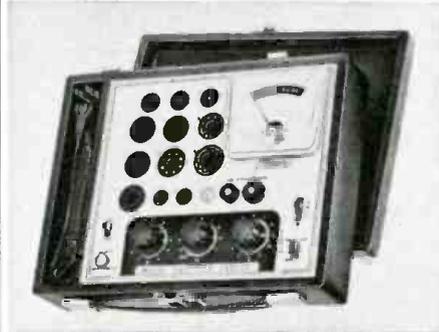


desired test after proper conditions are set by the voltage and current range switches.

Tests include base current, gain, collector current, collector voltage, leakage voltage, short test, diode or collector-to-emitter leakage, collector-to-base leakage, all selectable by the lever switches. The four rotary switches, one for voltage and one for current on both gain and leakage, set the desired conditions.

TUBE TESTER FOR SERVICE

20 Mercury Electronics Corp. has recently introduced a popularly priced tube tester which will check all tube types including novistors, com-



patrons, novars, and the new 10-pin tube types.

The Model 1100 will also handle battery tube types, auto-radio hybrid tubes, voltage regulators, foreign and hi-fi tubes, thyratrons, and industrial tube types.

The instrument tests for dynamic cathode emission, shorts and leakage, grid leakage, and gas content. As a multiple-socket tube tester, it tests tubes quickly and accurately with no time-consuming multiple-switching or roll-chart checking required.

The Model 1100 measures 10 $\frac{1}{2}$ " x 8 $\frac{1}{4}$ " x 3 $\frac{1}{4}$ " and comes in a leatherette covered case.

HI-FI—AUDIO PRODUCTS

TRANSISTORIZED RECORDER

21 American Gelsco Electronics, Inc. has added a transistorized tape recorder to its line as the "Unicorder 61."

This transistorized tape recorder will operate on either a.c. or d.c.—works on 10 penlight batteries or on 60 cycles without an a.c. adapter.

Small and compact and weighing only 5 pounds, the recorder can be played in its carrying case in any position. There are two 2 $\frac{1}{4}$ " dynamic speakers, it provides speeds of 1 $\frac{1}{8}$ and 3 $\frac{3}{4}$ ips, has a signal-to-noise ratio of better than 20 db, and a frequency response of 80-7000 cps.

RING-RADIATOR TWEETER

22 Stephens Trusonic Inc. is now offering a popularly priced ring-radiator-type tweeter, the "RT-1."

The unit is efficient in the 5000-20,000 cps range and continues to provide good response far beyond audibility. The entire diaphragm, voice-coil form, and compliant areas are manufactured to achieve a non-metallic unit, eliminating directional grain characteristics. The

edge-wound aluminum ribbon voice coil is attached to its form by a thermal-pressure method developed by the firm.

The RT-1 comes complete with a 5000 cps crossover network and attenuator control.

MAGNETIC CARTRIDGES

23 Shure Brothers, Inc. has added two new magnetic cartridges to its line of "Dynetic" units.

The M33 cartridge is recommended for turntable and record-changer arms capable of tracking at 1 to 3 grams. Frequency response ranges from 20 to 20,000 cps. It is available with either a .0005 or .0007-inch stylus. The M77 is designed for record-changer arms tracking above 3 grams. It is available with a .0007-inch stylus and has a frequency response of 20 to 17,000 cycles-per-second.



PUSH-BUTTON STEREO PREAMP

24 Heath Company has added a deluxe stereo preamp to its audio equipment line as the AA-11 kit.

As a master control center, all switches and controls are divided into two distinct groups: the first group consists of basic controls which are located on the plastic front panel while the other group is composed of secondary controls located behind the hinged cover on the lower front panel. The primary controls include 9 push-button switches for selection of five stereo inputs, three



mono inputs and "on-off" switch; a dual-tandem volume-loudness control; and separate dual-concentric bass and treble controls for individual channel adjustment.

CONSOLETTA ORGAN

25 The Schober Organ Corp. is now offering its consolette model electronic organ in a redesigned console with a new set of 17 pedals. The



new console avoids the boxy look with shaped outward curves at the front and legs which are integral parts of the sides rather than attached.

The standard finish is dark walnut with other finishes available on a custom basis at an additional charge. The unit measures 46" wide, 26 $\frac{1}{2}$ " deep, and 36" high. It has 5-octave keyboards and 22 pipe-organ-type voices. The consolette is offered in kit form only.

FOUR-TRACK TAPE DECK

26 Kimberley Industries, Ltd. is now distributing the Korting 114 four-track stereo tape deck which features three separate heads for record, playback, and erase.

Precision-made in West Germany, the new unit is equipped with a preamp equalizer for both recording and playback which allows use with an external power amplifier only. When the deck



is used for mono recording or playback, the internal preamp equalizer may be bypassed permitting use of an external preamp equalizer.

Frequency response is 40-15,000 cps at 3.75 ips and 30-20,000 cps at 7.5 ips. Wow and flutter are less than .2% at 7.5 ips.

P.A. AMPLIFIER LINE

27 Precision Electronics, Inc. is now offering a re-designed line of public-address amplifiers with new exterior features as well as improved circuitry.

The new line includes 10, 20, 30 and 60 watt



public-address units, a 25-watt mobile transistorized version, and a 30-watt mobile three-way unit which operates from 6, 12, and 117 volts a.c.

BATTERY-OPERATED RECORDER

28 North American Philips Company, Inc. has announced the availability of a new portable, fully transistorized, battery operated tape recorder, the "Continental 100."

Weighing only 8 pounds and using six "D" flashlight cells, the unit records at 1 1/2 ips and will provide up to two hours playing time on a



single four-inch reel. Frequency response is 100-6000 cps. The instrument includes recording and playback preamps, a power amplifier, and loud-speaker. It comes equipped with a Norelco dynamic cardioid microphone which fits into a recess in the recorder.

MONO TAPE RECORDER

29 Superscope Inc. is handling the U.S. distribution of the Sony Model 111 "Tapeorder"—a compact, two-speed, a.c.-operated mono tape recorder.

Decorator styled in coral and white, the unit features a sturdy drive mechanism with dynamically balanced flywheel-capstan assembly. Simplified one-knob control for all functions (stop, play, fast forward, rewind, and pause) is easy enough for a child to operate.

The instrument measures 8 1/4" x 4 1/2" x 7 1/2" and weighs 9 pounds. It comes complete with microphone and flight-type carrying case.

CB-HAM-COMMUNICATIONS

POCKET-SIZE TRANSCEIVER

30 Oneida Electronic Mfg. Co. is now in production on a pocket-sized, aluminum-cased transceiver which operates license-free on the Citizens Band.

Measuring a mere 2 3/8" x 4 3/4" x 1 1/2", the circuit uses four transistors and provides 100 mw. input. Standard production models are set on channel 7, with other channels available on request. The receiver is superregenerative with the tuning range factory tuned from 26.695 mc. to 27.225 mc. The unit is powered by a single battery and weighs 12 ounces.

D.C. POWER SUPPLY

31 H. O. Boehme, Inc. has developed a versatile and dependable d.c. power source which will operate under a wide variety of input conditions.

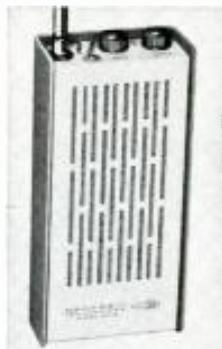
The Model 10-C is especially suited to communication's equipment and features a special panel switching system which provides a constant 115-volt d.c. output at load currents up to 3 amps under a.c. input voltages ranging from 115 volts \pm 10 volts and 230 volts \pm 20 volts, single phase, at 25 to 60 cps.



HAND-HELD CB UNIT

32 Heath Company has added a 9-transistor hand-held CB transceiver to its line of communications kits.

The GW-21 includes a crystal-controlled superhet receiver with r.f. amplifier, squelch and noise limiter circuit, and has better than 1 μ v. sensitivity for 10 db signal-to-noise ratio. The audio output and modulator section delivers 150 mw. of power to the 2 1/2" speaker which also doubles as a mike when transmitting. The transmitter section consists of a crystal-controlled oscillator/driver stage and a high-efficiency modulated r.f. output amplifier. Maximum power input to the final is 100 mw. allowing use without an FCC license.



5-BAND MARINE RECEIVER

33 Nova-Tech, Inc. is now marketing a five-band marine-home receiver as the "AM-FM Trans-ocean."

The receiver covers the beacon and weather (200-400 kc.), AM broadcast (550-1600 kc.), marine and police (1.6-5 mc.), short-wave (5-15 mc.), and FM (88-108 mc.) bands.

The instrument features built-in antennas,



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VOL. 3—EVERYTHING ON TV-RADIO CIRCUITS! 336 pages; hundreds of illustrations, circuit diagrams.

VOL. 4—EVERYTHING ON SERVICING INSTRUMENTS! How they work, how to use them. 368 pages; illustrated.

VOL. 5—EVERYTHING ON TV TROUBLE-SHOOTING! Covers all types of sets. 437 pages; illustrations, diagrams.

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Duo dial Model RB, Mfg by Helipot, 100 divisions per turn, will count to 15 turns. Dial suitable for helipots, Var. Inductors etc. With mounting hardware. PRICE

\$2.95

BC 442 ANTENNA BOX (ARC 5)

Contains RF Meter (750 Ma.) Relay, etc. Sec. Coaxial Relay conv. "CQ" March 1960. Price

\$1.95

POWER TRANSFORMER

110V-60 Cy.-Sec 385-0-385 V. @ 200 Ma. Fil 6.3V 6 Amps. 5 V. 3 Amps. Ea.

\$3.50

FILAMENT TRANSFORMER

Input 110V. 60 cycle. Secondary 6.3V. @ .6 Amp. Small Size. Ea.

\$1.25

Input 110V 60 cy. Output 6.3V @ 5 Amps. 6.3V @ 10 Amps., 5V @ 5 Amps. Ea.

\$2.75

CARDWELL TRANSMITTING VAR. COND.

Dual Section 211 UUF per section. 5700 Volts AC. Each

\$5.95

DYNAMOTOR SPECIALS

Input 5.5V—Output 405V @ 280Ma. Carter small size, Ea.

\$5.95

12 Volts Input-Output 440V. @ 200Ma. 12 Volts Input-Output 225V. @ 100Ma. All in one Dynamotor. BRAND NEW. Ea.

\$5.95

SILICON RECTIFIERS

PIV	Current	Price	PIV	Current	Price
100	500 Ma	\$.25	200	2 Amps	\$.75
200	500 Ma	.30	400	2 Amps	1.25
400	500 Ma	.50	100	15 Amps	2.50
750	500 Ma	.90	200	15 Amps	4.50
			400	15 Amps	8.50
*Items above are Hi-Efficiency Gold Plated!					
200	750 Ma	.30	100	50 Amps	4.95
400	750 Ma	.50	200	50 Amps	7.50
100	2 Amps	.50	200	50 Amps	9.50

POWER TRANSISTORS

PNP GERMANIUM — Similar to following trans. types

2N1320	70c	2N1355	70c
2N1328	70c	2N1373	2.50
2N156	70c		

CHOKE—FULLY CASED

5 HENRY @ 200 Ma	1.95
5 HENRY @ 250 Ma	2.25
10 HENRY 300 Mil	3.00
4 HENRY 400 Mil	3.95
4 HENRY 900 Mil	8.95
4 HENRY—1 amp.	11.95

BRAND NEW OIL CONDENSERS

50 MFD 200 VDC	4.50	4 MFD 2000 VDC	3.50
2 MFD 600 VDC	.50	6 MFD 2000 VDC	4.95
3 MFD 800 VDC	.60	1 MFD 3000 VDC	1.85
4 MFD 800 VDC	.70	2 MFD 3000 VDC	3.50
5 MFD 800 VDC	.80	2 MFD 4000 VDC	6.25
6 MFD 800 VDC	.85	3 MFD 4000 VDC	8.95
8 MFD 800 VDC	1.25	4 MFD 4000 VDC	12.95
10 MFD 800 VDC	1.19	1 MFD 5000 VDC	4.50
12 MFD 800 VDC	1.50	2 MFD 5000 VDC	8.50
15 MFD 800 VDC	1.70	4 MFD 5000 VDC	15.95
1 MFD 1000 VDC	1.95	5 MFD 7500 VDC	49.50
2 MFD 1000 VDC	.70	1 MFD 7500 VDC	6.95
4 MFD 1000 VDC	1.35	2 MFD 7500 VDC	17.95
8 MFD 1000 VDC	2.50	8 MFD 7500 VDC	49.50
10 MFD 1000 VDC	2.50	2 MFD 10,000 VDC	29.95
12 MFD 1000 VDC	2.95	5 MFD 10,000 VDC	49.95
15 MFD 1000 VDC	3.50	8 MFD 12,500 VDC	34.95
1 MFD 1200 VDC	.45	1 MFD 15,000 VDC	42.50
1 MFD 1500 VDC	.75	5 MFD 25,000 VDC	34.95
2 MFD 1500 VDC	1.10	1 MFD 25,000 VDC	69.95
4 MFD 1500 VDC	1.95	10 MFD 3000 AC	1.95
8 MFD 1500 VDC	2.95	30 MFD 330 AC	3.25
1 MFD 2000 VDC	.85	50 MFD 330 AC	4.95
2 MFD 2000 VDC	1.50	8 MFD 600 AC	2.95

RELAYS

WARD LEONARD Heavy duty relay coil 220V 60CY., 2 phase, 5 HP.

\$6.95

3 Pole 5T, 25 AMP contacts. Ea.

.95

6 Volt DC. H.S. Relay DPDT

.65

6 Volt DC. H.S. Relay 3 PST N.O.

\$2.50

GUARDIAN 110V AC. 2 Pole Single Throw (1 N.O. & 1 N.C.) Repl. BC-610

\$2.25

Potter-Brumfield SMLS 10,000 ohm, 2 Ma. Sens.

\$1.50

110 Volt AC Relay-DPST 60 Cy.

\$1.95

10 Amp. Contacts

\$1.95

Sens. Relay 11,000 ohm coil, 1 Ma Adj. cont. Armature Tension SPDT.

\$1.35

12 Volt DPDT DC Relay

\$2.49

SIGMA type 22RJ 8,000 ohm SPDT, small sealed relay.

\$1.95

Sealed Relay, SPDT, 6,000 ohm coil

\$1.10

G.E. Relay Control, contains 8000 ohm relay, sensitivity 2 mils, 10 for \$9.25 ea.

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0-20 Volts DC	0-2.5 KV
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PEAK

ELECTRONICS COMPANY
66 W. Broadway, New York 7, N. Y., WO-2-2370

panel lighting, slide-rule tuning, and interstation muting. Headphones can be used for private listening. The receiver operates from house current and can be plugged in anywhere. It can be used on a boat with 115-volt power or a d.c. converter.

GENERAL-COVERAGE RECEIVER

34 Hammarlund Manufacturing Company, Inc. has recently introduced a re-designed version of its HQ-145 general-coverage receiver which has now been designated as the HQ-145X. Crystal accuracy is now possible through the addition of



a single crystal-controlled channel that can be fixed at any desired point of the entire frequency range of the instrument.

The circuit includes a crystal filter and adjustable 60-db slot filter, 11-tube superhet circuit with improved noise limiter, frequency coverage of 540 kc. to 30 mc. in four bands, and dual conversion on 10-30 mc. band for maximum image rejection.

CB NOISE SUPPRESSOR

35 Business Radio Co., Inc. is offering a self-contained noise suppressor that may be connected to any Citizens Radio transceiver that uses a superhet receiver. The unit, known as the Model 612 "Noistop," not only prevents ignition interference from the CB operator's own unsuppressed car or boat—but it effectively blocks ignition interference from cars, trucks, outboard motors, or from any other nearby source of pulse-type electrical noise.

The "Noistop" is a later version of a circuit

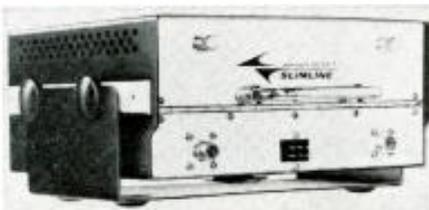


used by mobile radio amateurs for a number of years. It has been designed into a compact package, 1½" high x 2½" wide x 4" long, suitable for universal mounting on the outside of the transceiver. The unit is furnished complete with step-by-step installation instructions for wiring it into more than a dozen of the most popular CB transceivers.

V.H.F. MOBILE SET

36 Aeronautical Electronics, Inc. has announced a new high-powered, two-way mobile radio set for operation in the v.h.f. mobile band.

The 100-watt "Slimline" Model 6N100/SLT



provides flexibility and reliability by combining a compact under-dash transmitter-receiver unit with a high-powered amplifier unit placed in the trunk or other convenient location. Only one small coax cable is needed to connect the two units. A second model for low-band operation is also available.

The under-dash unit weighs less than 9 pounds; the amplifier less than 14 pounds. Both are transistor powered and constructed entirely of heavy gauge aluminum.

CITIZENS BAND UNIT

37 Hallmark Instruments Corporation is now offering its H1-104 for two-way communications in the Citizens Band.

The company claims the unit has a range of up to 25 miles, depending on terrain and type of installation. The transmitter and receiver are constructed with rugged, harness-type wiring for trouble-free operation.

Power consumption is 5.5 amps on 12 volts d.c. or 55 watts on 117 volts a.c.

FULL-COVERAGE V.F.O.

38 Electronic Instrument Co. Inc is now offering a self-powered, highly stable v.f.o. which provides full coverage of the ham bands from 80



to 10 meters (10 meters covered in two ranges).

The Model 722 features anti-backlash tuning, a low-heat silicon diode doubler power supply, a buffer-multiplier output stage, large easy-to-read slide-rule dial, and reliable drive. Output is high enough to drive any modern transmitter on all bands.

The company is offering this new unit in both kit and factory wired versions.

MANUFACTURERS' LITERATURE

MULTIPLE CONNECTORS

39 AMP Incorporated has issued a six-page folder describing three separate lines of multiple connectors, with specific data sheets for each of the lines. Included are connectors designed for the appliance and automotive industries, major appliances, and TV and commercial electronics applications.

The publication also describes the firm's compression-crimp technique and tooling, both hand and automatic, for attaching terminals to circuit leads and for stripping wire preparatory to crimping.

ELECTRONIC COMPONENTS

40 Herman H. Smith, Inc. is now offering copies of its 60-page catalogue covering a wide variety of electronic components.

The line covers clips, ham equipment, cable accessories, connectors, dial plates, fuse holders, grommets, hi-fi accessories, panel indicators, jacks, knobs, meter cases, patchcords and plugs, sockets, switches, terminal strips, etc.

Complete specifications and photographs are given on the products covered.

MEASURING EQUIPMENT

41 M. C. Jones Electronics Co., Inc. has just issued a 64-page catalogue covering an extensive line of r.f. power and v.s.w.r. measuring equipment.

Complete electrical and mechanical specifications are provided on r.f. power and v.s.w.r. in-

struments, absorption-type r.f. wattmeters, calorimetric-type r.f. wattmeters, r.f. load resistors, coaxial tuners, station guardians, and accessories.

INDUSTRIAL TOOL CATALOGUE

42 Mathias Klein & Sons has available copies of its Industrial Catalogue 105A covering a complete line of tools for the electronics industry, general industry, linemen, and electricians.

In addition to the extensive selection of hand tools of all types, the catalogue lists and describes pocket tool kits, tool pouches in leather and plastic, safety belts, knives, harnesses, and tool bags.

PARTS CATALOGUE

43 Allied Radio Corporation has announced the availability of its 1962 general catalogue of electronic parts and equipment, including a complete line of stereo hi-fi components.

The new 441-page catalogue lists over 60,000 items and includes 288 pages in rotogravure. Both product and manufacturer indexes are included to facilitate locating specific items.

SERVICE COMPONENTS

44 Centralab has just issued a 16-page illustrated booklet which gives detailed specifications and prices for some 40 lines of controls, switches, ceramic capacitors, and printed-circuit packaged circuits.

Also included is a full range of control, switch, capacitor, and packaged-circuit kits. All items are indexed inside the front cover of the catalogue. Two control-taper charts are also provided for quick reference.

PORTABLE MULTI-RANGE METERS

45 Weston Instruments Division of Daystrom, Inc. is now offering copies of its new Bulletin No. 06-209 "Portable/Panel Instruments" which discusses the features and specifications of the Model 911-912 line of a.c. and d.c. voltmeters and ammeters developed by the firm.

SPEAKER CATALOGUE

46 Acoustic Research, Inc. has just published a comprehensive speaker catalogue which includes general information, technical specifications, and surveys of press comment on the various models of the firm's loudspeakers.

INDUSTRIAL CATALOGUE

47 J. W. Miller Company has issued a complete 48-page catalogue which includes specifications on molded r.f. chokes, i. f. transformers, adjustable coils wound on stable ceramic and resin materials, exact replacement coils, and other related items.

More than 1500 items are shown in Industrial Catalogue No. 62.

ELECTRONIC KIT CATALOGUE

48 Heath Company is now offering copies of its 1962 catalogue which covers an extensive line of electronic kits in its 100 pages. Photographs of the equipment, complete descriptions, full specifications, as well as many schematic diagrams are included.

The kits covered include products for the audiophile, the radio amateur, the hobbyist, the service technician, and the electronics experimenter.

SEMICONDUCTOR DATA

49 Rheem Semiconductor Corporation has issued three booklets covering semiconductor products and processes. The first discusses the company's products and facilities, while a second provides full technical details on the firm's Rb750 ultra-high conductance nanosecond diode. The third booklet describes the manufacturer's master test specification for high reliability silicon diodes, known as the "Mark X."

SPEAKER SYSTEM DATA

50 Advanced Acoustics Co. has announced the availability of a new two-color catalogue sheet covering descriptive material on the "Wa-

fare Bi-Phonic Coupler" full-range, thin speaker system.

The publication includes full specification data, descriptive material, prices, and other pertinent information.

ELECTRONIC PARTS CATALOG

51 Barry Electronics Corp. has announced the current availability of its "Green Sheet" which lists hundreds of electronic tubes, semi-conductors, transformers, chokes, meters, wire, test equipment, and other components and equipment for the industrial market.

One unusual feature is the listing of many hard-to-find and unique electronic products.

PRECISION RESISTORS

52 Key Resistor Corp. has issued a new short-form catalogue, Bulletin SF 200, which lists complete up-to-date information on its precision resistor line.

The publication tabulates electrical and mechanical characteristics on a new line of epoxy molded carbon and metal film precision units as well as information on resin coated and hermetically sealed precision carbon films and precision and micro-miniature wirewound resistors.

CAPACITORS FOR SERVICE

53 Sprague Electric Company has just published a new edition of its popular hanging wall catalogue which contains a full listing of the company's products for radio, hi-fi, and TV service, including capacitors such as tubular and can-type electrolytics, paper and film tubulars, disc and plate ceramics, as well as ceramic-base printed circuits and miniature wirewound resistors.

Catalogue C-457 is clearly indexed and supplied with a string to hang it from the shop wall or above the service bench.

RADIO STATION GUIDE

54 Bendix Corporation's Marine Department has issued a completely revised edition of its radio station guide which reveals more than 50 changes in frequencies, locations, or call signs of broadcast and airways beacon stations since the guide was first published about a year and a half ago.

The guide lists exact locations of broadcast and airways beacon stations by latitude and longitude, their frequencies and call signs on the Atlantic, Gulf, and Pacific coasts and the Great Lakes area.

In addition, the marine weather broadcasts by telephone company and Coast Guard stations are listed, showing the radio frequency and time of the broadcasts.

INSTRUMENTATION TAPES

55 Reeves Soundcraft Corp. has just issued a colorful folder which describes in great technical detail its line of instrumentation tapes for industry. In addition to providing full physical and magnetic characteristics on six types of tape, the folder includes separate data sheets on each tape category.

EDUCATIONAL TV DATA

56 Community Engineering Corp. has prepared a four-page bulletin entitled "Tele-Quest" which explains the new educational TV system that allows students to put their questions to the television instructor and receive answers via the classroom TV set.

The detailed step-by-step procedure is diagrammed pictorially and technical specifications are given for systems of from six to 24 stations (classrooms).

VARIABLE CAPACITORS

57 Hammarlund Manufacturing Co. has announced the availability of a new 16-page catalogue which lists mechanical and electrical specifications of 20 different variable capacitor types. The list includes a broad selection of military trimmer type variable air capacitors available to the industry.

GET IT from GOODHEART!

2-METER RECEIVER & 2/6/10 METER XMTR

SCR-522 rcvr, xmtr, rack & case, exc. cond. 19 tubes include 832A's, 100-156 mc AM. Satisfaction grtd. Sold at less than the tube cost in surplus! Specify whether job Bremerton, Wn., or Buffalo, N.Y. Only **\$16.95**



Add \$3.00 for complete technical data Kroup including original schematics & parts lists. F. xtl formulas, instruct. for AC pwr sply, for rcvr continuous tuning, for xmtr 2-meter use, and for putting xmtr on 6 and 10 meters. For readymade AC Pwr sply, add for RA-62-C in excellent cond., job San Diego, Calif. **\$49.50**

COMMUNICATIONS RECEIVER BARGAINS

BC-453-B: 190-550 kc w/85 kc IF's. This rcvr is ideal as a tunable IF or to double-convert other rcvrs having 455 kc IF's. Checked, aligned, grtd 100% OK, not as-is junk. W all needed tech data. Pwr sply data, etc. job Los Ang. **\$12.95**

Same, in handsome cabinet w pwr sply, spkr, etc., ready to use, is our QX-535 **\$37.50**

RBS: Navy's pride 2-20 mc 14-tube superhet has voice filter for low noise, ear-saving AGC, high sens. & select. IF is 1255 kc. Checked, aligned, w/pwr sply, cords, tech dat., ready to use, job Charleston, S.C. or Los Angeles **\$99.50**

R-45 ARR-7 brand new, 12-tube superhet .55-43 mc in 6 bands, 5-meter, 455 kc IF's, xtl filter, 6 sel. positions, etc. Not and complete, it can be made still better by double-converting into the BC-453 or QX-535, pwr sply includes DC for the automatic tuning motor. FOB San Antonio **\$179.50**

AN APR-4 rcvr is the 11-tube 30 mc IF etc. for its plug-in tuning units; has 5-meter, 60 cy pwr sply, pan., video & audio outputs, etc. Pan output is ideal to feed 50 mc to the R-45 ARR-7. Checked and aligned, job Los Angeles **\$69.50**

Plug-in tuning units for above convert RF to 30 mc: TN-16, 38-94 mc, \$25.00. TN-17, 74-320 mc, \$25.00. TN-18, 300-1000 mc, \$35.00. TN-19, 975-2200 mc, \$59.50. TN-54, 2175-4000 mc, \$175.00. Power Plug for rcvr: \$2.00. Tech. Handbook: \$7.50.

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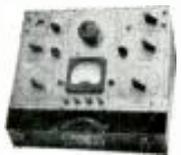
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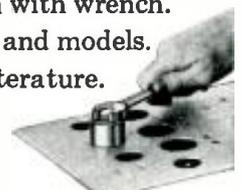
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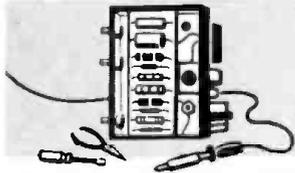
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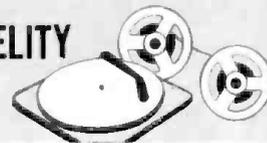
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125	Electro-Voice, Inc.	30, 31		National Radio Institute	25, 26	187	Tru-Vac	93
126	Electronic Chemical Corp.	100	158	National Radio Institute	112			
127	Electronics Book Service	101		National Technical Schools	15	188	U. S. Crystals, Inc.	93
128	Esse Radio Company	95	159	Oelrich Publications	115	189	University Loudspeakers, Inc.	1
			160	Olson Electronics	88	190	Valparaiso Technical Institute	114
129	Fair Radio Sales	115	161	Ortofon	97			
130	Fairchild Recording Equipment Corp.	73	162	Pacotronics, Inc.	8, 9, 10	191	Warren Dist. Co.	114
131	Federal Electric Corp.	22	163	Peak Electronics Company	110	192	Winegard Antenna Systems	77
132	Fisher Radio Corporation	71				193	Winegard Antenna Systems	79
133	G & G Radio Supply Co.	116						

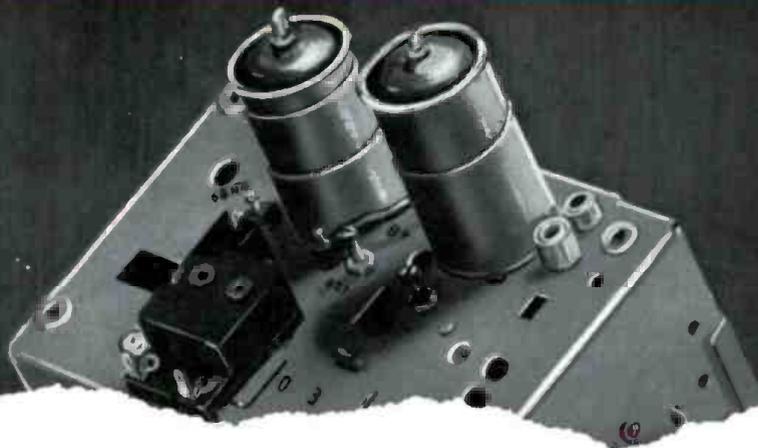
The coupon below can also be used to obtain additional information on the new product items shown on pages 106 through 111 as well as on the ads as listed above.

VOID 8 AFTER DEC. 31, 1961	NAME _____ STREET NO. _____ CITY _____ ZONE _____ STATE _____
	100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239
ADVERTISED PRODUCTS (SEE INDEX ABOVE)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
NEW PRODUCTS & LITERATURE	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
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INDICATE NUMBER OF ITEMS REQUESTED <input type="checkbox"/>	

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\$3.00 Defective Tuner Trade-In Allowance
Against a New STANDARD Replacement Tuner
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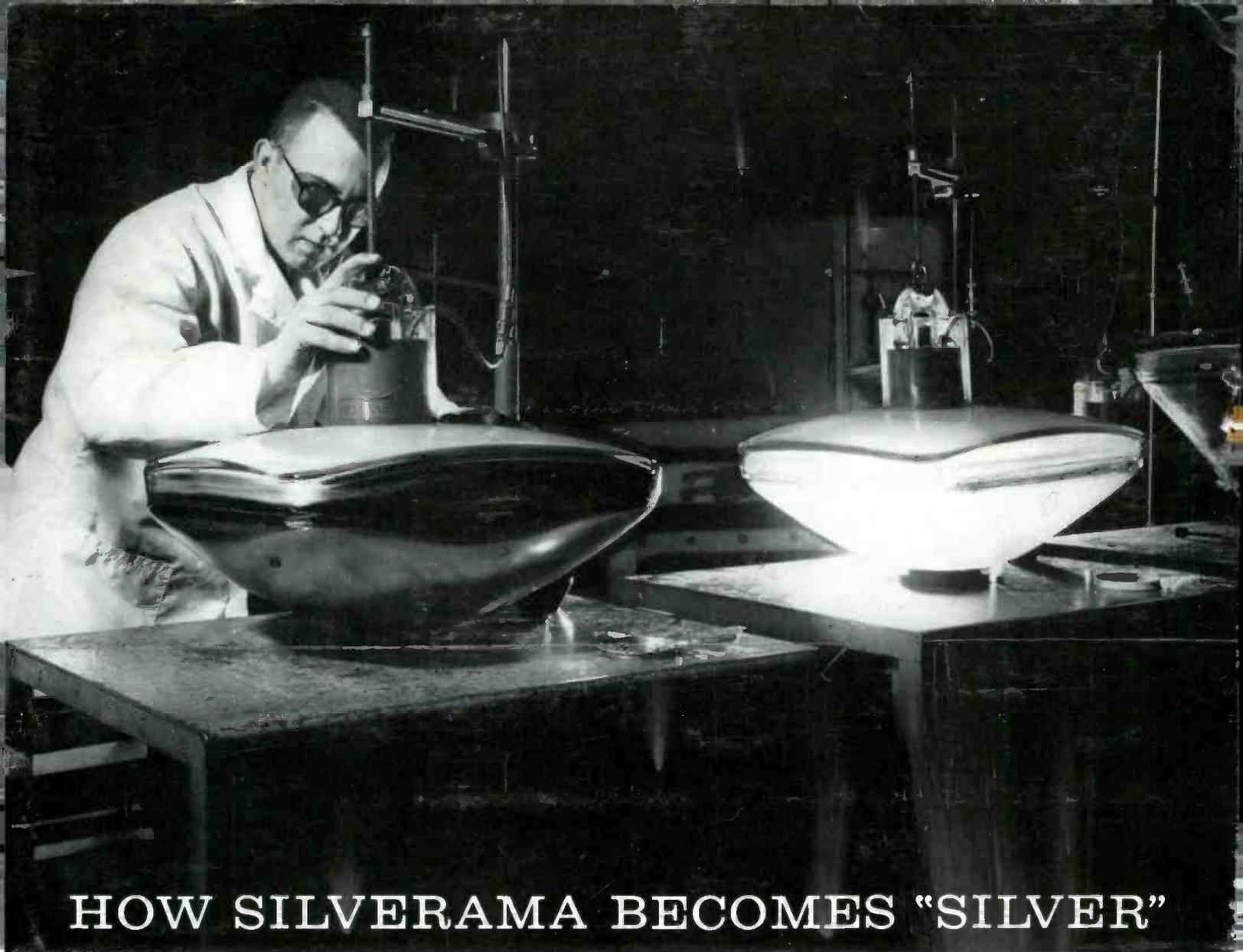
STANDARD has maintained uniform mounting centers for the last 13 years. Over 50% of the TV sets in existence today have STANDARD tuners—in the case of most other tuners one of the 8 STANDARD replacement models can be easily adapted or will fit directly in place of these units. All STANDARD replacement tuners carry a 12 Month Guarantee.

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HOW SILVERAMA BECOMES "SILVER"

High-Vacuum Aluminizing Assures Sharpest TV Picture Possible

Here RCA Silverama picture tubes become "silver" at the aluminizing station on our Marion, Indiana, production line. In a burst of light, aluminum is vaporized in a high vacuum and is deposited over the entire inner surface of the tube. Then the operator, with an RCA-designed electronic gauge, checks to be sure the aluminum film is of proper thickness. If it is not, the tube is rejected.

Such extra care in manufacture is an important reason why the Silverama you install today is free from "picture-spoiling" dark centers caused by an excess of aluminum deposited on the tube face. This extra care is the reason, too, why Silverama delivers

the brightest, sharpest picture your customers' sets can produce. Obviously, Silverama picture tube service is the surest way toward satisfied customers, repeat business, favorable word-of-mouth advertising for you—plus freedom from call backs and costly in-warranty failures.

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Final checkout before shipment. Here Silverama tubes receive final focus check before being shipped to customers.



Packing for final shipment. Before it can go into this box, RCA has made certain this Silverama is the best picture tube modern science and technology can produce.

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