Electronics World

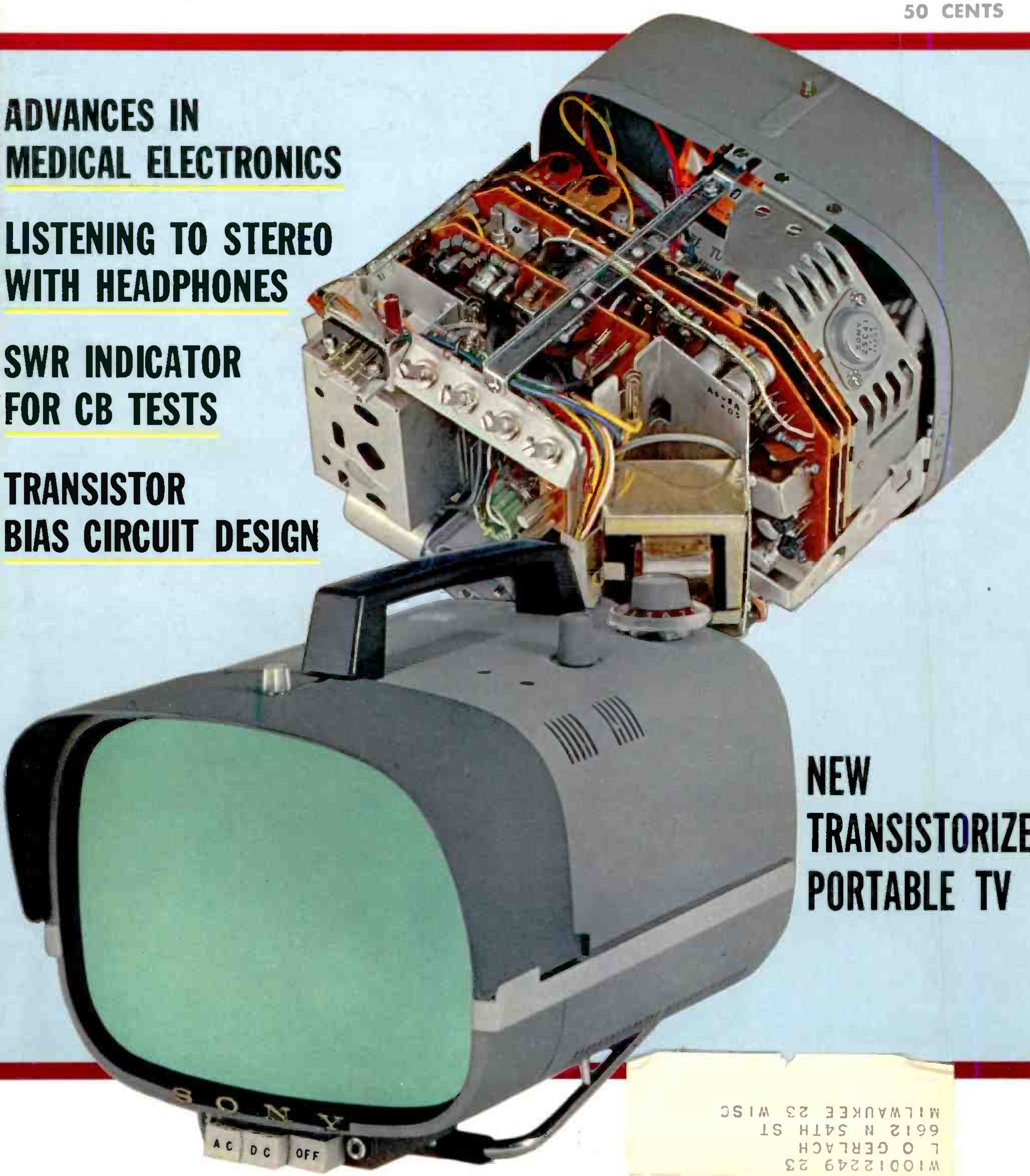
NOVEMBER, 1961
50 CENTS

ADVANCES IN MEDICAL ELECTRONICS

LISTENING TO STEREO WITH HEADPHONES

SWR INDICATOR FOR CB TESTS

TRANSISTOR BIAS CIRCUIT DESIGN



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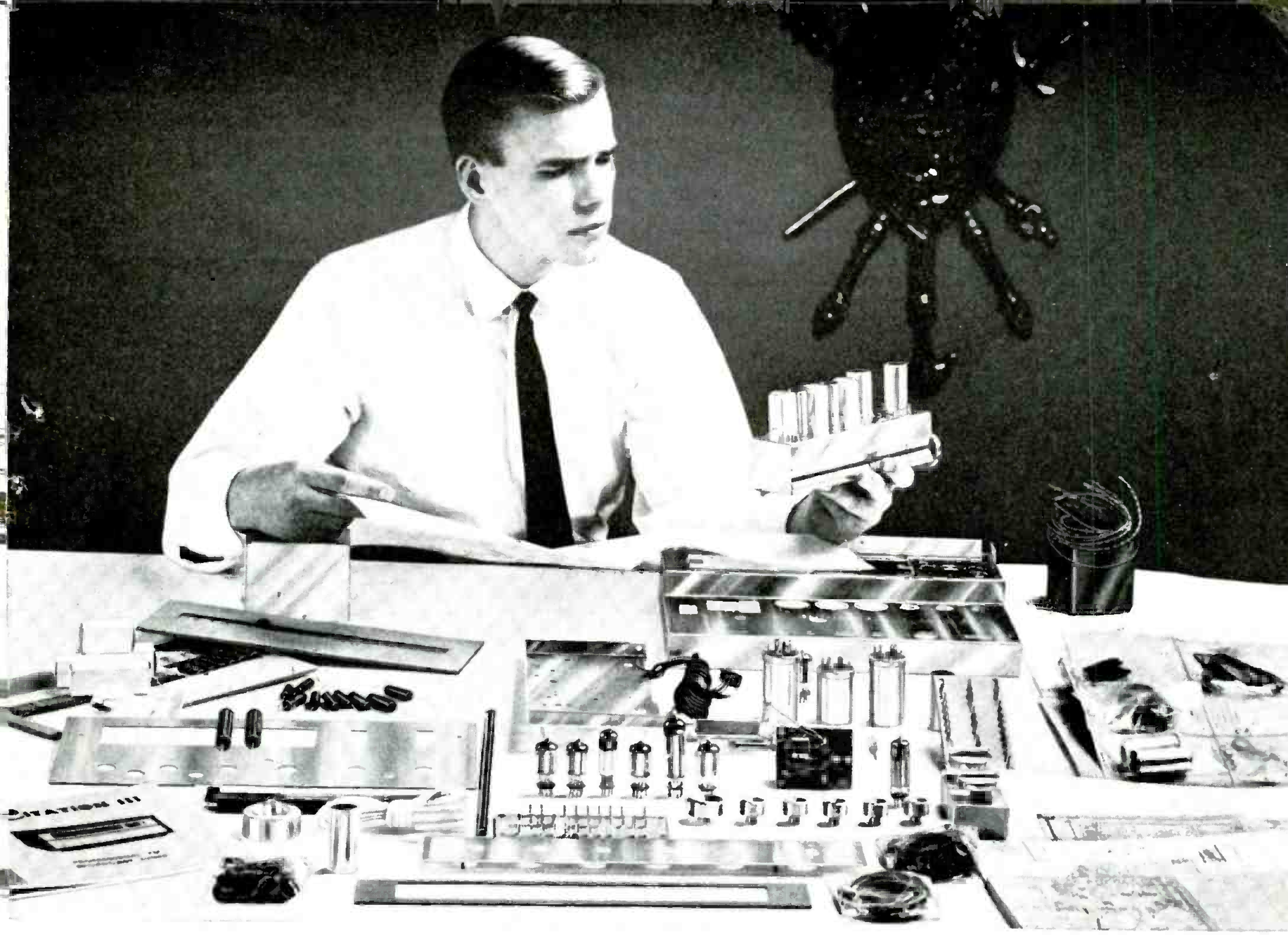


Can You Afford 15 Hours to Build The World's Best FM/Multiplex Tuner?

Fifteen hours. That's all it takes to build the world's best FM/Multiplex tuner.

Citation has the "specs" to back the claim but numbers alone can't tell the story. On its real measure, *the way it sounds,* Citation III is unsurpassed. And with good reason.

After years of intensive listening tests, Stew Hegeman, director of engineering of the Citation Kit Division, discovered that the performance of any instrument in the audible range is strongly influenced by its response in the non-audible range. Consistent with this basic design philosophy – the Citation III has a *frequency response three octaves above and below the normal range of hearing.* The result: unmeasurable distortion and the incomparable "Citation Sound."

The qualities that make Citation III the world's best FM tuner also make it the world's best FM/Multiplex tuner. The multiplex section has been engineered to provide wideband response, exceptional sensitivity and absolute oscillator stability. It mounts right on the chassis and the front panel accommodates the adapter controls.

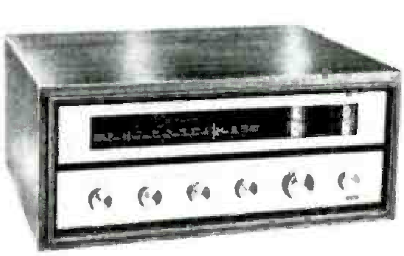
What makes Citation III even *more* remarkable is that it can be built in 15 hours without reliance upon external equipment.

To meet the special requirements of Citation III, a new FM cartridge was developed which embodies every critical tuner element in one compact unit. It is completely assembled at the factory, totally shielded and perfectly aligned. With the cartridge as a standard and the two D'Arsonval tuning meters, the problem of IF alignment and oscillator adjustment are eliminated.

Citation III is the *only* kit to employ military-type construction. Rigid terminal boards are provided for mounting components. Once mounted, components are suspended tightly between turret lugs. Lead length is sharply defined. Overall stability of the instrument is thus assured. Other special aids include packaging of small hardware in separate plastic envelopes and mounting of resistors and condensers on special component cards.

For complete information on all Citation kits, including reprints of independent laboratory test reports, write Dept. EW-11, Citation Kit Division, Harman-Kardon, Inc., Plainview, N. Y.

The Citation III FM tuner–kit, $149.95; wired, $229.95. The Citation III MA multiplex adapter–factory wired only, $89.95. The Citation III X integrated multiplex tuner–kit, $239.90, factory wired, $319.90. All prices slightly higher in the West.



The Citation III

Build the Very Best **CITATION KITS** *by* **harman kardon**

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NOVEMBER 1961 / VOL. 66 NO. 5 Electronics World

CONTENTS

INDUSTRIAL

TEST EQUIPMENT

HI-FI AND AUDIO

GENERAL

COMMUNICATIONS

MONTHLY FEATURES

(For Information on Next Month's Features, see page 4)

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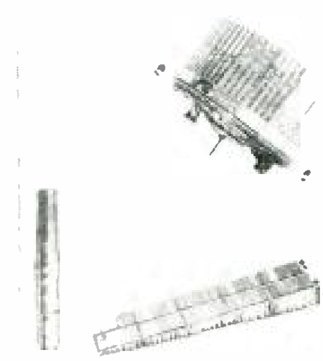

COMING NEXT MONTH

THE SILICON SOLAR CELL
A perpetual primary power source for the space age, this device makes possible direct, instantaneous, and efficient conversion of the sun's energy into useful electrical power.

RELIABILITY—SPACE AGE REQUIREMENT
As much time is often spent to improve reliability as to produce the equipment. Definitions and illustrations of the language of reliability engineers and technicians is included.

TESTING TAPE RECORDERS
A summary of the various tests used to check the operation and performance of tape recorders.

DOUBLE-CHAMBER SPEAKER ENCLOSURE
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.

U.H.F. NUVISTOR TUNER
A newly developed RCA nuvistor makes possible a front end with high gain and low noise, plus greater reliability than can be obtained with conventional u.h.f. triodes.

INDUSTRIAL X-RAY APPARATUS
Many tests on materials can be made in no other way or no better way than by radiographic examination. The variety of methods and equipment are covered, along with details on how such equipment works.

ELECTRICALLY OPERATED SWITCHES
This category ranges broadly from the simple circuit breaker to types used in "electronic brains." Among the devices used are relays, vacuum tubes, thyratrons, and transistors. The various types and their characteristics are covered in this article, along with details on their application.

TRANSISTORIZED CB CONVERTER
A printed-circuit, two-transistor converter for the car's broadcast receiver permits CB signals to be picked up.

MODULATED 10-KC. CALIBRATION OSCILLATOR
Construction of an accurate oscillator that will provide tone-modulated check points on communications receivers.

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

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16-S

...for the Record

By **W. A. STOCKLIN**
Editor

N.Y. HI-FI SHOW & FM MULTIPLEX

WE have just returned from a preview of the sixth annual New York High-Fidelity Show sponsored by the Institute of High Fidelity Manufacturers, Inc. There is no doubt that this is the largest such public event in the country and, according to official figures, over thirty thousand visitors attended the four-day session. They had an opportunity of seeing and hearing over six-million-dollars worth of the most up-to-date designs of high-fidelity component equipment.

This show and the one run on the West Coast, alternating between Los Angeles and San Francisco, are really much more than just showcases for the display of electronic equipment. The field of high-fidelity and music reproduction in general is unique in that almost all interested individuals have many questions to ask and some problems to be solved before complete satisfaction is obtained. Nowhere else in the world is there such a congregation of key hi-fi personnel, including many company presidents, owners, chief engineers, and technical people, who can answer these questions and solve these problems.

The high-fidelity industry is a relatively small and young industry. Therefore, many of the original pioneers, who over the past years have devoted their entire efforts to quality sound reproduction, can be found in attendance. Many individuals no doubt find great enjoyment in being able to talk personally with such men as Rudy Bozak, Avery Fisher, Dave Hafler of *Dynaco*, Saul Marantz, Hermon Scott, George Silber of *Rek-O-Kut*, Walter Stanton of *Pickering*, Ed Villchur of *Acoustic Research*, Paul Weathers, and many others. Most of these individuals started out as engineers and, although at present most of them operate their own companies, they are still actively engaged in designing and improving high-fidelity equipment.

The highlight of the show was, without a doubt, stereo FM multiplex. WDHA of Dover, New Jersey, actually transmitted FM multiplex direct from the New York Trade Show Building and its programs were carried *via* closed-circuit transmission lines from room to room. In addition, there were on-the-air stereo FM multiplex broadcasts from WQXR, New York; WLIR, Garden City, Long Island; as well as WDHA. There are at present over fifteen cities throughout the country that have stations on the air but for those in the New York area, this was their first opportunity of hearing this new form of musical entertainment.

We are fortunate in that we had heard stereo FM multiplex previously. We had heard it in Los Angeles, Chicago, and now in New York. In general, we were favorably impressed with what we heard. There were programs of excellent quality, with good separation and with no more distortion than normally encountered on monophonic transmissions. We do know that on some occasions across the country, transmissions have not been as good as expected, and that some of the FM stations have had trouble with their transmitting equipment. This is certainly no criticism nor a reflection on the stations themselves. Stereo FM multiplex is a new medium and like anything that is new, problems do exist at the beginning, but there is no doubt in our mind that these can be solved and eventually all FM stereo transmissions will be superb.

Unfortunately, there is an economic conflict prevailing behind the broadcast scene. We have heard comments from several FM broadcasters threatening to eliminate all stereo transmissions unless they are financed through commercial advertising by manufacturers of high-fidelity equipment. We can fully appreciate that the economic situation in any industry or business is an important factor and one that should be considered at all times. There certainly would be no criticism should a station decide that such an endeavor would be economically unsound in the first place and not go on the air with stereo at all. But once a station is committed to the installation and operation of such equipment, we feel that they should not take it upon themselves to discontinue such programs. There is negligible cost in continuing FM stereo transmission and there is definitely no deterioration of the monophonic programs. Also, there is no disservice to listeners of stereo programs who have mono equipment. There is, in fact, no reason to discontinue such programs. After all, every station when accepting an FCC license to broadcast, in essence promises to serve his community and the best interests of its listeners.

At present, few of the listening public have multiplex equipment. Once this situation changes and more multiplex equipment is in the hands of the public, FM stations will be forced by popular demand to supply the programs desired. For those stations which continue to keep the good will of their listeners from the beginning, rewards will accrue in the form of greater loyalty on the part of listeners and, in time, advertising will provide more support. ▲

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Channel Master's world-famous Antenna Development Laboratory has done it again! By using a brand new concept in antenna design... PROPORTIONAL ENERGY ABSORPTION... *Channel Master meets the fringe area challenge with the most powerful TV antenna ever produced...the Crossfire!*

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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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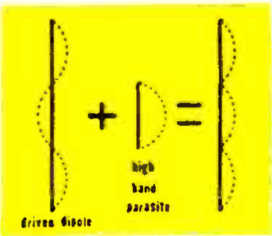
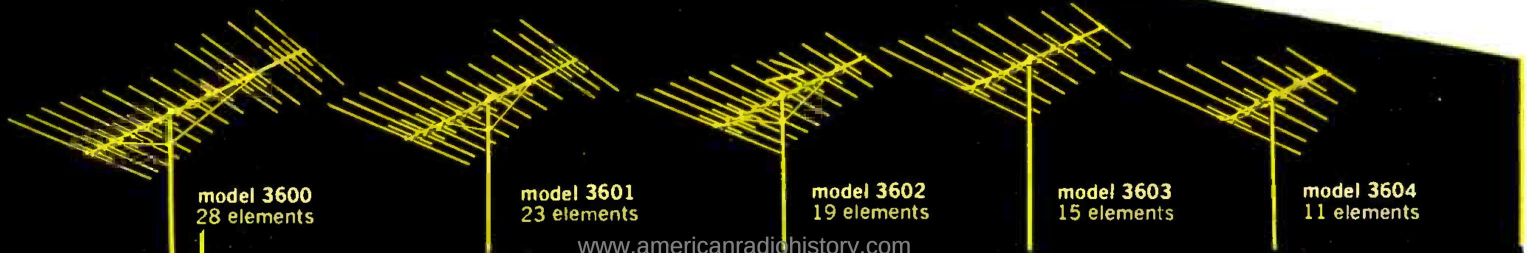


...And the Crossfire is Gold!

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.

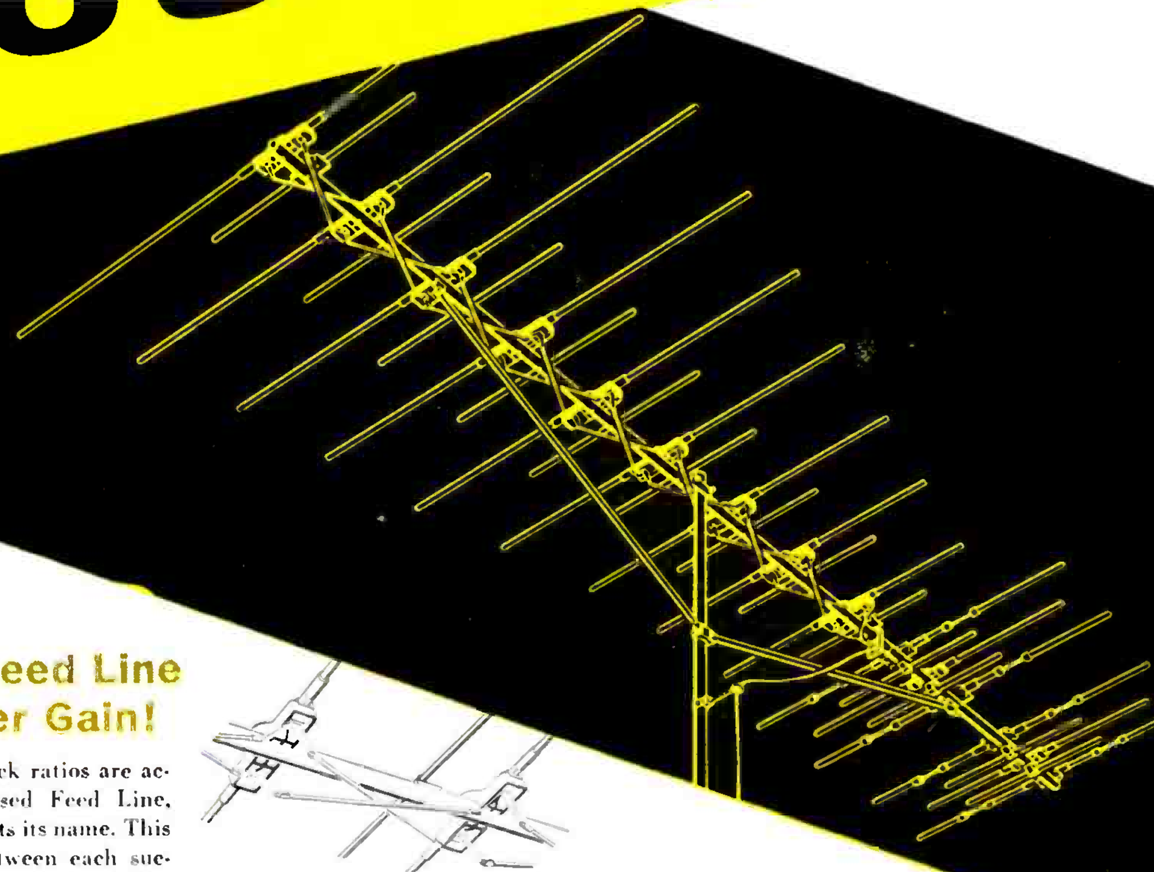
Channel Master's E*P*C Process is *not* anodizing! The disadvantage of anodizing is that the anodized film is an electrical insulator, and must be removed by *abrasion* wherever metal-to-metal contact is required. Therefore, anodized antennas have no surface protection on the very parts that need it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

THERE'S A CROSSFIRE TO MEET EVERY RECEPTION PROBLEM!



GOLDEN

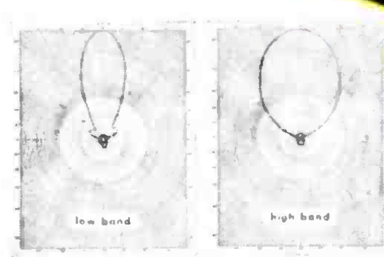
crossfire



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.

Because of these high front-to-back ratios, the Crossfire provides *cleaner* gain than any other all-channel antenna. It pulls in the signal you want while rejecting unwanted interference of every type (auto ignition systems, electrical noise, other TV signals, etc.) from both side and rear. See unretouched photo of actual horizontal polar pattern.



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

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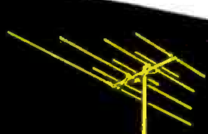

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Profiles in Electronic Engineering Technology

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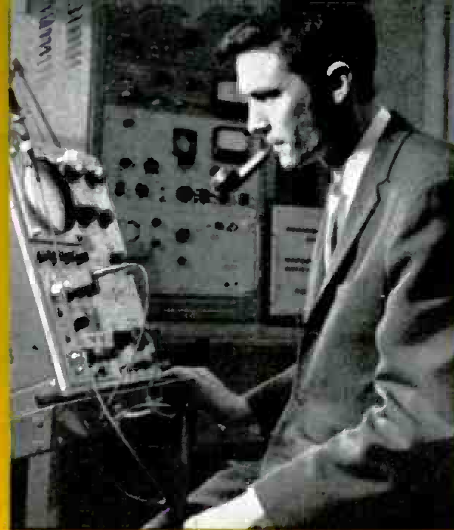

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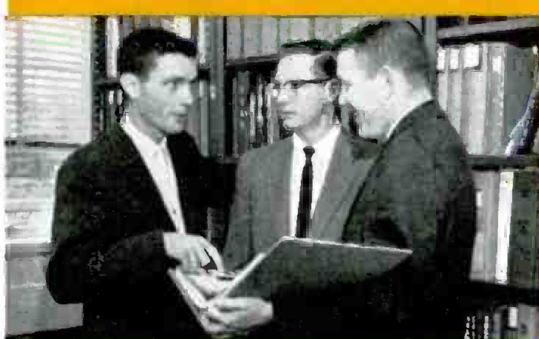

WHEN YOU ENROLL IN A CREI Home Study Program, you join more than 20,500 students working in electronics in all 50 states and most countries of the free world. One CREI Program helped Robert Blanks become an Electronics Engineer. Another helped Robert I. Trunnell become an Electronics Technician. While John H. Scofield—a Mathematician—is enrolled in still a different CREI Program relating mathematics to electronics. All work at Vitro Laboratories.

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Electronics Experience..
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LETTERS FROM OUR READERS

ADD A.F.C. TO TV SETS

To the Editor:

I have just finished reading the article "Add A. F. C. to TV Sets" in the July issue of your magazine. I do not see how the circuit given for adding a.f.c. can possibly work on any TV except very old ones with split-sound system.

All the TV's that I have seen made for the last seven or eight years have used an intercarrier sound system where the discriminator is tuned to 4.5 mc. No matter where the fine tuning is set, the sound section still receives a 4.5-mc. signal. In other words, in a properly operating set, the discriminator is tuned precisely regardless of the setting of the fine-tuning control so there can be no correction voltage taken off the discriminator since there is just no such voltage there.

IRVIN B. REA
Mt. Morris, New York

When we ran Author Wilson's "Add A.F.C. to TV Sets," we were aware that, in intercarrier receivers, the signal to the sound detector is held to 4.5 mc. even when the front-end oscillator is substantially mistuned. Nevertheless, we also knew that his unit, which we tried, works anyhow. Here's why:

Level of the detector-derived d.c. voltage used for control depends, not on frequency *shift of the intercarrier signal, but on changes in its* amplitude. *The latter, in turn, depends on the relative amplitudes of the two i.f. signals, audio and video, that are heterodyned to produce it. Fortunately, this relationship, which does vary with the tuning condition, is linear enough to make the d.c. voltage usable for oscillator correction.—Editors.*

* * *

ELECTRONIC AIR PURIFIERS

To the Editors:

Thank you for the fine article about electronic air purifiers in your July issue. The author is to be congratulated on his cautious attitude toward the claims for health benefits from negative ionization.

By contrast, another publication went rather overboard recently in accepting as reportable fact the most extravagant "findings" of investigators on the effects of ionization.

This sort of thing heightens one's appreciation of ELECTRONICS WORLD, a publication of considerable integrity.

WARNER CLEMENTS
Beverly Hills, California

To the Editors:

In your July issue of ELECTRONICS WORLD, Mr. Walter H. Buchsbaum presented a very informative article on the mechanism by which dust and pollen is removed from the air by an electrostatic precipitator. Because of the increase in air pollution of our city air resulting in lung cancer and other types of respiratory diseases, the subject of air purification and air purifiers is of increasing interest to laymen as well as to public officials. The subject of air precipitation is complex, involving particle size of dirt, ionization, odor, and killing of microorganisms. It is for this reason that I wish to amplify and correct some of the misconceptions that have crept into this article.

Industrial air may contain as many as 50,000 dirt particles per cubic foot ranging in size from 0.2 microns to over 100 microns. A regular filter will remove 50 to 80 per-cent of the dirt by weight but still permit 99% of the total number of particles through. This is because most of the particles are below 1.0 micron in size. An electrostatic precipitator such as the "Precipitron" will remove 85 to 95 per-cent of all the airborne particles. This can be achieved by an electrostatic precipitator only if the air flow is controlled, there is a proper amount of ionization, and the spacing, size and voltage of the collecting plates are all properly designed. An improper design would give poorer cleaning efficiency as well as could generate considerable amounts of ozone and oxides of nitrogen which are toxic in excessive amounts.

Negative ions have been used for the alleviation of certain respiratory conditions for nearly 60 years. As stated by Mr. Buchsbaum, many patients appear to be relieved. These tests were conducted under well-controlled conditions. The number of ions was constantly monitored, the patients were not aware that they were part of a test, and the examining doctor did not know the polarity of the air until after the tests. It must be admitted that some of the earlier and even recent investigators did not have such controls.

Ultraviolet radiation from germicidal lamps such as the "Sterilamp" would not ionize oxygen or nitrogen of the air. However, ultraviolet radiation has a sufficient amount of energy to remove electrons from dirt particles and many metals so that some ions are always observed with such a lamp. In fact it has been stated in the literature that it is possible that some of the beneficial results of ultraviolet lamps on man could have been a result of the ions generated by the lamps.

As far as is known, *all* bacteria and viruses can be destroyed by ultraviolet radiation. The quantity of bactericidal radiation necessary to destroy most of the common pathogenic bacteria has been accurately determined many years

New TRANSISTOR RADIO ANALYST

makes it Easy and Profitable to Service all Transistor Radios

B&K Model 960

TRANSISTOR RADIO ANALYST

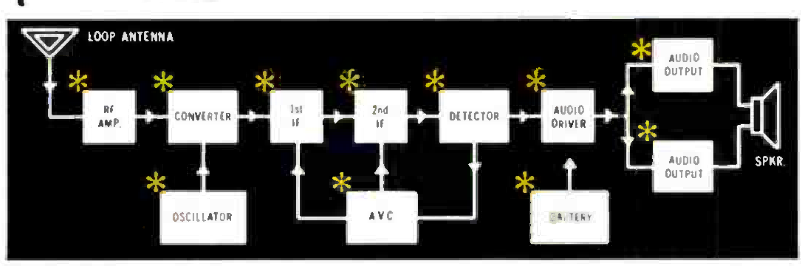
with Exclusive DYNA-TRACE Single-Point Probe—and Built-in Metered Power Supply and VTVM

Complete Transistor Radio Service Shop in One Instrument

Signal-Generator, Power Supply, Milliammeter, VTVM, Battery Tester, Ohmmeter, and Both In-Circuit and Out-of-Circuit Transistor Tester— All in One

Check all circuits - Pinpoint any trouble . . . in minutes

Now you *can profit* from transistor radio servicing! This amazing new B&K "960" ANALYST gives you *everything* in *one* complete easy-to-use instrument. Makes transistor radio servicing *quick and easy*. Nothing else is needed except the transistor radios themselves waiting to be serviced. Brings you new customers for service, parts, and batteries. Makes this new business *yours.*



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ago and the values are in the literature. The lamps are used in operating rooms, air ducts, TB wards, pharmaceutical houses, and food establishments. Lamps have been shown to inactivate such viruses as Asian flu, polio, hepatitis, encephalomyocarditis, mumps, measles, bacteriophage, and plant viruses. The bactericidal radiation, photon per photon, is 500 to 1000 times more effective than ultraviolet from the sun which everybody knows is germicidal. This radiation does not "cook" the bacteria as would infrared radiation but actually inactivates some of the enzymes, disrupts some of the nucleoproteins that carry the hereditary characteristics of the organisms and there is evidence that the cell wall is injured. All of these destructive processes may go on at the same time. One can calculate the amount of ultraviolet energy to destroy 50, 75, or 100 per-cent of the organisms. As an example, a 15-watt germicidal lamp emits about 3.5 watts of germicidal energy. The intensity of this energy would be 11,000 microwatts/cm.^{2} on the surface of the lamp. Most organisms coming in contact with such a lamp would be destroyed in 0.5 second. At a distance of one inch from this lamp, the intensity would be such that most organisms would be destroyed in less than 2 seconds. The number of organisms destroyed by smaller germicidal lamps would depend upon the exposure time and radiation intensity.

Everybody would agree that the "Precipitron" is very effective in removing dirt from the air. However, there is great need for small units as well. Some of the present small units are more effective in killing bacteria, ionizing, deodorizing, or removing dirt than others. The layman cannot properly make an evaluation of these units. If realistic standards were proposed as an example by a scientific society on what constitutes a purifier, it would not be necessary to "search for the truth" and many more purifiers would be sold.

R. NAGY, Ph.D.
Advisory Engineer
Research Department
Westinghouse Electric Corp.
Bloomfield, New Jersey

Our article indicated that a properly designed purifier would do a good job but that the very widely available, inexpensive "electronic air purifiers" would not fulfill many of the extravagant claims made for them.—Editors.

* * *

ELECTRONIC OVERLOAD RELAY

To the Editors:

The parts list for the circuit of the electronic overload relay shown on page 39 of your August issue indicates that S_1 should be a normally open push-button. The proper type of switch for this circuit is actually a normally closed push-button.

LEONARD TURKENKOPF
Brooklyn, New York

Reader Turkenkopf is, of course, correct since with a normally open push-button the plate voltage would not be applied to the thyratron.—Editors. ▲

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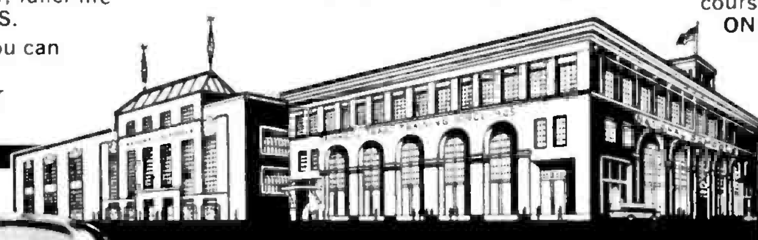

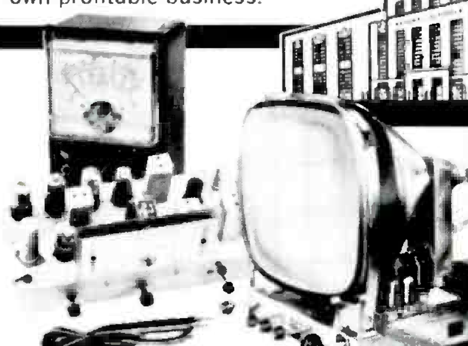

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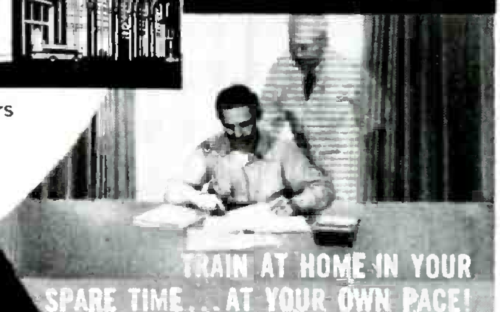

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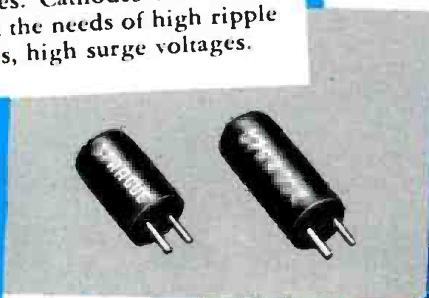

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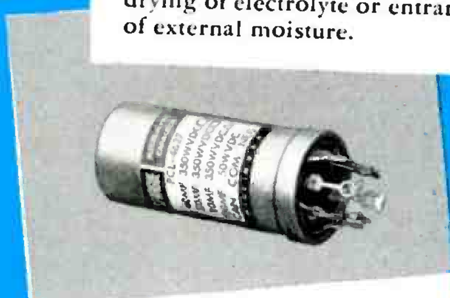

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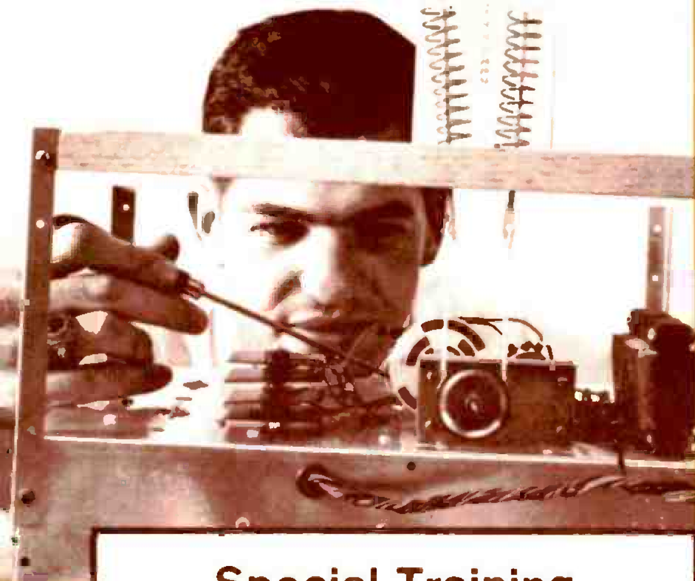

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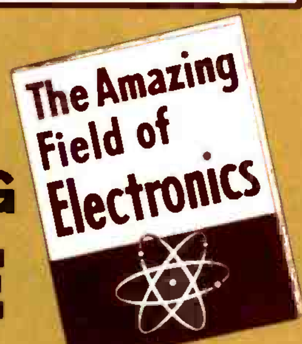

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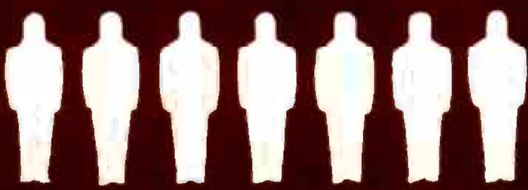

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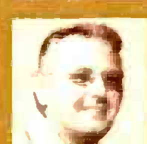
BUILDING ELECTRONIC CIRCUITS on specially-designed plug-in type chassis, is the work of Robert H. Laurens, Hammonton, N. J. He is an Electronic Technician working on the "Univac" computer. Laurens says, "My NRI training helped me to pass the test to obtain this position."

"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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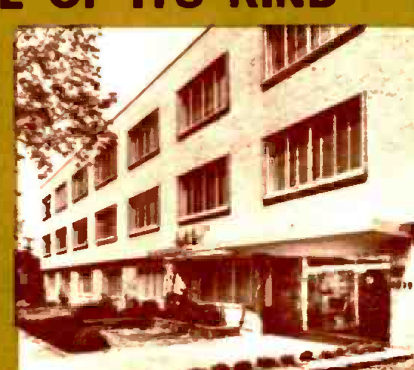

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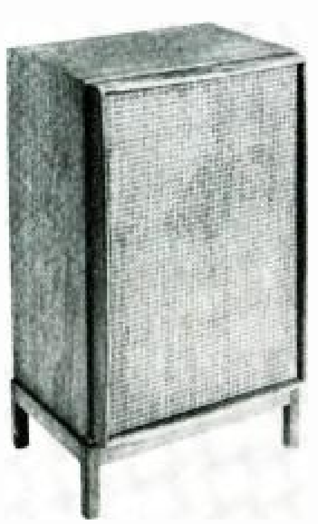
Product Test Report

PREPARED BY HIRSCH-HOUCK LABORATORIES

University "Medallion XII" Speaker System
Fisher X-1000 Integrated Stereo Amplifier
RCA WV-120A Power-Line Monitor
Eico Model 260 A.C. Volt-Watt Meter

University "Medallion XII" Speaker System

For copy of manufacturer's brochure, circle No. 57 on coupon (page 136).



THE *University* "Medallion XII" is a compact floor-model speaker system, measuring 24½" high x 17" wide x 13" deep. It is a three-way system, with a 12" high-compliance woofer, an 8" mid-range speaker, and a "Sphericon" super tweeter. The crossover frequencies are 600 and 4000 cps. The nominal input impedance is 8 ohms, although a 16-ohm amplifier tap may be used.

The enclosure incorporates what *University* calls "radiation resistance loading." This is essentially a ducted-port enclosure, with a cylindrical duct. The "Medallion XII" offers an interesting solution to the problem of adjusting speaker levels. The mid-range speaker has a two-position switch, marked "Normal" and "Max. Presence." In the latter position the mid-range level is elevated to give greater projection of program material into the listening room. The super tweeter has a level control marked "Brilliance." Both controls are on the front of the unit, on the speaker board itself. Once they have been correctly set, the speaker grille, in its wooden frame (available in several styles) is snapped in place and the controls are secure from accidental displacement. The only access to the system when the grille is in place is through the two input terminals on the back of the cabinet. The cabinet may be operated on its side or bottom and a matching base is available in a variety of finishes.

The "Sphericon" super tweeter is a tiny unit with a phenolic diaphragm and a plastic horn and diffuser. It is mounted forward of the speaker board by an inch or two. The instructions suggest that the tweeter level be advanced only enough to just make the listener aware of the presence of highs. We did so, ending with the level control near the center of its rotation. The presence switch was left in "Normal" position. The frequency response was measured indoors, at eight different microphone positions and two speaker locations in the room. Tone-burst photos were taken to illustrate transient response at typical points in the spectrum. The harmonic distortion was measured at low frequencies, with 1-watt input to the speaker.

The average of the eight response curves shows a good, smooth wide-range response from about 100 to 15,000 cps. There were no significant peaks or holes, even at the crossover frequencies. If the middles and highs had been brought up somewhat, which could have been done, the response curve would have been even flatter. The settings used, however, produced the most pleasing and balanced sound. Below 100 cps there is a substantial peak of about 10 db at 80 to 90 cps, below which the response falls to −13 db (referred to the average mid-range level) at 28 cps. The harmonic distortion remains very low at the lowest frequencies, however, which indicates that the speaker can be "pushed" harder to extend the low end without overload or break-up. It must be pointed out that these response curves do not necessarily show the performance of the speaker in all environments, but do suggest its behavior in a room of usual proportions.

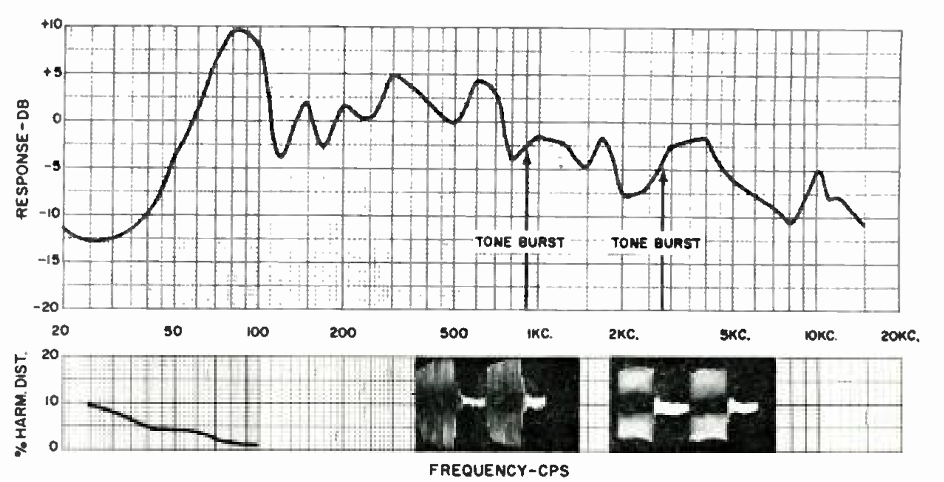
The tone-burst photos, at 900 and 2800 cps, show very good transient response. There is little overhang following the burst and only a slight overshoot at the beginning of the 2800 cps burst.

In listening tests, the "Medallion XII" proved to be a pleasantly balanced, smooth-sounding speaker. Many persons will prefer somewhat more high-frequency response, which is available by increasing the brilliance control. The bottom end sounds slightly heavy, probably due to the peak, but the true bass response extends all the way down and can be felt as well as heard.

The "Medallion XII" packs a lot of performance into an attractively styled compact cabinet. With its brilliance and presence controls the user can, to a large extent, tailor its sound to his taste.

The system is available unfinished at $134.95 and in various furniture finishes at $139.95. Front-grille frames and bases are available separately.

(Manufacturer's comments: We note that your high-frequency measurements extend only to 15 kc. Our measurements on the high-frequency response of this system indicate that, with the "Brilliance" control fully clockwise, response extends to 22 kc., within less than 3 db. Also, customers appreciate the interchangeable grilles which permit modifying the style of the cabinet in the event that the purchaser's tastes or room decor change subsequent to purchase.) ▲



Fisher X-1000 Integrated Stereo Amplifier

For copy of manufacturer's brochure, circle No. 58 on coupon (page 136).

THE *Fisher* X-1000 is an integrated stereo amplifier with an unusually high power rating—50 watts r.m.s. per channel or 110 watts total IHFM music-power output rating. It features, in addition to the normal complement of

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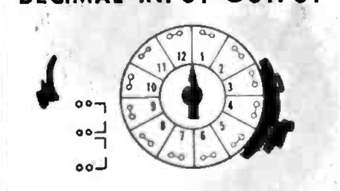

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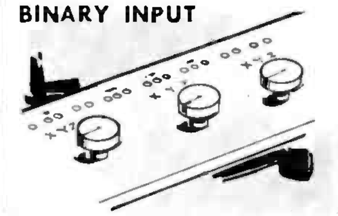

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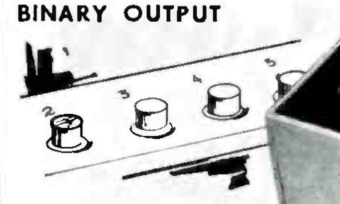

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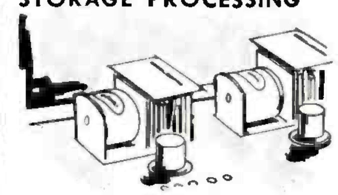

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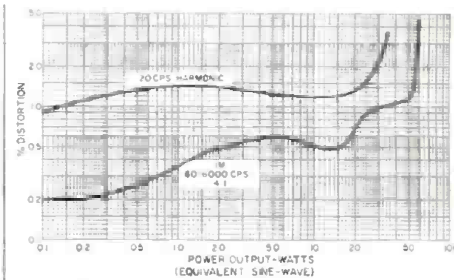

controls, several less common functions which will be described later.

Each power amplifier section of the X-1000 uses a pair of EL34/6CA7's, operating with fixed bias. There is a d.c. balance adjustment which varies the bias differentially on each pair of output tubes. The phase-inverter stage has a balancing adjustment to supply symmetrical drive to the output tubes. Ahead of this is an EF86 gain stage, to the cathode of which the over-all negative feedback is applied. Up to this point the amplifiers are quite conventional in appearance, but in the earlier stages they depart from run-of-the-mill circuitry.

For example, the tone controls are of the feedback type, with absolutely no effect on mid-frequency gain. They are driven from cathode-followers and isolated from the main power amplifier by a gain stage. The rumble and scratch filters, unlike many such circuits, have sharp cut-off points and 12 db/octave slopes, and cut out the required portions of the spectrum with a minimum of interference to the program material. They use feedback around multi-section *RC* filters to obtain the desired characteristics and the results are most satisfactory.

The phono equalization is also by means of feedback circuits around a two-stage amplifier. There are two independently selected phono inputs, one of which is RIAA equalized and the other of which offers a choice of RIAA or the old *Columbia* LP characteristic. Each phono preamp has its own front-panel level control, which enables the master loudness control to be set up for proper Fletcher-Munson compensation. The phono preamps also have playback equalization for tape heads, for both 7½ and 3¾ ips, as well as a flat-gain position for a microphone input.

Other inputs include a tuner and two auxiliary high-level inputs. One of the latter has level-set controls on the rear of the amplifier, performing the same function as the front-panel level controls for the low-level inputs. The X-1000 has the usual tape monitor facilities, for listening to the program from a three-head tape recorder while it is being recorded. As with most such arrangements, none of the tone controls, volume controls, or filters is effective on the output to the tape recorder. However, when listening to a previously recorded tape, switching the input to "Aux. 1" connects the tape playback amplifier so as to have full use of the amplifier's control facilities, even if the recorder is connected to the "Tape Mon." jacks. This is a somewhat more flexible arrangement than is usual in

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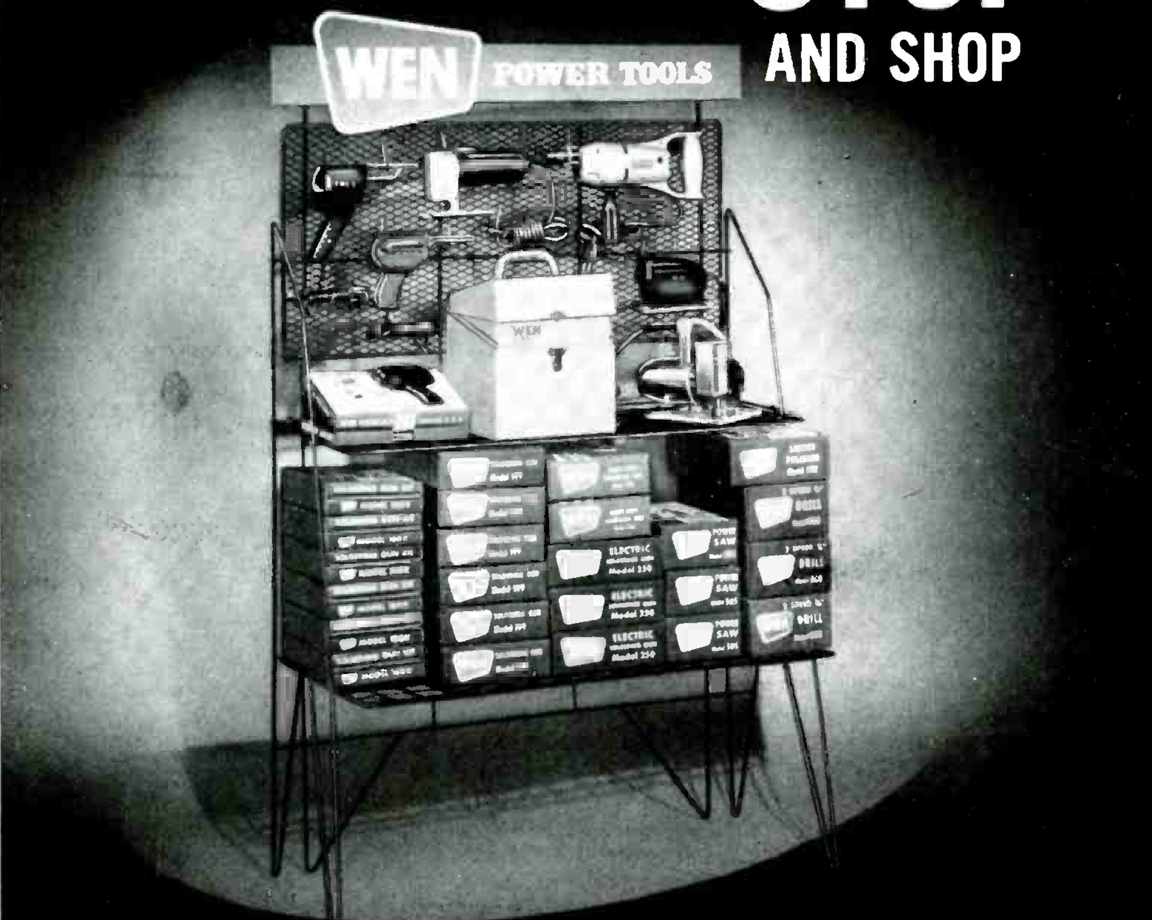
AND SHOP



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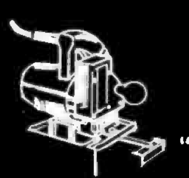

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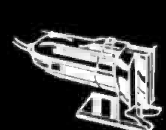

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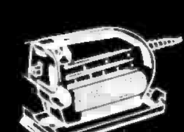

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stereophonic amplifiers of this type.

The "Mono-Stereo" mode switch on the front panel has seven positions: "Bal. R" and "Bal. L" which respectively connect the paralleled channel A and channel B inputs to the right-channel speaker only and to the left-channel speaker only; "Stereo"; "Reverse" (which interchanges the two channels); "Mono Phono," which connects the two inputs in parallel and is effective on all inputs; and "A" and "B" which connect the selected channel input to both speakers. A system of colored lights on the panel indicates the mode of operation, although we found this more confusing than helpful. A row of slide switches controls the rumble filter, scratch filter, reverses phase of one channel, and inserts a three-head tape recorder in the signal path.

Three other front-panel controls are noteworthy. A center-channel volume control, with switch, controls the level of a mixed signal to be supplied to a separate amplifier for driving a middle speaker. This can be of value if the speakers are spaced too widely or if excessive separation of the program occurs on the record. A center-channel speaker can be driven directly, without an external amplifier, in which case this control acts as an "on-off" switch rather than a level control.

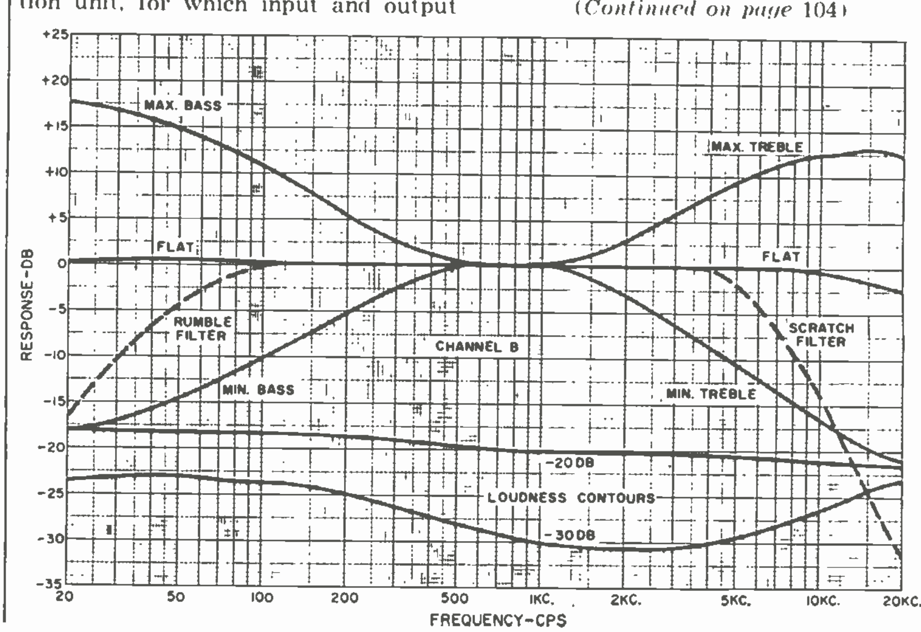
A pair of concentric controls labeled "Spacexpander" and "Dimension" complete the picture. The former duplicates the level control of the *Fisher* reverberation unit, for which input and output jacks are provided. The latter is what is usually called a "blend" control, which mixes the two channels in varying degrees to produce anything from full stereo to mono reproduction.

It can be seen that there is a certain amount of duplication of function in the X-1000, particularly in the matter of blending and filling a center "hole." In most cases only one of the several possibilities would be used, but they are all there to suit any taste.

We tested the *Fisher* X-1000 with both channels loaded and driven simultaneously, and using steady-stage r.m.s. power measurements. This is a much more severe test than the usual music-power rating of one channel at a time, but one which we feel is more realistic. As the distortion curves show, the X-1000 acquitted itself well. At 2% IM distortion each channel delivered 57 watts, or a total of 114 watts. At any power likely to be encountered in home use, the IM distortion was less than a few tenths of a per-cent. The 20-cycle harmonic distortion was somewhat higher, but the amplifier still delivered 30 watts per channel at 20 cps for only 2% distortion.

The tone control and filter response curves, taken at a low level, illustrate the complete lack of interaction between controls and the nearly ideal filter curves. The sensitivity of the X-1000 is high, only 1 millivolt at the phono input being needed to drive it to 10 watts output; 75 millivolts at a high-level in-

(*Continued on page* 104)



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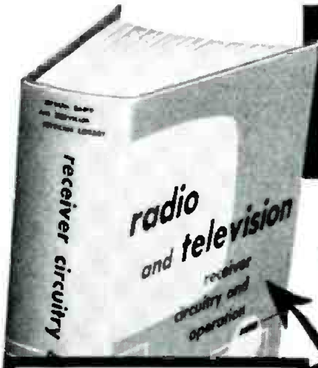

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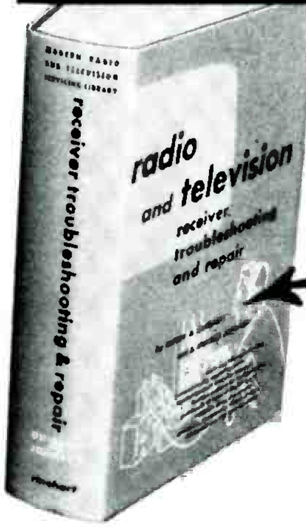

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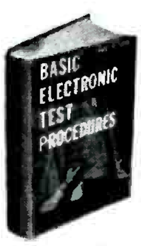

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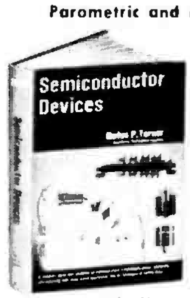

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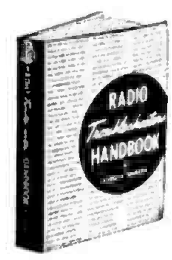

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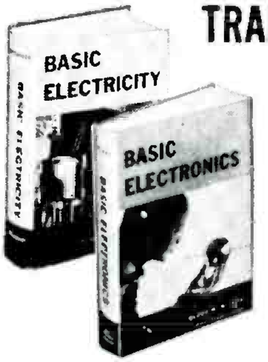

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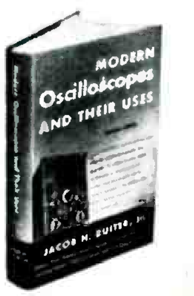

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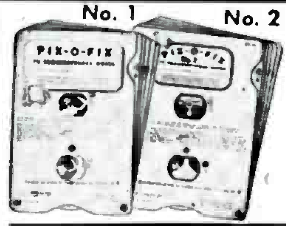

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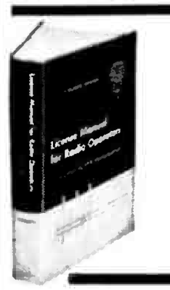

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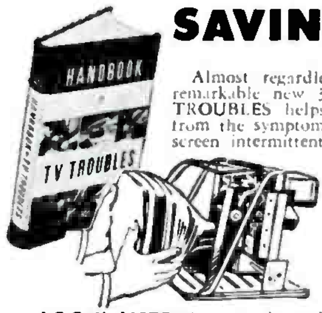

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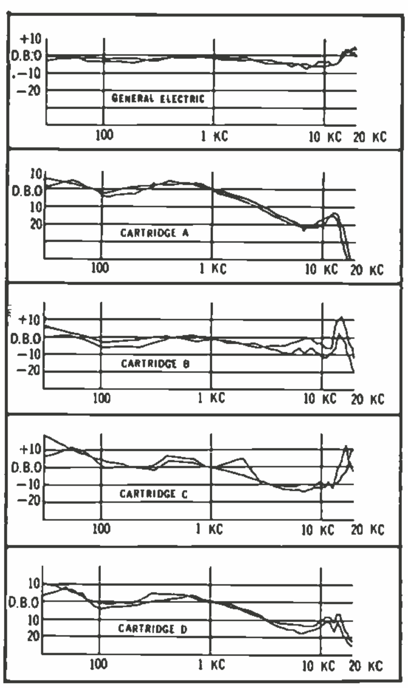

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Specifications for General Electric VR1000-5

.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 x 10^{-6} cms/dyne. **Vertical Compliance:** 9 x 10^{-6} cms/dyne. **Frequency Response:** 20 —20,000 cycles per second ±3 db. **Recommended Load Resistance Each Channel for Flat Response:** 47K chms. **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 chms per channel, nominal. **Inductance:** 400 mh, per channel, nominal. **Shielding:** Triple mu-metal. **Mounting Centers:** Standard ½" mounting centers. All measurements taken from RCA Victor stereophonic test record number 12-5-71.

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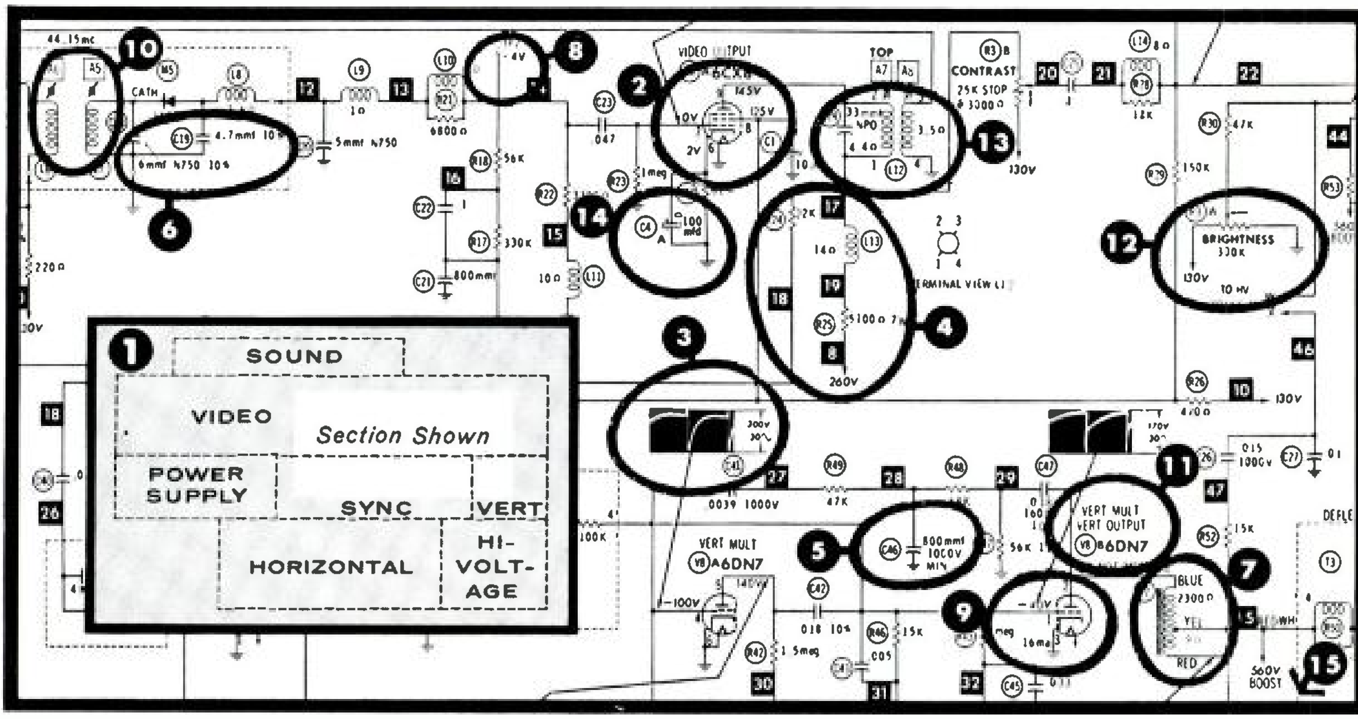

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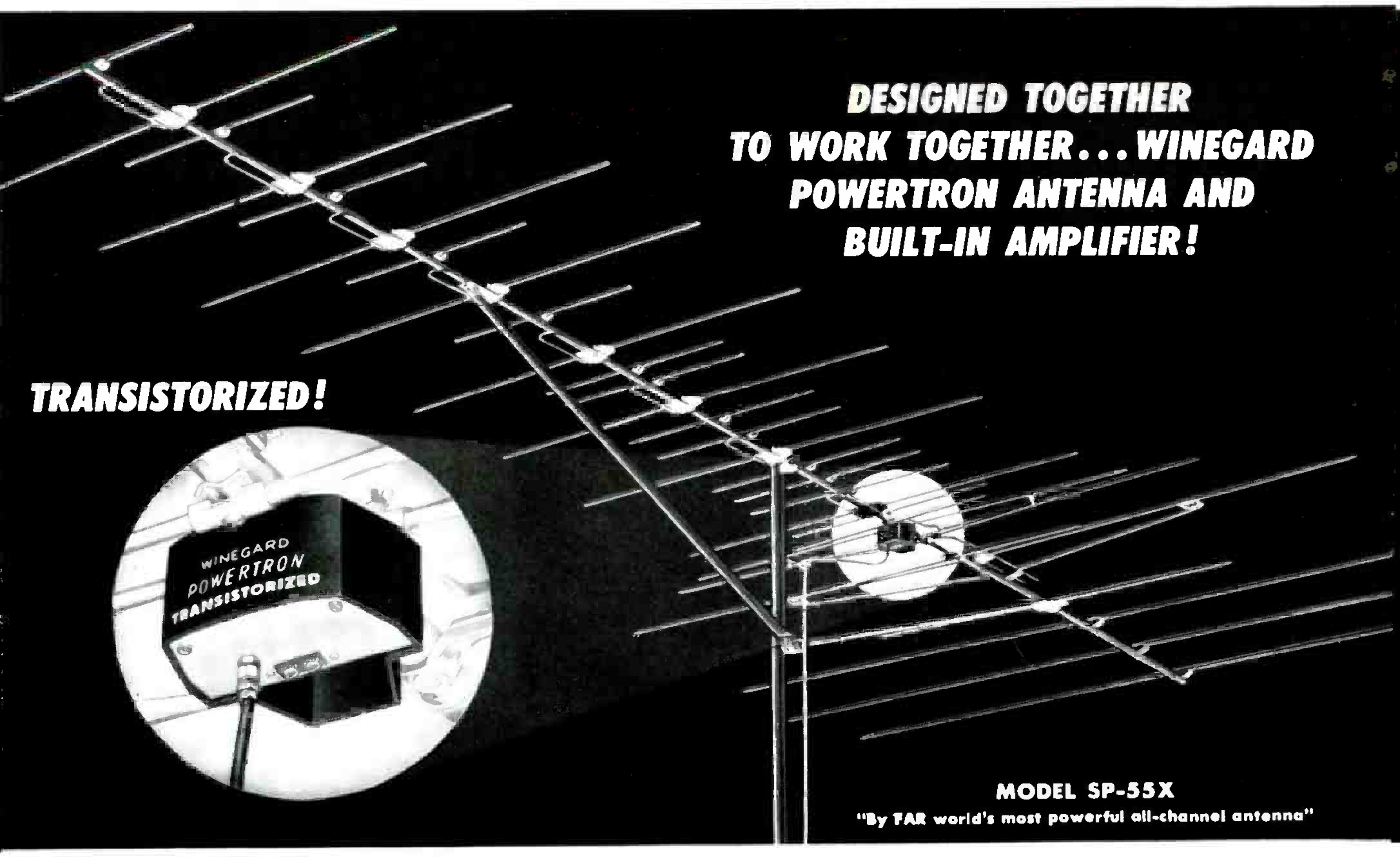

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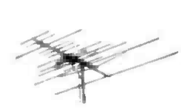

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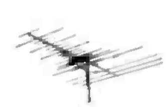

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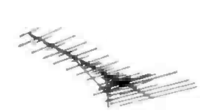

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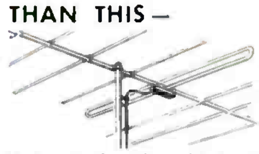
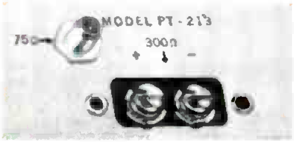


Not an after-thought "add on" signal booster hung on an ordinary antenna—not an old fashioned mast mounted booster.



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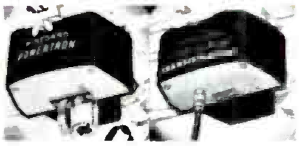

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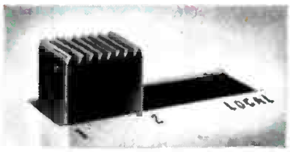

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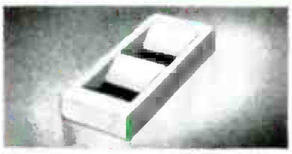

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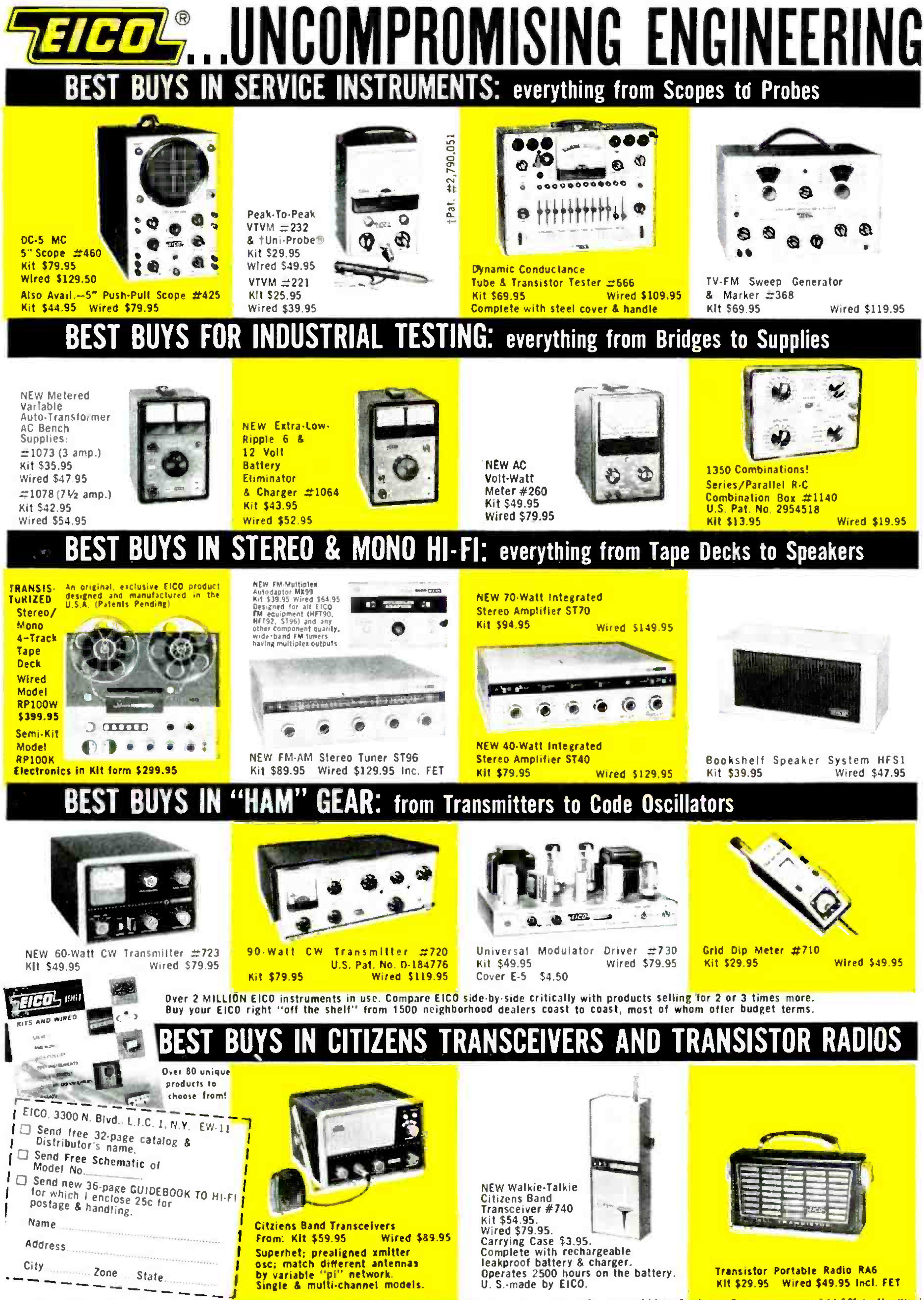
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A survey of some unusual ways that electronics is being teamed with medicine to give a better understanding of life processes.

Advances in MEDICAL ELECTRONICS

By WALTER H. BUCHSBAUM / *Industrial Consultant, ELECTRONICS WORLD*

EVERY taxpayer is well aware of the vast size of our annual defense budget and most of our readers also realize that a large portion of these expenditures go for military electronics. We have noted how some electronic techniques, developed for the defense effort, have eventually been used in commerce and industry. The host of novel applications of electronics to medical problems is far more thrilling because of their implication in matters concerning our health and vitality.

When we consider the electronic industry potential for human betterment, the prospect is staggering. The author has recently studied the field of medical electronics and has been convinced that, in this area alone, the application of electronic equipment has enormous possibilities. The benefits electronics can bring to bio-medicine may be greater by far than any previous medical discovery. We use the term "bio-medicine" because of the close interrelation between biology and medical research.

Electronics has been applied to medicine for many years in the form of such familiar equipment as the x-ray machine, the electrocardiograph, and the diathermy machine. Recently many doctors have installed ultrasonic vibration machines for deep massage of bruises, contusions, and simple bursitis.

Commonly used electronic devices which are found in practically every hospital are closed-circuit TV and audio systems for internal paging and instruction, along with radiation counters, timers, and similar devices.

In this article we will concentrate on the advances in the application of electronics in bio-medical research laboratories because this is where tomorrow's commonplace equipment originates. From the wealth of material and the wide variety of different electronic techniques perfected in the past few years we have selected a few examples which appear to be headed for use in the immediate future and which offer completely new tools in medical research.

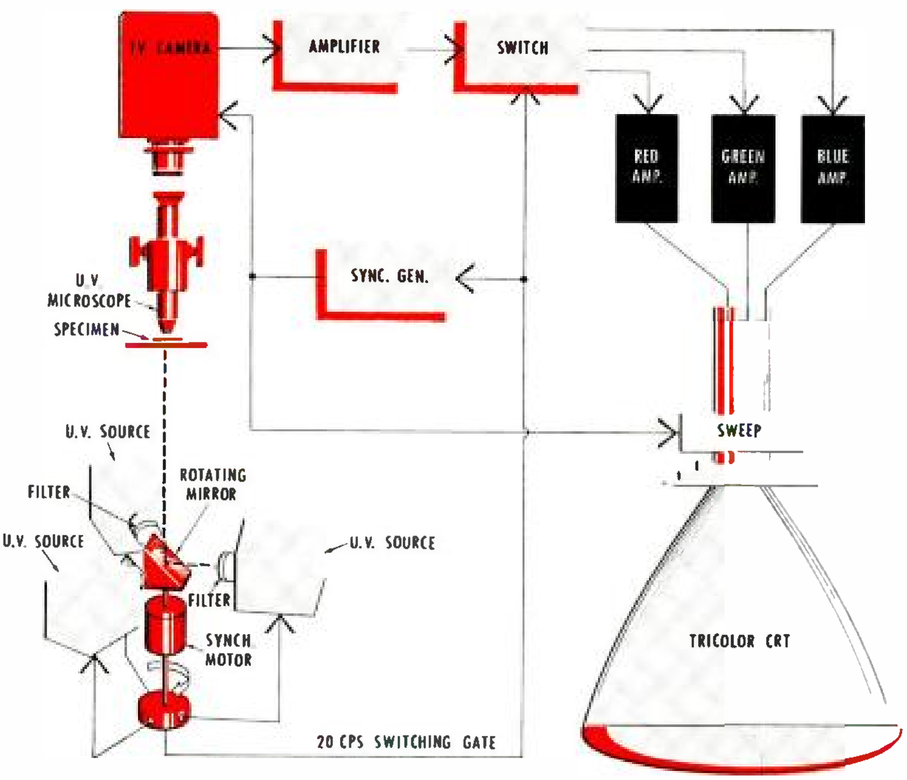


Fig. 1. Simplified block diagram of microscopy system using ultraviolet illumination combined with a color-television display.

Ultraviolet Microscopy

Many cells, bacteria, and other microorganisms are transparent to visible light and must be stained for microscopic investigation. This stain often disrupts the normal cell activity or else colors only the outside. A completely new insight into living cells and their structure will be possible by use of a new technique which replaces visible light with ultraviolet radiation and combines a microscope with a color-TV system to view the results.

Fig. 1 is a simplified block diagram of the ultraviolet microscopy system developed at the Medical Electronics Center of Rockefeller Institute. By combining the talents of a medical man, Dr. Aterman, a biophysicist, Mr. Berkely, and an electronics expert, Dr. Zworykin, this novel technique has been developed which promises to open broad avenues to understanding life processes.

Three different wavelengths of ultraviolet radiation are selected by the variable filters placed in front of the three

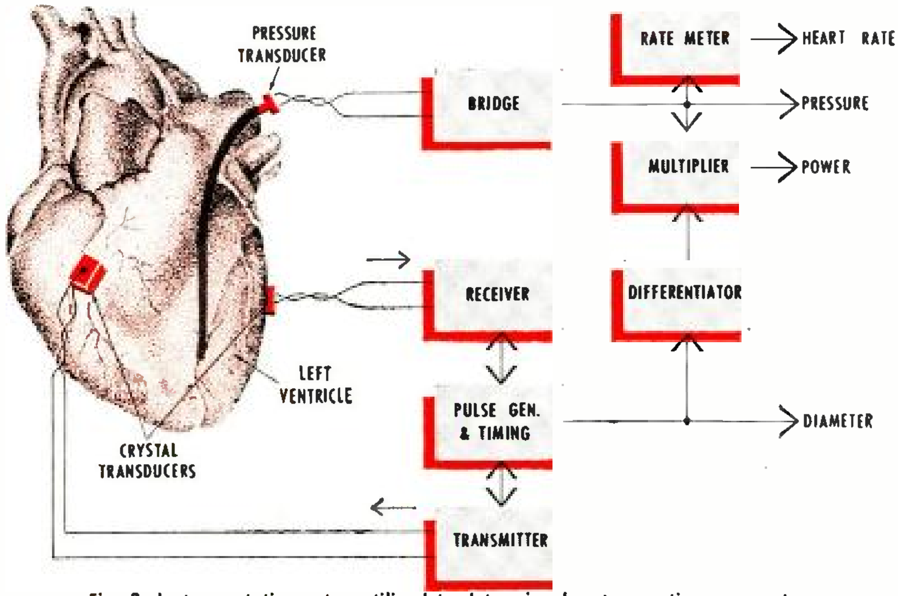


Fig. 2. Instrumentation setup utilized to determine heart operating parameters.

mercury xenon lights which serve as the ultraviolet sources. These wavelengths are reflected in sequence through the specimen by the rotating mirror; the specimen is magnified by the microscope. Instead of the observer's eye the image orthicon in the TV camera does the "looking." The microscope and orthicon are both selected to operate well into the ultraviolet spectrum, which means that all lenses must be quartz.

The video signal is amplified and then switched, in synchronism with the three ultraviolet light sources which are sequenced by the rotating mirror so that during one-twentieth of a second only one wavelength, corresponding to red, green, or blue, is seen. (Note: Because of light leakage from one ultraviolet source to another, the lights are switched by a commutator-like assembly rotated by a synchronous motor. This assembly also supplies a 20-cps switching gate for the electronics circuitry.) This is the same system as was used in the field-sequential color-TV system which preceded the present simultaneous system. Three separate amplifiers then drive a 21-inch tricolor tube. The result is a color picture of the specimen where the primary colors correspond to the three different ultraviolet wavelengths.

Many of the cells and microorganisms which are transparent to visible light, absorb or reflect the much shorter wavelengths of the ultraviolet spectrum. Different parts of these cells sometimes absorb or reflect different wavelengths so that it is often possible to see internal portions of cells in a different color. Where the microscope under visible light may show only vague shadows or nothing at all, ultraviolet illumination and subsequent translation into a color TV picture reveal a wealth of detail.

At the present time the research team which pioneered this new technique is primarily interested in advancing and perfecting it.

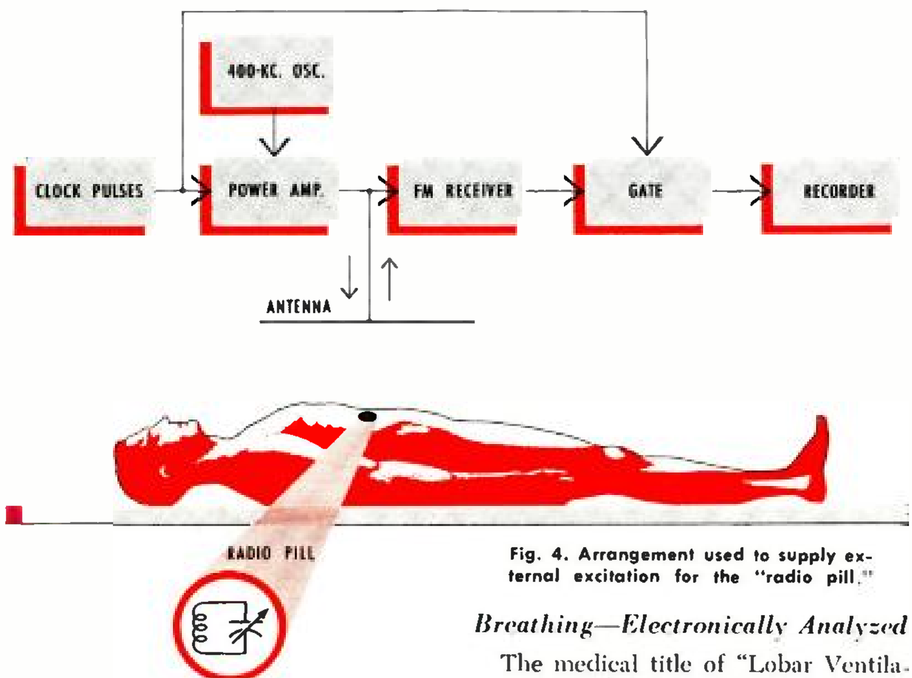


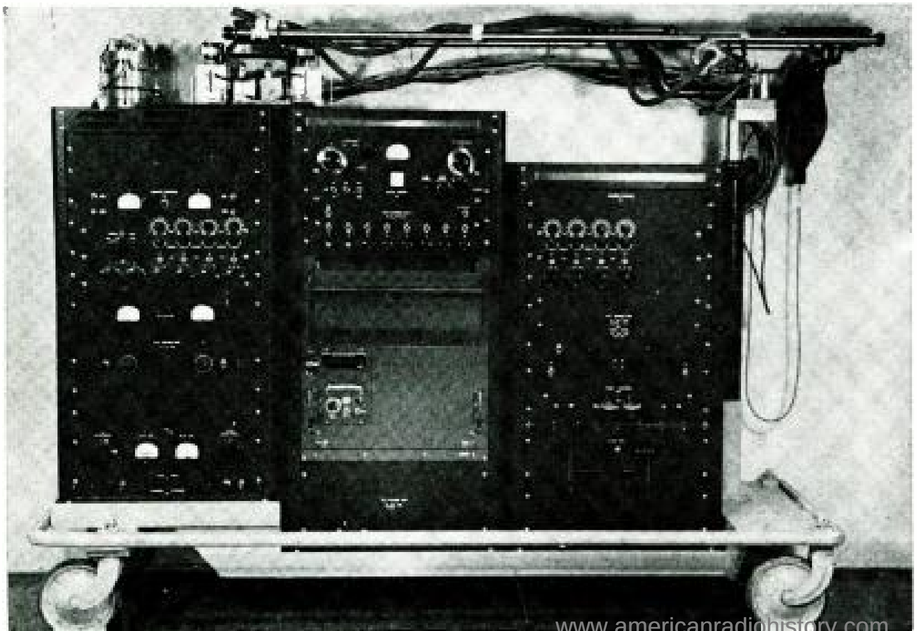
Fig. 4. Arrangement used to supply external excitation for the "radio pill."

Breathing—Electronically Analyzed

The medical title of "Lobar Ventilation in Man" by Drs. C. J. Martin and A. C. Young, covers a brief paper which is one part of a much larger effort to apply electronics to the study of the respiratory process. At the University of Washington Medical School, the electronics group has developed the "Respiratory Gas Analyzer" shown in Fig. 3. This unit, affectionately dubbed "The Monster," can be wheeled to any convenient location and provides a wealth of information about the patient's breathing.

In the lower center rack an 8-channel recorder indicates the percentage of carbon dioxide and nitrogen from the upper and lower lobes of one lung, the total volume of inhalation per breath, the flow of air from both lobes, and the pressure of the two lobes with respect to each other. Usually the patient breathes into a mouthpiece while walking a tread-

Fig. 3. Respiratory gas analyzer employing an 8-channel recorder to indicate percent of carbon dioxide and nitrogen in upper and lower lobes of lungs, flow rate of both lobes, volume per breath, differential pressure, and relative gas pressure.



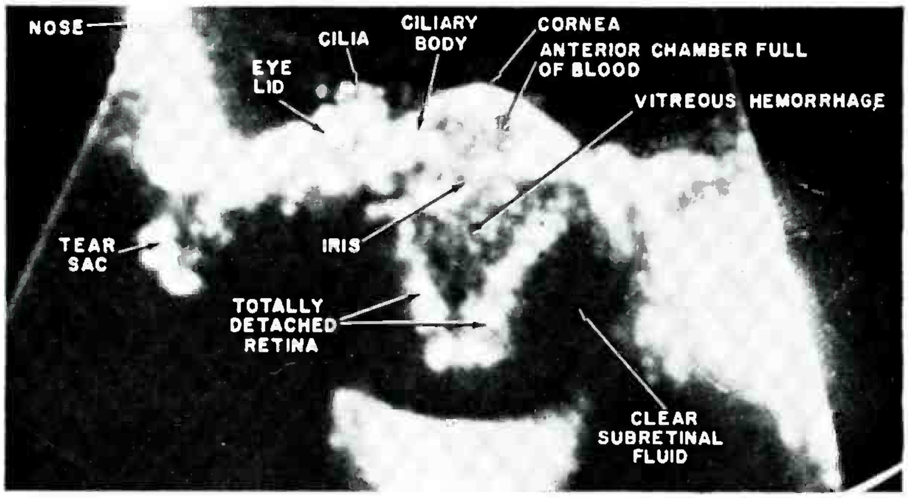


Fig. 5. An actual sonogram of a human eye. The view that is shown is from above.

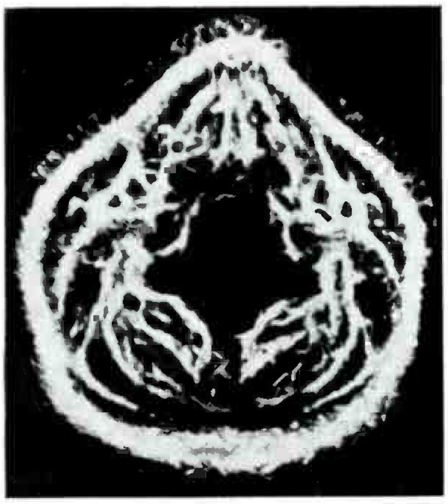


Fig. 7. Cross-section of a human neck.

mill, standing still, or in some other medically significant position. From the resulting data the doctor can determine lung defects with hitherto unknown accuracy and detail.

Heart-Measuring Techniques

The original electrocardiograph primarily indicates irregularities in the heartbeat, but today's techniques allow exact measurements of the flow of blood through the aorta, dimensioning of the heart and its chambers, and a much more detailed study of each heartbeat. For many of these measurements the chest must be opened, but the blood vessels and the heart itself remain undisturbed.

A group of researchers at the University of Washington have given a paper which briefly outlines some of these techniques. One simple method of measuring the expansion of the heart is to tie a thin rubber tube, filled with mercury, around the heart and record the change in resistance as the tube is stretched. A balanced resistance bridge and a pen recorder are all the electronic instrumentation needed.

Sonar can be used to measure the thickness of the heart by placing small crystal transducers at opposite sides of the heart or blood vessel and exciting one with some pulsed ultrasonic energy. The travel time of sound in tissue is about 1500 meters per second thus it takes about 16 μsec. to traverse 25 mm. of tissue. A sonar or radar-type of pulse generator and time-delay measuring system is required for body-tissue evaluation. In addition to the heart and aorta, successful measurements of liver and spleen have also been made by this technique. The Doppler effect, using ultrasonic signals, can be employed to measure the flow of blood without cutting into the blood vessel.

A still more sophisticated system has been devised for determining the effective power of the heart itself. It uses both an ultrasonic dimensioning arrangement of the heart and a catheter carrying a thermistor inserted into the bloodstream. The latter measures the heat carried away by the bloodstream as an indication of the velocity of the blood flow. It is also possible to utilize a pressure transducer, mounted at the end of a catheter which is inserted into the heart's left ventricle, to indicate the blood pressure in the heart itself. This pressure measurement may be made at the same time that the ultrasonic dimensioning measurement is made. A simplified version of the instrumentation for this procedure is shown in Fig. 2. Outputs of the two systems are measured by a pulse-timing circuit and a resistance bridge, followed by a simple analogue computer which feeds a multichannel recorder. From this doctors can read heart rate, change in diameter, pressure, and effective heart power.

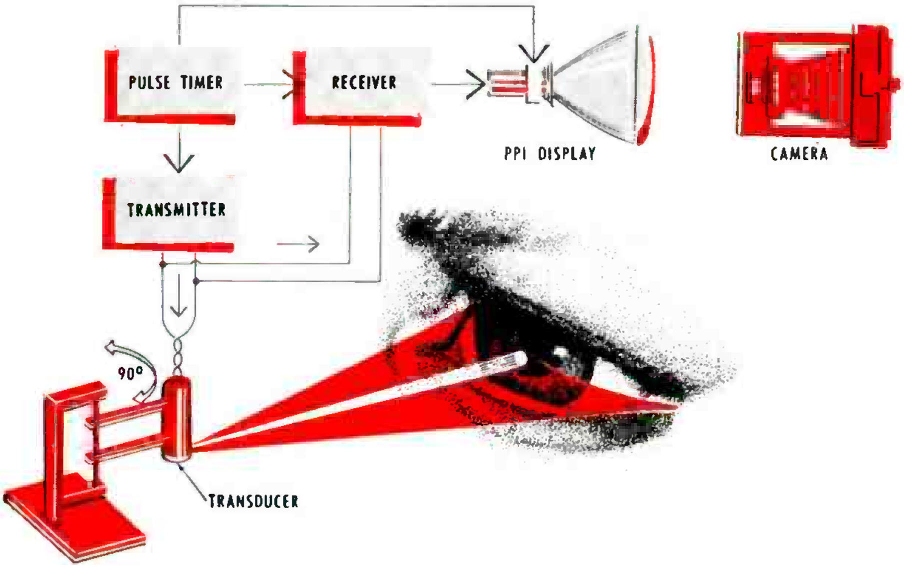
Radio-Transmitter Pills

Several years ago headlines were made by a small radio transmitter capsule which could be swallowed by the patient and which would then radio internal pressure data to external receivers. This original capsule contained a battery and a transistor oscillator and was about 1 cm. in diameter. Battery life limited the use of this "pill" to about 8 to 30 hours maximum.

A refinement of this technique has been described by Drs. Zworykin and Farrar and Mr. Berkely of the Medical Electronics Center of the Rockefeller Institute. In this novel arrangement the "pill" is much smaller and contains only a resonant circuit in which the capacitor is formed by a pressure-sensing transducer. As shown in Fig. 4, an external antenna is placed over or around the patient and excited 3000 times a second with short 400-kc. bursts. The energy received by the "pill" causes the resonant circuit to "ring" on after the burst and this "ringing" takes place at the resonant frequency of the "pill." These frequencies are amplified and detected by the FM receiver after each burst of transmitted energy and, after the "pill" has been calibrated, precise internal pressure indications can be obtained.

One of the advantages of this method

Fig. 6. Ultrasonic scanning technique used to map a cross-section of the eye.



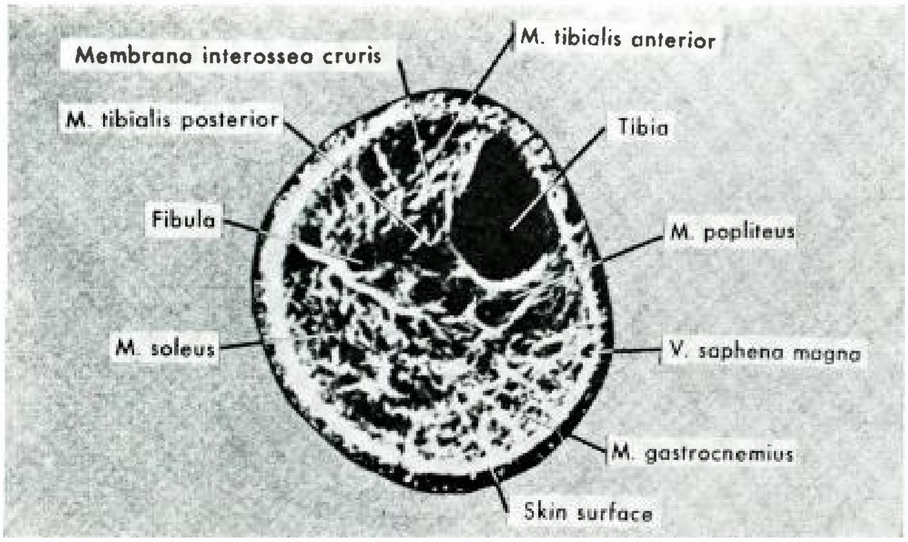


Fig. 8. Sonogram showing a cross-section of a normal human lower leg.

Fig. 9. Leg showing nephrotic edema. ▶

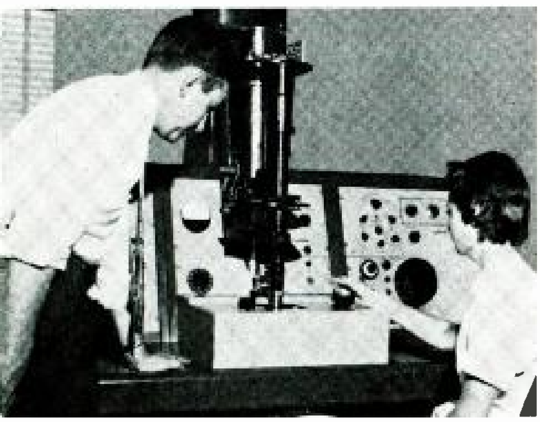


Fig. 10. The "Cytoanalyzer" automatically inspects cervical smears. ▼

is that the "pill" can remain in the patient for several days, permitting observation under natural conditions. Applications to organs other than the gastrointestinal tract are planned for future experiments.

Sonar in Medical Research

One of the most gratifying applications of an important technique of submarine detection is in the exploration of the human body. Our readers are familiar with the principles of sonar where sound waves are sent out in water and the echoes then indicate submerged objects. Various methods of pulsing, scanning, and displaying these sound waves are used to detect submarines, map ocean floors, and even communicate under water. In medicine the frequencies are much higher, transducers and the sonar beams themselves are much smaller, and different scanning techniques may be used, but the principles involved are the same as in sonar.

Because the body contains so much liquid, transmission of ultrasonic signals proceeds fairly well in muscles and blood vessels. Bones and cartilage transmit poorly and tend to reflect the ultrasonic signals. Based on this phenomenon, a number of investigators have used this method to "look through" human organs. A good example of the results obtainable with ultrasonic radiation is contained in papers presented by Dr. G. Baum who has explored the human eye. He can diagnose detachment of the retina where conventional methods indicate blindness due to glaucoma. The method used to scan the eye ultrasonically is illustrated in Fig. 6. The transducer is coupled to the body through a water bath, not shown. For display, Dr. Baum uses a portion of an AN/APS-23, an airborne radar indicator, and then photographs the screen to obtain a permanent record.

A typical "sonogram" of a human eye, together with a description of the anatomical parts, is shown in Fig. 5. The frequency used for these experiments is 15 mc. and the transducer is a specially cut crystal with an epoxy lens capable of providing beam diameters smaller than one millimeter. The transducer itself moves the beam in a sector scan, just like a radar antenna, while the entire transducer structure is moved over a 90-degree arc in front of the eye to "look into" all corners. The total picture is only seen by the camera which integrates the many sector scans over the entire 90-degree rotation period.

Drs. Howry and Holmes at the University of Colorado Medical School have applied the same sonar technique to other areas of soft tissue and have obtained extremely good results. By submerging the patient in a tub and rotating the transducer while the scanning goes on, they have been able to get cross-section views of the neck, as shown in Fig. 7, as well as many other hitherto impossible insights. As mentioned before, bone reflects the sound energy and in Fig. 7 the portion of the spine shows as the black area in the center. Arteries and veins are apparent by their black, blood-filled centers and the surrounding white walls.

A cross-section of a normal lower human leg is shown in Fig. 8 with the various parts labeled. Here again the two bones, the tibia and the fibula, appear as black areas while muscle fibers, skin, and veins show as a pattern of white. To demonstrate the value of this technique, the cross-section view of Fig. 9 illustrates the difference between the healthy leg of Fig. 8 and one showing the effects of nephrotic edema. Between the skin and the main muscles there is an area of black which is the edema fluid. Only a sonogram could show the extent and location of the disease so clearly.

Sonograms of the liver, breast, and other organs have been used to investigate cirrhosis, cancer, and many other diseases which manifest themselves only in the soft tissue and are difficult to observe with x-rays. Further improvement of the sonar method will eventually give medicine a tool perhaps even more powerful than the x-ray machine.

Infrared Techniques in Medicine

Infrared techniques which made possible the "Snooperscope" and the "Sidewinder" missile are also used beneficially in medical electronics. Among the many different applications is the "Pupillometer" which measures the contraction and dilation of the pupil of the human eye. Since the fine infrared beam scans the eye without being seen by it, it is possible to observe the effects of different light levels, drugs, or other stimulation on the patient. When the equipment is put into use, the patient's face is carefully aligned to the optical system which, itself, is accurate to within a thousandth of an inch.

Other applications of infrared to the human eye include a technique for looking through opacities of the cornea such as those occurring in cataracts and glaucoma. Infrared is also used in a number of studies of the effects of burns and in body heat experiments.

Communications & Computers

Many different approaches to the use

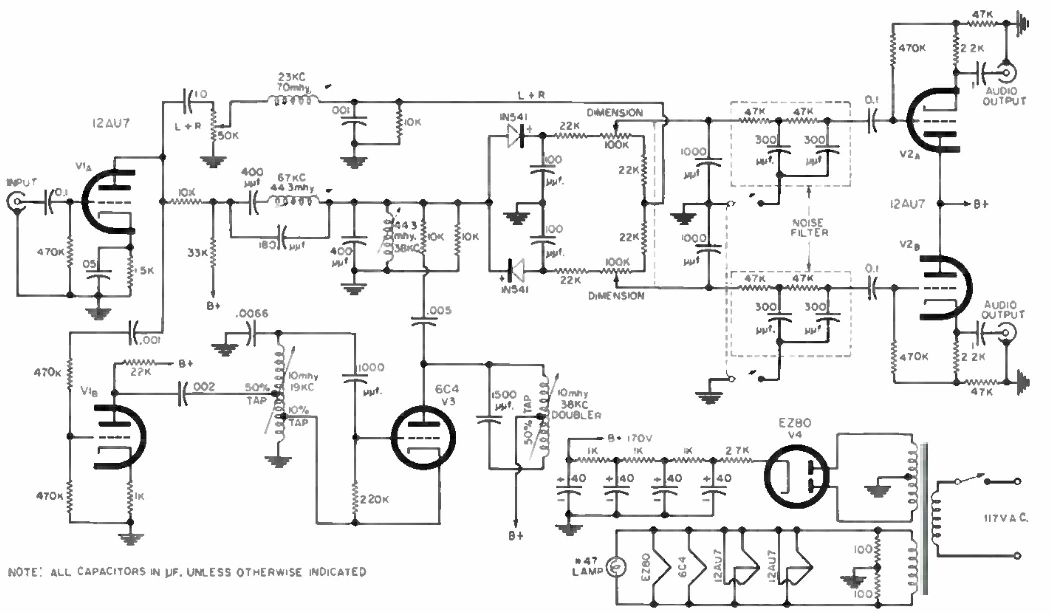
(*Continued on page 70*)

STEREO FM MULTIPLEX ADAPTER CIRCUITS

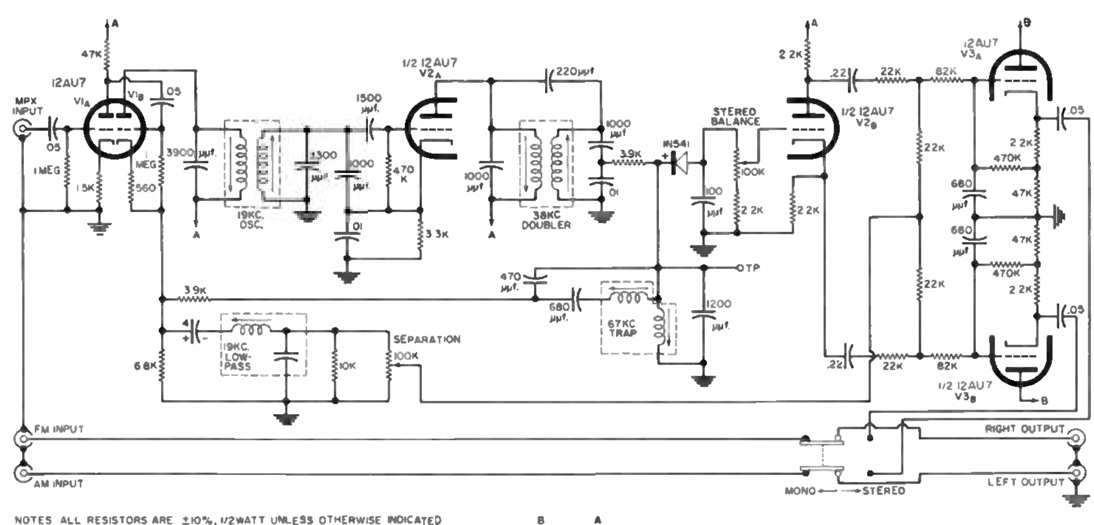
By **MILTON S. SNITZER**
Technical Editor, ELECTRONICS WORLD

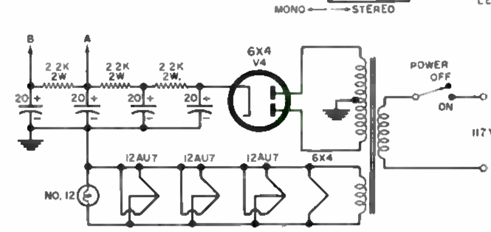
Schematic diagrams and circuit descriptions of two new commercially available FM multiplex adapters.

CROSBY *Model MX-101 self-powered adapter (below) consists of four tubes (including rectifier) and a matched pair of crystal diodes. Unde-emphasized signals from an FM tuner are applied to V_{1A} via the input jack. This tube section is a composite signal amplifier from which three separate outputs are taken. The upper output is applied through a low-pass filter (70-mhy. coil and .001-µf. capacitor) to the pair of 22,000-ohm matrixing resistors in the crystal-diode circuit. Information in this circuit consists of the L+R main-channel signals. The center output of V_{1A} is applied through bandpass networks (two 44.3-mhy. coils and associated capacitors) to the crystal diodes. Signals in this circuit are the L—R sidebands in the 23- to 53-kc. stereo subchannel. Storecast-music information (around 67 kc. and higher) is rejected by the bandpass networks. The lower output of V_{1A} is applied through a voltage divider to V_{1B}, the function of which is to amplify the 19-kc. pilot subcarrier that is transmitted by the FM station that is broadcasting a stereo program. This 19-kc. signal is then applied to the input tank circuit of V_3, the oscillator stage. The purpose of the pilot subcarrier is to lock the adapter oscillator into frequency and phase with itself. The oscillator is a Hartley circuit with a special film capacitor (.0066µf.) used across the tank for stability. The output tank circuit of V_3 is tuned to 38 kc., double the input frequency, and this signal is injected through a .005-µf. capacitor into the crystal detectors. Detected output from the crystals consists of a positive L—R signal and a negative L—R signal. When these signals are combined with the L+R signal in the matrixing resistors, the resulting output is a separate left signal and a separate right signal. De-emphasis also takes place in the detector circuit. A front-panel "Dimension" control adjusts the proportion of sum and difference signals so as to change the apparent stereo separation. The left and right signals are then applied through noise filters (that may be switched in or out as required) to the inputs of V_{2A} and V_{2B}. These cathode-followers deliver output voltages to the stereo amplifier. The power supply consists of a conventional full-wave rectifier (V_4) with a multi-section RC filter.*



BOGEN *Model PX-60 self-powered adapter (right) uses four tubes (with rectifier) and a crystal detector. Detected output from the FM tuner is amplified by V_{1A} and coupled to V_{1B}. Two cathode outputs are taken from this tube section; one is the sum-signal (L+R) channel via a 19-kc. low-pass filter, the other is the difference-signal (L—R) channel via a bandpass filter and storecast-music trap. Plate output from V_{1B} consists of the 19-kc. pilot subcarrier which locks in oscillator V_{2A}. The oscillator output frequency is doubled by the 38-kc. tank, and this signal is applied to the crystal detector along with the difference-channel information. Output of the crystal consists of the detected L—R signal which is then applied to paraphase amplifier V_{2B}. Positive and negative L—R signals are then matrixed with the L+R sum signal, resulting in separate left and right signals being applied to both sections of V_3, a pair of cathode-followers. Outputs from the cathode-followers may then be applied to the stereo amplifier. For mono use, the adapter circuits are bypassed by the slide switch. A conventional full-wave rectifier (V_4) is employed for +B.* ▲





A personal, portable TV

The third transistorized, battery-powered set to go on sale, Sony's 8-301W enters set-of-the-future sweepstakes.

COVER STORY

THE ADVENT of a transistorized, independently powered TV receiver no longer rates as a revolutionary development, with the *Philco* "Safari" and the *Motorola* "Astronaut" already on the record. However, such sets being far from commonplace, Japan's first entry in the domestic set-of-the-future sweepstakes, the *Sony* 8-301W, is still important news.

The entire receiver is scarcely larger than the 8½-inch, direct-view, rectangular tube on which it displays its pictures: width and height are about 8 inches, depth 10 inches without the battery pack that plugs into the rear and 12 inches with it. A built-in, monopole antenna telescopes out of the rear. Three push-buttons under the CRT, labeled "AC," "DC," and "Off," establish the various modes of operation when used singly or in combination.

Consumer controls at the top rear are for vertical and horizontal sync, brightness, and gain. Although the latter will be used as a conventional contrast control, it isn't and will give somewhat different action, as we shall see later. Also topside are the channel-selector switch concentric with the fine-tuning control and the volume control. An oval speaker fires out of the bottom.

On the back are connectors for external a.c., external d.c. (12 volts), and jacks for 75- or 300-ohm antennas. Flanking the push-buttons at the front are two earphone jacks, one of which cuts out the speaker. Included accessories are a zip-on carrying case, an a.c. cord, a length of 300-ohm line terminating in a plug matched to the receiver input, an earphone, and spare fuses. An optional kit permits operation from the cigarette-lighter socket of any 12-volt automotive system.

Weighing a little over 13 pounds, more than 17 with the power pack added, the set is reasonably portable if not featherweight. The lead-acid storage batteries will run the receiver for three hours. The ratio between discharge and charge time is 1 to 3. The batteries should always be kept upright although they are called leakproof. Charging is accomplished by depressing the "AC" and "Off" buttons simultaneously while the set is plugged into the line. Some trickle charging occurs during a.c. operation if "AC" and "DC" buttons are both pushed in.

Performance

The manufacturer rates the 8-301W at 30 microvolts sensitivity for a usable picture. In practice, sensitivity appeared quite commendable. In a medium-fringe area outside New York City, we were able to get usable to fairly good reception on all channels with the built-in monopole. In-city reception left nothing to be desired, with useful results obtained even inside a moving auto.

In fact, not even picture wash-out was serious in the shade of the car's interior on a sunny day. However, you can forget about daytime, outdoor use in such places as your favorite bathing beach. Indoor pictures were sharp, clear, bright, and viewable by a number of people at a reasonable distance.

Adjustment was somewhat more critical than on modern, tube sets, and some re-setting was required during the warm-up period. Set too high, the "Gain" control results in horizontal

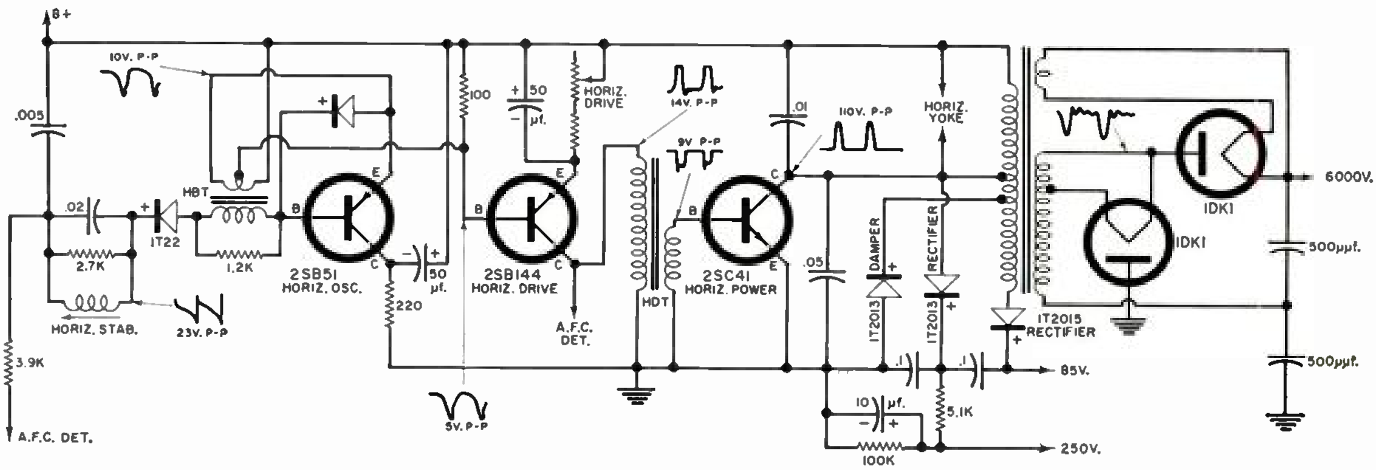


Fig. 1. Horizontal oscillator, sweep, and high-voltage sections highlight similarities and differences with respect to tube TV.

pulling and other signs of overload; set too low, it lets the picture fall out of sync. Between these points, however, it has a broad range of adjustment that was found to be quite adequate.

Circuitry

The set uses 23 transistors and 18 diodes. Included in the latter are 4 silicon rectifiers that form the power supply's full-wave bridge. This is fed by the power transformer's 15-volt secondary during recharge or line-voltage operation. A resonant filter minimizes both ripple and component size: following an input electrolytic, a 15-millihenry choke is shunted by another capacitor to resonate near 120 cps.

The antenna input includes a matching transformer for 300 ohms and a 1000-ohm potentiometer before the r.f. stage. The pot, which prevents overload of the sensitive tuner, is one-half the user-operated "Gain" control. It is ganged to another pot in the a.g.c. line.

The compact, disc-turret tuner is an incremental-inductance affair with 14 positions. The two spare spots are to take care of future developments, such as increased u.h.f. activity. Three 2SA161 *p-n-p* transistors serve as r.f. amplifier, oscillator, and mixer. This special, high-gain type is a germanium mesa unit with an *alpha* cut-off of 500 mc.

The four-stage 20-mc. i.f. strip uses 2SA124 *p-n-p* transistors in a generally conventional configuration. A noteworthy departure is a semiconductor diode that effectively shunts the secondary of the input i.f. transformer. This helps to lower "Q" and prevent overloading of the strip. The i.f. output is fed to two detector diodes, one for video and one for a.g.c. The latter connects to the base of an a.g.c. amplifier (*n-p-n* type). The other half of the dual "Gain" control, a 10,000-ohm potentiometer section, is in this amplifier's collector circuit. Emitter output is applied to the bases of the 1st and 2nd i.f. transistors.

The video detector is followed by a two-stage amplifier before the picture tube is reached. A take-off trap in the first (video driver) stage feeds the sound i.f. strip. The video-output transistor, a high-gain, *n-p-n* 2SC15, has been specially designed. It operates with a collector potential of 85 volts d.c. or slightly more, whose source will be discussed later. Its emitter circuit includes what is called a "contrast" control—which is a service adjustment not made available to the user and which does not function in the way we would expect from its name. Set at the factory, it need be re-adjusted only if the video-output transistor must be replaced, as follows: with gain adjusted so that signal-input to the base of this stage is 1 volt p-p, the "Contrast" control is manipulated to produce an output of 55 volts, p-p, which is enough to drive the picture tube. In effect, it is a compensating adjustment for differences in transistor characteristics.

Output is applied to the sync circuits as well as to the

Fig. 2. Removal of cabinet shell reveals compact internal layout. Note the three, vertically mounted, printed boards.

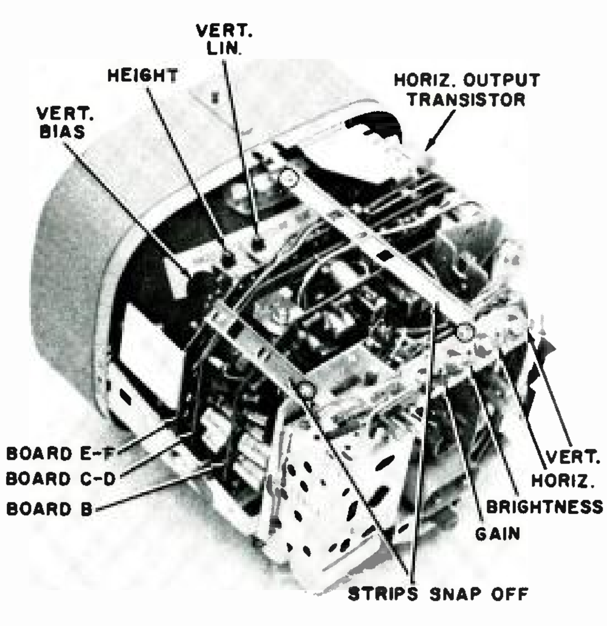
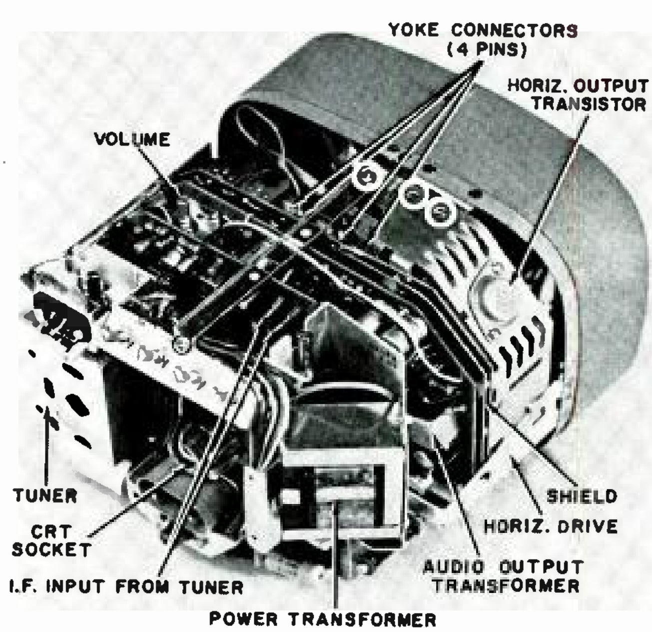


Fig. 3. Many components not visible in Fig. 2 are shown in this view. The shield is placed between boards C-D, E-F.



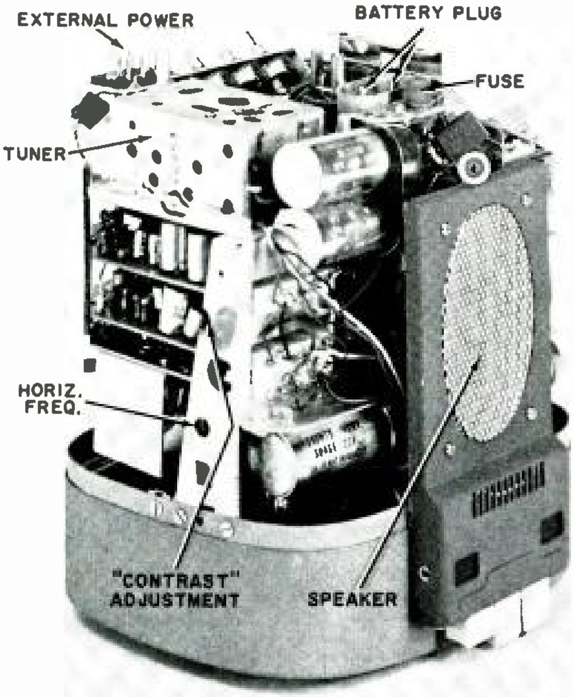


Fig. 4. Set resting on its face to show speaker at bottom. This is convenient position for slipping off outer shell.

cathode of the picture tube. The latter is a newly developed, 90°, rectangular tube, using electrostatic focus, whose type number is 210HB4. It uses a straight gun with no ion trap. *Sony* reports the gun construction is of a special type, under patent, but is not yet ready to divulge more specific details. Although this assembly fits into a CRT neck whose diameter is only one inch, operating voltages are not unexpected. 250 volts are applied to G_2, between 85 and 100 to G_1, which includes the brightness control, and the second anode takes 6000 volts. The filament connects to the normal 12-volt supply. The screen is aluminized.

The sound section consists of two i.f. stages, the second of which also limits, followed by two semiconductor diodes in a modified Foster-Seeley configuration. Detector output is applied to an a.f. driver and a push-pull pair of output transistors in an arrangement familiar to anyone who has worked on transistorized radios.

As to the sync section, a clamping diode at the base input of the first (amplifier) transistor serves as the separator. Output then goes to a phase splitter, which feeds the vertical section and a twin-diode a.f.c. detector. Output from the latter is applied to the horizontal section.

A closer look at the horizontal and high-voltage circuit (Fig. 1) will help us get the feel of the similarities and differences found in a transistor TV set as compared to the more familiar tube circuits. Not shown are a pair of pots controlling horizontal frequency. One, externally available, is for fine adjustments. The other is simply for centering the control range of the former. The first stage is a blocking oscillator distinguished by a pair of diodes not found in the tube version of this familiar circuit. Their principal purpose is to suppress peaks of excessive amplitude that might damage the transistor. A stabilizing coil is also evident.

The driver stage includes a drive control. Since transistor characteristics do not change as much with age as is the case with tubes, this is not an ordinary service adjustment. As is the case with the "Contrast" control, it is only to be used for compensation following transistor replacement. Finally, the output transistor is another special type. This silicon mesa unit, rated at 50 watts, is shown mounted on its heat sink in Fig. 3. It feeds the flyback transformer directly.

Not unexpectedly, the latter has several taps and windings. A damper diode shunts one. Two other semiconductor diodes connected to different taps provide rectified output at two different levels for requirements above 12 volts. One provides the 250 volts already noted for one CRT electrode. The other yields output in the order of 85-100 volts for the picture tube, the video-output stage, and the neon lamp that indicates channels and shows that the receiver is on. Two subminiature high-voltage diodes, type 1DK1 (the only two tubes aside from the CRT), act as a doubler to provide 6000 volts.

The vertical section uses three transistors: a blocking oscillator (diode-protected), a driver, and a power-output stage that couples directly to the vertical coils in the yoke, without a transformer. In addition to a hold control available to the user, screwdriver-adjusted height and linearity controls at the top of the chassis (Fig. 2) are available through openings in the top of the cabinet. However, the nearby vertical bias control in Fig. 2 can only be reached when the set is taken out of its cabinet. This is another compensating adjustment used only after transistor replacement.

Dis-assembly and Layout

How does one get inside the set for service? It's easy once you know how. Remove the sun shade by loosening the knurled nut that holds it. A single screw underneath, circled in Fig. 4, is next. Then the only two slotted screws at the rear are taken out, permitting removal of the two horizontal, metal strips, one on either side of the cabinet, and one of which is visible on the cover. Underneath each strip, toward the front, is another screw. These two also come out.

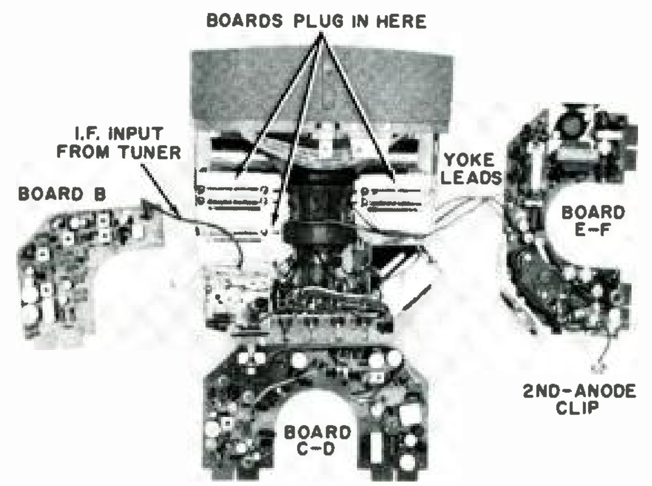


Fig. 5. The three printed chassis boards may be unplugged. This permits easy access to components on and off boards.

While we have the strips off, we may as well note that they cover some adjustments that now become available. These include the coarse horizontal frequency and "Contrast" adjustments on the right side from the front, shown in Fig. 4, and the horizontal drive adjustment on the left side, visible in Fig. 3.

Only four more screws of the seven remaining on the back need come out now. They all look alike, but the two mounting the 300-ohm input socket remain untouched, as well as the one directly underneath the vertical-hold control. After external knobs are pulled off, the set may be slipped out of its shell.

If you don't know any better, what you now see (Figs. 2, 3 and 4) will be quite discouraging: accessibility on this marvel of compactness seems impossible. However the set

(*Continued on page* 96)

Useful nomogram for technicians, experimenters, and servicemen simplifies parallel-R, series-C problems.

By **JIM KYLE**

PARALLEL-RESISTOR CHART

TECHNICIANS, experimenters, and servicemen often find it necessary to determine the resistance of two or more resistors in parallel. While this can be done by using the classic sum-of-the-reciprocals formula: $1/R_T = 1/R_1 + 1/R_2 + \ldots\ldots\ldots + 1/R_n$, the arithmetic involved frequently becomes cumbersome.

The more widely used formula $R_T = (R_1 \times R_2)/(R_1 + R_2)$ suffers the same drawback, when applied to standard resistance values, as anyone who has tried multiplying 39 by 18 and dividing the product by 57 knows.

This chart was designed to give a rapid answer to such calculations. In addition, it can be used to determine the value resistor which must be added in parallel with an existing component to reduce the total resistance to a specified amount—a procedure which becomes complex when standard formulas are employed.

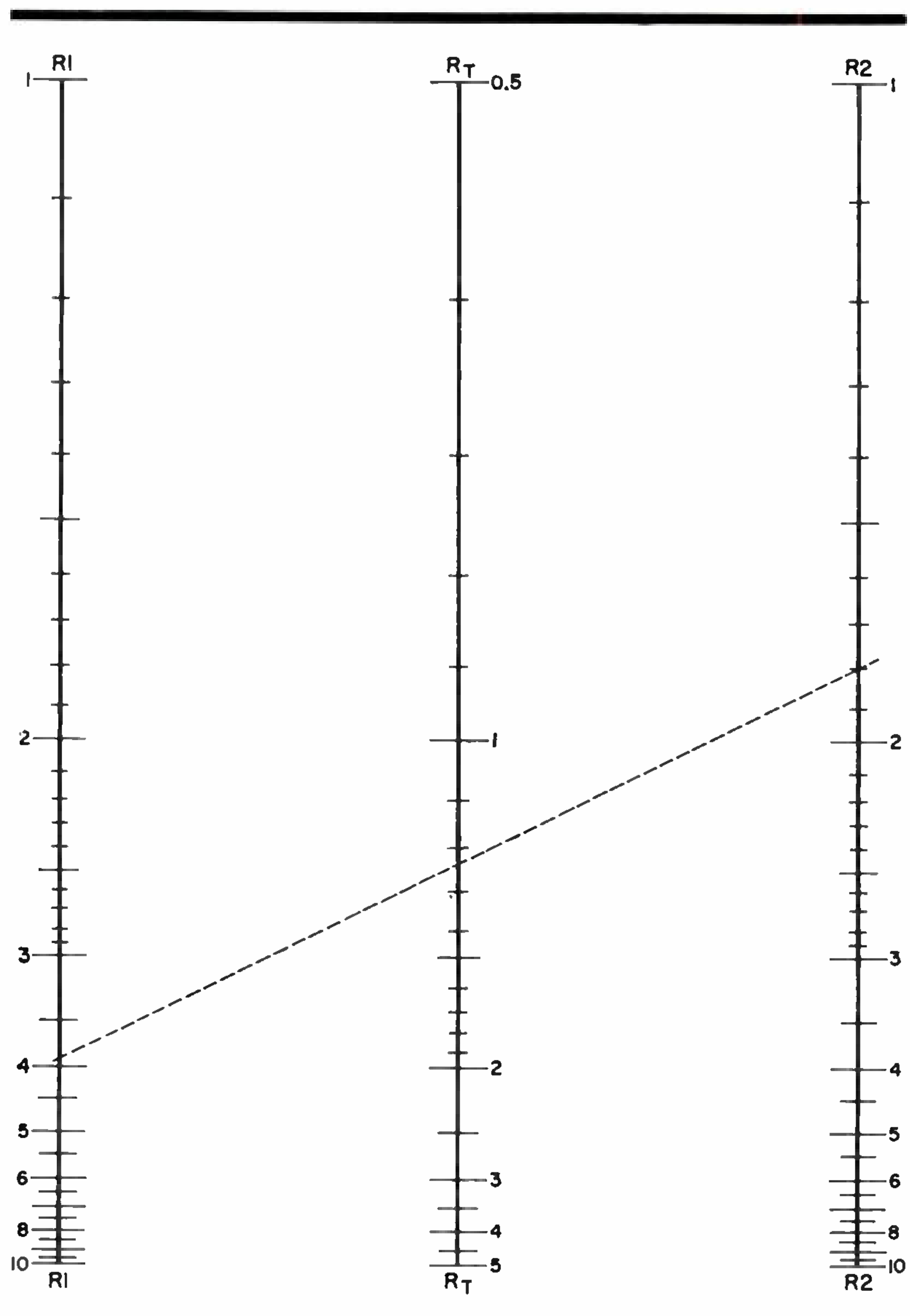
Using the Chart

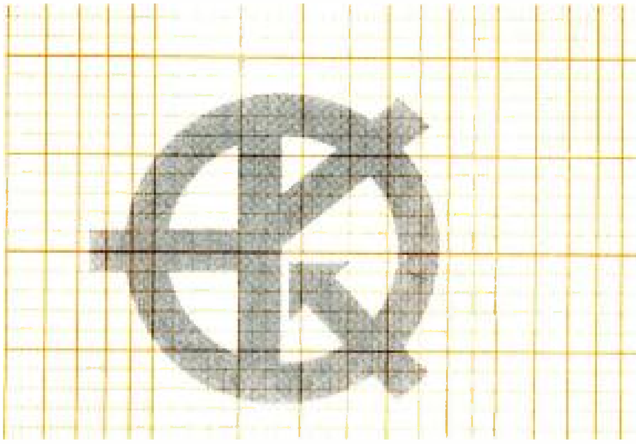
To use the chart, draw a straight line from the value of *R1* to the value of *R2*. This line will cross the R_T scale at the value of total resistance. Note that all values have been normalized to the range from 1 to 10 to make the chart universal. You can multiply or divide the values given by 10, 100, 1000, etc. as needed.

For example, the total resistance obtained by paralleling a 39-ohm resistor with an 18-ohm resistor is 12.3 ohms, as shown by the dashed line on the nomogram.

If you want to find out what size resistor to use to reduce an existing resistor's value to some specified amount, draw a line from the existing value on *R1* through the desired final value on the R_T scale and read the value of the resistor that is to be added from the *R2* scale.

In addition to its uses with parallel resistors, the chart can be used without change to determine series-capacitor problems, since the same formulas apply. Simply replace the "R" symbols mentally with "C" and proceed as described above. ▲





TRANSISTOR BIAS CIRCUIT DESIGN

By GENE L. JACKSON / General Dynamics / Fort Worth

Simplified design procedure to establish d.c. operating conditions that uses only Ohm's Law and basic ratios.

THERE are many published approaches to the design of transistor bias circuits as anyone who has studied engineering texts or other publications on this level can attest. While there is no denying that these approaches are very important in this age of technical design, the author believes that there are easier methods —particularly for the technician or casual designer.

Many of these mathematical approaches fall apart because of their dependence on other mathematical equations, such as those for a current stability factor or other variables. The current stability formula used is probably not exact and other factors are not considered. It is not surprising, then, when the results are not as expected after several pages of calculations. Other methods go into much detail and attempt to account for all variables. They usually work quite well if the designer has all of the necessary information available at his fingertips, but seldom is he this fortunate. This is partly because different manufacturers supply different kinds and types of information about their semiconductor products.

Ohm's-Law Method

The method of circuit design to be described uses only Ohm's Law, simple ratios, and common sense. This discussion will be concerned with the bias or d.c. operating conditions of transistor amplifiers and a.c. circuit analysis will not be attempted here.

Fig. 1 is a schematic of a *p-n-p* transistor amplifier used in a common-emitter configuration with transformer coupling on the output. The necessary forward bias is developed by the voltage divider consisting of R_1 and R_2. The d.c. emitter current divides between the collector and base circuit according to the ratio I_C/I_B or the value of h_{FE} which is called the d.c. forward-current transfer ratio. This value is given in most transistor data sheets.

R_E is the emitter resistor used for stability. It also represents a certain amount of negative current feedback. The amount of bias stability is determined mainly by the ratio of R_1 to R_E, therefore the value of R_1 depends greatly on R_E. The larger R_E, the better the current stability will be. Unfortunately, this limits the maximum output signal and the amount of emitter current that can flow, therefore the choice of R_E must be a compromise affected by the value of the emitter current desired, the load impedance, and other factors pertaining to the particular circuit application.

Example of Method

To further illustrate the problems of bias circuit design, a popular *n-p-n* transistor will be used to design a rather common type of transistor amplifier. This circuit is shown in Fig. 2.

A type 2N333 small-signal silicon *n-p-n* transistor is used in this example. Probably the first consideration is the

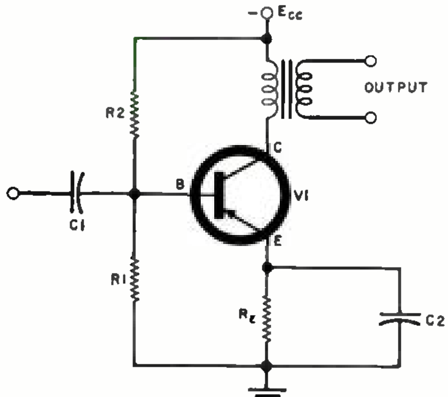
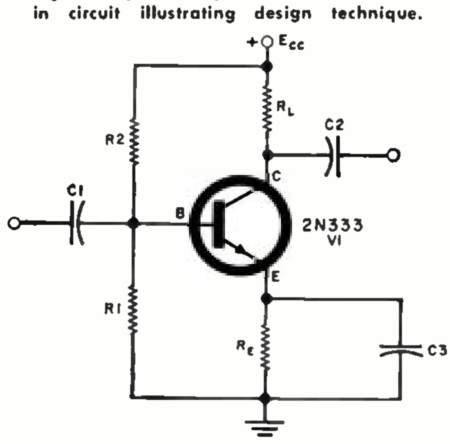


Fig. 1. Schematic of "p-n-p" transistor amplifier in common-emitter configuration.

Fig. 2. Popular "n-p-n" transistor is used in circuit illustrating design technique.



value of E_{cc}. This will be determined by the type of application, perhaps by the battery or power supply available, and by the maximum collector voltage allowed. The data sheet for the 2N333 transistor lists the maximum allowable collector-to-base voltage as 45 volts. For this example, let E_{cc} be equal to 40 volts.

Next the value of emitter current will be chosen. The maximum value of emitter current allowed for this transistor is 25 ma. If the signal-to-noise ratio is important, as when the transistor is used as a low-level preamplifier, the emitter current is kept to a low level for more favorable signal-to-noise ratio. If maximum power is wanted, a larger emitter current is necessary. Before deciding on a value for emitter current, the graph of h_{FE} *versus* collector current, shown in Fig. 3, should be studied. From this it can be seen that at a temperature of 25 degrees C, the transistor can be operated effectively between 1 and 5 ma. (A higher collector current can be used if desired.) If an emitter operating point of 3 ma. is chosen, the result should be satisfactory for most applications.

When the emitter resistor is bypassed with C_3, the emitter can be considered to be at a constant d.c. potential as the a.c. signal variations will be filtered out. If the d.c. voltage drop across R_I has been determined, the value of R_E can be calculated. The larger the percentage of E_{cc} dropped across the emitter resistor, the more stable the amplifier is with respect to changes in temperature and its associated effects. However, it must be remembered that efficiency will decrease and that the voltage drop across R_I will be lost, as far as voltage available for a.c. signal amplification is concerned. Usually the voltage across R_E will be 10 to 40 per-cent of the supply voltage. Compromising again, let E_{RE} be equal to 20 per-cent of E_{cc}, or 8 volts.

If the emitter current is 3 ma. and the drop across R_I is 8 volts, then R_I can be calculated as follows: $R_E = E_{RE}/I_I$ or $R_E = 8$ volts / 3 ma. = 2667 ohms. Thus the closest EIA value of 2700 ohms will be used. The actual drop across R_I is then: $E_{RE} = 2700$ ohms × 3 ma. = 8.1 volts. This leaves 31.9 volts across the transistor itself and the load resistor R_L.

Under ideal operating conditions, the voltage drop across the transistor itself and R_L would be equal with no signal input. This would allow the collector voltage to increase and decrease an equal amount with signal input, with minimum distortion. However, as I_C will increase if the operating temperature increases, certain precautions must be taken. As I_C increases, E_{RL} increases and the voltage drop across the transistor decreases. Therefore, the voltage drop across the transistor will be made a little larger than E_{RL} as a safeguard against increases in I_{CBO} and h_{FE}.

If E_{RL} plus the voltage drop across the transistor is 31.9 volts or approximately .80 of E_{CC}, E_{RL} can be assigned an arbitrary value of .35 E_{CC}. This leaves the voltage across the transistor at approximately .45 E_{CC} and E_{RL} at 14 volts.

The voltage drop across the transistor is 31.9 volts minus 14 volts or 17.9 volts. This gives us the necessary relationships. Because I_C is approximately the same value as I_E: $I_C=3$ ma., $R_L=E_{RL}/I_C$, or R_L = 14 volts/ 3 ma. or 4667 ohms. The nearest EIA value would be 4700 ohms.

There can be an increase of I_C due to changes in I_{CBO}, h_{FE}, or R_{EB} (emitter-to-base resistance) of approximately (17.9 v.—14 v.)/R_L without having an adverse effect on the circuit. With R_L equal to 4700 ohms, the allowable increase in I_C is 3.9 v./4700 ohms or .83 ma. With the low values of I_{CBO} for a 2N333, this should be sufficient protection against any possible changes in bias operating point.

Next the value of the base voltage is determined. The base must be slightly more positive than the emitter in an *n-p-n* transistor. How much more positive can be determined by the graph of V_{BE} *versus* I_C in Fig. 4. At a temperature of 25 degrees C and a collector current of 3 ma., V_{BE} is seen to be approximately .68 volt, therefore the base d.c. voltage with respect to ground is 8.1 volts plus .68 volt or 8.78 volts.

Stability Factor

Because the values of R_1 and R_2 will largely determine the current stability factor, they must be considered at this point. One stability equation is: $S_I=1/(R_E/R_1+R_E/R_2+1+h_{FB})$, where S_I is the current stability factor and h_{FB} is the d.c. forward current transfer ratio for a common-base amplifier.

As R_1 is usually much smaller than R_2, the ratio R_E/R_1 is the factor that largely determines the current stability of the circuit. If an S_I of 5 is wanted, it can be closely approached by making R_1 about six times larger than R_E. Thus $6R_E$ = 16,200 ohms. Selecting the closest 10% standard value, let R_1=15,000 ohms. R_2 can now be calculated. With 8.78 volts across R_1, the current through R_1 is: I_{R1}=8.78 volts/15,000 ohms or approximately .585 ma.

Again using Fig. 3, at 25 degrees C, with a collector current of 3 ma., h_{FE} is equal to 28. By knowing the value of h_{FE} and the collector current (collector current is approximately equal to the emitter current), we can calculate I_B. h_{FE} is equal to the d.c. collector current divided by the d.c. base current or $I_B=I_C/h_{FE}$ or 3 ma./28, which is about .107 ma.

Because I_{R2} is equal to $I_{R1}+I_B$, I_{R2} = .585 ma. + .107 ma. = .692 ma. The voltage across R_2 is: $E_{R2}=E_{CC}-E_{R1}$ or 31.22 volts. Next R_2 is calculated. Since $R_2=E_{R2}/I_{R2}$, it is equal to 31.22 volts/.692 ma. or approximately 45,000 ohms. Picking the nearest standard EIA value, R_2 would be 47,000 ohms.

To check on these values the current stability factor can be calculated thus: $S_I=1/(R_E/R_1+R_E/R_2+1+h_{FB})$ and $h_{FB} = -h_{FE}/(1+h_{FE})$ or $-28/29$ or -0.964. S_I = 1/(2700/15,000 + 2700/45,000 + 0.036) or 3.7.

This is a better (a lower value) than the current stability goal of 5. Therefore R_1 and R_2 can be made larger if a larger stability factor can be tolerated. Remember, for every value of R_E there are an infinite number of values for R_1 and R_2. As the values of R_1 and R_2 are made smaller, the S_I improves but the current drain from E_{CC} increases, as well as the shunting effect on the a.c. signal input. Therefore, the values of R_1 and R_2 are again compromises. For this design, let R_1 and R_2 have the calculated values.

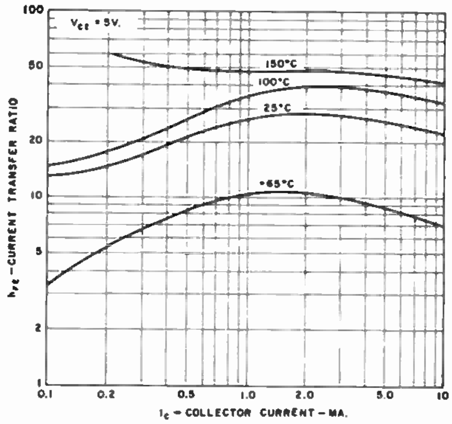


Fig. 3. Characteristics of transistor used.

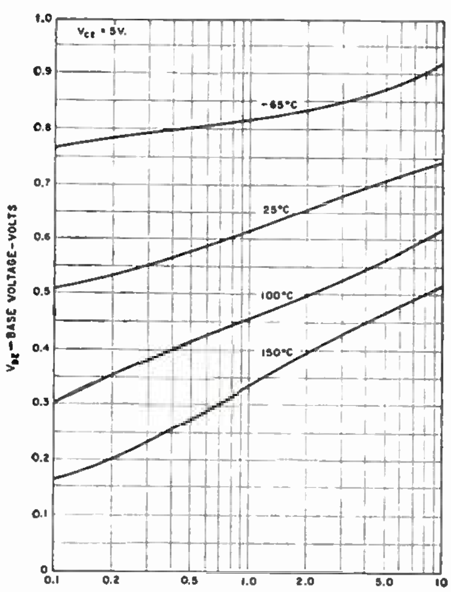
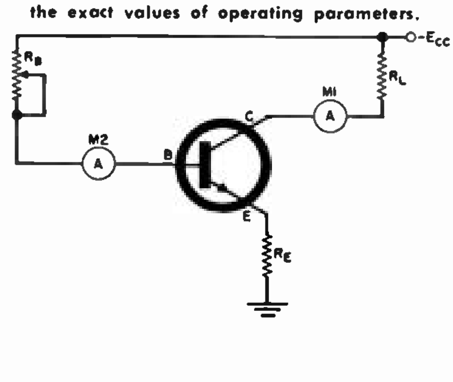


Fig. 4. Current-voltage characteristics.

Fig. 5. Circuit used in order to obtain the exact values of operating parameters.



Other Parameters

This completes the design of the amplifier as far as the bias circuitry is concerned. It should be remembered that several parameters such as I_E and R_E were chosen instead of calculated. This is necessary no matter what design procedure is followed. There is no *one* value for these components. For any reasonable value of R_E, there are many possible values of R_1 and R_2.

As in all transistor design procedures, the non-conformity of transistors is the greatest stumbling block. Because of the technical problems associated with production of all semiconductor devices, parameters cannot be held constant. For instance, the value of h_{fe} (a.c. forward-current transfer ratio) in a 2N333 will vary from 18 to 40 as shown on one data sheet. h_{FE} has a similar range.

In our particular problem, we assumed a value of h_{FE} equal to 28. However, if h_{FE} is not this average value, we will have to make some changes because of a different base current, I_B, for the same I_C. If after constructing this circuit, I_C is found to be different from the design value, R_2 may be changed to give the correct forward bias. If more I_C is wanted, R_2 should be made smaller. For smaller I_C, make R_2 larger. Do not change the value of R_1 because this will more directly affect S_I and may require a major re-design of the circuit.

If it is deemed necessary to know the exact value of h_{FE} of a particular transistor at a particular collector current and operating temperature, the circuit of Fig. 5 may be used.

After R_E and R_L have been calculated, a large variable resistor R_B can be connected as shown and set to give the correct collector current. Caution must be observed not to start with a minimum value of R_B as sufficient current may result in permanent damage to the transistor. The amount of base current can now be read on the meter, M_2. This value of I_B can then be used to calculate R_1 and R_2. If necessary, h_{FE} can be determined from the ratio I_C/I_B.

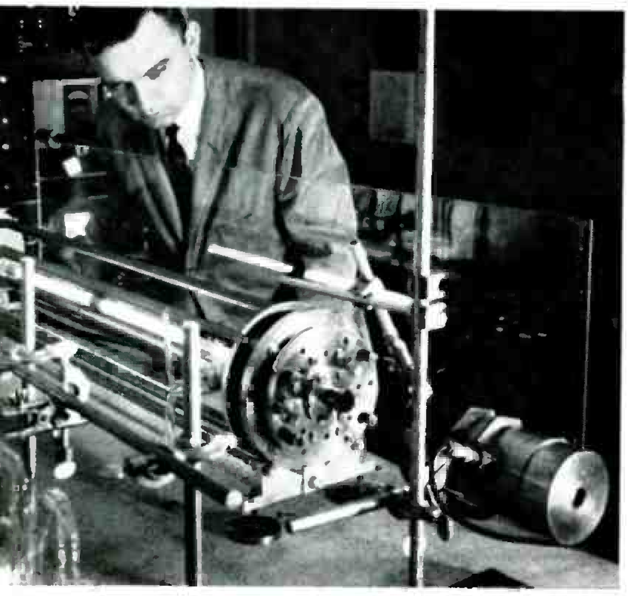
Germanium transistors have a much larger I_{CBO} than silicon units so that greater precautions must be taken to stabilize germanium transistors than for those made of silicon. Generally speaking, the stability factor for germanium transistors must be smaller and the operating temperature must be limited to a lower value. Also, the value of I_{CBO}, which flows between the base and collector, may become so large that it cannot be ignored when calculating the resistor values used in the amplifier bias circuitry. ▲

Clip-on Ear Transducer ▶

An earful of essential medical information is provided by the "clothespin" type transducer clipped to the ear of this hospital patient. The device is used with a new Minneapolis-Honeywell *medical electronics system that automatically monitors the condition of a dozen or more critically ill and post-operative patients. It measures diastolic and systolic blood pressures and pulse rate by shining a light through the patient's ear onto a photocell. Also monitored and recorded via two additional transducers attached to the assembly shown are body temperature and respiration. An alarm is sounded automatically if high or low limits for any of the five variables is exceeded.*

Gaseous Optical Maser

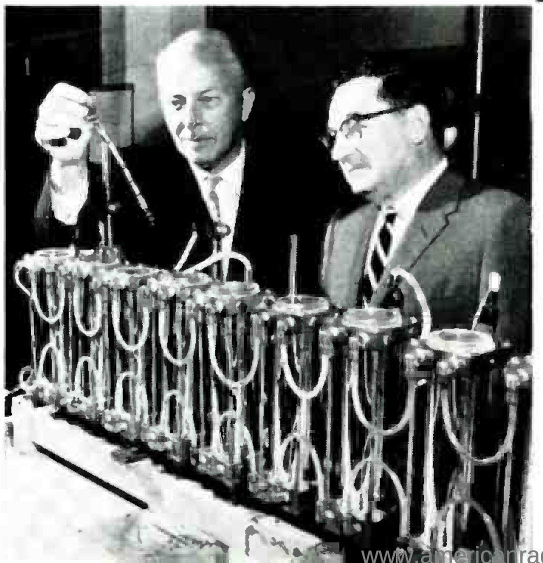
This version of a gaseous optical maser, or laser, emits a continuous needle-sharp beam of coherent infrared energy through the circular window at the near end. Simplified, straightforward design of this assembly, developed by Raytheon Co., *marks a significant step toward practical c.w. lasers needed for space communications and advanced military systems. The device is similar in principle to the gas maser developed by* Bell Telephone Laboratories. ▼



RECENT DEVELOPMENTS IN ELECTRONICS

▲ Ultra-fast Computer-Centers Link

This IBM *computer center in New York City is linked to another in Poughkeepsie, N.Y., (68 miles away) by a communications system that transmits information at a rate of 15,000 characters per second, more than 1000 times faster than human speech. The link uses a special magnetic tape transmission unit (left), telephone cable, and a microwave radio network.*

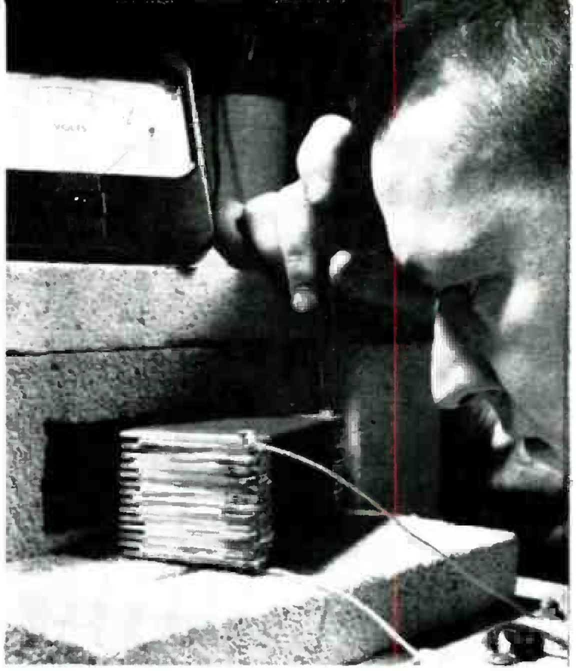


◀ Millionth Nuvistor Tube

A rack containing six thimble-size RCA *nuvistor electron tubes, including the company's millionth unit, is being lowered into an exhaust and sealing machine. Over 60 electronic firms have "nuvistorized" military and industrial products now in development or production.*

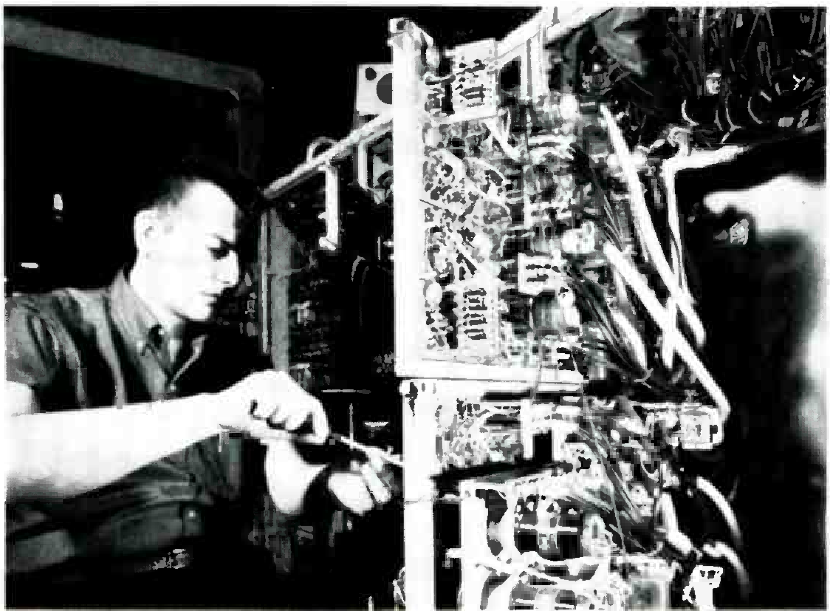
White-hot Thermoelectric Generator ▶

The Minneapolis-Honeywell technician at right is heating up to 2400 degrees F a new all-ceramic thermoelectric generator capable of converting white-hot temperatures into usable electricity. The generator—believed to be the first ever made of heat-resistant ceramics—is being tested by the Army for space-age uses. It is said to open the way to obtaining electricity from such "waste heat" as a rocket's exhaust, which would destroy presently available thermoelectric generators. Here, as shown on the voltmeter, the device converts the 2400-degree heat of an electric furnace into almost 100 volts of electricity.



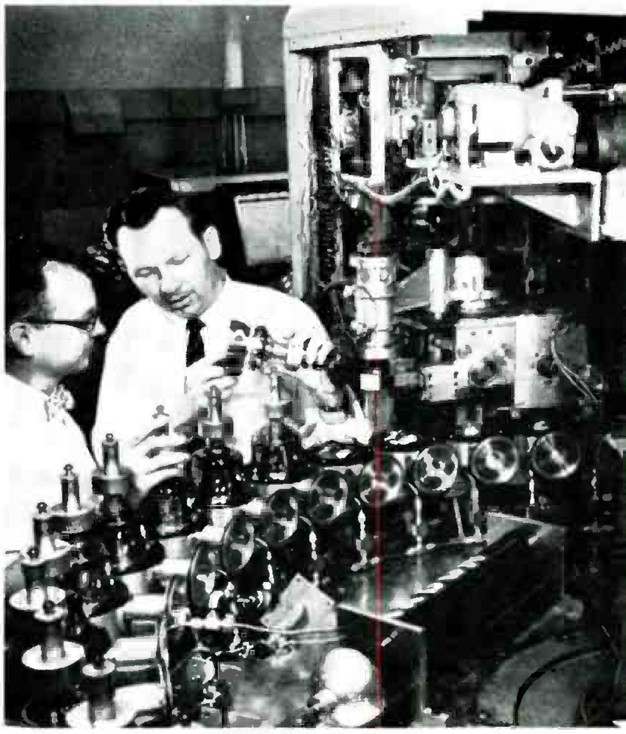
Electronic Flight Simulator

The electronic "heart" of the flight and tactics simulator of the F-105D fighter-bomber is adjusted for precise operation by a technician at ACF Electronics. More than 150 miles of wiring and nearly 400,000 parts make up the training device that exactly reproduces the responses of the aircraft and is described by the company as the most advanced electronic flight simulator ever ordered by the Air Force. ▼



Computer-Controlled Resistor Production Line

Engineering associates at Western Electric Co.'s North Carolina plant are inspecting the computer-controlled terminating machine in the automated production line for manufacturing deposited-carbon resistors. The gold cathode in the bottom of the bell jar being inspected is used to sputter a layer of gold on the ends of the carbon-coated resistor core. The gold termination forms a contact on each end of the resistor, to which the succeeding machine in the line attaches caps and wire leads. ▼



Battery-Powered Electromagnet

A battery-operated electromagnet, developed in Union Carbide laboratories, is used in a demonstration of the company's standard flashlight batteries. Two D-size cells power the candy-striped 7" diameter magnet which is supporting the automobile. When the technician removes the batteries, the car drops to the ground. The same two batteries are then used to operate a flashlight. The electromagnet, which can hold the car for about 25 minutes, draws 1.2 amps from the batteries. ▼

THE "TRANS-SELECT" AUDIO GENERATOR

Fig. 1. Frequency switches (S_2-S_5) may be used in combination.

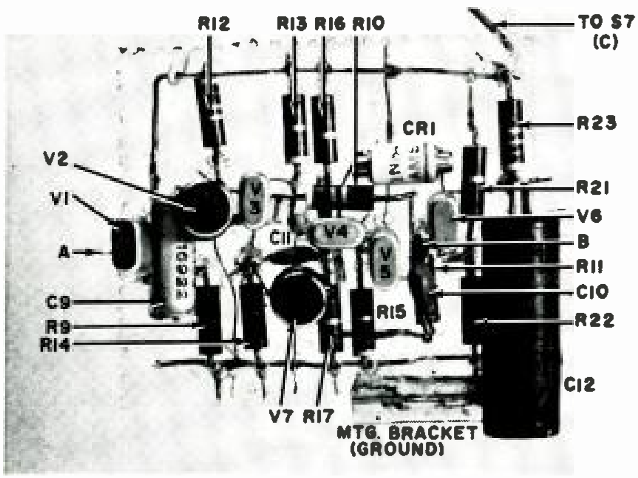


Fig. 2. Most of the components mount on this polystyrene board.

By **STANLEY E. BAMMEL**

It's small, light, battery-powered, and can be built at reasonable cost; yet it yields clean output and good level from 10 to over 100,000 cps.

BULKY, tube-equipped instruments, drawing considerable current and dependent on power lines, are often inconvenient to use. Transistors, with their promise of miniaturization, low power requirement, and the flexibility of battery operation, often tempt the designer or constructor.

However, transistors may pose problems of their own. In the case of this audio generator, for example, the problem of providing a constant output without introducing distortion and temperature instability had to be faced and resolved. Also, the use of transistors often increases equipment cost. That is hardly the case here. With reasonably careful shopping, total cost for this audio generator, using new parts, should not exceed $20. This is not high for the features provided.

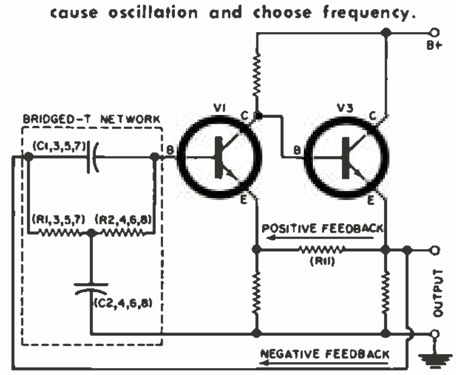
The instrument produces clean sine waves over a wide range. It gets its name in part from the fact that transistors are used instead of tubes, and in part from the means by which output frequency is determined. Instead of continuously variable tuning, a binary method of switching selects discrete frequencies. Four switches are used to select four basic frequencies as follows: 10, 20, 40, and 80 cps. However, the switches add up. For example, throwing the 10-cps and 20-cps switches simultaneously will give an output of 30 cps. Thus all frequencies from 10 to 150 cps are available in steps of 10 cycles with the use of the switches singly or in various combinations of two or more.

In addition, a 4-position range switch multiplies this basic range by 1, 10, 100, or 1000. Theoretically this provides output from 10 cps to 150 kc. Due to high-frequency circuit losses, however, the top end reaches only to about 110 kc., still providing a wide range. Output amplitude is up to half a volt (r.m.s.).

The Circuit

The bridged-T oscillator used, a basic version of which is shown in Fig. 3, is essentially an amplifier with both positive and negative feedback. The regenerative loop tends to produce and sustain oscillation at any frequency. The degenerative loop has the opposite effect, but is frequency-selective because it includes the bridged-T network. The latter acts as a filter for the chosen frequency of oscillation, at which negative feedback is suppressed. Thus the positive feedback is bucked at all frequencies but the one desired.

Fig. 3. Basic circuit: feedback paths cause oscillation and choose frequency.



The complete circuit is shown in Fig. 4. Positive feedback is obtained through R_{11} and C_{10} in parallel. The latter compensates for high-frequency circuit losses, as does C_{11}. The bridged-T network components include R_1 through R_8 and C_1 through C_8. The particular resistors used depend on the basic frequency chosen, while the capacitors depend on the selected multiplier range.

V_1, in the grounded-collector or emitter-follower configuration, provides the high input impedance necessary to avoid loading down the network. This high impedance also tends to minimize variation in circuit gain at different frequencies, helping to simplify the problem of providing constant amplitude. This stage is biased at its base, through the network, from the emitter of V_2. V_2, another emitter-follower, is biased through R_{10}. The latter provides a considerable amount of negative d.c. feedback to stabilize the d.c. circuit.

Collector output from V_3, a conventional grounded-emitter amplifier, is fed to the emitter of V_1, a grounded-base stage. The latter, which may at first seem superfluous, serves more than one purpose. It permits direct coupling to V_2. It can have a higher emitter-collector voltage than could V_3 alone; thus a greater undistorted output voltage is obtainable. But its most important function is that it facilitates amplitude control. As will be explained later, a point in the circuit is needed for control where signal level is low. This point is the junction between the collector of V_3 and the emitter of V_1.

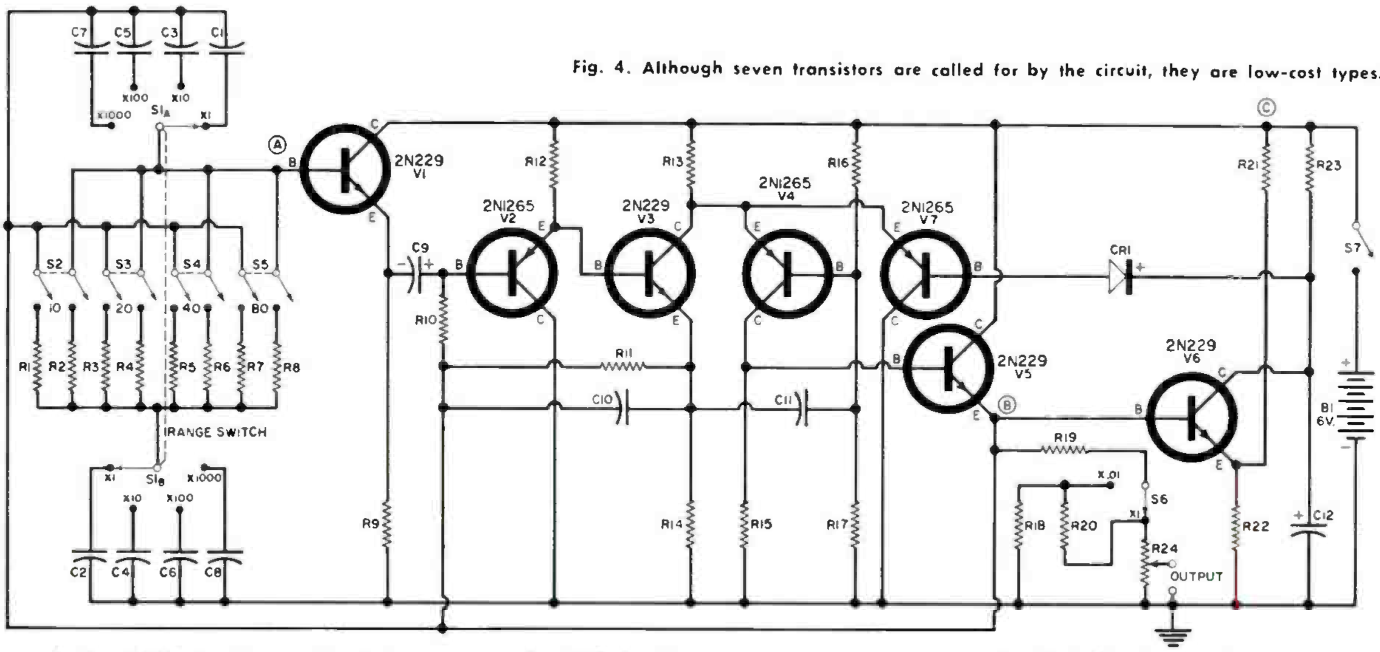


Fig. 4. Although seven transistors are called for by the circuit, they are low-cost types.

R_1, R_2—110,000 ohm, ½ w. res. (see text)
R_3, R_4—55,000 ohm, ½ w. res. (see text)
R_5, R_6—27,500 ohm, ½ w. res. (see text)
R_7, R_8—13,750 ohm, ½ w. res. (see text)
R_9—15,000 ohm, ½ w. res.
R_{10}, R_{12}, R_{20}, R_{23}—47,000 ohm, ½ w. res.
R_{11}, R_{14}—2200 ohm, ½ w. res.
R_{13}, R_{18}, R_{19}—470 ohm, ½ w. res.
R_{15}, R_{17}—4700 ohm, ½ w. res.
R_{16}—1000 ohm, ½ w. res.
R_{21}—1500 ohm, ½ w. res.
R_{22}—1800 ohm, ½ w. res.
R_{24}—500 ohm linear taper pot
C_1, C_2—.05 µf. tubular capacitor (see text)
C—.5 µf. tubular capacitor (see text)
C_3, C_4—.005 µf. tubular capacitor (see text)
C_5, C_6—500 µµf. mica capacitor (see text)
C_7—50 µµf. mica capacitor (see text)
C_9—10 µf., 3 v. elec. capacitor
C_{10}—220 µµf. disc or mica capacitor (see text)
C_{11}—68 µµf. disc or mica capacitor (see text)
C_{12}—25 µf., 6 v. elec. capacitor
CR_1—1N60, 1N295 or other diode
S_1—D.p. 4-pos. rotary switch
S_2, S_3, S_4, S_5—D.p.s.t. slide switch
S_6—S.p.d.t. slide switch
S_7—S.p.s.t. slide switch
B_1—Four 1.5-volt penlite cells in series
V_1, V_3, V_5, V_6—"n-p-n" transistor (2N229 or other general-purpose type)
V_2, V_4, V_7—"p-n-p" transistor (2N1265 or other general-purpose type)

Output stage V_5, an emitter-follower, provides isolation and a low output impedance so that neither the external load nor the feedback circuits will load down the gain. With switch S_6 in the X1 position, as shown, potentiometer R_{24} may be roughly calibrated from 0 to .5 volt. Throwing S_6 to the X.01 position attenuates output about 40 db, so that R_{24} may be set from 0 to 5 mv.

Transistors V_6 and V_7, in conjunction with diode CR_1, provide automatic amplitude control as follows: V_6 is normally biased to cut-off. When signal amplitude from V_5 exceeds a certain level, V_6 begins to conduct on negative peaks, with the current it passes being in proportion to the excess amplitude. This current is filtered by C_{12}, goes through CR_1, and biases V_7. The emitter of V_7 is connected back to the previously mentioned junction of V_3 and V_4, at which point V_7 grounds out some of the signal. How much of the signal is dropped through V_7 depends on the bias current to the latter from V_6 and CR_1. Thus circuit gain is automatically reduced to keep amplitude at the proper level.

Ordinarily the nonlinearity of the diode and V_7 in the control loop would introduce distortion. However, since the amplitude of signal at the point in question, the collector of V_3, is quite low, the effect is negligible. With this arrangement, amplitude control is excellent. If the generator is properly calibrated, output will not vary more than ±.5 db.

Construction

The author's version was built into an *LMB* chassis box 3" x 4" x 6". Outside and inside of the completed instrument can be seen in Figs. 1 and 5. Wherever possible, the terminals on the controls were used to mount parts. Other parts, except for batteries, were mounted on a polystyrene board about 2" x 2½", which may be seen edge-on to the right in Fig. 5. Board layout is shown in Fig. 2. In general, physical construction should present few problems. Probably the best procedure is to build the unit with everything in its place except for the frequency-determining components (R_1 through R_8 and C_1 through C_8), the latter to be installed permanently after values are found.

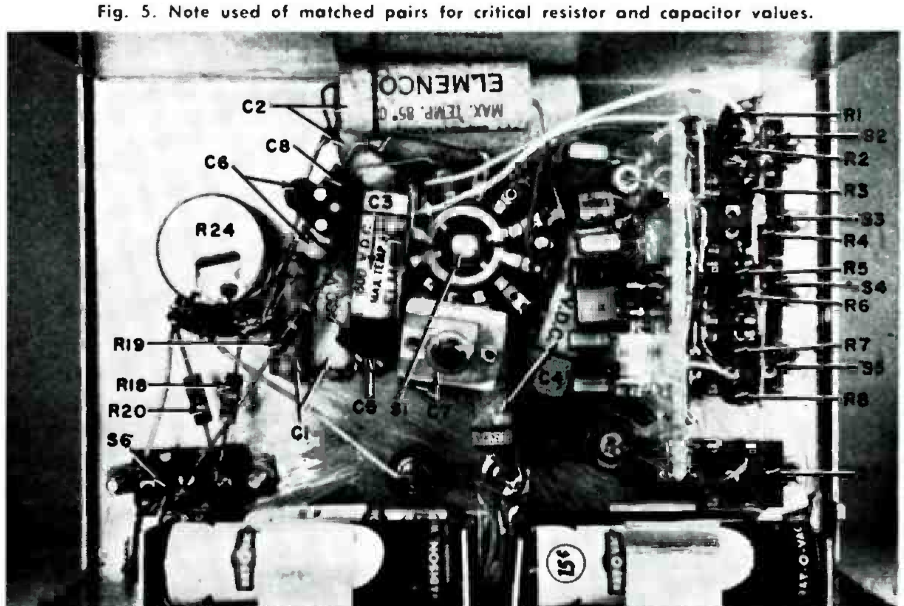
Calibration & Adjustment

To achieve good accuracy and to maintain constant amplitude at different frequencies, care must be exercised in choosing certain component values. A review of how such values relate to performance is in order before procedure is described. Two characteristics are involved.

For the amplitude to remain constant at different frequencies, the pairs of re-

(*Continued on page 72*)

Fig. 5. Note used of matched pairs for critical resistor and capacitor values.



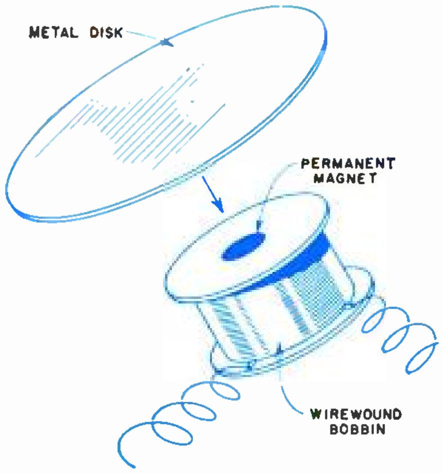


Fig. 1. The magnetic headphone.

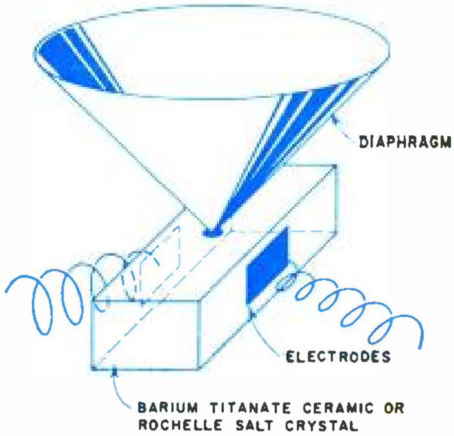


Fig. 2. Crystal or ceramic headphone.

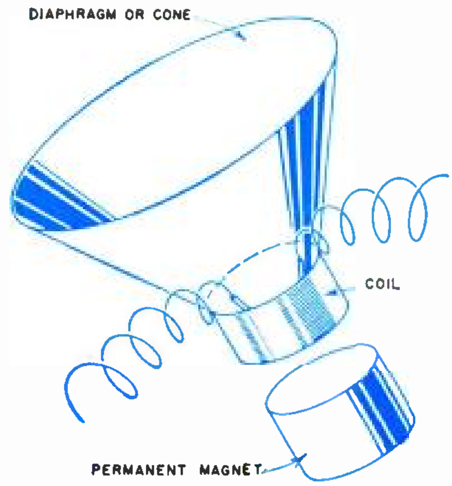


Fig. 3. The dynamic headphone.

Listening to Stereo

By STEVEN HAHN / *Round Hill Associates*

This method has advantages of freedom from room acoustics problems.

ONE OF the most enjoyable ways to listen to stereo programs is through stereo headphones instead of a dual-speaker system. While it is true that such listening has not enjoyed great popularity in the past, mainly because of the limited response of early units, major advances in recent years have widened the frequency response to the 30-cycle region at the bottom and to well beyond 16,000 cps at the top and headphones are at last coming into their own.

Headphone listening has a number of advantages over speaker listening. The first advantage is economic—a good pair of stereo headphones costs considerably less than a pair of good speakers. For example, the least expensive stereo headphone sells for about two dollars while the most expensive pair goes for around 80 dollars. The second advantage is that since headphones are such sensitive devices, they require only a few milliwatts of audio power to drive them. Consequently, audio amplifiers are not driven into overload regions and, as a result, even low-power and economy amplifiers give excellent results when used with headphones.

In addition, the use of headphones completely eliminates the vexing problems of room acoustics which are encountered when speakers are used. Thus, such matters as room resonances, unwanted reverberation, excessive mixing of the stereo signal, and doubling do not enter the picture in headphone listening.

Of course, headphone listening isn't entirely without drawbacks. Headphones will allow you to listen to program sources at the highest volume level you desire, but even the best designed headphones cause some physical discomfort after a while. In addition, a first-rate speaker system is capable of a somewhat wider reproduction range than the best headphones available today. Then, too, headphone listening tends to be "anti-social" since it is hard to share your enjoyment with a group. Headphones limit your "mobility" while listening to the length of the connecting cable.

Types of Stereo Headphones

Virtually all modern headphones fall into one of three generic groups: magnetic, crystal, or dynamic. In all the units we checked, only one was found to fall outside these categories—it being a variable-reluctance device.

Magnetic Headphones: The magnetic headphone consists of a permanent magnet and a bobbin or spool wound with fine wire. See Fig. 1. Some magnetic headphones contain two of these bobbins in each earphone cup, while the less expensive ones usually contain a single bobbin. The permanent magnet is inserted through the center of the bobbin and the entire fixture is mounted in a plastic case. A thin metal disk or diaphragm, about 2" or 3" in diameter, is placed on top of the magnet-bobbin combination so that it just barely touches the magnet and the outside rim of the plastic housing.

When an audio signal is impressed across the bobbin coil, it reinforces or opposes the magnetic field produced by the permanent magnet. Thus, the strength of the magnetic field will vary in direct proportion to the audio signal impressed across the bobbin coil. This causes the metal diaphragm to move back and forth, thereby setting up sound waves.

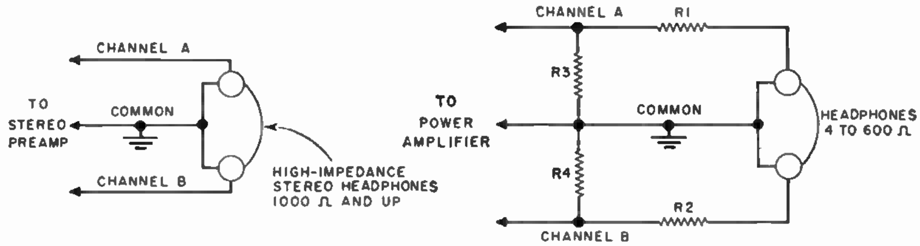
An unusual twist to this principle is employed in a stethoscope-type magnetic headset. In this unit, the magnetic driving system rests approximately on your collarbone and the sound is actually piped through ⅛" plastic tubing into your ears—just like a stethoscope. However, the manufacturer has arranged the plastic piping in such a manner that one leg is somewhat shorter than the other. This means that the sound from one channel will reach your ear before the sound from the other channel. As a result, a very slight amount of acoustic delay (on the order of a few microseconds) is obtained. This delay gives a very slight reverberation effect which, according to the manufacturer, increases intelligibility.

Magnetic headphones are extremely rugged and will withstand a great deal of abuse. They are not expensive—varying in price from $2.00 to about $16.00. Their over-all frequency response is about 100 to 8000 cps and they are offered in virtually any impedance up to about 6000 ohms.

Crystal and Ceramic Headphones: The crystal headphone is a device which operates on the piezo-electric principle. See Fig. 2. Actually, such a unit is similar to a crystal phonograph pickup only working in reverse, *i.e.*, converting electrical energy into mechanical energy-sound.

The headphone contains a material which physically vibrates when an electrical voltage is impressed across it. This material is usually a slug of Rochelle salt. Barium titanate ceramic material also exhibits piezo-electric properties and may be used.

In a crystal or ceramic headphone, two electrodes are attached to the piezo-electric material and this material is then mounted in the headphone case. A thin plastic circular or cone diaphragm is then glued to the piezo-electric material and



CONNECTING STEREO HEADPHONES TO A PREAMPLIFIER

(A)

R1, R2 – 2000 Ω, 1 WATT MINIMUM
R3, R4 – RESISTANCE MATCHES SPEAKER IMPEDANCE, WATTAGE EQUALS MAXIMUM AMPLIFIER WATTAGE

(B)

Fig. 4. Methods used to connect stereo headphones to (A) preamp and (B) power amplifier.

supported at the rim by the headphone case. When an audio signal is impressed across the crystal, it physically vibrates in accordance with the signal and sound is heard from the diaphragm.

Crystal or ceramic headphones are capable of extremely wide reproduction, especially at the high-frequency end. However, they are sensitive to vibration and can be permanently damaged if direct current flows through the piezo-electric substance. As a result, these headphones must never be hooked across a d.c. voltage source. This can be easily avoided by using a .1 to .01 μf. blocking capacitor. Even when headphones are used on audio signals, care should be taken not to impress a high voltage across them, since too much a.c. can permanently damage the sensitive piezo-electric material.

Crystal and ceramic headphones are the most sensitive of the three generic types. They cost from a few dollars to as much as $30 and they are invariably high-impedance devices—10,000 ohms to 100,000 ohms.

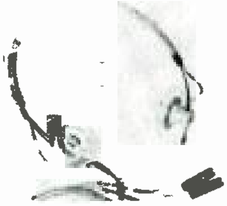
Dynamic Headphone: The dynamic headphone is as rugged as the magnetic type and a well-designed unit is capable of about as wide a frequency response as the crystal type. See Fig. 3. As a matter of fact, a good dynamic headphone excels the crystal in the matter of low-frequency response. In addition, it is difficult to damage a dynamic headphone by impressing large audio signals across it. However, in all fairness, it must also be stated that the dynamic headphone is usually the highest priced of the three.

A dynamic headphone is really a miniature speaker system; in other words, a coil of wire is attached to a diaphragm—not unlike the cone of a speaker. This coil-diaphragm combination is placed in the air gap of a metal structure using a fixed permanent magnet. As the audio signal is impressed across the coil, the entire diaphragm system moves back and forth in the magnetic field, thereby generating sound. In some ways the dynamic headphone is similar in operation to the magnetic headphone. However, in the magnetic unit, the coil is wound around

⇨ with Headphones

lower cost, reduced power needs,

Complete headphone directory included.


AKG K-50


Lafayette F618


Beyer DT48


Permoflux BDHS28


S. G. Brown "Super-K"


Plastic Mold LT-100


Clevite-Brush BA-200


Radio Shack A91L150


General Phones CLC-B


Rye Sound S-1S


Knight KN840


Sargent-Rayment "Binaphone"

the magnet and remains fixed, while the dynamic headphone coil is attached to the diaphragm and moves back and forth with it.

Dynamic headphones are considerably more sensitive than magnetic units although not as sensitive as crystal headphones. Some inexpensive dynamic types can be purchased for a few dollars. However, the better units cost anywhere from $25 to $80. Most dynamic phones have impedances that are in the 4 to 16 ohm range.

One manufacturer has actually combined a set of dynamic phones with ceramic units, coaxially mounted in the same set of earpieces. The ceramic units reproduce the higher frequencies *via* a crossover network, while the dynamic reproducers handle the lower frequencies.

Variable-Reluctance Headphone: In the variable-reluctance headphone a pair of fixed, rectangular permanent magnets is used in conjunction with a small flat coil to provide the driving force. A thin metal disk or diaphragm, separated from the magnetic structure, completes the magnetic path through an air gap. The permanent magnets are mounted parallel to the disk, and on the face of the coil away from the disk.

Audio current through the coil varies the magnetic flux in the gap and causes the disk to vibrate and produce sound. The operating principle is much the same as that of the magnetic headphone (shown in Fig. 1), although the physical construction is somewhat different. The variable-reluctance headphone gets its name from the changes in reluctance of the magnetic path as the metal disk vibrates. Only one manufacturer currently produces a headset of this type.

Connecting Stereo Headphones

Stereophonic headphones come in a

(*Continued on page* 108)

Table of presently available stereophonic headphones.

MANUFACTURER	MODEL	PRICE	TYPE	IMPEDANCE
AKG	K-50	$24.50	Dynamic	400 ohms
BEYER	DT48	$79.50	Dynamic	5 ohms
BROWN, S.G.	Super-K	$32.50	Dynomic	52 ohms
CLEVITE-BRUSH	BA-200	$16.35	Crystal	45,000 ohms
	BA-205	$22.50	Crystal	100,000 ohms
	BA-206	$26.15	Crystal	50,000 ohms
	BA-220	$29.95	Crystal	50,000 ohms
GENERAL PHONES	CLC-B-16	$29.40	Var.-Reluct.	3.2-16 ohms
KNIGHT	KN840	$22.95	Dynamic	16-600 ohms
KOSS	SP-3	$24.95	Dynamic	4 ohms
LAFAYETTE	F616	$15.95	Dynamic	4-8 ohms
	F618	$15.95	Dynamic	8 ohms
	MS431	$ 2.35	Magnetic	6 ohms
	MS432	$ 2.45	Magnetic	5000 ohms
	MS433	$ 1.95	Crystol	45,000 ohms
PERMOFLUX	BDHS28	$45.00	Dynamic	12 ohms
	BDHS17	$50.00	Dynamic	300 ohms
	HDB16/16	$40.00	Dynamic	16 ohms
PLASTIC MOLD	LT-100	$30.00*	Dynamic	10 or 300 ohms
RADIO SHACK	A91L155	$ 1.98	Crystal	70,000 ohms
	A91L150	$ 2.49	Dynamic	10 ohms
RYE SOUND	S-1S	$15-$17*	Dynamic	15,120, 500, 2000, 4000 ohms
	UCL-1S	$12-$14*	Dynamic	3.2-8000 ohms
SARGENT-RAYMENT	Binaphone	$24.50	Dynamic	16 ohms
SHARPE, E. J.	HA-10	$43.50	Dynamic	10 ohms
SUPEREX	ST-M	$29.95	Cer./Dynamic	8-16 ohms
	ST-S	$19.95	Dynamic	8 ohms
	ST-48,600, 2000	$ 2.35	Magnetic	4-8, 600, 2000 ohms
	ST-4000	$ 2.65	Magnetic	4000 ohms
TELEX	HAV-13	$13.50	Magnetic	128 or 2000 ohms
	HDP	$24.38	Dynamic	6 ohms
TRIMM	50-14	$15.60	Magnetic	4, 300, 1000, 6000 ohms

*Approximate price.


Koss SP-3


Sharpe HA-10

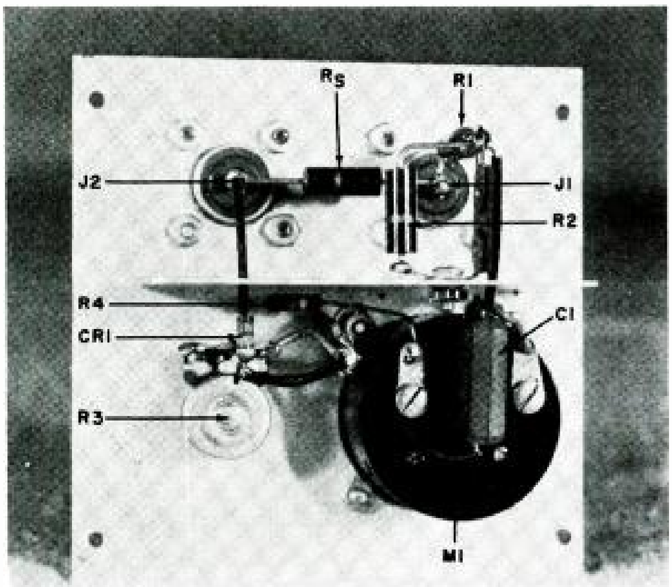

Superex ST-M


Telex HDP


Trimm 50-14

Standing-Wave Indicator for CB Testing

The completed standing-wave indicator constructed by the author. Standard coaxial connectors are used for output and input. A handle was added to the 4" x 4" x 2" metal cabinet for carrying.



◀ Interior view. All parts are attached to front panel. A metal shield divides the bridge circuit from the null-detection circuit. Bridge resistors are placed at right angles to each other as shown.

By **HAROLD REED**

Construction of compact antenna-matching bridge for most efficient power transfer.

WITH input to a Citizens Band transmitter limited to a relatively low power of 5 watts, it is desirable, for greater signal coverage, to deliver as much r.f. power to the antenna as possible to obtain maximum radiation intensity. This requires good impedance matching in the antenna system. Among other things, antenna impedance will vary with height above ground and its immediate surroundings. When the antenna presents an impedance to the transmission line which is equal to the characteristic impedance of the line, the antenna will absorb all the r.f. power. When the antenna does not match the line, some of the power is reflected back toward the input end of the line. This reflected energy, which sets up standing waves, is wasted power and increases with increasing antenna-line mismatch.

A simple way to check standing-wave-ratio is to use a resistance bridge. The miniature indicator here described employs this method and includes a self-contained null rectifier and meter.

Circuit Details

The basic bridge circuit is shown in Fig. 1. The four resistive arms of the bridge are composed of R_A, R_B, R_S, and R_X. The resistance values of R_A and R_B are not critical but they should be as nearly identical as possible. R_X is the unknown impedance and is compared against resistor R_S which can be termed the standard arm of the bridge. When R_A/R_B is equal to R_S/R_X there is no potential difference at the points where the meter is connected, the bridge is balanced, and the meter reads zero. If R_X does not match R_S, the bridge is unbalanced, a potential difference exists at the meter terminals, and the meter deflects.

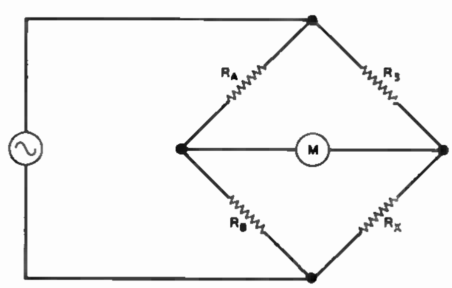


Fig. 1 Basic resistance bridge circuit.

In the practical application of the bridge in the standing-wave indicator, arm R_X is replaced by the transmitter end of the antenna transmission line and R_S is made equal to the rated characteristic impedance of the line. It is convenient to make R_A and R_B the same value as R_S. See Fig. 2. The meter of Fig. 1 is replaced by a crystal diode rectifier—microammeter circuit for null detection. Resistor R_4 provides a high meter-circuit impedance to prevent bridge loading, while R_3 is used for full-scale meter adjustment.

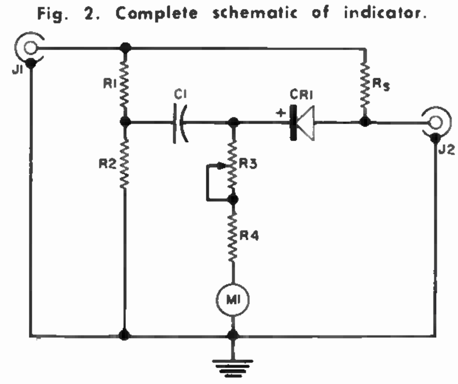
Assembly Details

The standing-wave indicator is assembled in a 4" x 4" x 2" cabinet. All component parts are attached to the front panel. The bridge circuitry is placed on the upper half of the panel and the rectifier-meter circuit is located on the lower half. A metal shield plate, attached to the panel and secured under the lower coax-connector screws, is inserted between these two sections of the complete circuit. The shield is included to minimize stray coupling between the bridge components and the rectifier-meter circuit. Also, to avoid stray coupling, the bridge arms are separated and placed at right angles to each other. Short, direct lead dress is employed in connecting the component parts.

The indicator is designed to be used

(Continued on page 80)

Fig. 2. Complete schematic of indicator.



R_1, R_2, R_S—51 ohm, 1 w. carbon res. ± 5% (Allen-Bradley, see text)
R_3—50,000 ohm miniature pot
R_4—5600 ohm, ½ w. res.
C_1—.003 μf. mica capacitor
CR_1—Crystal diode (Raytheon 1N66 or equiv.)
M_1—0-50 d.c. microammeter
J_1, J_2—Coax connector (Amphenol 83-1R Type SO-239)
1—4" x 4" x 2" metal cabinet

PHASING THE STEREO SYSTEM

By RALPH GLASGAL

Methods used to detect and to correct for improperly phased recordings and high-fidelity stereo components.

THAT proper phasing of stereo components seems to "faze" professional and amateur audiophiles alike is demonstrated by the continuing availability of out-of-phase records and by persistent reports of out-of-phase hi-fi show demonstrations. Perhaps this is so because phase distortion is the most difficult aural distortion to detect by casual, or hectic, listening methods. The human ear is less sensitive to phase distortion than to frequency or harmonic distortion, especially where only one sound source is involved. Nevertheless, in this era of stereophonic reproduction and low-distortion components, phase distortion must be eliminated from multi-channel systems if the best possible sound reproduction is to be obtained.

This article will survey some of the methods used to detect and compensate for incorrectly phased recordings and components.

What Is Phase?

First, let us define what is meant by "phase" in a multi-channel system. All audio waveforms, no matter how complex, can be reduced to a series of sine waves differing in amplitude, frequency, and phase. Phase in this context refers to the position of each sine-wave component in time relative to all the other sine-wave components. It has been demonstrated by experimenters at *Bell Telephone Laboratories* that the ear is insensitive to the phase of these sine waves. This conclusion applies only to a single waveform issuing from a single sound source. We might call this "internal" or "self" phase. Thus it is necessary to consider only external phase problems and characteristics.

External phase is the time relationship between two waveforms of the same waveshape emanating from two or more separate sound sources. The ear is exceptionally sensitive to external phase shifts. Indeed, the existence of stereo perception is, to a large extent, dependent on the ear's ability to detect even small external phase differences.

Stereo perception depends on a combination of amplitude and time differences between two or more channels. It is the recording engineer's job to capture these amplitude and time differences in a practical and effective manner. It is the function of the reproducing system to transmit these amplitude and time differences with as much fidelity as possible so as to re-create accurately the stereo image captured by the recording engineer.

The simplest form of phase distortion is a complete change in the polarity of one channel with respect to the other. The aural results of such distortion are reduction of bass response, lack of center-channel presence, and a generally confused sound pattern. The loss of bass response occurs because of acoustic cancellation of completely out-of-phase signals in the listening room. The amplitude of the lower bass frequencies is affected more than that of the higher frequencies because the microphone spacing used to make most stereo recordings is small compared to the wavelengths of the lowest bass frequencies, so that the low bass always arrives at both microphones essentially in-phase. Thus, if the two signals are combined out-of-phase, electronically or acoustically, bass cancellation will occur.

As will be described, it can easily be demonstrated that identical in-phase signals applied to two loudspeakers produce a virtual image midway between them for a listener who is sitting between the two speakers. The reproduction of solo or center orchestral instruments from two side loudspeakers is only possible because of this effect. If the phase of one speaker is reversed, the ephemeral center image is destroyed and the side speakers are heard individually. In general, it can be said that any tampering with the phase or timing of one channel of a stereo signal with respect to the other is detrimental.

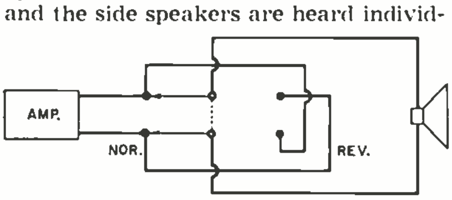


Fig. 1. Simplest phase-reversal switch.

An inexperienced stereo listener should practice listening to these phase effects so as to recognize them more easily when they appear unbidden later on. A very simple experiment and one which does not require elaborate equipment is performed by feeding the output of a single power amplifier to a set of stereo headphones. Headphones have the virtue of eliminating the effects of room acoustics and of magnifying out-of-phase defects to the point where they become very easily detectable by even the most inexperienced stereo listener.

Some means of reversing the leads to one earphone should be provided. Any type of program or test tone material can be used. A few minutes of A-B testing, by reversing the phase of the signal to one earphone, will demonstrate the basic character of out-of-phase sound reproduction. It is interesting to note that bass cancellation does not occur when headphones are used. This proves that the bass cancellation occurs acoustically in the listening room and not in the brain. The brain does not interpret phase differences in terms of volume level but in terms of direction, distance, and precedence.

System Phasing

Now that we understand and can recognize the nature of phase distortion, let us consider the phasing of stereophonic recording and reproducing systems. Since phase meters or oscilloscopes are not usually available to the audiophile, we will consider methods that rely only on the ability of a practiced ear to detect phase discrepancies.

First, we must standardize and adjust loudspeakers to produce a strongly in-phase sound pattern that ears can readily detect. This procedure also insures superlative stereo reproduction if applied rigorously. First connect an FM tuner to the input of a power amplifier. Remove the antenna from the tuner, disable its a.f.c., as well as any noise-muting circuit and tune it to an area of the FM band where there are no stations. Use the multiplex output jack if the tuner has one. Connect both loudspeakers to be phased to the single power amplifier. Wide-band noise should be heard from both speakers at equal volume.

If widely dissimilar speakers are involved, balance must be obtained by using different output impedance taps for each speaker or by using a previously phased stereo power amplifier with balancing controls. The object is to manipulate balance controls, speaker position, listener position, tweeter or mid-range level controls, and the phase of one speaker until the noise coming from the individual speakers merge into a single noise source emanating from a point between the two speakers.

Sometimes, if very dissimilar multi-speaker systems are used, particularly ones with complicated crossover networks and eccentric frequency and phase characteristics, no noise image can be formed and phase reversing makes little difference in the quality of the noise. In such a set of speakers, the phase *versus* frequency relationships are so widely divergent that the speakers cannot be maintained in-phase with each other in more than one region of the audio band at a time. Speakers that cannot produce an effective center noise image are not suitable for use in a stereo system and should either be altered or discarded in this application.

Beware also of tweeters that are not in-phase with their own woofers. Acoustic cancellation can occur near the crossover points and phasing such a speaker with another not similarly afflicted can be an exasperating experience! A tweeter may be phased with its woofer hy applying a signal at the crossover frequency from a signal generator or a test record. Correct phasing produces the loudest sound to an ear located equidistant from both sources. If possihle, the components of the crossover network should be shorted while this test is being made. If the terminals of both tweeter and woofer are accessible, phase is hest accomplished by using a flashlight battery and observing the direction of cone motion when the battery is applied to each pair of terminals in turn.

Once two loudspeakers have been reliably phased they can be used, in turn, to check other stereo components for phasing. The hasic method for doing this consists of applying a monophonic signal to the stereo system involved and listening for the characteristic in-phase and out-of-phase sound over the previously standardized loudspeaker system.

Thus a control amplifier or power amplifier-preamp can be phased by putting the controls in the monophonic position and listening to any program source or by applying the same signal to both channel inputs simultaneously. A stereo control and amplifier system may also be checked for phase and balance by momentarily connecting a single loudspeaker from the high tap on one amplifier to the same tap on the other. With the same signal fed to the inputs of both channels, no sound will be heard from the loudspeaker, if both phase and balance are exact. The balance should be adjusted to produce the least sound possible. Whatever residue of sound remains is then due to differences in phase between the two channels. Often, adjustment of tone controls improves balance and introduces phase shift that improves the null. If the channels are completely out-of-phase, the balance control is ineffective and no null can be obtained.

Stereo phonograph cartridges may be phased by playing a monophonic record through a stereo system and listening for the null, as before, or for a center image. Likewise, a tape recorder can be checked for phase by recording the same signal on both channels and listening for the null or center image on the standard system during playback. The null method, while more complex than the center-image method, has the virtue of being more sensitive to small phase shifts and does not require special listening abilities. The center-image method, however, requires no special wiring and is good enough to detect blatant phase errors.

Microphones can be phased by placing a sound source equidistant from them and listening for a center image on the standard system.

Changing the Phase

There are only a few places in a stereo sound system where phase changes can be made conveniently: at the power amplifier output terminals. stereo cartridge output terminals, tape record or playback head terminals, and microphone output or transformer terminals. Changes at the three latter points affect only the phase of the components involved, whereas reversal of the power amplifier leads changes the phase of the entire system.

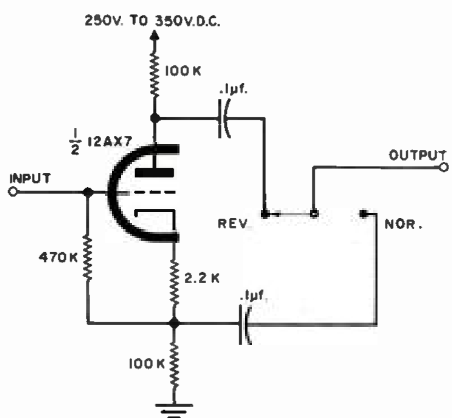


Fig. 2. Phase-reversal circuit that may be employed with the split-load inverter.

The phasing of an FM tuner with a multiplex adapter is a more difficult matter. We can assume, in most cases, that a tuner and adapter of the same make will be designed to produce in-phase outputs but when an adapter of one brand is connected to a tuner of another make, there is a 50 per-cent chance that the outputs will be out-of-phase. Unfortunately, the monophonic signal needed to phase a multiplex system reliably by ear is not easily come by. Broadcast stations almost never transmit monophonic multiplex so phase must he determined by using stereo material that is being broadcast. This is most easily done with a coordinating phase meter but it can be done by ear, using the standard system and a phase-reverse switch for A-B testing.

The audiophile's phase problems do not end when his own equipment is in-phase. It is a rare stereo record collection that does not contain several out-of-phase discs. There are records that are in-phase on one side and out-of-phase on the other. There are also records that shift phase erratically because they were edited from two master stereo tapes, one of which was in-phase and the other one of which was not.

At least for the next few years, the phasing of stereo broadcasts is likely to be haphazard until studios discover and eliminate the out-of-phase cartridges, microphones, recorders, line amplifiers, modulators, etc. in their own equipment.

Because of the prevalence and continuing availability of out-of-phase program sources, it is desirable to incorporate some means of phase reversal in all stereo systems that do not already have them. Fig. 1 shows the simplest of all phase-reversal circuits. This switch circuit is generally usable only if inserted in the lead between amplifier and speaker. It is a very effective and simple method but has the disadvantage of making the phase change after the signal has been through the blend control or tape recorder outputs. Thus, with only this phase-reversal circuit in a stereo system, it would be impossible to make in-phase recordings from out-of-phase program sources and the blend control would operate as a cancellation control.

Figs. 2 and 3 show electronic phase-reverse circuits which can be used at almost any point in a stereo system. Fig. 2 is a common split-load phase inverter, used to provide phase reversal. It has some disadvantages when used as a phase-reversing device. There is a loss of gain, the output impedance is not as low as it might be (particularly at the plate), and distortion is higher than that obtained with the circuit of Fig. 3. This circuit, also known as an anode-follower, has very low distortion, very low output impedance, and no loss in gain—but it must be fed from a source impedance small compared to 470,000 ohms or the gain in the reverse-phase position will decrease. The circuit

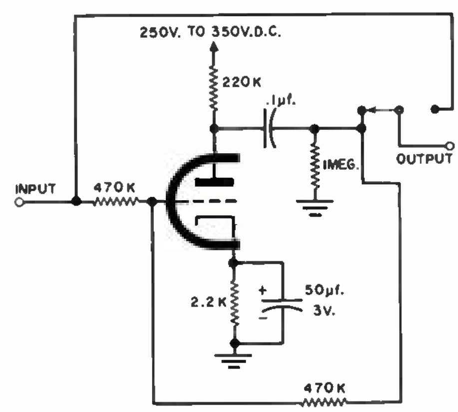
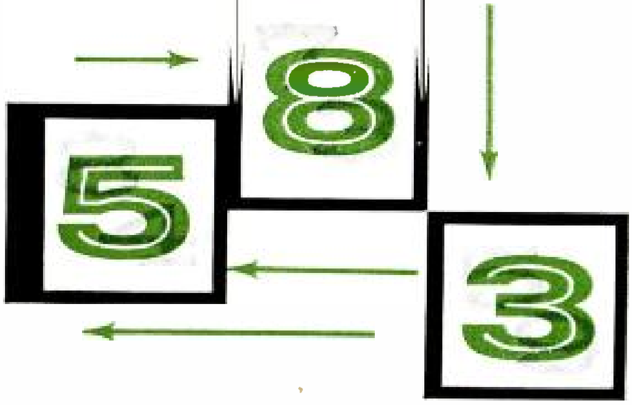


Fig. 3. Phase reversal with anode-follower.

of Fig. 2 is independent of the input source impedance.

Finally, it is necessary to point out that there are some stereo records to which the problems of external phase do not apply. These are recordings made with such widely spaced microphones that no part of the signal heard by one microphone is picked up by the other. Such a recording is completely uncorrelated, produces no center image, has two channels but is not stereophonic, and is entirely unaffected by phase changes in the reproducing system. Such "pseudo-stereo" records are, unfortunately, widely distributed among devotees of audible "ping-pong" matches. ▲



By ED BUKSTEIN
Author, "Digital Counters and Computers"

COMPUTER REGISTERS and ACCUMULATORS

The versatile flip-flop, other roles aside, is involved with storing, transferring, and combining information.

THE flip-flop stage is one of the essential building blocks of the digital computer. Stages of this type may be used for storing information in the form of binary numbers, and for performing mathematical operations on such numbers.

The storage register, as the name implies, is used for *storing* or *holding* information. The register consists of stages of the type shown in Fig. 1, each stage storing a single bit of binary information (either 0 or 1). In this circuit, only one of the two triodes can be below cut-off. When V_1 is below cut-off, for example, V_2 *must* conduct because the plate voltage of V_1 is high enough to drive the grid of V_2 positive with respect to cathode. Likewise, if V_2 is below cut-off, its plate potential will raise the grid of V_1 to the saturation level. Since the circuit is stable in either one of two possible conditions, one of these conditions can represent binary 0 and the other can represent binary 1. When triode V_1 in Fig. 1 is below cut-off, the stage represents binary 0; when V_2 is below cut-off, the stage represents binary 1.

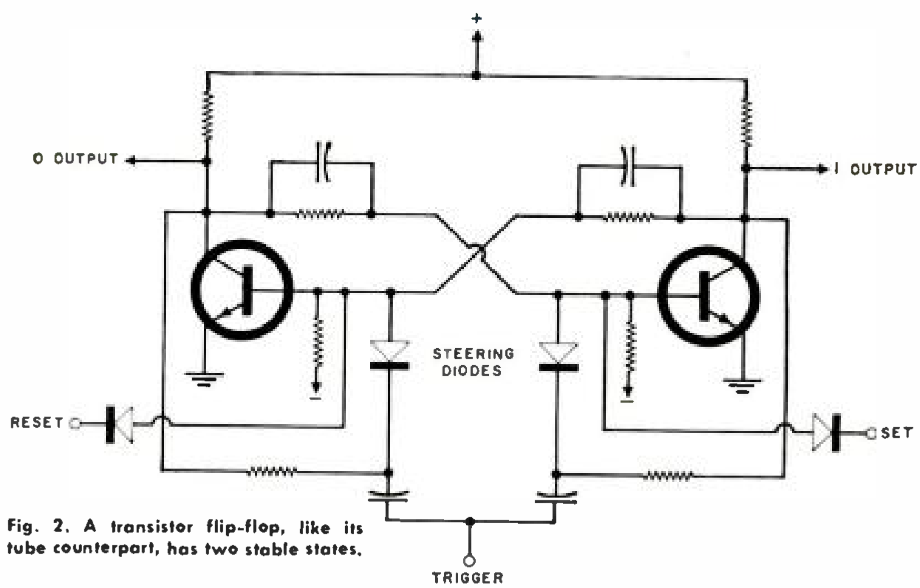


Fig. 2. A transistor flip-flop, like its tube counterpart, has two stable states.

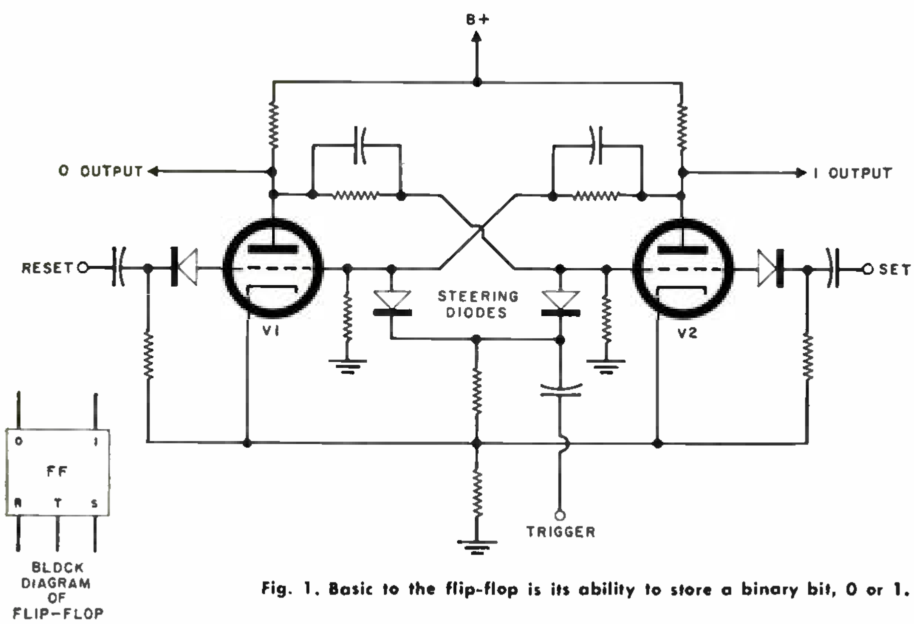


Fig. 1. Basic to the flip-flop is its ability to store a binary bit, 0 or 1.

As indicated in Fig. 1, the circuit has three input terminals: *set*, *reset*, and *trigger*. The set terminal is used to switch the circuit to the binary 1 condition. This is accomplished by applying a negative pulse to the set terminal, driving triode V_2 below cut-off. If a negative pulse is now applied to the reset terminal, triode V_1 will be driven below cut-off and binary 0 is now stored in the stage.

If a flip-flop stage is already set (V_2 below cut-off), a pulse applied to the set terminal will produce no change in the circuit. Similarly, if a flip-flop stage is already reset (V_1 below cut-off) a pulse applied to the reset terminal will produce no change. By contrast, a pulse applied to the *trigger* terminal will always reverse the stage regardless of its previous condition. The two diodes in the trigger circuit are effectively connected between grid and cathode of the two triodes. Since, at any given instant, one grid is negative with respect to cathode and the other grid is positive, one of the two diodes is forward biased and the other is reverse biased. The input pulse applied to the trigger terminal passes through the conducting diode only and therefore reaches the grid of the conducting triode only. In this way, the input pulse is *steered* to the conducting triode, driving this triode below cut-off and reversing the condition of the circuit. It is for this reason that the diodes in the trigger circuit are referred to as *steering* diodes.

The flip-flop has two output terminals, one from each plate. Since one triode is at saturation and the other is below cut-off, the voltage level is high at one output terminal and low at the other. When the stage is set to the binary 1 condition, a high level of voltage appears at the "1 output" terminal. When the stage is reset to binary 0, a high level is available at the "0 output" terminal. As indicated in the block diagram in Fig. 1, the three input terminals of the flip-flop are labeled reset, trigger, and set, and the two output terminals are labeled 0 and 1.

A transistor flip-flop circuit is shown in Fig. 2. Since the collector of each

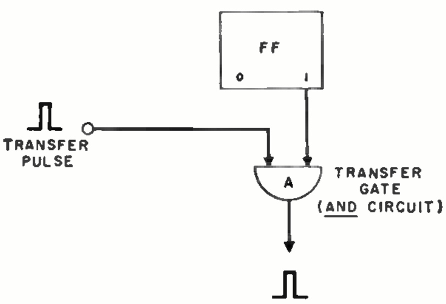


Fig. 3. Transfer gate yields high-level output if flip-flop is in binary-1 state.

transistor is resistively coupled to the base of the opposite transistor, only one of the two transistors can be below cut-off. When the left-hand transistor is below cut-off, for example, its collector voltage is sufficiently high to raise the base of the right-hand transistor to the conducting level. As in the case of the vacuum-tube circuit of Fig. 1, a pulse to the set terminal will cut off the right-hand transistor, a pulse to the reset terminal will cut off the left-hand transistor, and a pulse to the trigger terminal will reverse the stage regardless of its previous condition. A transistor flip-flop fabricated in the form of a plug-in card is shown in Fig. 4.

Information Transfer

The technique of transferring information out of a flip-flop stage is illustrated in Fig. 3. As shown, an *and* circuit is used as a *transfer gate.* (See "Computer Logic Elements," ELECTRONICS WORLD, December, 1960, for discussion of *and* circuits.) Since the *and* circuit can produce output only when both of its input terminals are at a high level, the transfer gate will produce a high-level output only when *both* of the following conditions exist:

1. Binary 1 is stored in the flip-flop so that its "1 output" terminal supplies a high level input to one of the *and* terminals.

2. A transfer pulse is applied to the other terminal of the *and* circuit.

If binary 0 is stored in the flip-flop, the "1 output" terminal will be at a low level. Under these conditions, the transfer gate cannot produce a high level output. The reason for the name *transfer gate* now becomes apparent: whichever binary bit is stored in the

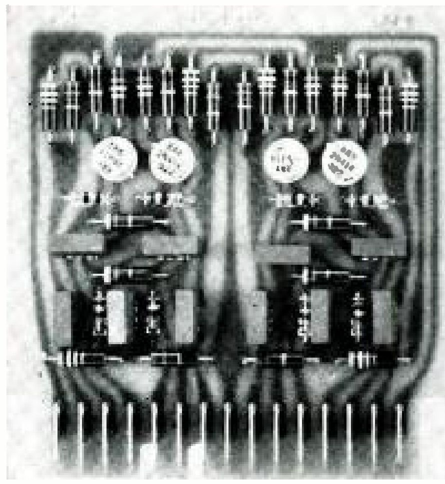


Fig. 4. A transistorized flip-flop fabricated in the form of a plug-in card.

flip-flop appears at the output of the gate. If the flip-flop has a 1 in it, the gate produces a high level output when the transfer pulse is applied; if the flip-flop has a 0 in it, the gate output remains at a low level when the transfer pulse is applied. The gate output is represented as a positive pulse in Fig. 3. This assumes that the high level is more positive than the low level. If desired, however, the *and* circuit can be designed so that the high level is more *negative* than the low level.

A five-stage storage register and associated transfer gates are shown in Fig. 5. (In the computer, many more stages are used so that larger numbers can be stored.) As indicated, a *clear* terminal is available to permit all stages to be reset simultaneously. A pulse applied to the clear terminal therefore has the effect of *erasing* any binary number previously in the register. In Fig. 5, it is assumed that set pulses have been applied to three of the stages so that binary number 11001 is stored in the register. The shaded stages are assumed to be in the binary 1 condition, and the unshaded stages are assumed to be in the 0 condition.

The three stages in the binary 1 condition supply high-level inputs to the associated transfer gates. When a transfer pulse is applied, these three gates produce high level outputs to represent the binary 1's. The other two gates produce low level outputs to represent the binary 0's. Binary number 11001 therefore appears at the output terminals of the transfer gates when the transfer pulse is applied.

The Accumulator

The accumulator is an arithmetic circuit which, as the name suggests, accumulates (adds) binary numbers applied to its input terminals. As indicated in Fig. 6, the accumulator consists of flip-flop stages connected in cascade. In this respect, it is similar to a binary counter except that an independent input terminal is available for each stage of the accumulator. Each time a stage switches from the 1 condi-

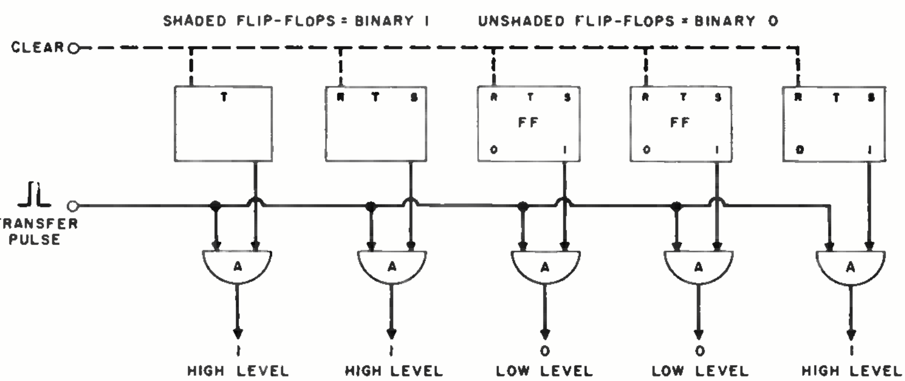
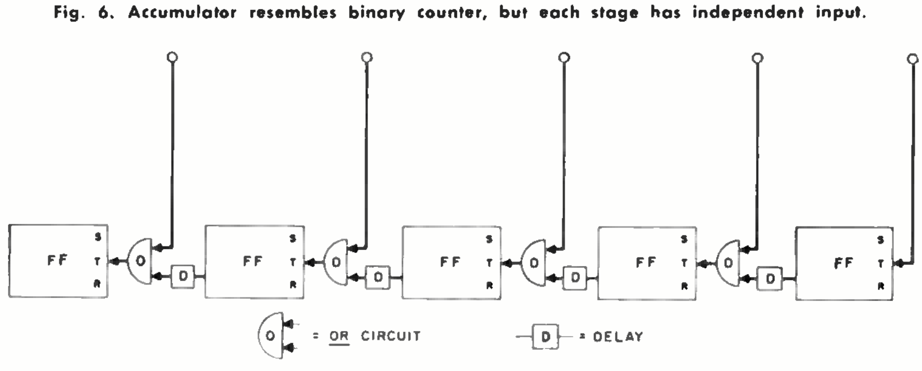


Fig. 5. Binary information in flip-flops appears at output terminals of transfer gates.

Fig. 6. Accumulator resembles binary counter, but each stage has independent input.



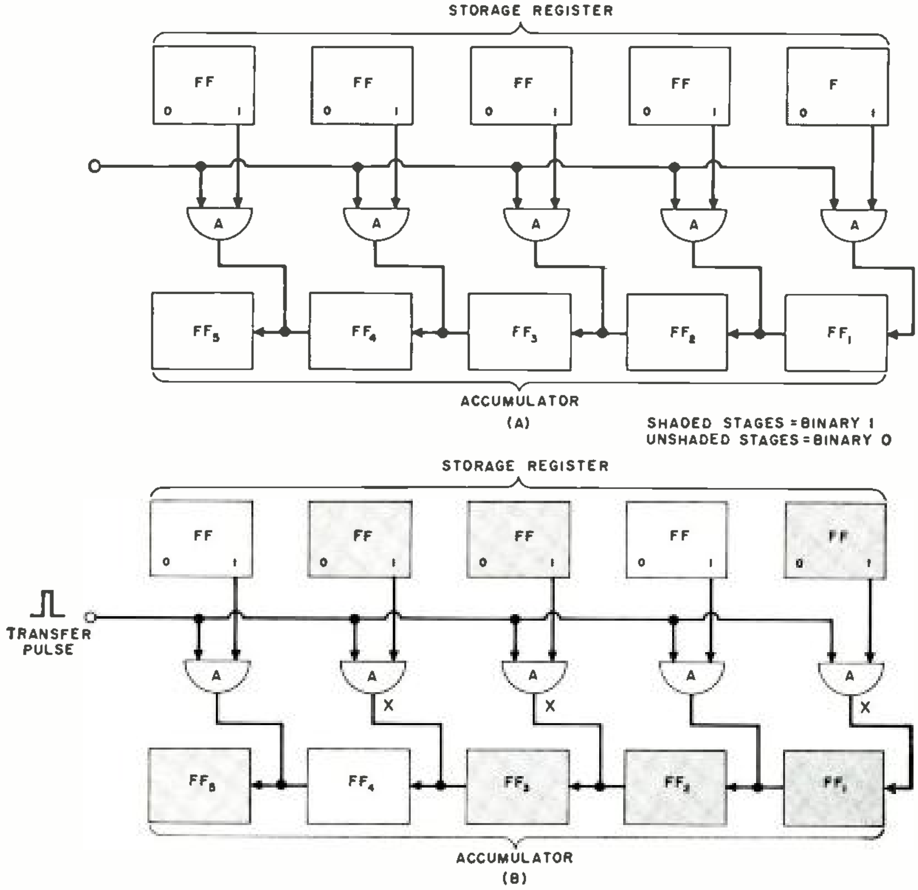
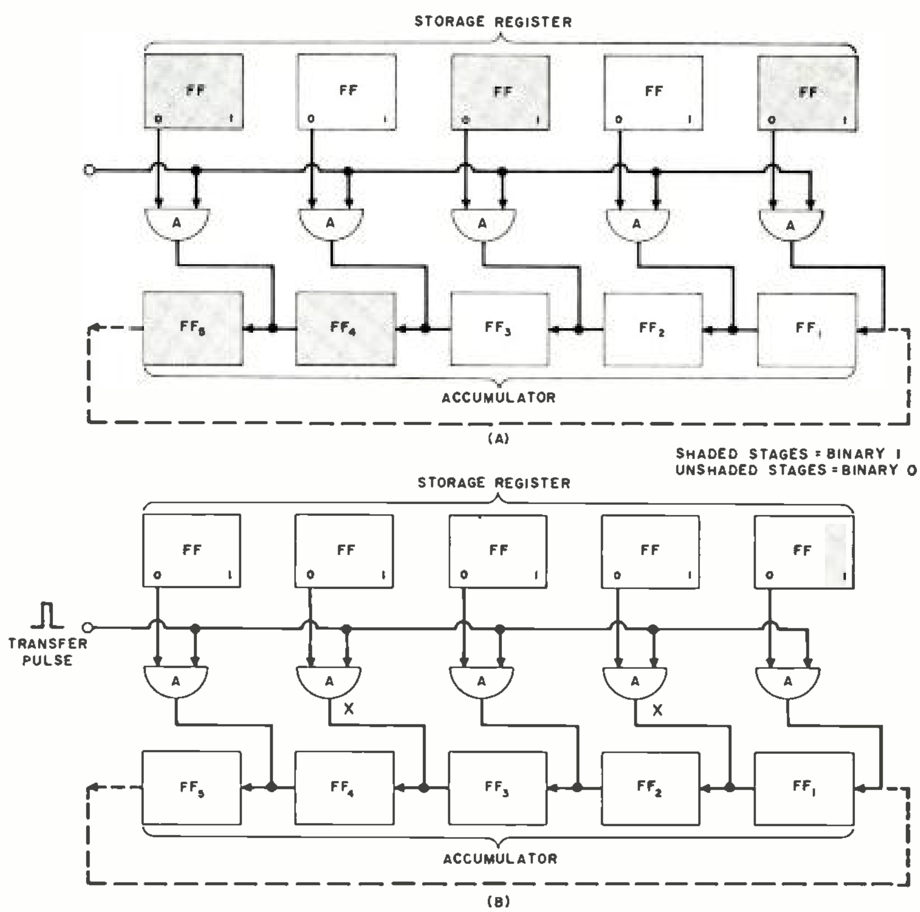


Fig. 7. A storage register and accumulator connected for binary addition. The conditions shown are before (A) and after (B) a transfer pulse has been applied.

Fig. 8. A storage register and accumulator connected for binary subtraction. The conditions shown are before (A) and after (B) a transfer pulse has been applied.



tion to the 0 condition, it generates a pulse of the correct polarity to trigger the following stage. An *or* circuit is used for interstage coupling because a stage may receive an input from either of two sources: from the preceding stage or from its own independent input terminal. Since one of these inputs may attempt to switch the stage to 0 while the other input attempts to switch it to 1, the two inputs must not be allowed to arrive simultaneously. This is the purpose of the delay (usually an *RC* network) in the interstage coupling.

For simplicity, the *or* circuits and the delays of the accumulator are not shown in Fig. 7. Here, it is assumed that binary number 01010 (equivalent to decimal *ten*) is stored in the accumulator, and that binary 01101 (equivalent to decimal *thirteen*) is in the storage register. These conditions are shown in Fig. 7A. If a transfer pulse is now applied to the circuit, three of the transfer gates will produce high level outputs (labeled "X" in Fig. 7B). These high level outputs are applied to the trigger terminals of the associated stages of the accumulator. The following changes therefore occur in the accumulator:

1. FF_1 receives a high level input and reverses its state to the 1 condition.
2. FF_2 receives no input and remains in the 1 condition.
3. FF_3 receives a high level input and reverses to the 1 condition.
4. FF_4 receives a high level input and reverses to the 0 condition.
5. FF_5 receives a triggering signal from FF_4 (which switched to 0) and therefore reverses to the 1 condition.

After these changes have occurred, binary number 10111 is now in the accumulator. This binary number is equivalent to decimal *twenty-three* and is the sum of the number in the storage register (13) and the number previously in the accumulator (10). The transfer pulse therefore causes the contents of the storage register to be added to the contents of the accumulator.

Problems in subtraction can be performed either directly or indirectly. The indirect method is frequently used in the computer because it permits a reduction in the total amount of circuitry required (the circuits used for addition are also used for subtraction). An example of the indirect method of subtraction is shown below:

step 1:

$$\begin{array}{r} 8 \\ -3 \end{array}$$

step 2:

$$\begin{array}{r} 8 \\ +6 \end{array}$$

step 3:

$$\begin{array}{r} 8 \\ +6 \\ =14 \end{array}$$

step 4:

$$\begin{array}{r} 4 \\ +1 \\ =5 \end{array}$$

The *subtraction* problem in step 1 is converted to an *addition* problem (step 2) by using the *nines complement*. Two numbers that add up to nine are com-

(*Continued on page* 115)

Citizens Band Crystal Checker

By **HAROLD REED**

Simple single-transistor device checks crystal activity. Can also be used with other LC circuits on other bands.

WITH the number of Citizens Band stations increasing daily, technicians and constructors engaged in CB work should be able to make independent tests on crystals. Since these tests cannot be made with the usual gear on hand, there is a need for a small, portable device for this purpose—one that can be constructed inexpensively. The present lower cost of some r.f. transistors and miniature meters makes this possible. The little instrument to be described seems to fill the bill and is easy to build.

The Circuit

A common-emitter transistor oscillator circuit is used. The crystal socket is connected between the collector and base of the transistor and when the crystal to be tested is plugged into the socket, the oscillatory circuit is completed. Tuning from below to above the Class D Citizens Band is provided for by the *LC* circuit made up of L_1, C_4, and C_5. Output from the oscillator circuit is coupled to a crystal diode, CR_1, through capacitor C_3. The diode rectifies the r.f. signal and this d.c. output is indicated by microammeter M_1. Meter sensitivity is varied by potentiometer R_4. Base bias for the transistor is obtained from resistors R_1 and R_2 connected across the battery supply source. A stabilizing resistor, R_3, is included in the emitter circuit. Battery B_1 supplies the required d.c. voltage for the circuit.

Construction

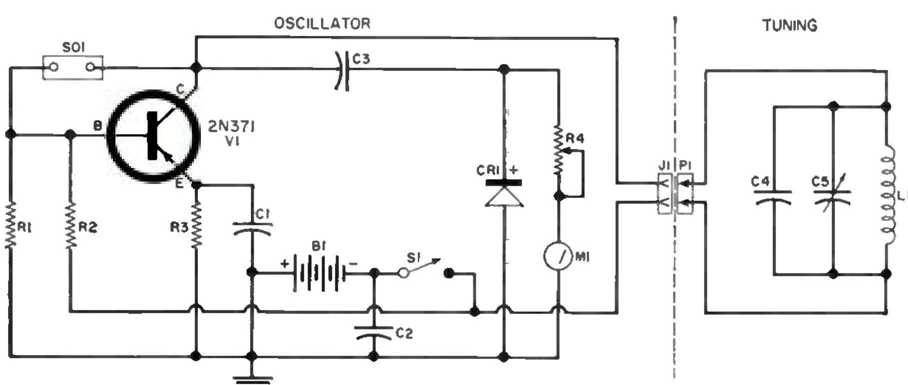
The crystal checker is built in two 1⅝" x 2⅛" x 3¼" metal boxes. This was done so that any *LC* circuit may be tested with any crystal. One box houses all of the circuit components except the *LC* circuit. All small parts, including the transistor and diode, are attached to a piece of perforated phenolic board which is mounted under the miniature meter terminals. The wire leads of these small parts are simply pulled through the holes in the board and bent over on the other side. All connections and soldering at the rear of the board should be taken care of before the board is mounted.

Wire leads running from the board to component parts not on the board are soldered in just before attaching it to the meter terminals. The leads to the crystal socket are connected last and should be just long enough to permit the box to be opened for battery replacement. The battery, whose life should equal shelf life, is secured by a thin copper band attached by two machine screws to the end of the box. A small pin jack is placed at the other end of the box for plugging in the *LC* circuit. The meter sensitivity control is connected so that all of its resistance is in the circuit when the control knob is in the extreme counterclockwise position. This control and the slide-type power switch are mounted to the left of the meter.

The other box contains the *LC* circuit which is tuned by a miniature vernier dial. A miniature pin plug for inserting into the jack on the other box is attached to one end of this box. This plug is not designed for chassis mounting so it was adapted to this purpose by unscrewing the plug cap and drilling a hole in the box just slightly smaller than the size of the remaining part of the plug in which the pins are set. After applying cement, the plug was force-fit into the box hole. It holds securely.

Coil L_1, 11 turns of #18 enamelled wire, is self supporting. It has a diameter of ⅜ inch and is spread to a length of ¾ inch. This length may vary with different units depending on circuit lead

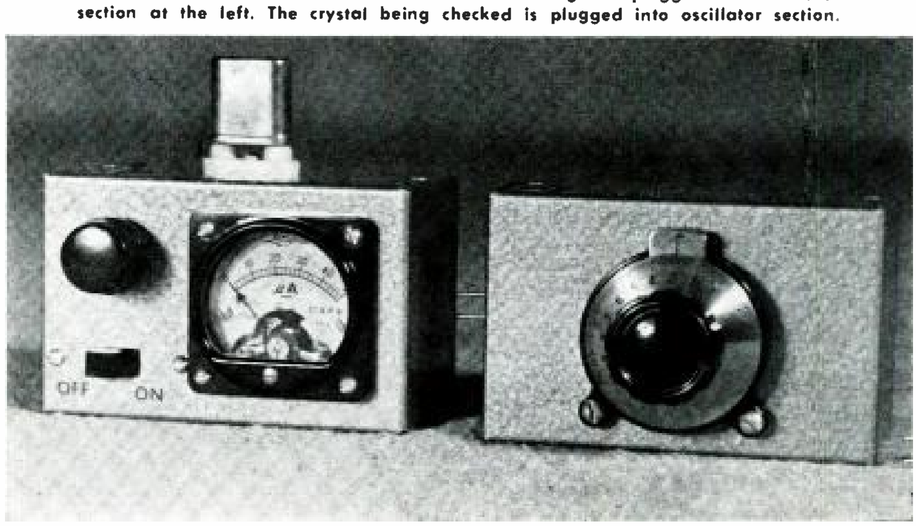
(*Continued on page* 78)



R_1—3900 ohm, ½ w. res.
R_2—270,000 ohm, ½ w. res.
R_3—1200 ohm, ½ w. res.
R_4—500,000 ohm miniature pot
C_1, C_2—.001 µf. mica capacitor
C_3—18 µµf. ceramic capacitor
C_4—47 µµf. mica capacitor
C_5—3-15 µµf. midget variable capacitor (Bud #1850 or equiv.)
L_1—11 t. #18 en. self-supporting coil, ⅜" dia., ¾" long
CR_1—Crystal diode (Sylvania 1N56A)
M_1—0-50 µa. meter
S_1—S.p.s.t. slide switch
SO_1—Crystal socket (National CS-7)
J_1—Two-pin miniature jack
P_1—Two-pin miniature plug
B_1—9-volt battery (Burgess P6M or equiv.)
V_1—"p-n-p" transistor (RCA 2N371)
2—Chassis boxes 1⅝" x 2⅛" x 3¼"

Complete schematic diagram of the CB crystal checker. SO_1 is the crystal socket. J_1 is the miniature jack on the oscillator box, and P_1 is mating plug on the tuning-circuit box.

Front view of two sections of checker. LC unit at right is plugged into oscillator section at the left. The crystal being checked is plugged into oscillator section.



Servicing Tape-Recorder Oscillators

By **HERMAN BURSTEIN**

The audio technician must understand this circuit to keep the tape recorder in top-notch working condition.

TRY this quiz. Name a possible cause for each of these symptoms in a tape recorder brought to you for servicing: (1) low output at normal recording level; (2) excessive distortion; (3) severe treble loss; (4) excessive treble response; (5) excessive noise produced in recording; and (6) erase head doesn't do its job well.

What is more natural than to answer that the above symptoms indicate defective tubes, resistors, or capacitors associated with the voltage amplification stages; defective components in the power supply; defective record or erase head; magnetized heads? Yet if for each symptom you said, "something to do with the tape oscillator," you would be right every time.

The tape amplifier is much like other audio amplifiers in many respects. To this extent the service technician can get by on his knowledge of standard audio servicing procedures. But the tape amplifier is unique in that it incorporates a bias-erase oscillator. Here is the source of problems that can arise to vex the technician who hasn't yet learned the ins and outs of tape machines. The chances of a "sick" tape recorder experiencing a speedy recovery at your hands are increased if you know the tape oscillator well—what it is supposed to do, how it operates, how it is coupled to the rest of the amplifier circuit, what to expect of it in terms of frequency and waveform, and the special problems that are apt to arise, such as drift and stray pickup.

Functions

The purpose of the tape oscillator is to (1) send bias current through the record head, thereby reducing distortion and increasing the amount of signal recorded on the tape and (2) energize the erase head.

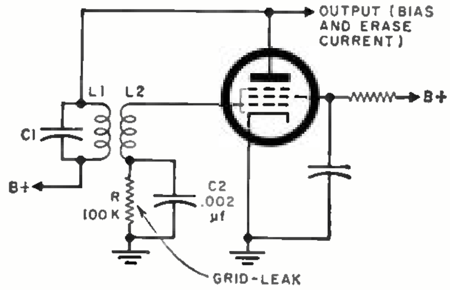
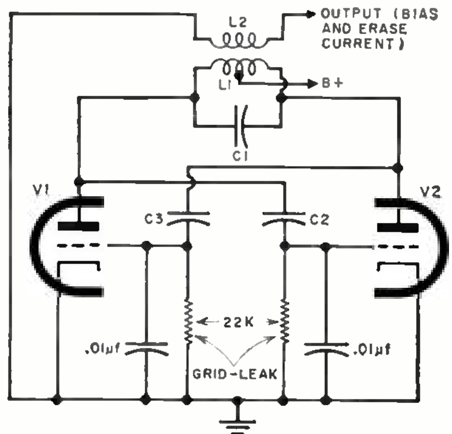


Fig. 1. Typical single-ended tape oscillator.

Fig. 2. A typical push-pull tape oscillator.



The amount of bias current fed to the record head is quite critical and should be very close to the value specified by the manufacturer of the tape recorder or of the head. Deviations of 10% or even less from the optimum value are serious. If bias current exceeds optimum, distortion is reduced, but treble response deteriorates. If bias current is below optimum, treble response goes up, but so does distortion.

To check the amount of bias current flowing through the record head, place a 100-ohm resistor in series with the ground lead of the head and measure the voltage across the resistor. Calculate the bias current by Ohm's Law: current equals voltage divided by resistance (100 ohms in this case). Optimum bias current in home tape machines ranges between .3 ma. and 1 ma.

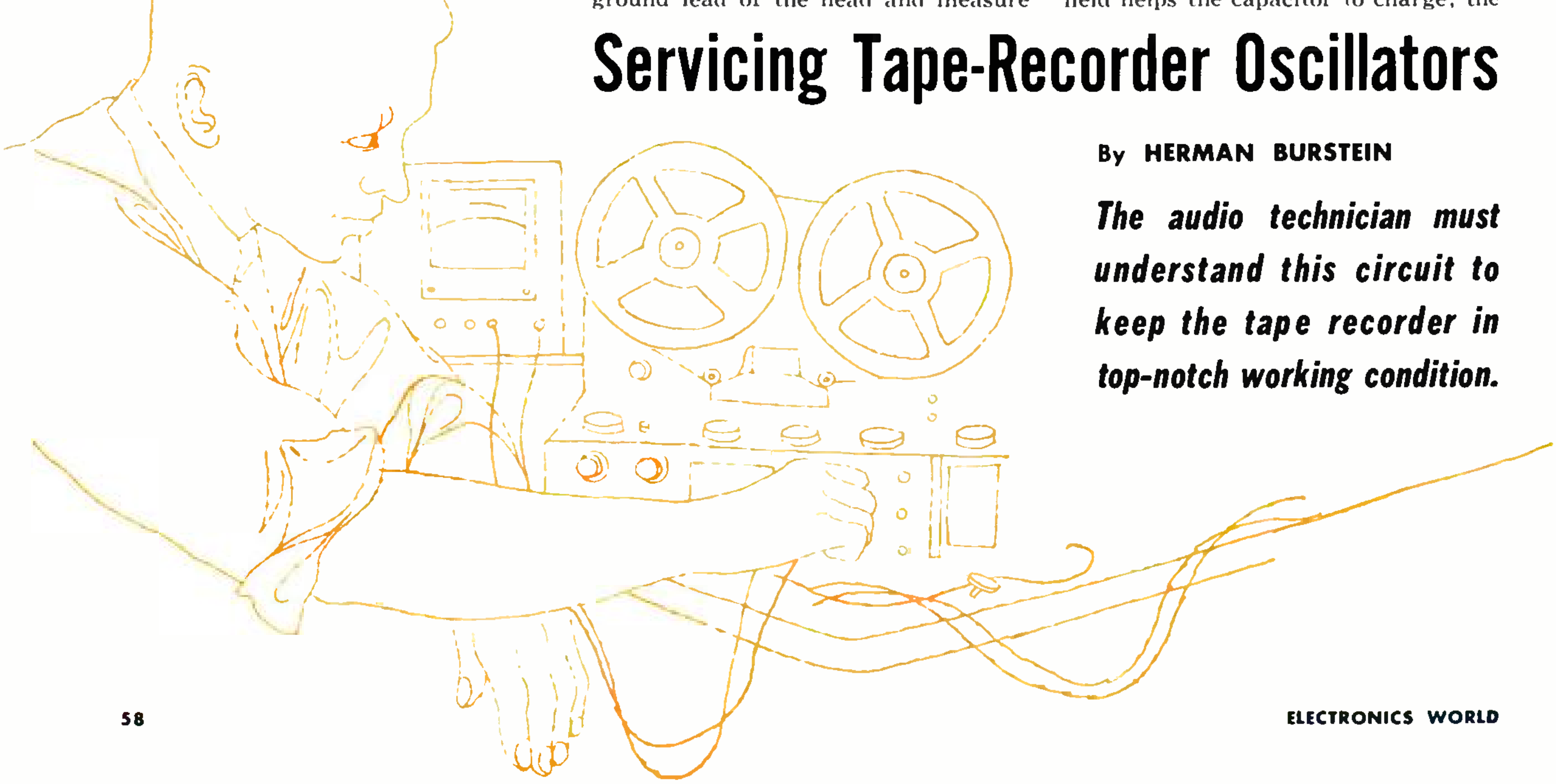
In the case of the erase head, oscillator current flowing through it can vary over a moderate range without upsetting matters. The amount of current can be checked in the same way as for the record head. Typical erase currents used in home machines range from 10 to 50 ma. The manufacturer's service data should be checked for exact values.

Operation

Tape oscillators are sometimes single-ended affairs, as in Fig. 1 or, for minimum distortion, push-pull types as shown in Fig. 2.

For a basic understanding of how a tape oscillator works, consider the arrangement of Fig. 1. Oscillation is due to positive feedback between plate and grid. Assume a random increase in tube current so that the plate is negative-going. L_2 of the oscillator coil is connected so that a negative-going voltage across L_1 results in a positive voltage on the grid of the tube, causing further increase in tube current. Eventually, however, the current increase must slow down, causing the magnetic field of L_1 to collapse, thereby reversing the voltage across L_2. So the grid goes negative, abetting the decrease in tube current. But the decrease in tube current also cannot continue indefinitely. As the decrease approaches an end, there is another collapse in the magnetic field around L_1 and another reversal of the voltage at the grid. Once more the grid is positive and promotes an increase in tube current . . . and so forth.

The oscillator frequency is essentially governed by the value of L_1-C_1, which determines how long it takes for the magnetic field around L_1 to build up and to collapse. The collapsing magnetic field helps the capacitor to charge; the



discharging capacitor helps the magnetic field to build up.

R and C_2 in Fig. 1 provide negative grid-leak bias so that the tube will work on the proper portion of its operating curve. To maintain a stable level of oscillation, the time-constant of R and C_2 should be at least five times as great as the time required for one cycle of oscillation. For example, if the oscillation frequency is 50,000 cycles per second—20 μsec. for 1 cycle—the time-constant should be at least 100 μsec. for stable operation. Should R or C_2 substantially decrease in value, bias current can fluctuate and adversely affect recording results.

Feedback must be great enough to maintain oscillation yet small enough to permit the tube to operate within the linear portion of its characteristic curve; otherwise there will be excessive harmonic distortion and, consequently, noise produced in recording. In Fig. 1, the amount of feedback is controlled by using a suitable turns ratio between L_1 and L_2 and by the degree of coupling between them. Shorted turns in one winding or the other can result in distorted operation or in no operation at all.

Turning to Fig. 2, we note that positive feedback takes place *via* capacitors rather than through transformer coupling. The feedback is from the plate of V_1 to the grid of V_2 and from the plate of V_2 to the grid of V_1. Reduction of distortion (even-harmonic) depends upon symmetry of operation which, in turn, depends upon symmetry of component values.

In many home tape recorders the same tube functions as an oscillator when recording and as the audio output tube in playback. Fig. 3 is a typical circuit of this kind. At audio frequencies, L_1 of the oscillator transformer provides a low-impedance path between the audio transformer primary and "B+." At the oscillator frequency, capacitor C_2 provides a low-impedance path between the plate of the tube and the oscillator tank circuit, L_1-C_1.

Coupling the Oscillator

Oscillator current is usually fed to the record and erase heads *via* coupling capacitors, as shown in Fig. 4. The values of these capacitors determine the amount of current going through the heads. A change in their value will upset operation, particularly in the case of the record head. When there is too much distortion, improper treble response (too much or too little), or inadequate erasure, it is wise to check whether the capacitances are those specified by the tape recorder manufacturer.

Some tape machines, particularly the more expensive ones, employ a variable capacitor instead of a fixed one, so that bias current can be precisely adjusted to its optimum value. Sometimes a variable resistor is employed instead of a variable capacitor to control bias current to the record head.

Waveform

The bias waveform should be as close to a perfect sine wave as possible. One can check for obvious distortion by connecting an oscilloscope across the record head when the tape machine is in the record mode, but without an audio input signal.

If appreciable noise is generated in the record mode although there is no signal input and the input gain control is all the way down, it pays to check components in the oscillator circuit. Significant distortion can be due to a defective tube or to capacitors or resistors that have changed values. In the case of a push-pull oscillator, substantial lack of symmetry between the two triodes, in terms of their mutual conductance, or the capacitors and resistors in the circuit of each triode may be causing distortion. It is also possible that distortion is due to excessive loading by the erase head. The erase head may be drawing too much current because of shorted turns; or because the coupling capacitor to that head is shorted or too large in value.

Frequency

To avoid noticeable beats between the bias frequency and the harmonics of the upper audio frequencies, the oscillator frequency should be at least four to five times the highest audio frequency that the tape machine is capable of recording. This dictates a bias frequency upward of 50,000 cycles for quality results; preferably, the frequency should be closer to 75,000 cycles.

On the other hand, the erase head tends to lose efficiency as oscillator frequency rises. There is increasing impedance to current flow because of the erase head's inductance. And the self-capacitance of the head's winding causes an increasing portion of the current to

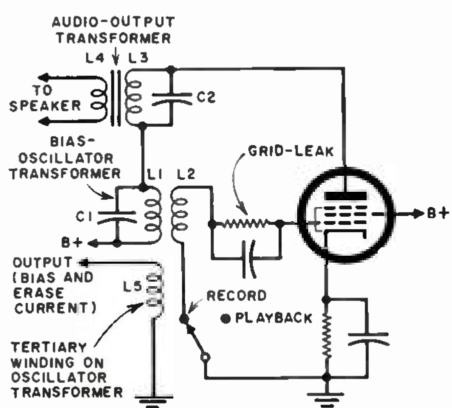
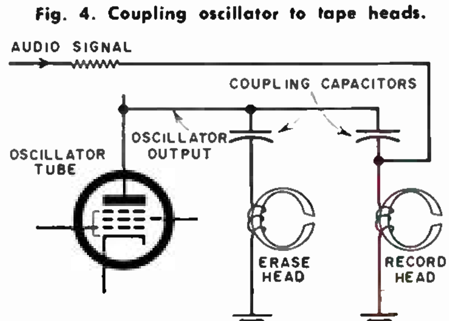


Fig. 3. Circuit showing use of audio-output tube as an oscillator in the record mode.

Fig. 4. Coupling oscillator to tape heads.



be shunted to ground. Poor erasure can sometimes be traced to an excessively high oscillator frequency.

Between these conflicting requirements of the record head and of the erase head there is an optimum oscillator frequency, which is the one recommended by the manufacturer of the tape machine. To check the oscillator frequency, note the number of cycles on an oscilloscope connected to the record or erase head; then connect the scope to a signal generator and adjust the latter until the same number of cycles is obtained again. The dial reading on the signal generator indicates the frequency of the tape oscillator. Bias signals and generator signals may also be applied to vertical and horizontal scope inputs simultaneously and the frequency may be checked by means of the resulting Lissajous figures.

Drift

Oscillator frequency and output tend to change somewhat during warm-up, with a resulting change in the amount of bias current supplied to the record head, which in turn affects distortion and treble response. Drift of this kind may last 15 minutes or more. Therefore it is advisable to allow a generous warm-up period if checks or adjustments of bias current are to be made. By the same token, the operator of a tape machine is well advised to allow a warm-up period before making a tape recording.

The capacitor in the oscillator tank circuit is sometimes of the negative-coefficient type in order to minimize frequency drift. If it becomes necessary to replace such a capacitor, it is important to replace it with one of the same type. Or it is sometimes possible to correct a serious case of drift by substituting a negative-coefficient type for a standard capacitor.

Variation in the amount of bias current reaching the record head may be due to an erase head that overheats, thereby changing the load on the oscillator. Reducing the amount of oscillator current going to the erase head may be the cure, provided that the reduction does not materially affect the efficiency of the head.

Stray Pickup

The oscillator frequency is high enough to have the properties of a radio wave. Hence the oscillator frequency can be broadcast into unwanted places to work mischief. The same thing can happen through stray capacitance. Care must be taken with respect to the location and lead dress of oscillator components, as well as of circuits susceptible to stray pickup, chiefly the early tape amplifier stages. When service work is done on these circuits, the original lead dress should be carefully observed, assuming that all was well in the beginning.

Should appreciable stray pickup occur in the record-level circuit, a false indication of recording level will result, leading to an under-recorded tape and therefore too low a signal-to-noise ratio.

(*Continued on page* 116)

By **JOHN T. FRYE**

Senior Citizen Service

THE CALENDAR indicated it was the first of November; but summer, like an aging actress, could not resist taking one last curtain call before leaving the stage for good. The rays of the sun, in spite of the disadvantage of their inclination, still managed to drive the mercury up into the low 80's; and the doors of Mac's Service Shop stood wide open.

There was, though, something incongruous, almost oppressive, about the untimely warmth. As Barney, the Number Two Man of the service shop, put it when he returned tardily from his lunch hour, "It kinda feels as though Nature has a fever out there today."

"I was wondering if only I had that feeling!" Mac exclaimed with relief. "But don't try to distract me. How come you took such a long lunch hour?"

"Well," Barney said glibly, "you might say I did it for you. After lunch I called CQ on twenty meters with my ham rig and raised a fellow down in Ormond Beach, Florida. After we had exchanged the usual stuff about handles, QTH's, rigs, beam antennas, reception reports, and the weather, he asked what I did for a living. When I told him, he came right back and said he operated a small radio and TV shop down there. With that, naturally, we were off and running. This guy, Bud, is a pretty bright boy. He not only works at radio and TV service; he thinks about it, too, and he has some doggoned good ideas. In fact, he was coming up with so many interesting comments that I decided I could do us more good listening to him than I could pushing a solder-gun."

"I've got to hand it to you," Mac said, shaking his head admiringly. "Your Irish tongue always comes up with a good story. But you darned well better come up with some examples of those fine ideas you were allegedly drinking in; otherwise you can work a half hour late tonight."

"Fair enough," Barney agreed. "First off, I asked if the humid weather and the nearness of the ocean caused any peculiar service problems. He said he was confident they did. Coil windings in particular took a beating from the salt-bearing moisture. Open windings and shorted turns were a very common occurrence in transformers, yoke windings, peaking coils, etc. Moisture also got into paper capacitors and caused them to become leaky and short-circuited more often than happened in drier inland localities. He was sure these troubles were unusual in their frequency because his experience revealed tubes *were not* the most common cause of set failure in his area. From his reading, he knew tube failures carried off the booby prize in most other places. I asked if the same conditions adversely affected printed circuits, and he said they didn't. Printed circuits seem to stand up just as well in the humid atmosphere as they do in drier climates."

"This is interesting, in an academic sort of way," Mac admitted; "but I've not heard anything yet of much use to us here in the Midwest."

"Be patient; I'm coming to the goodies," Barney retorted. "But don't forget you're always telling me a really good technician is interested in everything electronic, no matter if the information is of immediate benefit to him or not."

"I said it, it's true, and I withdraw my comment," Mac admitted cheerfully.

"Well, then," a mollified Barney continued, "Bud says the main thing that makes his service work different from that of most other service technicians is the average age of the people he serves. According to him, Ormond Beach is second only to the St. Pete area as a retirement center. A very high percentage of his customers are what Bud calls 'Senior Citizens.' Not once did he say 'old codgers,' 'old folks,' or anything like that. I very definitely got the feeling he not only respects these senior citizens but actually likes them."

"Is that so hard to believe?" Mac asked drily. "If a man doesn't like older folks, he must already despise his parents and is surely going to hate himself one of these days."

"Yeah! How about that? I never thought of it just that way," Barney admitted. "Anyway Bud says these retired people insist on having the set repaired in the home. There are several reasons for this: first, they do not want to take a chance of having a large bill run up against them without their knowing it. When the work is being done right under their eyes, they feel they are in control of the situation. Secondly, most of them are a little lonely and really enjoy talking to a stranger. In fact, Bud says in working for senior citizens you must learn to work and to listen at the same time. At first it may seem a little difficult to be puzzling out the cause of a missing boost voltage while your ear is being bent with an account of how the customer's son was a real 'electronical' genius as a boy—you know: how he got KDKA loud and clear the very first time he adjusted the catwhisker on his homemade crystal set—but once you get used to it, it's not too hard."

"How about grandchildren?" Mac asked.

"They and pets come under the heading of sacred cows in the home of a senior citizen," Barney explained. "Quite often visiting grandchildren are encountered in the home, and rarely do the doting grandparents exercise as much control over them as parents would, but you must shoo them out of your tube caddy very gently. Be cross with them, and you might as well kick the dog or yell at the parakeet. In either case, your name is mud with that customer."

"Does he think these older people are more critical, more difficult to please?"

"In a way, yes. You see the TV set occupies a much more important place in their lives than it does in the lives of younger, more active people. That TV set often takes the place of an afternoon at the track, the country club dance, nine holes of golf, an evening of nightclubbing, or a day at the beach. In other words, it is their most important, if not their only, source of entertainment. Lavishing, as they do, so much attention on the set, these people are much more annoyed by imperfect reception than are more casual watchers. But by the same token they recognize and appreciate little improvements in performance that would escape people who only watch TV when they can't find something more exciting to do. There is satisfaction in working for a truly critical and appreciative customer—as we both know."

"Well, I know it, and I'm pleased and mildly surprised to learn you do. How does he find his senior citizens when it comes to paying for work? Did he mention that?"

"Yes, very emphatically. He says they are excellent pay. When the job is done, they have the money ready for you. There is none of this 'I'll-see-you-payday' jazz. He says senior citizens usually budget their money very closely. They have to. Most of them live on Social Security checks or other limited retirement income, and they have a horror of slipping into debt. They know how hard it is to get out when most of their income is already assigned to meeting current obligations."

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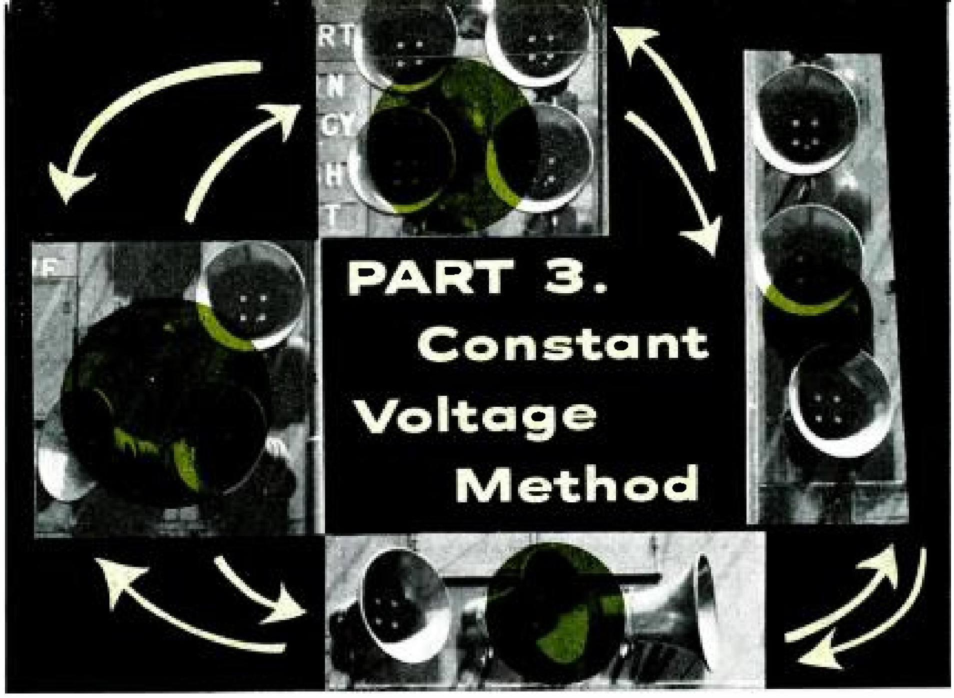


IMPEDANCE MATCHING IN PUBLIC-ADDRESS SYSTEMS

By **MORTIMER S. SUMBERG,** Director of Sales
Bogen-Presto Div., The Siegler Corp.

Even inexperienced sound-system installers can match amplifier and speakers perfectly with speed and confidence—and by the use of only simple arithmetic.

IN THE preceding articles we reviewed the techniques for providing a proper impedance match between an amplifier and its loudspeaker load by means of a high-impedance transmission line. Although this method enjoys many advantages and makes possible the installation of complex sound systems, the advantages are frequently offset by certain inherent disadvantages. Not the least of these is the complex computations required for large sound systems. More important, however, is the high voltage developed across lines by amplifiers of even moderate output power.

As an example, a 100-watt amplifier will develop 224 volts when delivering rated power to a speaker load from a 500-ohm output tap. This is, obviously, of serious concern to those responsible for protecting personnel and property from both shock and fire hazards.

In order to comply with the recommendations of *Underwriters' Laboratories*, the Committee on Sound Systems of the EIA proposed that the industry utilize a system of impedance and voltage selection which is based on a recommended nominal distribution-line voltage at rated output. This system was adopted years ago by most amplifier manufacturers and has been called the "constant-voltage" system.

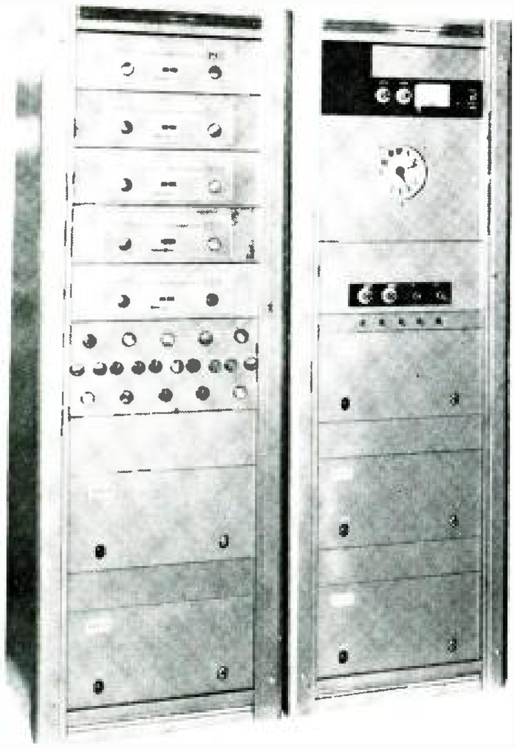
Although specifically recommending 70 volts (more exactly 70.7 volts), the Committee suggested other possible voltage values including 25, 35, 50, 100, and 140 volts.

School and p.a. systems have used 25-volt and 70-volt outputs; 140-volt output has been used for higher power systems covering large areas. The constant-voltage system presents still another important advantage over the constant-impedance system (*i.e.*, employing high-impedance transmission lines) which can best be illustrated by the following example.

Assume a system is installed in a small factory using a 30-watt amplifier with its 500-ohm output tap connected to a number of line-matching transformers and speakers. After several years of service the factory is expanded to a size which requires 100 watts of power. If a 100-watt amplifier with a 500-ohm output tap is substituted for the 30-watt unit, connections to every existing transformer will have to be changed to a higher impedance tap on the primary (to provide the correct loudspeaker driving level as previously). If this is not within the range of the transformer, it will have to be replaced. Needless to say, this involves considerable labor and component cost.

Had the constant-voltage system been employed in the first place, virtually no problem would exist when the sound system is expanded. A 30-watt amplifier with a 70-volt output tap would have been selected and constant-voltage transformers would have been installed at each loudspeaker to provide the proper level. Expansion of the system would then require only the replacement of the original 30-watt amplifier by a 100-watt amplifier, also having a 70-volt output tap. The same line-matching transformers would be used and there would be no need to make any change in the wiring to them. The 100-watt amplifier would drive a loudspeaker to 4 watts if the latter were originally connected to the 30-watt amplifier so as to draw 4 watts. Expansion of the system would entail the addition of loudspeakers, each with a constant-voltage transformer and a loudspeaker transmission line.

It will be noted that involved computations are completely eliminated by



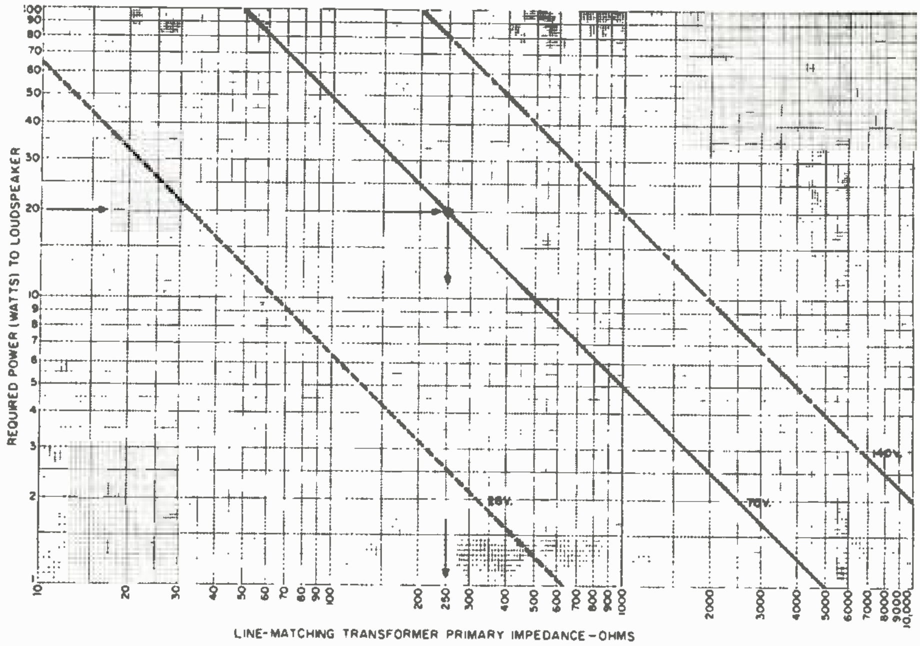


Fig. 16. Primary impedance versus loudspeaker power in constant-voltage systems.

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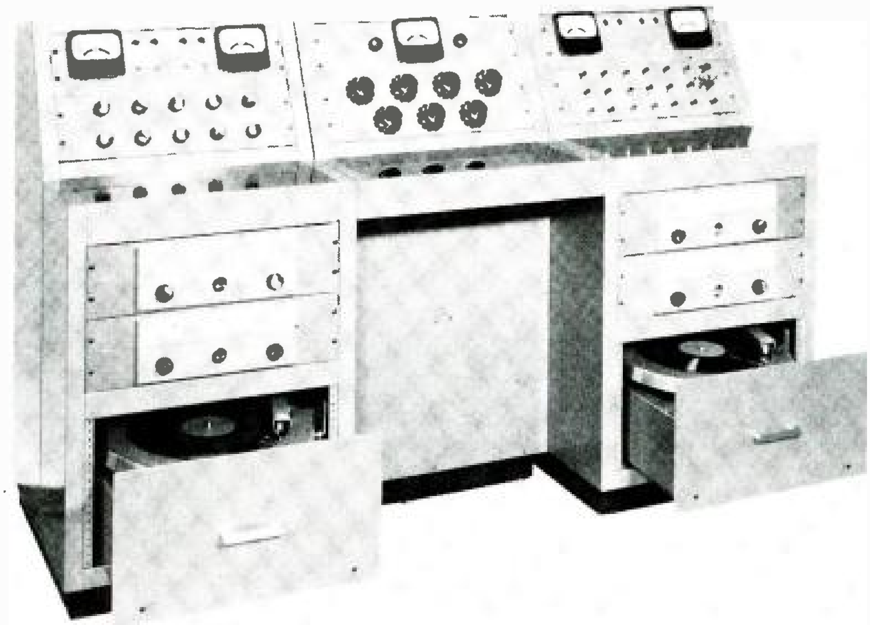
This versatile four-channel sound system is installed in one of our large hospitals.



the use of the constant-voltage system since the loudspeaker-matching transformer is selected as simply as a light bulb—by wattage.

There is frequently some misunderstanding as to the exact meaning of the expression "constant voltage." Stated simply, this implies that the amplifier has a 70-volt output tap. It does not mean that the voltage at this tap will always be 70 volts. When the system is operating at levels well below the rated output of the amplifier, the voltage may be less. The 70 volts will appear across the output tap when the amplifier is terminated by its rated load impedance and is supplying power to the load equal to the rating of the amplifier power. In order to simplify still further the few calculations which are required to set up a constant-voltage system, it may be considered that the amplifier is always delivering its full output and that 70 volts appears across the output tap.

Constant-Voltage Xformer Matching

A typical impedance-matching problem was solved in Fig. 13 (Part 2) by means of a high-impedance transmission line and matching transformers. Computations of a nature which all but the most experienced sound men would consider involved were required to determine the kind of matching transformers to install, the proper primary taps to which connections would be made, and the most convenient amplifier output tap impedance from which the transmission line would originate.

To demonstrate the ease with which this same system can be set up by means of the constant-voltage method, the identical requirements will be assumed. To begin with, a total of five loudspeakers is needed and these will be driven to levels of 20, 10, 5, 4, and 1 watt respectively. Since the total power requirement is 40 watts, we select a 40-watt amplifier, as we did previously—but now we make certain that it provides a 70-volt output tap. A constant-voltage transformer with a 20-watt tap—designed to work with a 70-volt line—is installed at Loudspeaker No. 1, as shown in Fig. 17. When the amplifier is operating at its rated output, 20 watts will be delivered to this speaker. For Loudspeaker No. 2 we install a similar transformer—but one with a 10-watt tap. The same simple procedure is followed with the three remaining loudspeakers, in each case selecting a transformer no larger in power-handling capacity than is required.

Returning to the system shown in Fig. 13, consider the problem of rematching which would be posed if a new section were added to the building and the sound technician were called in to install two more trumpets—each operating at a 30-watt level. A 100-watt amplifier would have to be substituted for the 40-watt amplifier, of course; but the job would not end there. Connections at each line-matching transformer would have to be changed so that the loudspeakers continued to draw the same amount of power. For example, a 1250-ohm primary tap would now be used on T_1 instead of the 500-ohm tap originally required. (If the 250-ohm output tap on the 100-watt amplifier were decided on, the 1250-ohm transformer tap would represent an upward mismatch of 5:1. This transformer would therefore draw one-fifth of the amplifier rated power—20 watts.) In addition to the recalculations and the labor of reconnecting the transmission line to the five matching transformers, it is quite probable that several of the latter will have to be replaced with others which provide the correct primary tap impedance. In other words, if T_1 did not also provide a 1250-ohm primary tap, it would have to be replaced by one which did.

The addition of two 30-watt trumpets to the constant-voltage system in Fig. 17 presents no problem at all and dramatically points out the remarkable ease with which otherwise complex matching problems are handled. The two trumpets will add 60 watts to the existing power requirements (40 watts) and bring the total to 100 watts. Accordingly, a 100-watt amplifier will replace the original 40-watt amplifier and the same transmission line—with connections at the five constant-voltage transformers remaining as before—will be terminated at the 70-volt output tap. In addition, a transmission line will be run to the two trumpets and tied to constant-voltage transformers which will provide 30-watt taps. In like manner, the sound system could be further expanded by installing additional loudspeakers, transformers, and a larger amplifier—without making any changes whatsoever in the original hook-up.

Matching with Available Transformers

It frequently happens that constant-impedance transformers (*i.e.*, primary taps marked in impedance values) must be used with a constant-voltage amplifier. This situation would arise if constant-voltage transformers were not immediately available or if the installer preferred to turn over his stock of the other type. To determine the correct primary impedance tap which will deliver the desired amount of power to the loudspeaker when the transformer is connected to a 70-volt transmission line, the following formula may be applied: *Correct transformer primary impedance tap = 5000/watts desired in loudspeaker*. The mathematician states this same relationship as follows: $Z = E^2/P$.

In the above formula, the factor 5000 represents the square of 70 volts (E^2). If a 140-volt output tap is used, as might be the case with a large amplifier, this factor (E^2) becomes 20,000. With the 25-volt output tap found on many school console amplifiers, the factor 625 applies. For those who prefer to work with graphs, Fig. 16 is offered.

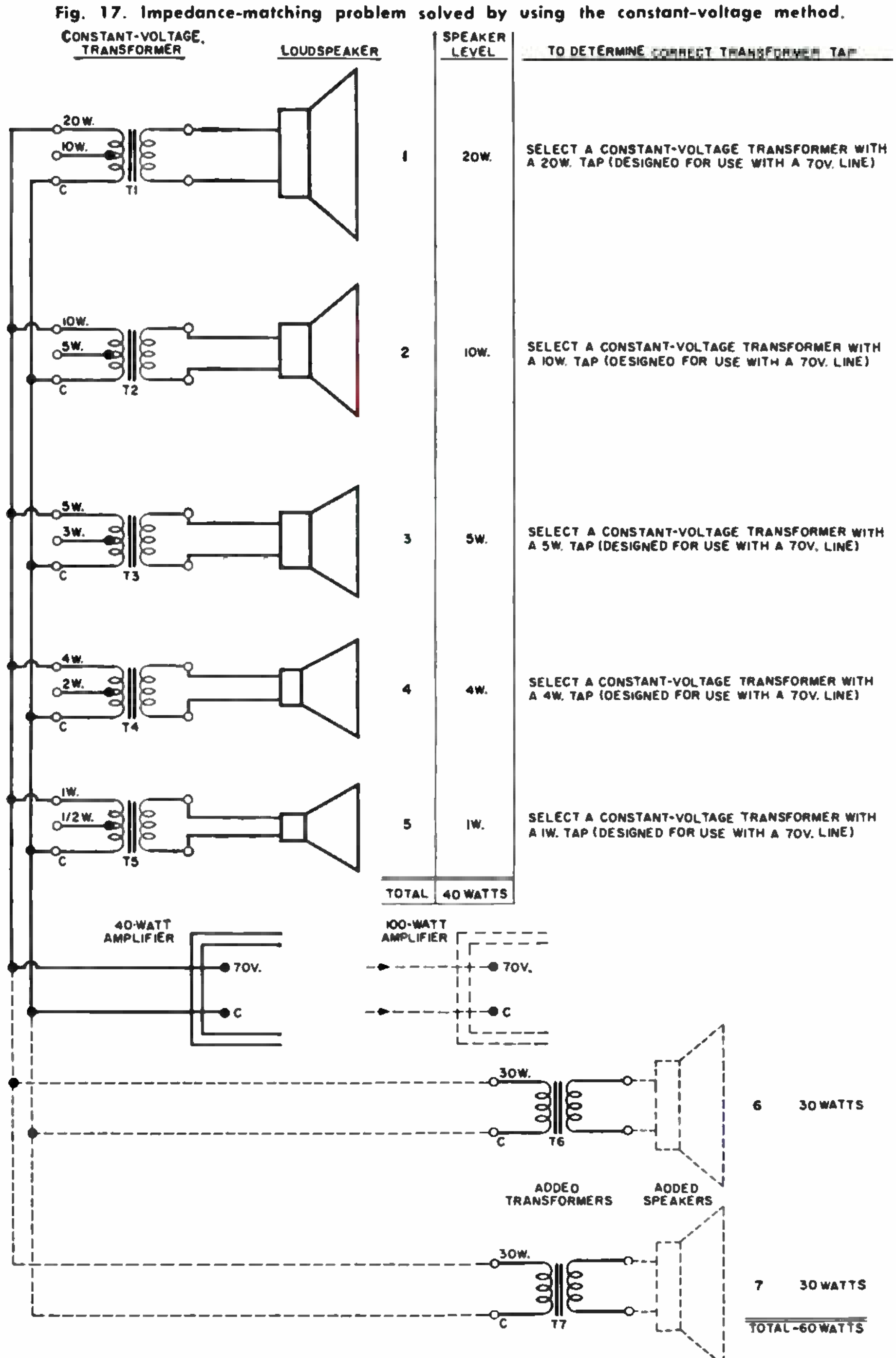
To illustrate the use of the graph, let us suppose that while installing the system of Fig. 17 it is discovered that a suitable constant-voltage transformer (T_1) for Loudspeaker No. 1 is unavailable but that several constant-impedance transformers are at hand. Our problem is to determine the primary impedance value of a transformer which will deliver 20 watts to the loudspeaker. Since a 70-volt output tap is used, the formula is applied in the following way:

$$Z = E^2/P = 5000/20 = 250 \text{ ohms}$$

Obviously, the transformer must not only provide a 250-ohm primary tap, it must also have a secondary tap to match the voice-coil impedance—and be rated to pass 20 watts of power. Referring to Fig. 16, we can check the above impedance value by finding the point on the solid line (for 70-volt systems) which is intersected by the horizontal line representing 20 watts. Dropping this point vertically, we discover that it corresponds to 250 ohms.

The above formula and graph may be used in the same manner to ascertain the impedance value of an amplifier's constant-voltage output tap. The impedance of the 70-volt tap on a 20-watt

Fig. 17. Impedance-matching problem solved by using the constant-voltage method.



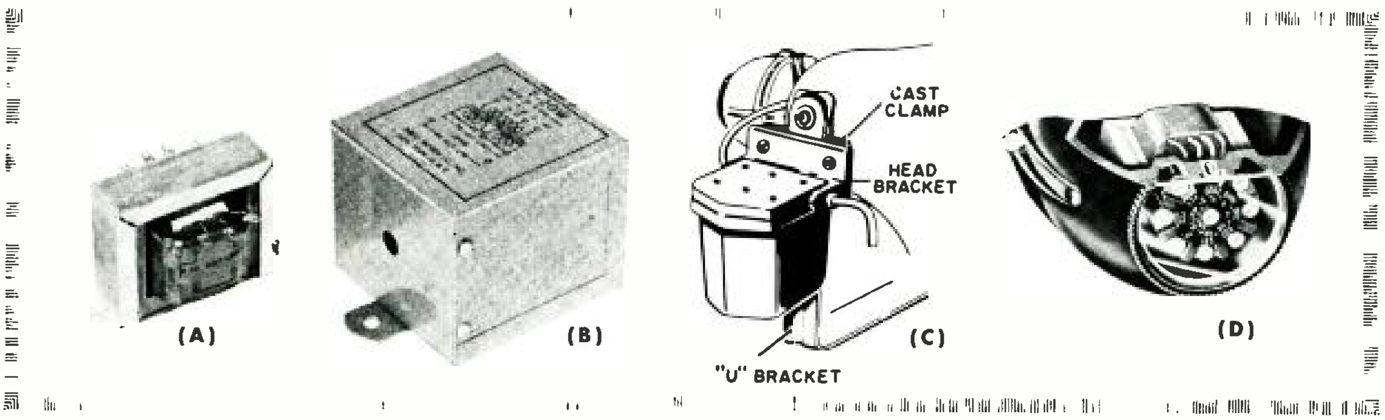


Fig. 18. Typical line-matching transformers. (A) Standard type. (B) Weatherproof type. (C) Weatherproof transformer in multipurpose housing, shown here mounted on speaker. (D) Transformer built into driver unit of speaker trumpet.

amplifier is equal to 250 ohms. Similarly, the 140-volt output tap on a 100-watt amplifier is equivalent to 200 ohms (the dot-dash line in the graph is used in this instance).

Line-Matching Transformers

Line-matching transformers, of the constant-voltage and constant-impedance types, are produced in a wide variety of designs so that selection of a specific component presents little difficulty. When purchasing a line-matching transformer, the following considerations have to be examined: (1) required primary impedance or voltage tap; (2) required secondary-impedance tap to match loudspeaker voice coil; (3) power-handling capability; (4) required frequency response. (Costly transformers with the ability to pass a wide range of frequencies are available if a wide-range loudspeaker is being used to reproduce a wide-range signal. For most commercial and industrial sound installations, a frequency response of 100 to 7000 cps is entirely adequate and permits the use of moderately priced matching transformers.); (5) location of transformer and mounting requirements. (Transformers are available for indoor use and, at somewhat higher prices, for outdoor use. Electrically these transformers are identical and the outdoor type may be used if cost is no object. The indoor transformer will not stand up well, however, if it is exposed outdoors to the effects of salt spray, rain, and extremes of temperature for long periods.)

Fig. 18 shows several typical line-matching transformers which are intended for use in a wide range of applications. The two audio transformers in Figs. 18A and 18B are electrically identical. The encased component is an outdoor type which usually is located adjacent to a speaker or trumpet, whereas the open-frame indoor transformer is designed to attach directly to a cone loudspeaker frame.

The construction of the weatherproof transformer in Fig. 18C permits an outdoor reflex trumpet to be attached directly to the transformer housing, thereby eliminating the necessity for having to attach the trumpet and transformer separately to a wall or pole. In Fig. 18D, we have a unique arrangement whereby a line-matching transformer is built into a driver unit housing which attaches to a reflex trumpet. The transformer is rated at 50 watts, passes wide-frequency audio signals and affords a number of power taps (for a 70-volt line) and impedance taps (to match a high-impedance transmission line). In installations where reflex trumpets are mounted at the top of poles or at other relatively inaccessible points, the use of this combination eliminates the need for mounting the trumpet and line-matching transformer separately—a time consuming and possibly dangerous job which must be handled in the shortest possible time.

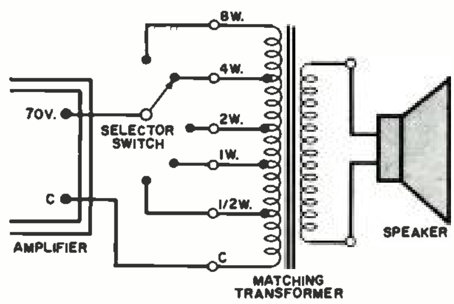
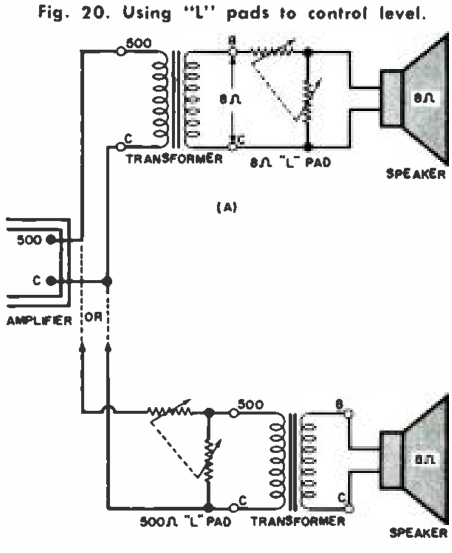


Fig. 19. Power-tap selector controls level.

Fig. 20. Using "L" pads to control level.



"L" PAD DUAL GANGED VARIABLE ELEMENTS
PADS ARE AVAILABLE IN THE FOLLOWING IMPEDANCE VALUES(Ω)

4	200	3000
8	250	4000
16	500	5000
50	1000	
100	2000	

(C)

Most of the line-maching transformers are wound with solder terminal lugs. Connections to these should be made with considerable care since the application of excessive heat from the soldering iron may cause the connecting lead between the lug and the transformer coil to open. Similar care should be exercised when soldering the short leads between the transformer secondary and the loudspeaker voice coil.

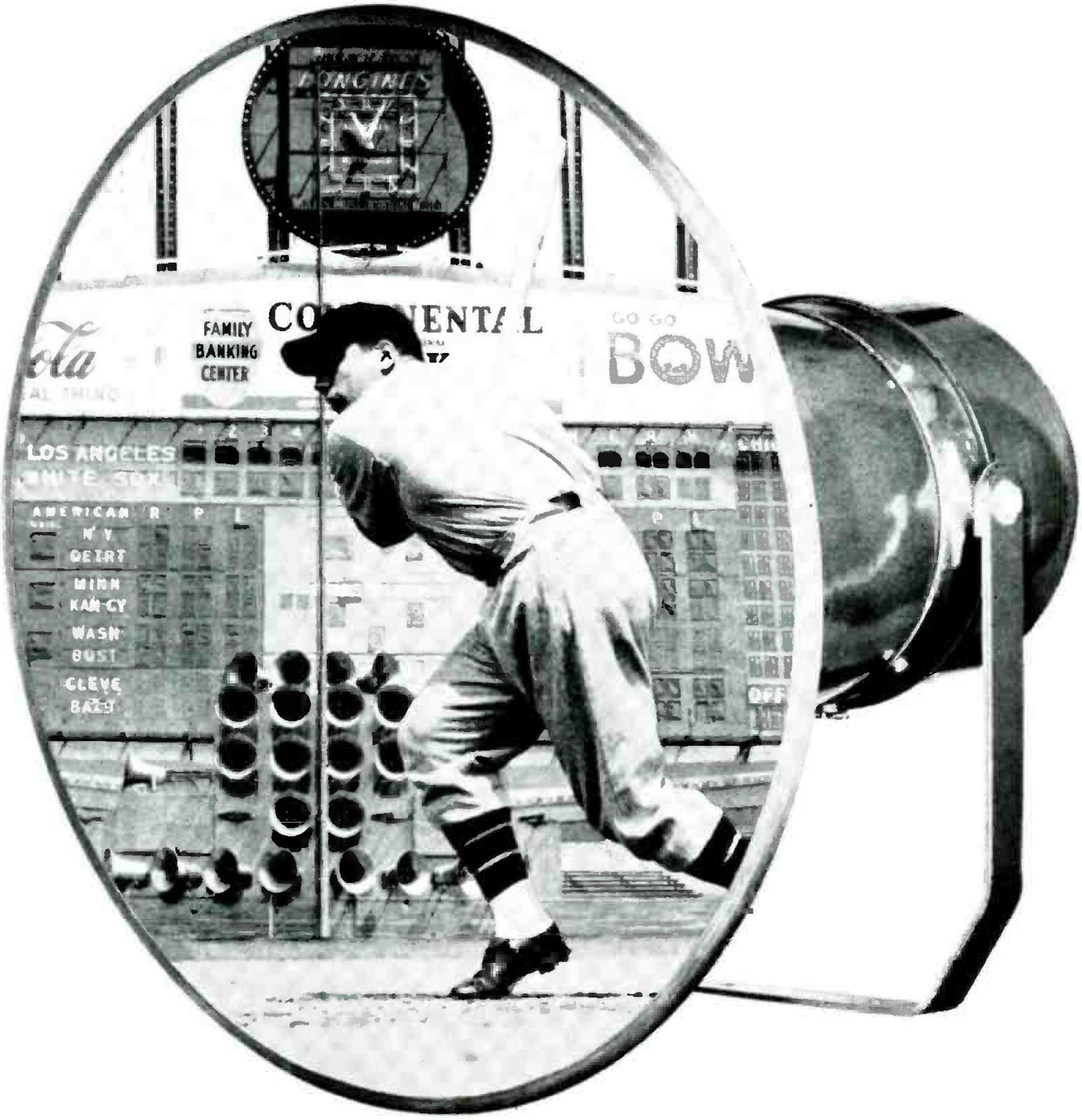
Control of Speaker Levels

Although the relative amounts of power delivered to various loudspeakers can be established by selection of the matching transformers or by the arrangement of voice coils, it is sometimes necessary to vary the sound level from one or several speakers in the system without influencing the operation of the others. There are several ways of accomplishing this.

The simplest technique consists of wiring the available primary taps of the line-matching transformer to a selector switch, as shown in Fig. 19. The selection of power taps in a 2:1 ratio is reasonable since this represents approximately the smallest important change in sound level that can be discerned by the average listener.

Other methods of loudspeaker-level control employ the selection or change of resistance networks to vary the amount of power loss between the amplifier and loudspeaker. The most common of these is the continuously variable "L" pad shown in Fig. 20. In Fig. 20A, an 8-ohm "L" pad is employed in the transformer secondary circuit whereas in Fig. 20B, a 500-ohm "L" pad

(*Continued on page* 111)



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New Motorola Color CRT

This rectangular picture tube, lighter and shorter, provides more viewing area and is easier to make.

Announcement of *Motorola's* version of the three-gun shadow-mask, color picture tube (see our October issue, page 100) has aroused considerable industry interest. The manufacturer has since released additional details about the display device.

Requiring the same 25,000 volts for its second anode that is used by existing types, it makes no additional demands on the high-voltage circuit. Aside from this, deflection angle of the 23-inch rectangular tube is 92 degrees as compared to 70 degrees for the 21-inch round type. This difference largely accounts for the significant reduction in CRT depth: from 25.25 inches to 20.25. While image size is about the same, restoring information lost in the missing corners of the round tube adds 22 square inches of viewing area to the complete picture: an increase from 261 to 283 square inches Using less glass, a costly ingredient, the squared-off design weighs only 30 pounds as compared to 33.5 for types in current use.

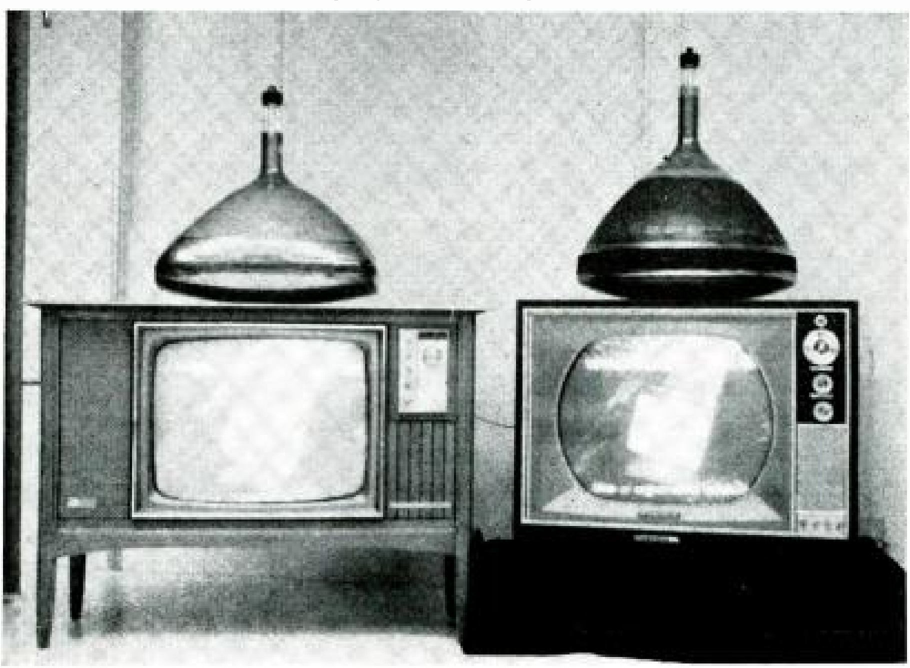
Convergence problems become considerably more stringent, due both to the increased scan angle and the need to maintain three-gun tracking in the extreme corners added to the rectagular version. This can be met by elaborating convergence circuitry—indeed, has been met in the working receiver using the new CRT that was put on display by *Motorola*. The associated deflection yoke is also a new design. The chassis employed was adapted from that for a color set the manufacturer marketed some years ago.

Significance of the development, as this manufacturer sees it, lies in its belief that receiver appearance rather than price has been the chief impediment to widespread acceptance of color TV. With consumers accustomed to the trim styling and compactness of modern monochrome sets, made possible by wide-angle, squared-off picture tubes, they balk at the "bulky, boxy look" of current models, like the table receiver to the right in the accompanying photograph. Extra height is needed to accommodate the wasted, masked-off portion of the CRT, and extra depth is needed for the front-to-back length.

By contrast, note the trim console in which the rectangular version is housed to the left. To make a point, the latter cabinet is one used for a recent, popular, monochrome set in the *Motorola* line. Samples of the new and old tubes, shown atop their housings, suggest the depth difference. The cup for the base of the CRT that protrudes from the rear of the console, of course, is deeper than it would be for a black-and-white tube; but the flat appearance that is expected today has not been changed because depth of the cabinet itself is unaltered.

With no facilities for CRT production and no plans to acquire them, *Motorola* has produced working models in cooperation with an established tube manufacturer. Since fabrication is based on techniques for monochrome devices, largely obviating the heavy investment for all-new equipment needed to make round color tubes, it is hoped several CRT makers will show interest. ▲

The new (left) and old (right) picture tubes, together with associated cabinets.



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Advances in Medical Electronics

(*Continued from page* 36)

of communications techniques and various computer applications are now under study. It is a logical step to combine some of the electronic instrumentation methods already described with a data processing and computing system. For example, several electronic respiration analyzers could be connected to a central station in the hospital and indicate, remotely and instantaneously, how each patient is doing. An automatic alarm could be added to alert the attending nurse or doctor when a patient's condition deteriorates.

A computer could also be used to find the right diagnosis after the results of a series of tests and detailed patient characteristics have been entered. Statistical probability would be computed to indicate the most likely disease and, possibly, the best treatment based on comprehensive statistics gathered over a period of years and covering a large number of cases.

A more immediate application of TV scanning techniques, combined with data processing, is the "Cytoanalyzer" shown in Fig. 10, which automatically inspects microscopic slides of cervical smears for cancer. Developed by *Airborne Instruments Labs*, in conjunction with the Sloan-Kettering Institute, this unit eliminates the time-consuming and painstaking microscopic examination of large numbers of slides involved in routine cancer checks. The "Cytoanalyzer" measures the light absorption of each of about 10,000 cell nuclei per slide and enters the result on *IBM* punch cards. This method provides effective screening of large numbers of definitely negative slides and will bring out any suspicious samples for further detailed study.

While we cannot visualize the day when a patient will simply drop a coin in the slot and let an automatic medical computer give him a complete physical examination, provide a punched card diagnosis, hand out a prescription and neatly wrapped medicine bottle, we can see that computers will play an ever-increasing role in the practice of medicine. Just as in industry the computing device can assume the burden of routine statistics, medical administration, and general medical data processing to remove such details from the overworked doctor's shoulders and leave him free for more important tasks.

Exploring the Brain

You have probably read of the electroencephalograph which measures brain waves. This is a very useful instrument which, together with mapping and recording devices, can help locate tumors and other brain troubles. To probe still more deeply into the mysteries of the human brain, researchers now use micro-miniature electrodes to stimulate selected sections of the brain and record electrical activity of brain tissues.

The Mayo Clinic in Rochester, Minn. has done extensive research in this area and has found, for example, that electrode currents vary with the patient's smelling activities, with his body movements, eye actions, and his state of "awakeness," with different sections of the brain reacting to various stimuli. Carried out on patients suffering from epilepsy, schizophrenia, and other mental disturbances, this method has yielded invaluable data not only about the particular patient, but about brain functions in general.

Conclusion

In all fairness to the many devoted researchers in the field of bio-medicine we must point out that many teams, at different hospitals and laboratories, often work on the same problem, interchanging their knowledge at conventions and through technical publications. We would have to devote an entire article to names were we to give due credit to all those working on the particular projects mentioned here.

In order to develop any of the electronic bio-medical techniques described, research teams are often made up of specialists not only in medicine and biology but in optics, electronics, and similar fields. Because research institutes always operate on limited budgets, electronics people have, in some instances, volunteered their services on a part-time basis. We know, for example, of a group of engineers in Buffalo who have selflessly given of their spare time to design and build the specialized electronic equipment needed in an ultra-sensitive blood-flow meter. This device is able to measure blood flow in unopened arteries which are part of the heart's own blood supply. The 1-μv. sensitivity of this device has made possible new studies of hardening of the arteries and certain heart defects.

Another group of engineers, all working for *Illinois Bell Telephone Company*, teamed up with a local hospital to design a transistorized, self-contained electronic cardiotachometer. This instrument can be carried by the patient under his clothing for as long as 72 hours and records accurately the number of heart beats.

The continued devotion of dedicated researchers and the application of the latest techniques of electronics to biomedical problems holds out the promise of continued progress in this field. As we gain a greater understanding of the life processes and are better able to deal with the many ills to which the body is heir, life expectancy should increase and better health result. ▲

"Trans-Select" Generator

(*Continued from page* 47)

sistors in the bridged-T network (R_1 & R_2, R_3 & R_4, etc.) must be matched in value. For the amplitude to remain constant on the different ranges, certain combinations of capacitors must have a proper relationship to each other. Note that the ratio between the value of C_1 (.05 μf.) and C_2 (.5 μf.) is 1:10. This same ratio must be maintained between C_3 & C_4, C_5 & C_6, and C_7 & C_8. Increasing the value of the odd-numbered capacitors in this group decreases amplitude on the range or ranges involved, while decreasing the value increases amplitude. Increasing the value of even-numbered capacitors increases amplitude, and conversely.

So much for output *amplitude* which, as has been noted, depends on certain relative values. The individual values of components in the frequency-selective network affect *frequency*. Increasing the value of a component, whether resistor or capacitor, will decrease frequency, while reducing its value will raise the frequency.

As to obtaining the needed values, it is not necessary to use components of high precision. One way of adjusting the value of a component, for example, is simply to try several different units whose tolerance includes the exact value desired until the right one is found. Other simple methods include the following: if a resistor or capacitor is somewhat low, adding a small resistor in series or a small capacitor in parallel can produce the desired increase. To reduce these components if too high, a larger resistor in parallel or larger capacitor in series can achieve the desired result. With such methods and a reliable means of checking frequency, there is no need for an unusually precise means of determining resistance or capacitance.

The best way to measure frequency is with an oscilloscope, using Lissajous figures. Full details of the method, available in many reference sources, will not be presented here. Generally, a 60-cps sine-wave signal, available from line voltage, is applied to the horizontal channel of the scope. This position is provided internally on many instruments. The output of the generator to be calibrated is fed into the vertical channel. When generator frequency is an integral multiple or submultiple of 60 cps, a reasonably stable pattern will result. For example, when generator output is exactly 10 cps, a figure with six horizontal peaks but only one vertical peak will result. Other integral ratios may be used. In any case, generator frequency is the number of vertical peaks divided by the number of horizontal peaks and multiplied by 60. For the four basic, switch-selected frequencies, the ratios for the number of vertical peaks to the number of horizontal peaks is as follows: for 10 cps, 1:6; for 20 cps, 1:3, for 40 cps, 2:3, and for 80 cps, 4:3.

This method is practical for measuring frequency and correspondingly "adjusting" component values, using the general principles already described, only on the two lowest ranges of the generator. Frequency checks on the higher ranges can be made, in each case, with reference to the next lowest range. This is accomplished as follows: Set the scope to display a single cycle of signal on the lower range, using the smallest possible amount of synchronizing voltage. Then switch the generator to the next highest range and adjust values to obtain exactly 10 cycles in the display.

In the author's unit, the sequence of adjustment began with the selection of the pair of matched resistors for R_7 and R_8, obtaining the closest possible values. Precision resistors could be used at this starting point, but ohmmeter accuracy should be satisfactory. Then install C_1 and C_2, and "adjust" their values (as described) for 80 cps.

Next switch out R_7 & R_8, with S_3, and install the other resistors, one pair at a time, individually adjusting each pair for the proper frequency if necessary. If there is a slight mismatch in any pair, adjust for amplitude as well. When this procedure is completed for the first position of range switch S_1, install the pair of capacitors, C_3 & C_4, for the next higher range, adjusting them for proper output amplitude and frequency. Then proceed in order to the two highest ranges, adjusting each range to ten times the one below it.

Accuracy can be just as good as your patience in making the adjustments. In the author's version, this was better than 5 per-cent except for the high end of the highest range. Evidence of the recommended adjustment procedure can be seen in Fig. 5, where two components are identified for such part numbers as C_4, C_3, and others.

The transistors and diode specified are about the least expensive types on the market. Virtually any general-purpose transistors and diodes should work as well, if they are more readily available. C_{10} and C_{11}, as mentioned, extend the upper frequency limit and maintain amplitude at this limit. Their values may have to be altered somewhat for different transistors, even of the type recommended.

Modifications

To meet different requirements and situations, the frequency-determining components could be dealt with in other ways. The generator could be designed to operate at a single frequency only, simplifying the number and choice of components. On the other hand, there could be a continuously variable frequency control in place of the switched frequencies. In this case, a dual potentiometer would take the place of switches S_2 to S_3 and the resistor pairs associated with them. Switch S_1 along with its associated pairs of capacitors could be retained for multiplying the basic, continuous range. The only precaution in this arrangement is that potentiometer resistance be adjusted to fall between the approximate limits of 5000 and 100,000 ohms. ▲

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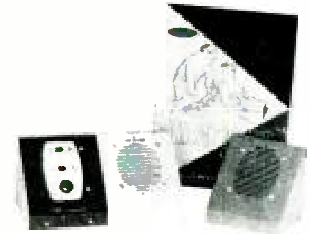

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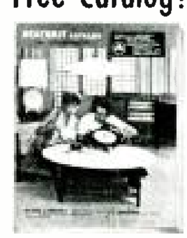

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British Audio Trends

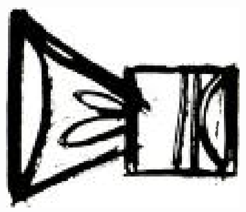
By **PATRICK HALLIDAY**

Rundown on some of the interesting products and the displays at London's 1961 International Audio Festival.

THE LATEST in audio equipment was seen and heard recently at the 1961 International Audio Festival in London, supported by more than seventy British, American, European, and Japanese firms. Prominent among the exhibits was an increasing number of high-fidelity tape recorders, ranging from the miniature, pocket-sized transistorized models by *Fi-Cord* (only 9⅝" x 5" x 2¾", but claiming a 50-20,000 cps ± 3 db response) to the larger professional recorders by *Ampex* and *E.M.I.*

A new low-distortion moving-coil loudspeaker system with a particularly clean bass response was shown by *Leak*—the firm which first pioneered 0.1 per-cent distortion amplifiers. The new loudspeaker and enclosure is relatively small—26" x 15" x 12"—and combines 13" and 3" units with a half-section crossover network. The 13" speaker incorporates a new "sandwich" cone which is ⅜" thick and provides an extremely stiff cone which, it is claimed, behaves as the theoretical ideal of a rigid piston and avoids the flexing of the cone at large amplitudes; it has no greater weight than conventional cones of paper, plastics, or aluminum. The term "sandwich" is derived from the layer construction of the diaphragm, with a skin material denser and stronger than the inner part.

The demonstration of stereo sound using two of these sandwich speakers was certainly impressive, although your reporter would like to hear the system under better listening conditions before



fully endorsing this reputable maker's claim that the stiff cone represents the "greatest advance" since the development of the Rice-Kellogg moving-coil speaker! A single enclosure and speaker is priced in Britain around the $110 mark.

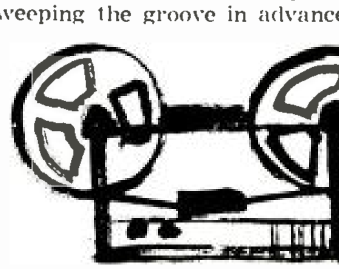
Another British maker well-known on both sides of the Atlantic is *Lowther* who has always championed the use of a single high-efficiency speaker driver unit in connection with compound horn enclosures; this year the *Lowther* range of enclosures has been extended with a re-designed "Acousta-Twin" enclosure. For stereo, only a single enclosure is used, placed in the center of the wall, offering the widest expansion of sound facing the normal listening area. It is designed to reverse the accepted Blumlein principle for stereo, that is, the placing of two microphones at a central point and angled to collect sound from a given area; the sound pattern from the "Acousta-Twin" is designed to be of the same order, with the concentration of sound in the central area, intended to give the feeling of the original.

Lowther also showed the only all-transistor hi-fi amplifier noted at this year's show and then only in prototype form. It is a direct-coupled amplifier using a symmetrical push-pull circuit with two 0C26 power transistors in the transformerless output stage; no direct current flows through the 16-ohm voice coil. Power rating of this amplifier is only 5 watts (continuous sine-wave power). Although this may seem low by conventional audio standards, it should be remembered that the unit is designed for use with this firm's horn-loaded speakers which have an unusually high electrical/acoustical conversion efficiency.

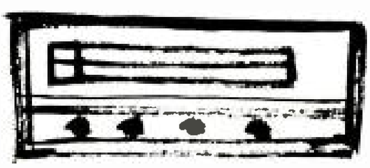
The *Quad* wide-range electrostatic loudspeaker has been in continuous production since 1957, yet continues to attract keen interest—indeed on the day this writer visited the Festival, it was one of the few demonstrations for which one had to queue. Although other makers have from time to time demonstrated speakers using the push-pull electrostatic principle, the *Quad* model remains the only wide-range speaker of this type on the British market.

A new, compact integrated 10 + 10 watt stereo control unit and amplifier in a 4"x 14"x 13¾" cabinet has been introduced during the past year by *"His Master's Voice"*—one of the brand names of the *E.M.I.* organization, long prominent in the audio field. An unusual feature is the small cathode-ray tube included for balancing and speaker phasing and with a built-in calibration signal. Independent control of each channel is provided by means of dual concentric knobs. Like many other British amplifiers, the "Ultra-Linear"-type output stage in each channel uses two EL84 tubes. The complete unit, termed the "Stereoscope," is priced in Britain at under $190.

Long popular in Britain for ensuring groove cleanliness has been the "Dust-bug" device which can be mounted either with a special arm or on the pick-up arm. It consists of nylon bristle sweeping the groove in advance of the stylus to remove dust which is then trapped on a pad which also discharges surface static electricity. An accessory seen for the first time at this year's Festival is the *S.M.E.* "bias adjuster" for fitting to their pickup arms so as to correct the force developed by friction between stylus and record. Because of the offset of the arm, this force tends to swing the arm toward the record center. The new device has no springs but incorporates a small weight suspended by nylon thread and acting on a lever attached to the bearing assembly.



The *M.S.S. Recording Company* has announced a new form of transistor sine-wave oscillator capable of delivering 1-watt output at frequencies from 1 to 100 kc. with an efficiency better than 75 per-cent. A conventional a.f. transistor of the type often found in the output stage of broadcast portable receivers is used in this circuit—full details



of which have not yet been disclosed, pending patent application. In the audio field this circuit should be of interest for erase and bias currents in portable tape recorders, and may have applications in communications and industrial electronics.

Noted among the overseas exhibits was the Japanese *Sony* "Radio Microphone"—a lightweight transistorized FM transmitter used on 27 mc. in conjunction with a tube superhet receiver. Among the many high-quality microphones were a number of *Shure* and *A.K.G.* units.

Not shown at the Festival was one of Britain's main audio talking points—the controversial Gough loudspeaker enclosure. This new cabinet enclosure, which costs under $15 to construct, has set audiophiles arguing and manufacturers busy issuing comments on the more sweeping claims put forward in some circles. The enclosure, announced late in 1960, was invented by Jabez Gough, a radio dealer in South Wales. The inventor, who developed the design empirically, considers that it conforms to no known earlier design: he claims that it differs from recognized design principles by being open at both ends, need not be constructed of particularly heavy materials, and does not contain interior padding. Gough himself makes no attempt to explain how the enclosure works. ▲

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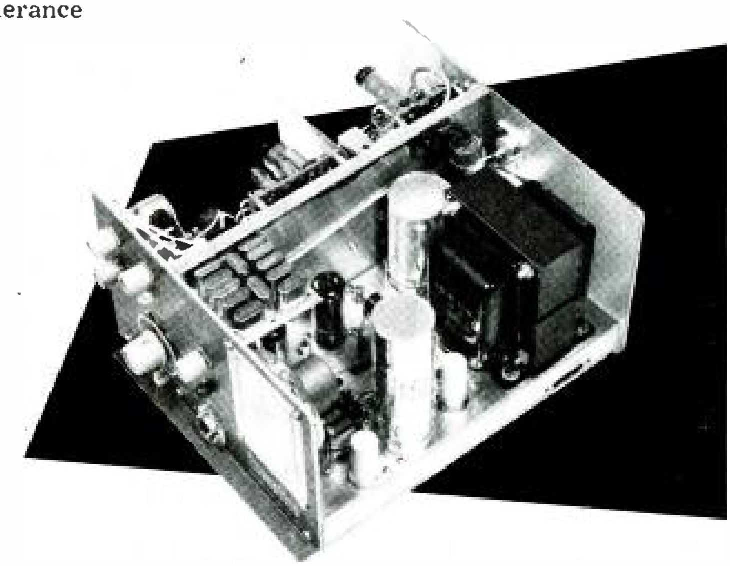

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CB Crystal Checker

(*Continued from page* 57)

lengths, etc. The coil should be expanded or compressed until capacitor C_3 covers the band.

It is not necessary to follow the author's layout. If the device is to be used solely as a Citizens Band crystal checker, the complete circuit may be built into a single box of slightly larger size. The only precaution to be taken is to keep the leads as short as possible.

Using the Tester

To check crystal activity, plug the *LC* tuning section into the crystal oscillator box. Set the meter sensitivity control to its extreme counterclockwise position to protect the meter. Plug the crystal to be checked into the socket. Throw power switch S_1 on. Vary tuning capacitor C_5 by means of the vernier dial. If the crystal is good there should be some indication of rectified r.f. output on the meter. The meter sensitivity control may then be advanced for a more convenient meter deflection while adjusting the tuning dial for maximum meter indication.

In the author's unit the meter deflected to full scale with the sensitivity control advanced to about three-quarters of its maximum rotation when checking crystals of frequencies at either end of the band—26.965 and 27.255 mc. The activity of different crystals may be compared by setting the sensitivity control for a given meter reading and then adjusting the tuning dial for maximum meter indication as different crystals of the same frequency are plugged in.

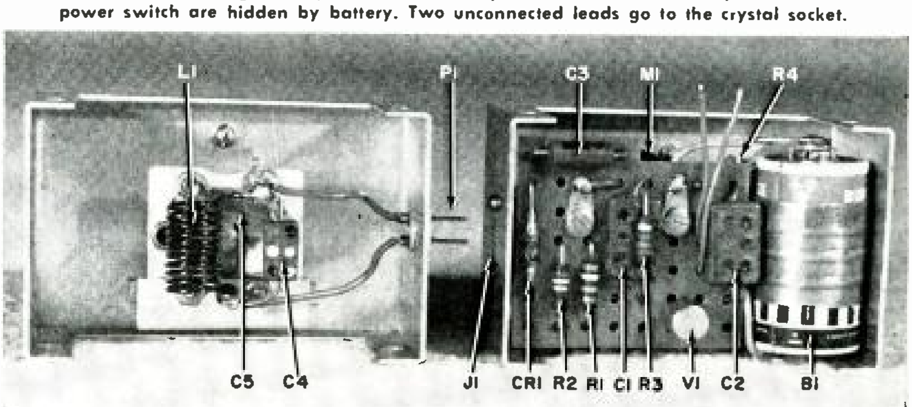
In transmitter construction work an *LC* circuit can be pre-checked with any given crystal. The *LC* circuit need not be mounted in a box but can be connected to an extra pin plug. This plug can then be inserted into the oscillator box jack and the *LC* circuit can then be tailored for optimum results with the crystal in the socket. Keep the leads to the plug as short as possible.

The crystal checker may also be set up for testing crystals and *LC* circuits of other services such as in amateur radio work. Output from the tester can be picked up on a communications receiver for checking frequency.

The constructor may calibrate the tuning dial in terms of frequency or Citizens Band channels if desired.

Since the current drain is quite small and the tester will not normally be in continuous use, battery life will be extremely long. ▲

Inside view showing small parts mounted on phenolic board. Sensitivity control and power switch are hidden by battery. Two unconnected leads go to the crystal socket.



SIMPLE CHECK FOR TV ANTENNA LEAD-IN WIRE

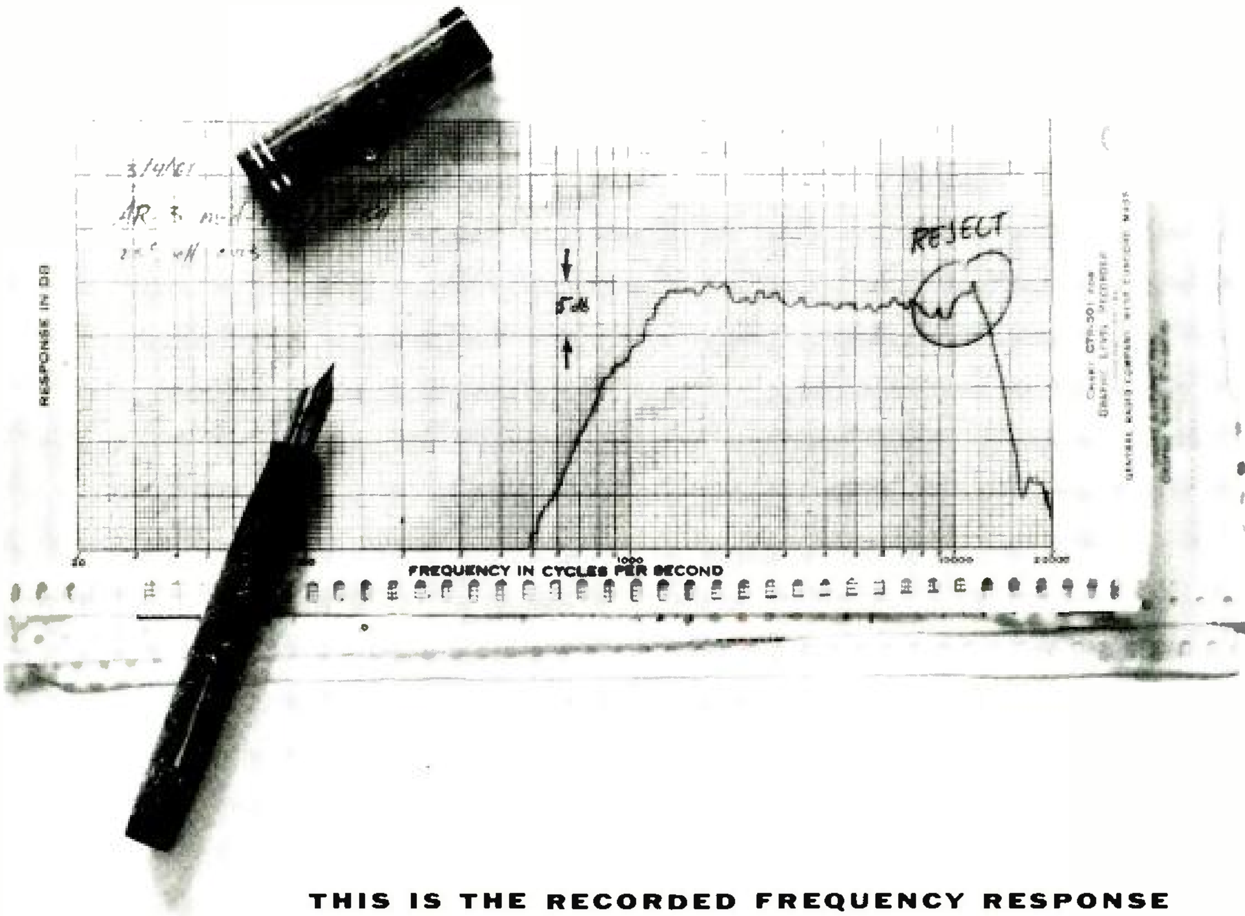
By HERB BROWN

A SUSPECTED break in an antenna lead-in, especially if intermittent, is not easy to confirm. It can be anywhere along a line that is not accessible along most of its length. However, if you own a capacitor checker, you can test this easily.

Because the pair of wires act as capacitor plates, every two-conductor cable has capacitance whose value depends on the line length. If a break exists in either side of the line, the capacitor seen at one end of the line ends at the point of the break. Many 300-ohm, twin-lead types are rated at 4.4 $\mu\mu$f. per foot, although some go as high as 5 $\mu\mu$f. If you encounter an unusual type, check this rating in a catalogue or the manufacturer's fact sheet.

Disconnect the lead from the TV set and connect the clips of your checker to the bare ends of the wire. Starting at the low end of the lowest range, rotate the instrument's "value" knob until you get a reading. Divide this figure, in $\mu\mu$f., by 4.4 or other applicable figure for a reading in feet. For example, a reading of 220 $\mu\mu$f. indicates 50 feet of unbroken line. Suppose you know (a visual estimate will do) that the lead-in is about 50 feet long. You have confirmed continuity all the way up. But suppose the wire is about 100 feet long. Your reading has not only revealed a break: it has located it at the middle of the line.

An erratic reading on the tester's eye tube or other indicator exposes an intermittent. To check for this possibility, try to agitate the line if the wind isn't helping you. A final note: the antenna element to which the wire connects may be folded dipole, which tends to place a short across the wire. If your checker doesn't give a usable reading and this is the case, disconnect the wire at the antenna end too before re-testing. ▲



THIS IS THE RECORDED FREQUENCY RESPONSE CURVE OF A REJECTED AR-3 MID-RANGE TWEETER

Although this curve does not depart from the ideal by more than 2 decibels at any point, the sharp peak at 11,500 cycles is evidence of transient distortion.

The frequency response of all AR-3 tweeters and AR-2a super-tweeters is recorded and examined critically before installation. One out of fifteen never makes it to the cabinet.

AR speakers are priced from $89 to $225. They may be heard at AR Music Rooms, on the west balcony of Grand Central Terminal in New York City, and at 52 Brattle Street in Cambridge, Massachusetts. No sales are made or initiated at these showrooms.

Literature, including a list of AR dealers in your area, is available for the asking.

ACOUSTIC RESEARCH, INC., 24 Thorndike Street, Cambridge 41, Massachusetts

Standing-Wave Indicator

(*Continued from page* 51)

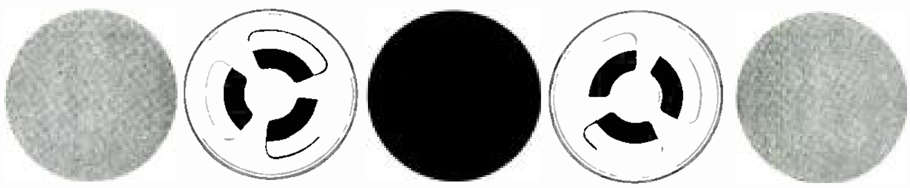
with 52-ohm coaxial cable since this is most commonly used in Citizens Band service. If some type 72-ohm cable is to be used, the indicator can be employed with this cable simply by changing R_s to 72 ohms. (This 72-ohm resistor may be selected from a group of standard 68- or 75-ohm carbon types, as suggested below for the 52-ohm types.) Ideally, special non-inductive resistors should be used but the carbon types listed serve very well for this purpose. The standard value of 51 ohms is near the value wanted and is close enough for all practical purposes. Some 51-ohm resistors, measuring slightly on the high side, may be used if the constructor wishes to hand pick these units. The supplier here cooperated in this respect. Most any diode can be used with this bridge.

Using the Indicator

For test purposes it is convenient to use an extra 51-ohm resistor soldered to a mating coax connector. To test the indicator, plug this test resistor into the connector marked J_1. Connect the output from a Citizens Band transmitter to connector J_2. Very loose coupling to the transmitter tank should be employed in order to protect the meter. The meter sensitivity control, R, should be set to its extreme counterclockwise position. This control, however, does not reduce the rectified current to the meter to zero. It simply serves as a fine adjustment in setting the meter to full scale. After full-scale indication is obtained on the meter, the coax connections are reversed, that is, transmitter output goes to J_1 and the test resistor connects to J_2. The meter should now read near zero. (Even when trying the unit with unselected 51-ohm resistors, the meter read down to 0.5 μa. when a test resistor was plugged into J_2, and 3 μa. with the test resistor terminating 25 feet of RG-58/U transmission line.)

In making antenna impedance matching tests, this same procedure is followed except the antenna coax line is used in place of the test resistor. The better the antenna-line impedance matching, the lower will be the reading on the meter. When the meter reads zero, a 1:1 s.w.r. exists, which would indicate perfect matching.

Although unnecessary for straight impedance matching measurements as just described, the constructor may calibrate the instrument, if desired, by plugging carbon load resistors of various values into connector J_2 and plotting the meter reading against the resistance ratio R_s/R_l or R_l/R_s, the larger value in each case being placed in the numerator and where R_l is the load resistor. As an example, the meter reading obtained with R_l one-half or twice the value of R_s would be calibrated as a 2:1 standing-wave ratio. For each load resistor used, the indicator must first be adjusted for full-scale meter reading as previously described. ▲



RECORD & REEL REVUE

By **BERT WHYTE**

THOSE of you who read this column undoubtedly read other record reviews in other magazines. I know I do. because I am interested in what my peers have to say and their evaluations of recordings on which I have formed my own opinions. Without being specific, it is apparent that some critics concern themselves primarily with the purely musical aspects of a recording. Still others add some technical evaluation, and some go a few steps farther in this direction.

For the most part, there is generally some expression and opinion on sound quality. Unfortunately, such information as "nice recording" and "good sound" doesn't convey a great deal to the reader who is more than casually interested in the sound qualities of a recording. I do not say this as a rebuke to my colleagues but merely to point out that such reporting isn't sufficiently differential for the more technically minded.

More often than not, when there is more involvement with the technical aspects of a recording, it is amazing to note the wide diversity of opinion. One critic will lambast a certain recording for its poor sound and, in another publication, this same recording will be acclaimed a sonic masterpiece. How come? Why this disparity?

There are variables of course . . . differing playback equipment, a variety of acoustical environments, perhaps even differences in auditory response. There is always the question of maintenance . . . is one part of the system worn or out of balance, etc.? Admitting to these variables, it would still seem that a recording which is really good should receive favorable reviews in general.

This is a complex problem and I do not pretend that I have the answer, but all the foregoing is in preface to a situation I recently encountered. Perhaps it will afford a little insight into these technical inconsistencies. At the very least, it will give you an idea of some of the odd-ball things with which we must cope and why a critic's hair turns gray!

As you are probably aware, there are quite a number of recordings on the market that appear on mono LP, then on stereo disc, and then on stereo tape. It is always interesting to compare the stereo disc with the stereo tape of a certain performance. There are expected differences, of course, and sometimes differences which are totally unexpected. For our purposes here, we will dismiss the most obvious differences.

Now I have a neat little setup whereby I can play back stereo discs and stereo tapes and get an instantaneous *A-B* comparison. I was thus engaged with a certain recording of a Beethoven symphony. I cued up the disc and the tape so that they would sync together (not an easy job, but it can be done with the right equipment), started them rolling, and began to punch the compare button.

As I have said, there were the expected differences, but there was something else. It was slight, but an absolutely definite variation in pitch! This was a stopper. The human ear is more sensitive to pitch than most people realize and it is actually capable of separating very minute increments of tone. OK, so we have a difference in pitch. The question now is whether the tape or the disc is off pitch. Or, more to the immediate point, is it the tape and disc themselves, or the turntable or tape machine which is out of kilter?

Thus began an arduous series of tests. First I checked the available voltage and current—which was right on the nose and stable. The turntable I was using has a built-in strobe with variable drive and she was as steady as a rock, both with the record alone and with tonearm in place (you would be surprised how a good strobe shows up the drag on the record surface imposed by even a one-gram pressure).

The tape machine was checked with a timing tape, then aligned and given a frequency check just for the heck of it. All was OK. Next step was to play back on the turntable an acetate I had cut on a professional *Scully* lathe, which contained a 440-cycle tone derived from a signal generator. While it was playing, I struck a 440-cycle tuning fork and beat it against the tone on the record. Again all checked OK.

I followed the same procedure with the tape machine, beating the fork against a tone on the tape and with the same results. Conclusion? In view of the accuracy of the playback drive systems of both tape and disc, it would seem that either the disc or the tape itself was the pitch offender.

Now we must enter another world of variables . . . somewhere along the processing line, between the master recording and the finished product, somebody or something "goofed." Perhaps a tape playback machine wasn't checked out that particular day and, although they are mechanical marvels, a lathe might have been slightly out of whack, or perhaps one of the tape duplicating slaves was off.

Let us consider the possibilities in dimensional stability of the final product. Here the nod must go to the disc, because vinyl is relatively inert and expansion and contraction are so minute as to be disregarded. Tape, on the other hand, is subject to a certain degree of stretch, especially after repeated play, but this too can largely be ignored. It is true we are splitting hairs here . . . the erudite critic blessed with perfect pitch can put on the "D Minor" symphony and tell you right off whether or not it is on pitch. However, for his slightly less gifted peers and in the interests of accuracy, one solution might be to incorporate on a production tape or disc, at some appropriate spot, a 440-cycle "A" which could function as a standard with which he could compare a standard "A" tuning fork.

Big question . . . this is but one of the phenomena likely to be encountered. There may be others which, in the long run, contribute to the diversity of opinion on sound quality in a given recording. The final arbiter is your own ear. Given reasonably good equipment which you keep in top shape, if you think a certain disc or tape sounds good—a view contrary to what some of the critics say—I say a pox on the critics . . . enjoy yourself!

ALBENIZ
IBERIA (Orchestral Version)
RAVEL
RHAPSODIE ESPAGNOLE
Paris Conservatoire Orchestra conducted by Jean Morel. Victor Stereo LSC-6094. Price $11.95. Two discs.

The Ravel is an adequately performed "filler" in this album, the real treasure being the "Iberia" orchestration. Originally scored for piano, the various sections have been set in orchestral form by Enrique Arbos and Carlos Surinach and their tonal colorings are the very essence of the Spanish musical idiom. One has but to listen to this music for a few bars and it is instantly recognizable as a Spanish utterance.

The twelve sections are widely varied in mood and expression. Perhaps the most famous is the "Feast Day in Seville," which is a masterpiece of massive sonorities.

Morel is a very perceptive interpreter and his reading sounds completely authentic. He intrudes none of his personality but lets the music speak for itself. Above all, he pays strict attention to the indicated tempi and elicits some surprisingly brilliant playing from the not-always-too-reliable Paris Conservatoire Orchestra.

(*Continued on page* 86)

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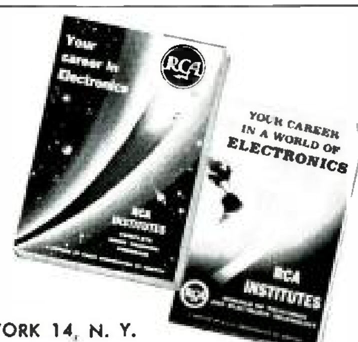

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PACIFIC ELECTRIC BLDG., 610 S. MAIN ST., LOS ANGELES 14, CALIF.

RCA The Most Trusted Name in Electronics

This is generally a good, clean sounding recording with but a few of the triple *forte* peaks a little on the "blurred" side. The stereo is good in both depth and direction, although the depth has been achieved somewhat at the expense of orchestral detail and "presence." Nice wide dynamic and frequency response. These are delightful listening—a refreshing change from the usual symphonic diet and I recommend this album to your attention.

SEA SHANTIES
Men of the Robert Shaw Chorale conducted by Robert Shaw. Victor Stereo LSC2551. Price $5.98.

This is one of the saltiest albums to appear in a long time. If you have a friend who is a sailing bug and he invites you to crew for him, I can't think of a gift he would appreciate more than this.

When I was very young and foolish (maybe romantic is a better word), I had an experience few men can share today . . . I made two voyages in four-masted sailing ships. These were the *Herbert Rawding* and the *Constellation*. The *Rawding* rots in some forgotten harbor and the *Constellation* tore her vitals out on a reef near Bermuda. When she went down she took with her several thousand cases of *Johnny Walker* and other assorted goodies. One of these days, if she is not too deep, I'm going to strap on my scuba and give the old girl another look.

The crews of these ships were one part wet-nosed kids like myself and the other part ancient "shellbacks"—many of whom had rounded the Horn on such great old ships as the *Grace Harwar* and the *Pamir and Ponape*.

It was from these utterly fascinating characters that I first heard sea shanties (or chanties, if you prefer), many of which are on this album. So I listened to this with more than a little nostalgia. Needless to say, although the cracked and whiskey-baritones of my old shipmates may have been more authentic, the superbly trained voices of the Robert Shaw Chorale are much more pleasant to the ear.

They sing all the great favorites, from the immortal "Blow the Man Down" to the haunting "Shenandoah" and the lusty "What Shall We Do with the Drunken Sailor?". One of the most beautiful—and done here with wonderfully rich blending and sonority—is "Lowlands."

The recording is exceptionally clean with the voices projected well forward and the presence outstanding. The various choirs are perceived with fine directionality and the acoustics are handled well, to afford a nice rounded spaciousness and depth.

So, tell the boatswain to pipe all hands to "splice the mainbrace" (have a drink, in landlubber parlance) to toast a wonderful album.

WAGNER FOR BAND
Eastman Wind Ensemble conducted by Frederick Fennell. Mercury Stereo SR90276. Price $5.98.

As might be expected when Fennell's spirited group turns its attention to something as rich in sonority as the music of Wagner, the result is slightly overwhelming.

Although scoring what is essentially an orchestral piece for band is not altogether favored by Fennell, once set on the path he comes up with some fabulous sounds. In excerpts from "Lohengrin," "Rheingold," and "Parsifal" he leads his bright youngsters in readings of great power and vitality. The album opens with the "Prelude" to Act 3 and the "Bridal Chorus" from "Lohengrin." Then we are treated to some huge brass and percussion in a great outpouring for the "Entry of the Gods into Valhalla," the "Cathedral Procession" from "Lohengrin," a really rousing Overture to "Rienzi," and the "Good Friday Spell."

The sound throughout is very clean and of great dynamic compass. The stereo was well handled as to depth and direction, with the superb acoustics of Eastman Theatre lending their customary aid to the recording.

The only disappointment was in the "Valhalla" wherein I thought *Mercury* would come up with some stupendous sound to challenge what *London* did in their memorable recording of the complete opera. But this is but one point and the rest is more than worth the price of the album.

Now that Fennell has broken the ice with this recording, I hope we can look forward to many other great transcriptions for band which have lain fallow for many years.

BEETHOVEN
PIANO CONCERTO #1
SONATA FOR PIANO #31

Andor Foldes, pianist, with Bamberger Symphoniker conducted by Ferdinand Leitner. Deutsche Grammophon Stereo 138636SLPM. Price $5.98.

This album is a bit of a surprise, since Foldes is much better known for his interpretations of the moderns—most especially Bartok. Still, I suppose every pianist wants to do Beethoven. While Foldes' performance will not cause Richter or Rubenstein any sleepless nights, one can be fair and say that if it is not a performance on that lofty scale, it is at least an honest reading, making no pretensions and Foldes plays it straight.

Technique this fellow has and superb phrasing is the best of it. Now, if he could manage a bit more warmth and be a little less stiff, his reading would go up the ladder a great many rungs. He gets a fine, sympathetic, and knowing accompaniment from Leitner, who has always been a first-class Beethoven man.

Soundwise, this is a departure from the usual M/S stereo of *Deutsche Grammophon*. The sound has much more pronounced directionality and much more presence and orchestral detail, yet they have managed to retain their good depth effects and fine acoustic handling. The piano is nicely centered and stable too. All of which leads me to believe that this is either a new and unusual modification of the M/S technique or an American-style three-channel recording.

Everything is fairly clean with the

first strings sounding a little coarse and wiry at times. Good dynamics were a feature, but most surprising of all, surfaces were a little "ticky"—something *Deutsche Grammophon* has rarely been guilty of in their recordings.

DELIBES
SYLVIA (Excerpts)
COPPELIA (Excerpts)
Paris Conservatoire Orchestra conducted by Hugo Rignold. Victor Stereo LSC2185. Price $5.98.

Those who are real balletomanes will probably want to get the superb complete editions from either *London* or *Mercury*. Those who want just the meat of these ballets, with most of the familiar numbers, will find this an attractive album.

That urbane and affable chap, Hugo Rignold, is an old hand with ballet and affords a completely satisfying performance. The orchestra plays very well for him and between them they manage to impart a really balletic feeling to the works.

The sound is big and bright, with good stereo direction and depth and no audible distortions. Nothing world-shaking here, but a highly listenable disc all the same.

LALO
CELLO CONCERTO IN D MINOR
SAINT-SAENS
CELLO CONCERTO IN A MINOR
BRUCH
KOL NIDREI
Pierre Fournier, cellist, with Orchestre Lamoureux, Paris, conducted by Jean Martinon. Deutsche Grammophon Stereo 138669SLPM. Price $5.98.

Fournier is, of course, one of our major talents on the cello and here he gives fresh evidence to support his reputation. His work on this disc is exemplary, but if one must choose the best among the works, I would pick the Saint-Saens. Here his bowing is magic, such wonderfully modeled phrasing and rich sonorous tone are a delight to the ear.

Martinon is effective as usual, although I question some of the balances at times. This may, however, be less Martinon and more the engineer's fault. I may be wrong but this sounds as if it were recorded at the Salle Pleyel in Paris, a hall for which I have no great love. It is a difficult place to record, especially for stereo and what seems to have happened here is that the over-all sound is slightly coarse and the balance between cello and orchestra is variable. At times the cello covers the orchestra and at other times the orchestra covers the cello.

Again in this disc I feel a departure from the usual M/S technique has been made and the result is greater presence, more directionality, and more "close-up" sound which, if the *DGG* boys can bring under full control, should give us some fine records in the months to come.

On The Lighter Side

POP CONCERT IN SOUND
Richard Hayman and his Orchestra. Mercury Stereo PPS6010. Price $4.98.

This recording will send the purists howling for cover. What Hayman has done is take snippets of familiar classical pieces like "Ritual Fire Dance," "Sabre Dance," "March Militaire," "Danse Macabre," etc. and score them for a light pop orchestra and in the fullest type of ping-pong stereo imaginable.

I can hear the composers moaning now, but for those folks who can take or leave their classical music and whose taste doesn't encompass the usual concert-hall versions, this may be just the ticket.

One can't deny the arrangements are clever (Hayman makes lots of the Boston Pops arrangements) and the stereo speaks very strongly for itself with ultra-close-up of big, bright sound that also has depth *via* the echo-chamber route. Plenty of blustery brass and percussion here—all nice and clean, so turn up the volume control.

JEWELS OF THE SEA
Les Baxter and his Orchestra. Capitol Mono T1537. Price $4.98.

If you are familiar with Baxter's other record excursions into exotically and colorfully scored lush and romantic type music, here is more of same.

This is all original writing and here he has produced a sort of tone-poem of the sea in twelve sections, depicting the various moods of the sea. The sections are all titled such as "Sunken City," "Sea Nymph," "Dawn Under the Sea," etc. OK, so a lot of this is pure corn, but there is a crackerjack orchestra playing the undeniably colorful orchestrations and, from a strictly sonic viewpoint, this is first rate.

All is nicely balanced and clean, with excellent string and woodwind sound and, of course, a plethora of Baxter's beloved percussion, mostly of the high, tinkly variety. As good as it is here, stereo is practically mandatory for this type of music and I wish *Capitol* would send me the stereo version instead of the mono.

THE ROMANTIC APPROACH
Stan Kenton and his Orchestra. Capitol Mono T1533. Price $4.98.

Stan has essayed just about every style in his constant experimenting with new sonorities. Here he is on a romantic kick, playing all the evergreen romantic ballads like "When Your Lover Has Gone," "All the Things You Are," "Once in a While," and others of similar persuasion. But how they are played and with what an orchestra! Dig this if you will . . . 5 trumpets, 4 trombones, 5 saxes, 4 mellophoniums (designed for Kenton), tuba, drums, bongoes, bass, and Stan's piano.

The numbers are mostly slow beat stuff you could dance to, but when that brass armamentarium lets loose in some of Stan's massive outpourings, the walls shake. The over-all sound is clean except that when the tuba, mellophoniums, and trombones are playing in unison in some of the lower registers, there is a coarsening of the sound due to the natural intermodulation that occurs among these instruments when they play in this fashion.

Frankly, I prefer the crisp, clean

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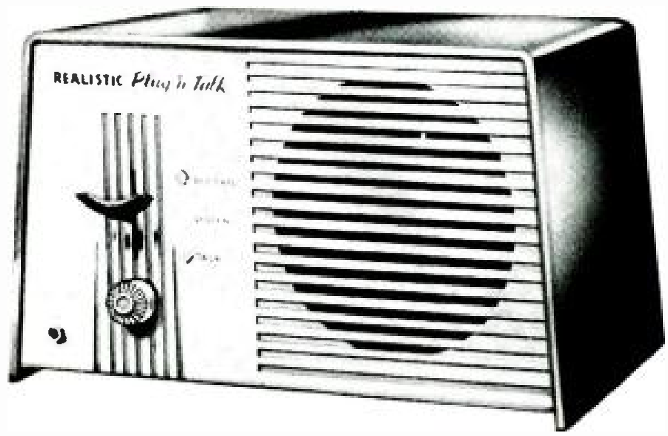

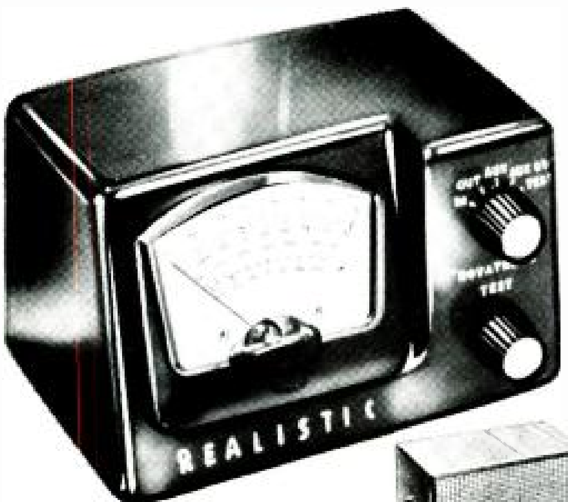

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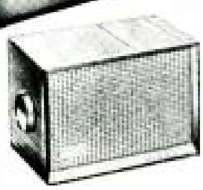

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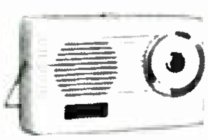

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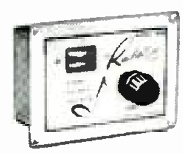

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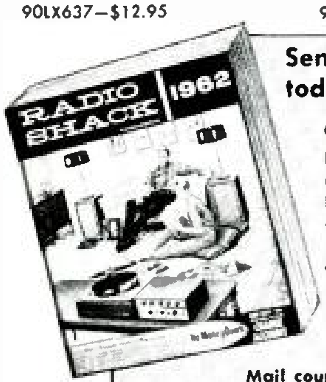

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power-drivin' Keaton of the "Intermission Riff" days, but it doesn't seem as if we are ever going to get any more sound like that. Once again, this would have benefited greatly by stereo and should be the version to buy if you are so equipped.

TAPE TOPICS

About the only new thing to report on in the tape world isn't strictly tape. *Westrex* has marketed a combination transistorized radio with a unique playback system. This uses the cartridge concept, the cartridge itself being a gray plastic affair, quite large by other cartridge standards—measuring roughly 3" x 4" x 2½" thick. A belt of red vinyl, about 1 inch wide, is looped around the playback slot after the cartridge. Twelve individual selections are recorded on the belt and each is individually selectable, *via* a sort of cueing wheel.

Now here is the kicker . . . the recordings on the belt are reproduced by a tiny needle! Yessir, you can drop this needle onto any of the 12 channels and out of the speaker comes some fairly respectable sound. The amount of needle scratch I heard was negligible. You can play the belt through in automatic sequence, which will give you about an hour and a half of music or you can play what you wish *via* the selector wheel.

Is there any future for this sort of thing? I dunno. I can't see why a needle should have any advantages, other than cost, over a conventional magnetic head. There would seem to be a wear factor and the size of the cartridge would appear to be a stumbling block. On the other hand, who knows what the engineers can come up with after further refinement?

HAYDN
SYMPHONY #101 IN D
MOZART
SYMPHONY #40
Vienna Philharmonic Orchestra conducted by Herbert von Karajan. Victor Stereo FTC2080. Price $8.95.

Herr von Karajan here and with results if not quite as salutory as other discs, at least worth listening to. His approach to the Haydn I thought a shade too pedantic and a bit stiff, while the Mozart he whipped up the tempi here and there and inflicted a few other mannerisms which keep it out of the top bracket.

Oddly enough, the small deficiencies in sound noted elsewhere have been cleared up on this tape. There is no stridence at all here—all is bright and clean, with beautiful woodwind sound. Reverb hasn't increased much but enough to lend some depth. Direction here was excellent and over-all balances well handled. The increase in orchestral detail and the very definite central image leads me to believe that they are now employing American 3-channel techniques in Vienna, which is all to the good, especially as one might anticipate its application to some forthcoming operas. ▲

Squelch Circuit for Wireless Intercom

By L. M. DEZETTEL / Allied Radio Corp.

An unusual circuit that provides for speaker muting between calls and keeps out triggering transients.

EARLY models of the wireless intercom, using house wiring for signal transmission, were subject to considerable noise and hum pickup. Annoying "hash" in these units often led the user to reduce speaker volume to the point where he would miss incoming calls.

This deficiency has been largely overcome with the signal-operated squelch to be described. With the addition of this circuit, only receipt of a desired signal "opens up" the intercom's audio stages for amplification. During standby periods, the speaker remains silent. The system herein described is used by *Allied Radio* in its "Knight-Kit" wireless intercom. It is designed to provide speaker muting between calls and render the unit insensitive to sharp transients which tend to falsely trigger the squelch.

Basic Circuit

A block diagram of the intercom is shown in Fig. 1. It can be considered a radio-frequency transceiver. When the selector on the front panel is thrown to the "Talk" position, the loudspeaker functions as a microphone and voice currents are built up in the three-stage amplifier V_2, V_3, and V_4. Audio power modulates the oscillator V_1. The radio-frequency output of the oscillator is nominally 180 kc. although it may be retuned and shifted if more than one intercom system is to be used on the same power line. The modulated r.f. is impressed on the line through a link on the r.f. oscillator coil.

Switched to "Listen," the circuit performs as a receiver. The oscillator is now a diode detector formed by the control grid and cathode of the tube. The plate and screen are de-energized and grounded by the switch. The rectified carrier is applied to the volume control and is available for amplification.

The circuit, just described, is subject to all manner of interference: from sparking of electric motors and a variety of other transient disturbances existing along the power line.

The Squelch Circuit

The heart of the squelch circuit is V_2, a tube which has a dual function. When the intercom is on "Talk," it acts as a conventional mike preamp stage to amplify the low-level output of the speaker (operating as a microphone). On "Listen," however, the received signal is adequate to drive the circuit without an assist from a preamp stage—and the tube is freed for squelch purposes. All necessary connections are made as the selector switch is thrown from the "Talk" to the "Listen" position.

A schematic of the stages involved in the squelch action is shown in Fig. 2. The output of the detector, audio with a d.c. component, appears at the top of the volume control where a split-up occurs. Audio proceeds to the grid of V_3 for amplification, while d.c. (rectified carrier at several volts negative) is applied to the grid of the squelch tube V_2. The resting plate current of V_2 drops under the biasing effect of the signal. The direct result is a rise in V_2 plate voltage of approximately .5 to 25 volts.

The screen of V_3 is tied to the plate of V_2 through a 470,000-ohm resistor. This coupling causes the screen voltage to rise correspondingly and V_3 is now capable of normal amplification. Audio impressed on its grid by the volume control is able to proceed through the circuit and drive the loudspeaker.

The squelch tube can be considered a switch in the screen circuit of V_3—its operation keyed by signal action. This, however, is not the complete solution to the muting problem since the circuit is still susceptible to power-line transients which happen to occur at frequencies on, or near, 180 kc. The effect of this interference is to open and close the squelch with an audible burst of noise in the loudspeaker. Fig. 2 shows the method of preventing this. A 470,000-ohm resistor and a .1-µf. capacitor in the screen circuit form an *RC* time-constant circuit which grounds noise transients. The values were chosen to provide enough delay to reduce impulse-type noise which is, characteristically, of short duration. The desired signal experiences little significant loss in the *RC* network.

Performance

In operation, the circuit performs well under weak-signal conditions—one of the more important criteria for judging squelch action. With approximately 58 µv. of r.f. signal on the line, the squelch opens up the controlled audio stage for usable signal reception. In the absence of the carrier there is about a 50-db reduction in loudspeaker output, a figure that cuts objectionable pickup below the level of audibility. The sensitivity of the circuit eliminates the need for a squelch-adjusting pot, usually found in older units, for determining the muting threshold. ▲

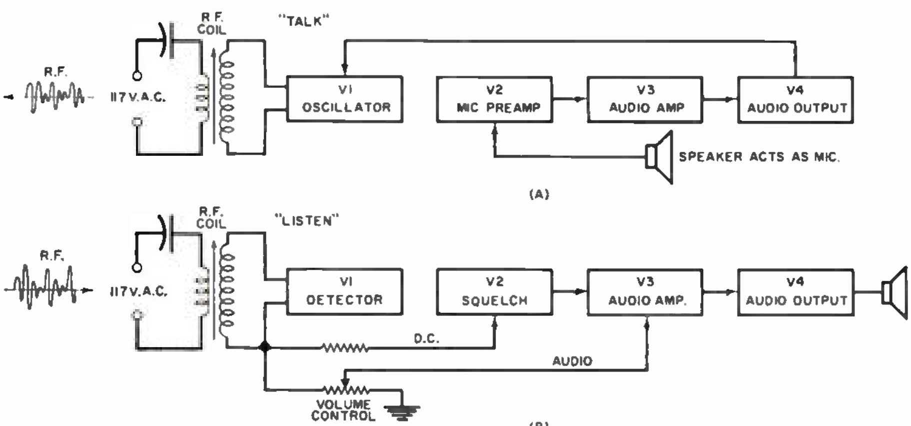


Fig. 1. Block diagrams illustrating circuits used on "talk" (A) and "listen" (B).

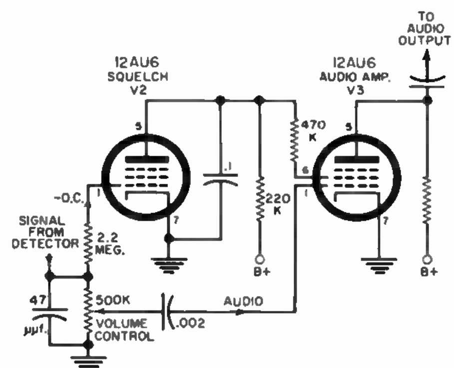
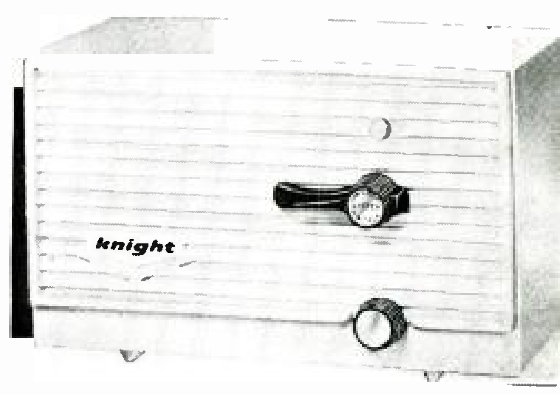


Fig. 2. Simplified schematic diagram of squelch tube and controlled amplifier.



The intercom that incorporates the squelch.

ALUMINUM DIALS AND NAMEPLATES

By *HERBERT FRIEDMAN*

Small lithographic plates may be employed for custom dials and nameplates to dress up prototype and experimental models of electronic equipment.

MANY a fine piece of prototype amateur, experimental, or even custom-shop equipment is marred by a poorly made dial or nameplate—reflecting very little credit on the builder who has expended so much time and effort in constructing the instrument itself.

Admittedly, if there is no commercial nameplate meeting the requirements, the easy and usual recourse is to a grease pencil, "Labelon," or "Eveready" tape. Yet, if we consider how commercial nameplates are made, it becomes apparent that a process exists whereby quality dials and nameplates can be made without difficulty right on the workbench.

Commercial nameplates—be they of anodized aluminum, etched aluminum, or just plain paper—are generally made through either screen or offset printing. For our purpose only the offset process will be considered.

In the offset process a lithographic (litho) plate is prepared on which the characters or background are represented with ink (or special resist). The ink is transferred by a "transfer blanket" to the material used as a nameplate.

It is the litho plate, usually made of aluminum or zinc, which gives us the basis for "custom-made" aluminum nameplates. Basically, a litho plate is a piece of aluminum coated with a photosensitive diazo compound. When a litho plate is exposed to light through a negative and then developed, the diazo areas which are not exposed are dissolved and removed by the developer. The exposed diazo compound remaining on the plate has the ability to absorb ink. Normally, the plate is inked, locked in an offset press, and then used to print nameplates.

If a fast-drying ink is combined with the developer, the litho plate is developed and inked simultaneously. When the ink is dry, the litho plate itself can be used as a dial or nameplate. The inked litho plate appears as the usual nameplate—aluminum characters with a color background or colored characters with an aluminum background. The plate, being the approximate weight of foil, can be trimmed with scissors, shears, or a paper cutter.

The processing of a litho plate *is not* similar to nor as difficult as the processing of photographic printing paper. The processing of a litho plate is performed under subdued room illumination. As for developing-inking, a small quantity of developing ink is poured on the exposed litho plate and rubbed in with a damp sponge. That is all there is to it. The process is quick and inexpensive. In less than five minutes an entire 8"x 10" plate of nameplates can be made at a cost of under three dollars.

While a negative is necessary for the preparation of a litho plate, the usual photographic negative is not needed. The original dial or nameplate drawing can be used as the negative. In this instance a reverse nameplate is produced. Fig. 1 is the original drawing of an instrument dial. By using the drawing as a negative, a completed dial appears as in Fig. 2. For sharp characters, the drawing must be prepared on a very thin material since the amount of "spill" of the exposing light source is a direct function of the thickness of the drawing base. A .0025 matt-surface, polyester drafting film will give the sharpest reproduction.

The artwork can be prepared in many ways. Fig. 4 shows an instrument dial lettered with *LeRoy* (*LeRoy* or *Letterguide* produce the neatest lettering). Maximum density is achieved in the lettering by using an acetate drawing ink.

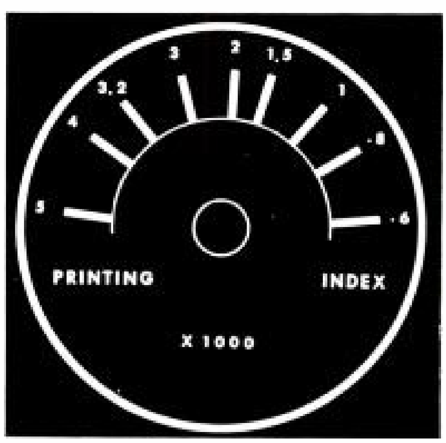


Fig. 2. The use of the drawing as a negative produces this negative dial directly.

Fig. 3. Print-quality nameplates are made by using adhesive letters and lines.

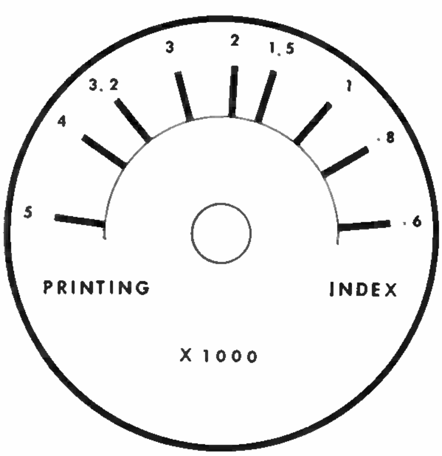


Fig. 1. The desired dial drawing, prepared by combination of adhesive letters and ink.

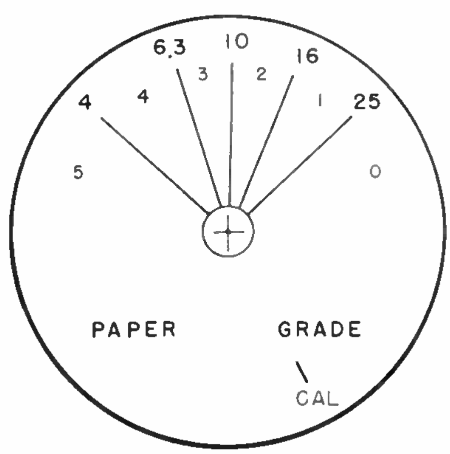


Fig. 4. Dials may be made with LeRoy lettering. Intermediate negative produces positive.

It is very important in working directly from the drawing that the characters be a dense black. If the inking of the drawing varies from light to dense black, this disparity will be even more pronounced on the nameplate.

If print-quality characters are desired, the letters and lines can be done with adhesive characters similar to *Artype*. In this instance the characters are arranged as desired and then pressed against the polyester film. The completed drawing appears "professional" and produces quality of the type illustrated in Fig. 3. For complex dials, adhesive characters can be combined with inking—in which case the adhesive characters should be applied after the inking. The dial shown in Fig. 1 is such a combination.

When the drawing is completed it is placed face up on a litho plate and locked in a printing frame or covered with a piece of weighted glass. The plate is then exposed for two minutes by a No. 2 photoflood placed 12 inches from the drawing. After exposure, developing ink is rubbed over the plate until the desired density is obtained. A water rinse removes the excess ink and the nameplate is completed.

For positive dials, Fig. 1, an intermediate negative must be used. A lithographic film is necessary for maximum contrast, however a high-contrast film such as Contrast Process Ortho will give adequate results. If you are unable to make your own negatives, the local litho supplies dealer can recommend a negative processer.

The nameplate can be mounted either with screws or contact adhesive although the latter will give the easiest and firmest mounting, particularly on curved surfaces.

While it is possible to assemble the necessary supplies from various sources, much time and effort can be saved by purchasing a Nameplate and Panel Kit. These kits sell for around seven dollars and contain the required supplies: 8x10 litho plates, developing ink, three sets of adhesive letters, printing glass, and mounting adhesive. Such kits are available from some of the larger electronic parts dealers, *Allied Radio* for one, and from the *Keil Engineering Co.*, 4356 Duncan Ave., St. Louis 10, Mo. ▲

"He said he would take the set out and clean it off when we paid the bill."

Personal, Portable TV

(*Continued from page 40*)

opens out with little more difficulty than a road map (and goes back together easier than some). Most of the circuitry is on three plug-in printed boards that fit around the neck of the tube. To free the boards, you must remove the two metal strips that support them at the top (Fig. 2). The shorter strip is released by removing the one screw (circled) that holds it. The longer strip is held by the two screws circled in Figs. 2 and 3. Two other screws, circled in Fig. 3, must also be removed to free the heat sink for the horizontal output transistor, which is attached to one of the boards.

With the boards removed (Fig. 5) you can reach anything on or off them with ease. Most connections to and from the boards are made through the keyed, multiple, plug-in sockets visible on the chassis. A few others are made through clearly identified leads that can also be unplugged (Fig. 5). Board *B* includes the video i.f. and detector section. Sound, video-amplifier, and sync circuits are on board *C-D*. Vertical and horizontal sweep circuits fill board *E-F*. Component sides are shown in Fig. 5. Component, voltage, and connector markings are indicated on the wiring side.

How about the availability of replacement parts, service, and service data? *Sony* is making the same effort to provide these that it has done with its radios. The set comes with a 90-day warranty on labor and a year on parts. A network of manufacturer installations will provide service and/or parts, but service data, in preparation at this writing, will be available to independents.

Most parts will take domestic replacements. The manufacturer obligingly provides on request a list of domestic equivalents for most of the transistors used. For some of the special types however, such as certain transistors used in the sweep circuits and the tuner, there are no such equivalents. This also applies to the picture tube. Anxious to avoid replacement problems, *Sony* is introducing the TV set in one part of the country at a time, as it can be sure that replacements and service will be available.

The set's schematic is generously marked with waveforms, and amplitude designations are indicated. Obviously, the scope is going to be a major trouble-shooting instrument when service is needed.

Although service techniques will differ from those used on tube-TV receivers, they should not be radically different from the methods required on the two other transistor sets already on the market. For that matter, the techniques probably will not differ much from those that will be useful for other transistorized TV receivers not yet born. Such sets are inevitable in the future. The service technician, as he has done in the past, will doubtless take these innovations in stride. ▲

SERVICE INDUSTRY NEWS

IF LICENSING itself has not swept the country from coast to coast, it cannot be said that all legislation pertaining to the service industry has experienced the same sort of slow going. Laws requiring the proper labelling of picture tubes with respect to whether they are all new or have been rebuilt, for example, are now in force in three states, although pressure for legislation of this type developed many years after the first license bill was proposed. Ohio and Pennsylvania are the two recent states to get on this bandwagon. Legal requirements and obligations of service dealers who sell replacement tubes are essentially the same as in New York State, where a similar law went into effect over a year ago. For further details, see this column in our issue of November 1960, page 106.

In Ohio and Pennsylvania, the labelling laws were supported by the statewide service associations. There is good reason for the fact that industry groups are having less trouble getting such regulations than has been the case with licensing: another powerful interest is also promoting labelling. The big glass manufacturers who produce the CRT shells have a stake in the matter. Three states out of 50 doesn't sound like an important trend—until we consider that these three account for 21 per-cent of the total U.S. population and 23 percent of all replacement picture tubes sold in the nation.

California Apprentice Program

On another front, the apprentice training and journeyman program fostered by the California State Electronics Association is well under way. State certificates are being issued to service technicians in that part of the country right now. Since CSEA's own complete program operates in addition to the official one, many of these men are also receiving association certificates designating them as master technicians or in other categories. State journeymen certificates are being issued to men who have passed the CSEA apprentice training program, another CSEA-nurtured project.

The apprenticeship program starts out with trainees who are placed in the shops of association members at half of journeyman pay. Training standards and requirements have been worked out in cooperation with local educators, who function on the Trade Apprenticeship Committee. A carefully planned course in theory and manipulative skills, involving classroom and lab work, is coordinated with the shop activity.

One of the goals the proponents hope to realize from their plan is the stabilization of industry wages. (Apprentices advance from the half-pay start to full journeyman wage at stated intervals.)

Another benefit that should be noted, not entirely divorced from the wage issue, is some relaxation of the manpower problem. While "tube pullers" of questionable qualification will probably always be available in sufficient numbers, there is now and will continue to be a real shortage of properly trained men to function in the service industry and other areas of electronics. The California approach is bound to encourage more people to enter the industry on a legitimate basis.

Decisions in Indiono

Three affiliates of the Indiana Electronic Service Association recently elected to join NATESA. This trend within IESA began more than two years ago, when ITTA of Indianapolis, a leading affiliate, decided to enter the national. The new groups include FESA-Fort Wayne, RTSEA of Anderson, and TVB of Elkhart. While some groups within the state body are still reluctant to take the step, this increases pressure for state-wide association with NATESA.

Meanwhile ITTA was having other problems in its own back yard, Indianapolis, with the launching of a new, local service company that is promoting itself by offering free TV tube testing in the home. Principals behind the new organization were reported to be six ITTA members, otherwise in good standing, who are trying it out as a sideline.

Considering the past record of such service companies, a group of ITTA members has drawn up charges against the six, on the grounds that such an operation is detrimental to the policies and aims of the association. The six contend that they should not be held responsible for what others may have done. As far as they are concerned, they intend to run a clean, legitimate business offering a service that appeals to a certain type of customer. Taken up at a recent meeting, the matter generated so much discussion that other, pressing business was put aside. Finally, the charges were dropped for the time being, but it is not likely that the matter will rest there. One of the claims made by the six is that they are acting in behalf of all Indianapolis service dealers to combat the effect of drug-store checkers and other, questionable, "free-test" operators.

Thus we have another issue, disruptive of unity, that can easily spread to other parts of the country. How ITTA finally resolves the matter will be of interest to all service people.

Service Income Shifts

That the problem of the drug-store checker cannot be ignored altogether is reflected in a letter to "TSA News," the Delaware Valley organ, sent in by a member. He is primarily concerned with the reasons for his own ultimate decision to join an association, but the ground he covers in the process has other interest. His moment of revelation came last January when his accountant told him that he had made less last year than in preceding years.

This was quite a blow to the reader, an established operator who had considered his position secure for years and who knew he was just as busy as ever.

After a session with his records, he came up with some hair-raising figures. The anticipated rise in overhead was not a serious factor. However, tube sales were found to have dropped 60 per-cent, battery sales 45 per-cent, and accessories 54 per-cent. Although this man's volume of sets handled had gone up (radios by 13 per-cent, TV sets by 18 per-cent), losses in the areas noted were enough to account for the serious drop in profits.

Checking further, he soon discovered that his experience was not unique. Other shops in the area confirmed that the same thing was happening to them. His distributor salesmen also acknowledged the trend. Believing that the reasons for his decreased income involve problems that can only be handled by group action, he elected to join TSA.

Service of Air Purifiers

One of the measures perennially suggested to counteract dwindling profits is diversification into service of products other than TV. To a certain extent, such activity will be inevitable as new electronic devices for the consumer reach the market. The electronic air purifiers that seem to be capturing the public's fancy are a case in point. This equipment is being sold without the growth of correlated service establishments. Nor need there be such growth. Herman Shore, president of TSADV, has written a letter to the *Philco* people expressing appreciation for their cooperation with independents with respect to service on the "Ionitron" purifiers. The TV service dealer is the "natural" inheritor of work on such devices. He will do himself no harm by getting familiar with the equipment before he finds one on his bench. Our July 1961 issue, incidentally, carried a helpful article.

FTC Wholesale-Retail Stand

At their otherwise successful "Telerama" and convention in Atlantic City, New Jersey, members of the Tri-State Service Council heard unpleasant news about a long-term industry problem. For years, service dealers have been hoping to get the Federal Trade Commission to take action against wholesalers and distributors who have sold freely to the public at the same prices they charge legitimate dealers. Basis of the complaints is the fact that unfair competition is involved. An FTC letter, addressed to complaining service dealer Leon Skalish, says there is nothing to stop a distributor from engaging in this practice. Furthermore, a distributor is "under no legal obligation to sell to dealers at prices which will enable them (dealers) to compete with their supplier on sales to consumers. In a case where the distributor sells to consumers at prices which his dealers cannot meet, the distributor is simply making use of his lawful competitive advantage." ▲

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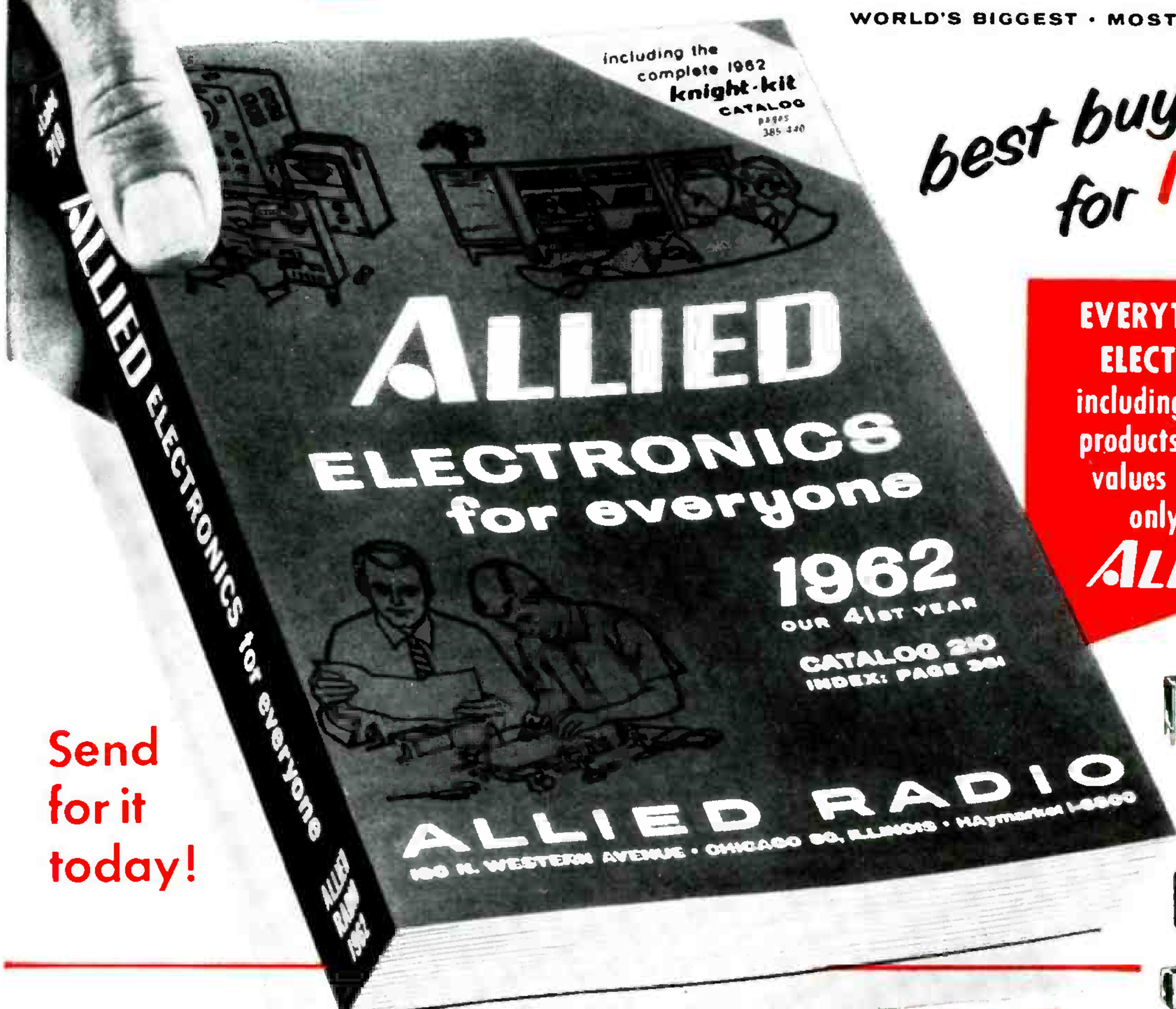

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Product Test Report

(Continued from page 24)

put produced the same output. Hum levels were lower than *Fisher* specs, being better than 82 db below 10 watts on high-level inputs and 70 db below 10 watts on phono inputs.

The X-1000 is a rather large, heavy unit, some 16-7/16" wide and 14-3/8" deep and weighing 44 pounds. Its 4-13/16" high panel, finished in brushed gold, matches the *Fisher* 202-R tuner. The X-1000, selling for $339.50, is capable of driving any speaker system and has all the flexibility required for any conceivable home music system. It is a worthy companion to the company's 202-R tuner. ▲

RCA WV-120A Power-Line Monitor

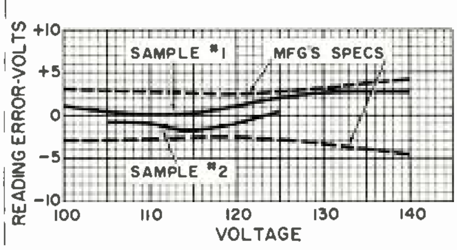
For copy of manufacturer's brochure, circle No. 59 on coupon (page 136).

THE *RCA WV-120A* is a conveniently packaged, exponded-scale a.c. line voltmeter which, when plugged into an a.c. outlet, continuously monitors the value of the line voltage. The instrument is designed for radio-TV service shops, loborotories, and industries where it is necessary to know the line voltage at all times. It is especially useful with variable autotransformers to allow exact voltage adjustment.

The scale of the meter, reading from 100 to 140 volts, has large numbers and a red pointer so that it is possible to take an approximate reading from practically across the room. The meter movement is a moving-vane type that indicates r.m.s. values of line voltage directly, even if the input waveform is distorted.

In using the meter it is important to allow at least a 5-minute warm-up. The meter-movement coil and the series-dropping and calibrating resistors dissipate about 6 watts. If a reading is taken with the instrument cold, it is apt to be several volts too high. After about 5 minutes, though, the reading stabilizes at its correct value.

We checked two samples of the unit against a ½% expanded-scale laboratory-type a.c. line



voltmeter; our results are shown by the curves (page 104). The manufacturer rates the accuracy of the instrument as ±2% at 120 volts and ±3% at 100 volts and 140 volts. These specs, converted to a reading error in volts, are shown dashed in the figure. Note that both of the samples checked were well within the accuracy specified; one of the samples reading about .8% high and the other reading about .9% low at 120 volts.

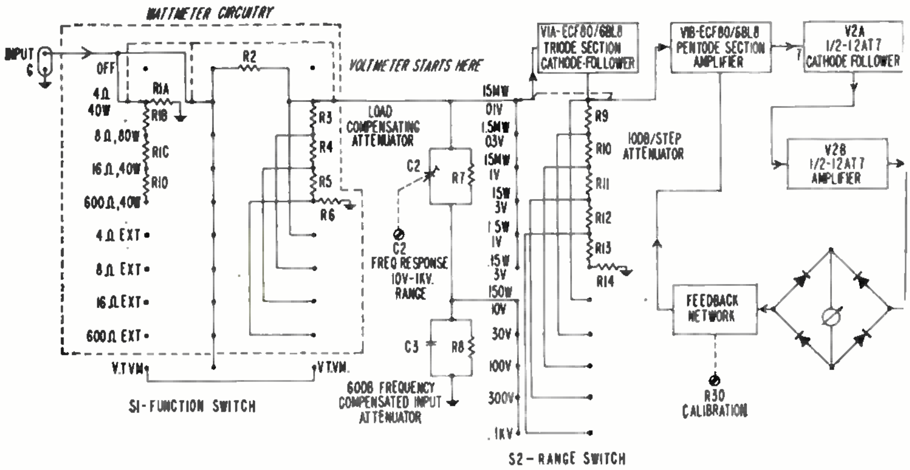
The instrument has convenient mounting holes so that it can be hung on a wall in the service shop. The price of the WV-120A is $14.95. . E.W.

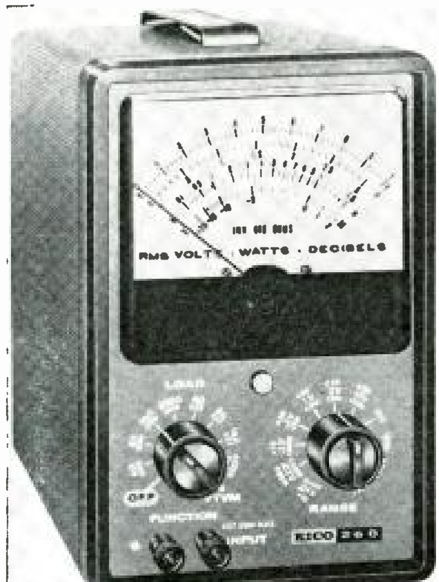
Eico Model 260 A.C. Volt-Watt Meter

For copy of manufacturer's brochure, circle No. 60 on coupon (page 136).

ANOTHER unit in the new *Eico* line of professional and industrial test equipment is the Model 260 a.c. volt-watt meter. This instrument will be of great value to those who are interested in making accurate audio measurements of frequency response, power response, and audio voltage levels at values ranging from a few millivolts out of a stereo cartridge up to as much as 1000 volts or less across the secondary winding of a power transformer in a hi-fi amplifier.

Some eleven wide-band voltage ranges are available, from 10 mv. full-scale to 1000 v. full-scale. Readings may be made directly in volts or in db. According to the manufacturer, the voltmeter is flat from 10 cps to 150 kc. with the response falling to −3 db at 500 kc. The input impedance is high (2 megohms shunted by 15 $\mu\mu$f.) to prevent circuit loading. The accuracy of the





instrument is specified as ±4% of full-scale.

In addition to the vacuum-tube voltmeter function, the instrument will also read audio power output directly. Built-in loads of 4, 16, and 600 ohms permit power measurements up to 40 watts; a built-in 8-ohm load can be used to measure power up to 80 watts. It is also possible to read up to 150 watts by using external load resistors. In all, there are seven power ranges, from .15 mw. full-scale up to 150 watts full-scale. The frequency response and accuracy of the power measurements are specified as flat from 10 cps to 100 kc. and ±5% of full-scale.

The block diagram (p. 105) shows the basic circuit arrangement. To measure power, the instrument simply measures the voltage across a known load resistor that is switched across the input terminal. On the highest power range, the voltage is attenuated 60 db (1000:1) by a frequency-compensated attenuator before being applied to the v.t.v.m. circuit. This attenuator is also used in the five highest voltmeter ranges. The voltage being measured is applied to cathode-follower V_{1A}. The output of this circuit consists of a 6-tap, 10 db/step voltage divider that passes the voltage to V_{1B}, a pentode voltage amplifier. The output of this amplifier is then applied through an isolating cathode-follower (V_{2A}) to V_{2B}, the meter amplifier. Signal is then rectified by a full-wave germanium diode bridge and applied directly to the 200-μa. meter.

Degenerative feedback from the bridge back to the pentode amplifier stabilizes and linearizes the meter. The power supply uses a half-wave silicon diode, RC filter, and a VR tube for regulated "B+."

Construction of the kit-version of the instrument was quite simple, requiring only about 7 hours' time, not including calibration and frequency-compensation trimmer adjustment. This adjustment is made at 150 kc. The line voltage is used for calibration and since we have a ½% expanded-scale meter to measure the line voltage, we were able to set up the instrument precisely. After completing the calibration, we took voltage readings at three widely separated frequencies on each of the ranges, comparing them with readings taken on a *Hewlett-Packard* laboratory a.c. voltmeter. All readings were extremely close to those taken on the *Hewlett-Packard* instrument and in all cases the readings were within the manufacturer's specifications.

The *Eico 260* is available in kit form at $49.95 and factory-wired at $79.95. ............E.W.

CARD INDEX FILE FOR EW ARTICLES

By RAYMOND B. RAWLINSON

MANY readers of ELECTRONICS WORLD have copies extending back several years. They have at their fingertips an immense volume of information on electronics and associated subjects. The ability to locate an article on a specific subject, however, is difficult despite the fact that an index is published each December covering feature articles which appeared during the year.

The writer's solution to this may be of interest to others. It is a card index file. The desired information is typed on conveniently sized 3" x 5" cards. Complete indexing takes not more than 20 or 30 minutes a month at most. The information included on the cards is: title of article, month and year of publication, page number. Most titles are self-explanatory but, if not, a brief word of explanation is included. Five single-spaced entries with double spacing between entries will fit on the standard card.

The following headings were set up ten years ago:

1. Amplifiers (audio)	2. Antennas
3. Audio (general)	4. Binaural
5. Business	6. Computers
7. Electronic Controls	8. FM
9. Ham Radio	10. Marine Radio
11. Misc.	12. Mobile Equipment
13. Musical Instruments	14. Noise Suppressors
15. Phono	16. Photography
17. Radio Receivers	18. Radio Servicing
19. Recording	20. Rectifiers & Power Supplies
21. Safety	22. Speaker Enclosures
23. Speaker Networks	24. TV Receivers
25. TV Servicing	26. Test Equipment
27. Transistors	

No attempt is made to justify such a list. Each reader will undoubtedly have his own ideas about whether it should be expanded, compressed, or revised. Time has shown that "Noise Suppressors" and "Speaker Networks" have not had enough coverage to warrant separate headings. "Binaural" has now become "Stereo." The biggest error was in the "Transistor" category. The transistor is no longer a curiosity. It is now involved in all phases of electronics. This listing should be broken down into a number of subheadings. Expanding the categories makes it easier to locate specific information while fewer listings makes the monthly typing chore easier.

The writer's stack of cards is now 3 inches thick. Metal boxes are made for the 3" x 5" size cards and solve storage and protection problems nicely, although the cards have been kept for years with nothing more than a rubber band looped loosely around them.

The index has been a real convenience and time-saver and is recommended to other readers on that basis. ▲

Stereo with Headphones

(*Continued from page 50*)

wide range of impedances. Crystal headphones are usually of the high-impedance type (10,000 ohms and up), magnetic headphones tend to cover the medium-impedance range (around 2000 ohms), while dynamic units favor the low-impedance range (4 to 16 ohms). The impedance ranges cited are only generally valid and there are, for example, high-impedance dynamic headphones, low-impedance magnetic headphones, etc. In addition, the impedance of any of these headphones can, of course, be changed through the use of a suitable transformer.

Headphone impedance is of primary importance when the units are connected to associated amplifying equipment. Devices which have low impedance (600 ohms or less) load the circuit to which they are connected while the loading encountered with high-impedance devices will be negligible.

Stereophonic headphones can be hooked directly to the output of a stereo preamplifier—tone—control system. See Fig. 4A. These circuits are usually terminated in a high-impedance network or in a cathode-follower configuration which has a nominal impedance of approximately 1000 ohms. Any type of headphone will work with such a unit as long as the impedance of the headphone is 1000 ohms or higher so that the circuit is not unduly loaded.

Headphones may, of course, be connected directly to the output taps of the power amplifier (see Fig. 4B). If only headphones are used while listening, the power amplifier should be loaded down with a resistor whose value is equal to the impedance of the speaker normally used in the installation. This resistor should have a wattage rating equal to the maximum wattage rating of the amplifier.

In addition, as mentioned before, headphones are very sensitive devices and may reproduce equipment hum and noise quite loudly even when the volume control is set at minimum. This is caused by the fact that the headphone does not load down the circuit and actually reproduces the very small amount of hum and noise which occur in the circuit after the volume control. Also, it may be found that when the volume control is turned ever so slightly clockwise, excessively high signal will immediately result. To overcome this condition, a 1-watt resistor of approximately 2000 ohms is inserted in each leg of the headphone circuit. When connecting headphones to power amplifiers in this manner, headphone impedance should match the power-amplifier impedance. However, considerable leeway is permissible here and a

600-ohm headphone will certainly work off an 8-ohm tap.

One point to remember, whether the headphones are used with a preamplifier or with a power amplifier, try to avoid passing d.c. through the headphones. Thus, when making these hookups, be sure that the phones are isolated from d.c. paths by means of a coupling capacitor or by the output transformer.

In conclusion, the final choice of the type of headphone—as is so often the case with high-fidelity equipment—is primarily dependent upon what the listener likes and is willing to pay for. In any event, no matter what type of headphones you choose, you can anticipate a unique listening experience—in many ways totally different from what you are used to with loudspeaker systems. ▲

VOLTAGE QUIZ

By JOE TERRA

Match the words in the first column with the definitions in the second column, then check your answers on page 134.

1. Inverse peak
2. Boost
3. Working
4. Line
5. Ripple
6. Critical-grid
7. Inverse
8. Sparking
9. Primary
10. Cut-off
11. Surge
12. Signal
13. Equivalent-grid
14. Saw-tooth
15. Fluctuation

A. Voltage supplied by the damper tube to attain greater saw-tooth output.
B. In a thyratron, the value of voltage which causes tube to fire.
C. Negative grid bias at and beyond which plate current ceases to flow.
D. E_g plus E_b/μ.
E. Voltage variation due to thermal agitation or shot effect.
F. Reverse voltage that a gas or vapor rectifier can stand without breakdown.
G. Effective voltage value existing across a rectifier tube during that half-cycle in which current does not flow.
H. Wall-outlet voltage generally between 115 and 120 volts.
I. Maximum voltage which can be applied to electrolytic capacitors for a period not to exceed 30 seconds.
J. Voltage applied to the input terminals of a transformer.
K. The alternating components of a undirectional voltage.
L. Used in TV receivers to insure uniform rate of movement of the beam across and down the face of the picture tube.
M. Modulating voltage of a transmitter or a detected voltage in a receiver.
N. The starting potential of a cold-cathode gas tube.
O. Voltage rating of a fixed capacitor.

Mac's Service Shop

(*Continued from page 60*)

"OK, you win," Mac conceded. "You don't have to make up that half hour. Your conversation with Bud has obviously turned your attention to a very important subject: how we, as service technicians, can best serve the interests of our senior citizens.

"Here in the United States we now have better than 16,500,000 people over 65 years of age, and the number is growing at the rate of more than 1000 a day. These figures are pretty impressive in themselves, but consider this: 929,000 of those people are over 85! This compares with 91,000 in 1920, or an increase of better than 920 per-cent in thirty years. If you want to think of a person as becoming 'old' at 65, quite obviously he has a fair chance of staying in this category for at least 20 years.

"These people must be clothed, fed, housed, doctored, and entertained. That means they are very important customers in a wide variety of businesses and professions. Even a casual look at national advertising shows most business men and their advertising agencies are already keenly aware of this fact. But I think this over-65 group is especially important to the radio and TV service technician. I say this because I'm convinced the most avid TV watchers are found at both ends of the life span: children and oldsters. Both groups have a great deal of leisure time; both must find a large part of their diversion in the home. TV watching provides a method of escape from the boredom that would otherwise result from such a combination of leisure and restricted movement. They depend on TV for entertainment; we depend on TV to earn a living. They need us; we need them."

"I'm with you all the way," Barney chimed in. "And when you get right down to it, the service the senior citizens demand is not much more than any customer has a right to expect."

"There is one other thing they want that is a little extra," Mac said slowly. "It is an 'extra' that does not cost the service technician much to give, but it has a lot to do with his success in dealing with these senior citizens. They want to be treated as real people, not as over-age children. They want to be listened to with genuine interest instead of amused tolerance. The technician who can provide good service *plus* a little sympathetic understanding can easily win for himself a loyal following among this Golden Years crowd. I use the word 'loyal' advisedly. Elderly people do not like change for its own sake as younger people do. When they find a technician they like, they will stick with him year after year."

"I simply gotta get you and Bud together on the air. I never heard two guys sound so much alike."

"People who think right frequently think alike," Mac retorted. "You just listen to Bud and me and we'll make a thinking man's technician out of you yet!" ▲

Impedance Matching for P.A.

(*Continued from page* 64)

is used between the amplifier and the line-matching transformer.

When the "L" pad is in the full "on" position it generally is designed so that the series arm is zero resistance and the shunt arm is open-circuited. The insertion loss is then zero. As the control is turned toward "off" position, the series arm approaches the value of the rated impedance and the shunt arm approaches zero resistance. In this way the pad-speaker combination presents approximately a constant impedance back to the line, causing a minimum amount of interaction. Though the "L" pad varies to a very slight degree the impedance presented to the amplifier output, this is ignored in practice.

The "T" pad is a similar component, having three ganged variable elements (see Fig. 21) wired into the speaker line in such a manner as to present a

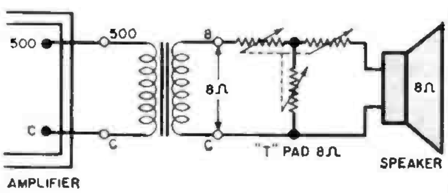


Fig. 21. Using "T" pad to control level.

constant impedance to the amplifier as well as to the speaker at all times. The "T" pad sells at a somewhat higher price and is not therefore used as widely as is the "L" pad.

In selecting an "L" or "T" pad, careful consideration must be given to the dissipation rating of the component as established by the manufacturer. For example, if a loudspeaker is wired through a line-matching transformer to be driven to a 4-watt level, an "L" or "T" pad should likewise be rated at 4 watts so that it can safely dissipate the power not used by the loudspeaker. Pads are made to absorb up to 30 watts of audio power. The smallest acceptable rating is always chosen, of course, to keep the cost down. Pads may be selected for use with 4-, 8-, or 16-ohm voice coils (when wired in the line-matching transformer secondary circuit) or with 250- and 5000-ohm values (for wiring between the line-matching transformer primary and amplifier).

Although this discussion has involved many words and a fair amount of space in three issues, the job of impedance matching speakers in public-address systems is neither difficult nor impossible. With a little practical experience plus a firm grasp of the theory behind impedance matching, any competent audio technician can handle this interesting and profitable work. ▲

Technical BOOKS

"UNDERSTANDING CAPACITORS AND THEIR USES" by William F. Mullin. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 91 pages. Price $1.95.

Written by a man who is intimately connected with the capacitor field, this volume is a nice amalgam of design theory and practical application data on this vital electronic component.

The text is divided into six chapters dealing with capacitor theory, construction, application, replacement, and testing. The material is presented in a practical format which makes it suitable for technicians, students, and those concerned with specifying capacitors for electronic circuits.

* * *

"MOST-OFTEN-NEEDED 1962 TV SERVICING INFORMATION" compiled by M. N. Beitman. Published by *Supreme Publications*, Highland Park, Ill. 192 pages. Price $3.00.

This is Vol. TV-19 in this publisher's series of service data manuals and covers TV sets made by *Admiral, Emerson, General Electric, Magnavox, Montgomery Ward, Motorola, Philco, RCA, Sylvania, Westinghouse*, and *Zenith*.

Like its predecessors, this volume includes chassis views, tube location diagrams, complete schematics, alignment data, adjustment of the various controls, plus special circuit hints, as suggested by the manufacturer.

* * *

"TWO-WAY MOBILE RADIO MAINTENANCE" by Jack Darr. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 250 pages. Price $4.95.

This volume has been prepared expressly for the field service engineer who plans, maintains, and installs all types of two-way mobile radio systems.

Included in the nine chapters are specific instructions for tuning up the system, test procedures and equipment for locating troubles, record keeping as required by the FCC, installation procedures, remote controls, noise elimination, towers, receivers, and transmitters.

Since this volume was written by a man specializing in this type of service work, the suggestions and procedures are characterized by a down-to-earth practicality.

* * *

"SERVICING TRANSISTOR RADIOS" by Sams Staff. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 160 pages. Price $2.95. Vol. 9.

This latest volume in the publisher's series on the servicing of transistorized receivers covers 47 models produced during 1960 including sets by *Admiral, Calrad, Channel Master, Columbia, Coronado, Crown, Emerson, General Electric, Linmark, Magnavox, Nec, Norelco, Olympic, Philco, RCA Victor, Robin, Silvertone, Sylvania, Toshiba*, and *Truetone*.

Like the earlier volumes in this service series, this book features schematics, dial-cord stringing arrangements, cabinet and chassis photos, alignment instructions, parts lists, and replacement data.

* * *

"BASIC ELECTRICITY" by C. E. Matson. Published by *McKnight & McKnight Publishing Co.*, Bloomington, Illinois. 123 pages. Price $1.70.

This manual covers 30 instruction units for use by teachers giving courses in electricity. Each of the instruction units combines information, job, and operation sheets and can be used at either a junior or senior high-school level.

The projects are graded and presented in logical progression. Six appendices include aids for the instructor in planning and conducting such a course in basic electricity.

* * *

"SOUND AND TELEVISION BROADCASTING" by K. R. Sturley. Published for "Wireless World" by *Iliffe Books Limited*, Dorset House, Stamford Street, London SE1, England. 373 pages. Price 46 s. 4 d. postpaid.

Although prepared as a training manual for *BBC* engineering recruits, the material included by Dr. Sturley (head of the *BBC* Engineering Training Department) is of interest to all those involved in sound and television broadcasting.

The text covers fundamental principles, sound studios and recording, TV studios, telecine and telerecording, remote TV broadcasts, the r.f. transmission of sound and video programs, line interconnection systems, etc. Although the techniques and equipment covered are those used in Great Britain much of this material will find a ready audience among broadcast engineering personnel in the U.S.

* * *

"TROUBLESHOOTING AMATEUR RADIO EQUIPMENT" by Howard S. Pyle, W7OE. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 128 pages. Price $2.50.

Author Pyle, who is a familiar byliner of ham articles in this magazine, has come up with a thoroughly practical handbook on ham radio maintenance.

The seven chapters and three appendices include receiver troubles, transmitter troubles, the antenna system, accessory equipment, preventive maintenance, mobile equipment, component color codes, schematic symbols, as well as complete schematics of nine popular transmitters and receivers.

As a practicing ham for more than 50 years and a former assistant U.S. Radio Inspector and FCC license examiner, there is little about ham radio that Mr. Pyle doesn't know. His enthusiasm in sharing his knowledge and experience makes this a "natural" for the tyro and "Old-Timer" alike.

* * *

"ABC'S OF MODEL RADIO CONTROL" by Allan Lytel. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 96 pages. Price $1.95.

Since model enthusiasts come in all ages, interests, and vocations, this basic text on the radio-control of various types of models should find a vast, ready-made audience.

Basic R/C systems and their operation, applications of radio controls, equipment, servicing and troubleshooting, FCC regulations, etc. are all covered in layman's language with a healthy boost from the excellent photos, diagrams, and illustrations with which the text is supplied.

* * *

"FUNDAMENTALS OF UHF" by Allan Lytel. Published by *John F. Rider Publisher, Inc.*, New York. 150 pages. Price $3.90.

This text covers that portion of the spectrum from 300 to 3000 mc. and deals with antennas, transmission lines, wave propagation, generators, communications equipment, test equipment, and techniques.

In addition, the FCC rules and regulations covering the use of these frequencies are included, making this a self-contained source book for those actively engaged in the field.

Written at an intermediate level and featuring numerous diagrams, photographs, charts and graphs, this book is suitable for both student and practicing engineer.

* * *

"BASIC MATHEMATICS" by Norman H. Crowhurst. Published by *John F. Rider Publisher, Inc.*, New York. 136 pages. Price $3.90.

This is the second in the projected four-volume series covering basic mathematics. This book introduces algebra, geometry, and trigonometry to the student and covers simple, simultaneous and quadratic equations; powers and roots; imaginary numbers; simple mechanics, including resonance; proportion and ratio; simple trigonometry calculations; and properties of triangles and circles.

The step-by-step presentation in "pictured-text" form poses a problem, then discusses the nature of the problem and explains how one or more methods of solution are tied to the problem.

* * *

"FIRST-CLASS RADIOTELEPHONE LICENSE HANDBOOK" by Edward M. Noll. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 304 pages. Price $4.95.

This handbook is designed to assist those preparing for their first-class tickets, for broadcast station engineers, and for technicians. It includes questions and answers based on Element IV of the FCC license exam and a complete discussion of frequency assignments, duties and license requirements, broadcast microphones, record and tape machines, studio and control-room facilities, remote facilities, AM broadcast transmitters, AM broadcast antennas and lines, FM transmitters, transmitter monitor and test equipment, proof-of-performance measurements, television broadcasting, audio and power circuits, transmitters and antennas, laws and test procedures, and TV and FM broadcasting. ▲

Registers & Accumulators

(Continued from page 56)

plements of each other: 4 and 5, 7 and 2, 1 and 8, etc. The 6 in step 2 is therefore the complement of the 3 in step 1. After the addition has been performed (step 3) the left-hand digit is added to the right-hand digit (step 4). This is known as an *end-around* carry. The result obtained in step 4 is the answer to the original problem in step 1.

A circuit for subtracting binary numbers by the indirect method is shown in Fig. 8A. This is similar to Fig. 7 except that the "0 output" instead of the "1 output" terminals are connected to the transfer gates. As a result, the stages in the 0 condition supply high level inputs to the transfer gates. This effectively complements the binary number in the storage register because the complement of a binary number is obtained by changing the 1's to 0's and the 0's to 1's.

When a transfer pulse is applied, Fig. 8B, the transfer gates labeled "X" produce high level outputs. These outputs, representing the complement of the number in the storage register, are applied to the corresponding stages of the accumulator. These changes now occur:

1. FF_2 switches from the 0 condition to the 1 condition.

2. FF_4 switches from the 1 condition to the 0 condition, generating a trigger pulse for FF_5.

3. FF_5 switches from the 1 condition to the 0 condition, generating a trigger pulse which is fed back to FF_1 (end-around carry).

4. FF_1 switches from the 0 condition to the 1 condition.

After these changes have occurred, the binary number in the accumulator is 00011 (decimal 3). This is the *difference* of the number in the storage register (10101 = decimal 21) and the number previously in the accumulator (11000 = decimal 24).

Multiplication can be performed as a series of repeated additions, and division can be accomplished by repeated subtractions. Modifications of the circuits in Figs. 7 and 8 can therefore be used for performing the operations of multiplication and division. ▲

"He fixed his first printed-circuit job."

Servicing Recorder Oscillators

(Continued from page 59)

There is often a small capacitor at the input to the record-level circuit in order to shunt the oscillator frequency to ground. Sometimes, as in Fig. 5, there is

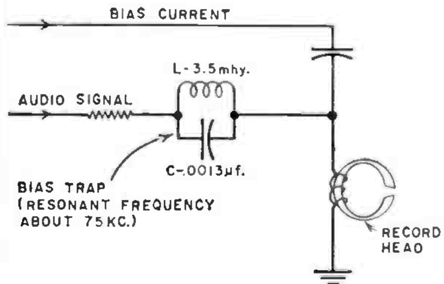


Fig. 5. Use of a bias trap to prevent oscillator output from getting into record amplifier.

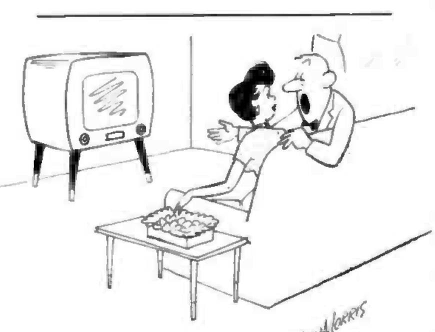
a bias trap between the record head and earlier stages in order to prevent bias current from getting into these prior stages. These components should be checked if there is significant stray pickup.

If there is stray pickup of the oscillator frequency at an early stage of the record amplifier, it may be amplified along with the audio signal, resulting in excessive bias current applied to the record head, with a reduction in treble response. Such stray pickup can also cause oscillation or blocking of the record amplifier.

Stereo Load Resistors

In a stereo tape machine, the oscillator must feed two sets of record and erase heads. But when the machine is used for mono recording, oscillator current is removed from one set of heads and fed into a substitute load, usually a resistor.

If the load resistor departs appreciably from its design value, the oscillator current supplied to the one set of active heads will be either too much or too little, causing a substantial change in treble response and in distortion. Accordingly, if one channel or the other exhibits an appreciable change in treble response when shifting between the stereo mode and the mono mode of recording, the substitute load resistor should be checked. ▲



"There's something I must tell you, Thelma . . . Your set has a bad 6SN7."

If you've recently changed your address, or plan to in the near future, be sure to notify us at once. We'll make the necessary changes on your mailing plate, and see to it that your subscription continues without interruption. Right now — print the information requested in the spaces below and mail it to: ELECTRONICS WORLD, 434 So. Wabash Ave., Chicago 5, Illinois.

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ELECTRONIC TERMINOLOGY

By MARGARET LeFEVRE

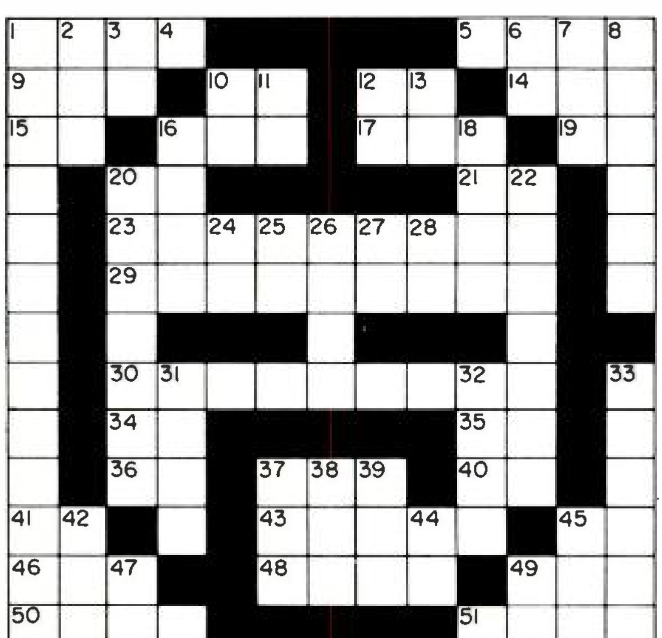
(*Answer on page* 134)

ACROSS

1. People in general.
5. In push-pull amplifiers a _____ of tubes is used.
9. A ham's apparatus.
10. Debt discharged (abbr.).
12. River in Italy.
14. To own (code spelling).
15. Type of transmission (abbr.).
16. "Worked All Countries."
17. Bow of flame formed between two electrodes connected to an electric current.
19. A lady ham.
20. It goes with "hi."
21. Near (code spelling).
23. To vibrate.
29. "Listening" sets.
30. Bands of frequencies on either side of the carrier wave.
34. Chemical symbol for thoron.
35. That thing.
36. Chemical symbol for silicon.
37. Frequency changing device.
40. While.
41. Lower than r.f. (abbr.).
43. Last stage.
45. This type of emission is steady, unmodulated pure carrier.
46. Vim.
48. Bovine quadrupeds.
49. Landing ship dock (abbr.).
50. River in Germany.
51. An instrument for transforming air-pressure waves of sound into electric currents or voltages.

DOWN

1. To adapt to the use of solid-state devices.
2. That man.
3. For example.
6. An exclamation.
7. Climbing plant.
8. Electro-magnetic switches.
10. Sound system (abbr.).
11. Battery current (abbr.).
12. The final (abbr.).
13. Companion of "either."
16. Sagacious.
18. Center (code spelling).
20. Large wooded areas.
22. Hinder the flow of an electric current.
24. Volume measure (abbr.).
25. That is to say (abbr.).
26. Arm or branch.
27. Fifty-five (Rom. numerals).
28. Digraph in Latin names.
31. Beginning (abbr.).
32. It indicates frequency.
33. Three-element tube.
37. Same as 37 across.
38. Radar is used to _____ location of objects.
39. Single thing.
42. Tube element (abbr.).
44. Indefinite article.
45. Inquire.
47. Chemical symbol for fusible metal alloy used in all radio construction.
49. Fifty-one (Rom. numerals).



EXAMINE ANY OF THESE TESTERS *BEFORE* YOU BUY!!

Yes, we offer to ship *at our risk* one or more of the testers described on these pages.

SUPERIOR'S NEW MODEL 770-A

VOLT-OHM MILLIAMMETER

FEATURES:

- Compact—measures 3⅛" x 5⅞" x 2¼".
- Uses "Full View" 2% accurate 850 Microampere D'Arsonval type meter
- Housed in round-cornered, molded case.

SPECIFICATIONS:

6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts.

6 D.C. VOLTAGE RANGES: 0-7.5/15/75/150/750/1500 Volts.

2 RESISTANCE RANGES: 0-10,000 Ohms, 0-1 Megohm.

3 D.C. CURRENT RANGES: 0-15/150 Ma., 0-1.5 Amps.

3 DECIBEL RANGES: —6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db.

The Model 770-A comes complete with test leads and operating instructions. **Price is $15.85. Terms: $3.85 after 10 day trial then $1.00 monthly for 3 months.**

SUPERIOR'S NEW MODEL 79

SUPER-METER

WITH NEW 6" FULL VIEW METER

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries. 7 to 7,000 Henries.
DECIBELS: —6 to + 18, + 14 to + 38, + 34 to + 58.

The following components are all tested for **QUALITY** at appropriate test potentials. Two separate **BAD-GOOD** scales on the meter are used for direct readings.
All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. All Germanium Diodes.
All Silicon Rectifiers. All Silicon Diodes.

Model 79 comes complete with operating instructions, test leads and carrying case. **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL VIEW METER

Compare it to *any* peak-to-peak V.T.V.M. made by *any* other manufacturer at *any* price!

SPECIFICATIONS:

- **DC VOLTS**—0 to 3/15/75/150/300/750/1500 volts at 11 megohms input resistance.
- **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1500 volts.
- **AC VOLTS (Peak to Peak)**—0 to 8/40/200/400/800/2000 volts.
- **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

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries

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 Milliamperes, 0 to 15 Amperes.
3 DECIBEL RANGES: —6 db to +18 db, +14 db to +38 db, +34 db to +58 db.

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 $1.00 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!

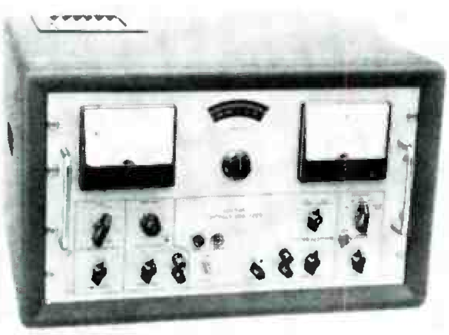
sensitive panel meters which are rugged... to extreme shock, and provide a high degree of accuracy.

twin-lead so as not to cut the stranding. One quick jerk on the pliers strips off all insulation neatly. The tool can also be used as end-cutting resistor pliers.

CONTROLS ANALYZER

23 Superior Manufacturing and Instrument Corp. is in production on a new controls analyzer for the complete checking of servo-mechanisms and feedback controls systems.

The Model 140 incorporates a novel brushless rotating transducer. Carrier frequencies of 5000 cps are easily accommodated in the standard unit, while considerably higher frequencies are available on special order. The Model 440 in-

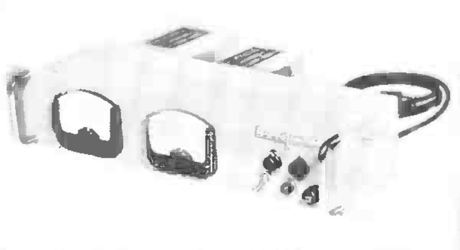


This suspension-type meter makes use of a short, very thin, narrow band kept tightly suspended on special spring terminals to support the coil and its moving counter parts. There are no pivots, no jewels, no hairsprings, and no rolling friction.

The new line is available in case sizes including 2½", 3½", 4½", 6", 7", and 8".

POWER SUPPLIES & MODULES

17 **Technipower, Inc.**, has developed a new line of power supplies and modules designed for a wide variety of component-type applications in



laboratories, test equipment, and finished products.

Available in rack-mounted configurations, both metered and unmetered, one, two, or three isolated outputs may be provided on a single rack panel. The units feature regulation of ±.05% versus line and load, and ripple of less than 1 mv. r.m.s. The units are suitable for use in

cludes a self-contained response channel, obviating the need for an oscilloscope.

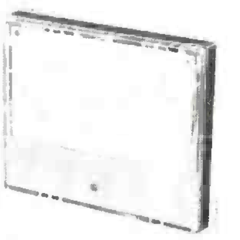
LINEAR CONVERTER

24 **Neshaminy Electronic Corporation** has introduced a wide-range, highly linear voltage-to-frequency converter as the "Volcon."

The all solid-state circuit converts a given voltage into a corresponding frequency with better than .1 per-cent linearity and with a stability approaching that of a good crystal oscillator. Virtually the only variable in the circuit is temperature drift which is held to .2 per-cent per degree C from zero to 50 degrees C without the need for temperature stabilization.

PANEL INSTRUMENTS

25 **Weston Instruments Division** has added the Model 1931 to its series of rectangular a.c. and d.c. meters.

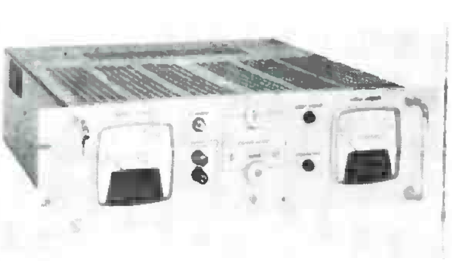


The new 3½" instrument is available as an ammeter, milliammeter, microammeter, or voltmeter with optional 1 or 2 per-cent accuracy. Instruments of 1 per-cent accuracy feature a knife-edge pointer and mirror scale; models of 2 per-cent accuracy are equipped with a lance-type pointer and conventional scale. Front covers are available in either clear plastic or Bakelite.

TRANSISTORIZED POWER SUPPLIES

26 **Amoux Electronics Division** is now in production on a new line of rack-mounted, low-voltage, transistorized a.c. to d.c. power supplies for applications involving equipment operation and secondary battery changes.

There are four basic production categories: 4.5 volts d.c., 5-amp output; 4.5 volts d.c., 10-amp output; 30 volts d.c., 5-amp output; and 4.5 volts



d.c., 10-amp output for battery charging. All types operate from 115-volt, 60-cps power lines.

The supplies, designed for the standard 19" relay rack, occupy 5¼" of vertical space.

LOW-VOLTAGE DISC CAPACITORS

27 **Centralab** is now marketing a new line of low-voltage disc capacitors designed especially for transistor circuitry in both original equipment and replacement applications.

Capacities range from .005 µf. to .1 µf ±20%. Working voltage is 50 volts d.c. Initial leakage resistance is over 7500 megohms, while leakage resistance after humidity testing is over 1000 megohms. Power factor is 2% maximum at 1 kilocycle.

The Type CK capacitors are 5/32" thick with diameters ranging from ⅜" to ⅝", depending on capacity.

MULTI-TRACE CRT

28 **Sylvania Electric Products Inc.** has introduced a multi-trace cathode-ray tube with three independently controlled electron guns capable of producing three displays simultaneously.

Designated Type SC-3061, the 10-inch tube is available in a variety of phosphors, is electrostatically focused and deflected, and features an astigmatism control electrode. Deflection factors at 5 kv. anode voltage are approximately 130 v./in. horizontal and 70 v./in. vertical. The useful horizontal scan of each parallel trace is approx-

imately 8½" while traces are 1⅜" apart on a common vertical line.

DUAL-GUN SCOPE

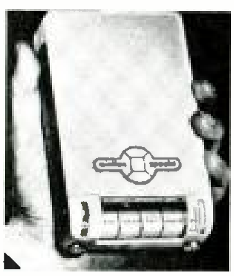
29 **Packard Bell Electronics** has introduced a dual-gun d.c. to 5 mc. oscilloscope which weighs 22 pounds. With only two types of vacuum tubes and the CRT the scope is designed for easy maintenance and repair. Identical amplifiers on each vertical input provide identical traces over the full screen face with no phase shift.

A preamplifier is built into the lower vertical amplifier, increasing the sensitivity from 100 mv./cm. to 1 mv./cm. Sweep range is from 1 μsec./cm. to 1 sec./cm. Both internal and external triggers are provided.

HI-FI—AUDIO PRODUCTS

MINIATURE RECORDERS

30 **International Telephone and Telegraph Corp.** is handling the U.S. distribution of the "Minifon" line of wire and tape recorders.



Included in the new line are three portable recorder models and a number of accessories which make them adaptable to special needs. The "Special" is a long-play wire recorder, capable of transcribing up to five hours of continuous conversation; the "Attache" offers features aimed at general business and commercial dictating requirements, while the "Hi-Fi" is a precision-engineered, hi-fi instrument for professional use.

All models are battery-powered and fully transistorized, weighing as little as 1 lb., 12 oz.

STEREO & MONO TAPE HEADS

31 **Sonotone Corporation** has announced that its record/reproduce and erase heads, produced for original equipment manufacturers, are now available for distributor and service replacement.

Two series are represented in this new replacement line: the RH-2 series for mono taping with matching EH-2 erase heads if desired, and the RH-4 series for stereo recording, also with matching EH-4 erase heads.

All of these new models can be obtained singly or with matching erase heads as required by the user.

STEREO TAPE SYSTEM

32 **Pentron Electronics Corporation** has developed a compact, lightweight, completely self-contained stereo tape recorder and playback system which can record from any source, add to existing recordings, as well as play stereo quarter-track and half-track tapes.

The "880" design incorporates two hand-wired amplifiers and preamps, two full-range speaker

systems, two microphones, and a push-button-controlled tape transport mechanism all housed in a molded fiber case measuring 14" x 7¼" x 14½".

The unit comes complete with microphones, connecting cables, a reel of blank tape, and a take-up reel.

FM/MULTIPLEX ADAPTER

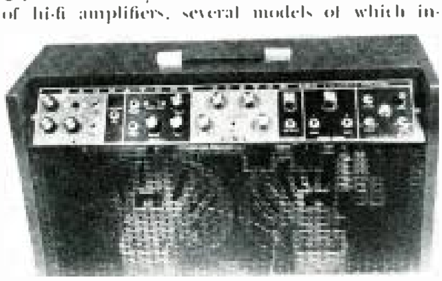
33 Stromberg-Carlson is now marketing a miniature, all-transistorized FM multiplex adapter that adapts any quality FM tuner to receive stereo multiplex broadcasts.

The new unit, which can be installed in a matter of minutes, measures 3" x 5" x 1½". Since it generates virtually no heat, this separate modular component can be placed anywhere on the chassis.

The adapter features stereo separation of more than 20 db, automatic electronic balancing which eliminates manual controls, automatic adjustment of various input signal levels, and a.f.c.

STEREO AMPLIFIER

34 Magnatone Amplifier and Guitar Division has recently introduced an extensive line of hi-fi amplifiers, several models of which in-



corporate the Hammond reverberation unit as well as the firm's patented stereo vibrato.

The Model 180 shown in the photo has 14 tubes, two output channels totaling 50 watts output, two custom-designed extended-range hi-fi 12" speakers, two matched 5" x 7" oval mid-range speakers with high-frequency diffusers, two separate input channels, stereo input jack, a two-position switch, jacks for two separate remote speakers, and the patented stereo vibrato circuit.

The line offers units with outputs of from 5 to 50 watts.

CB-HAM-COMMUNICATIONS

CB ANTENNA LINE

35 Clear Beam Antenna Corporation is now offering a new series of economy CB antennas. The Model GP-1 ground-plane features a unique design with a 1" diameter driven element and drooping radials to give improved impedance matching with coaxial lead cable. The Model CBY3 is a three-element Yagi for 27 mc. with full .10 and .15 wavelength spacing.

AUTOMATIC SIGNAL DEVICE

36 Aquatronic Industries has developed a portable, easy-to-operate distress-signal transmitter for boats which is being marketed as the "Res-Q-Matic."

Designed to transmit an SOS signal on 2182 kc., the unit has a self-contained power source and is activated in an emergency at sea simply by extending the antenna assembly.

The unit is five inches in diameter and twenty inches high with the antenna collapsed for storage. It comes complete with its own stowage and carrying case. Colored a brilliant "distress-orange" to provide maximum visibility, the transmitter is designed to float. Its effective range allows its signal to be heard and fixed on inland and coastal waters.

CB TRANSCEIVER

37 Monarch Electronics International, Inc. has announced the availability of a pocket-sized transceiver for the CB service.

Designed to operate with a range of a mile or more, output power is 100 mw. The transmitter is a crystal-controlled r.f. oscillator while the receiver is a crystal-controlled superheterodyne.

Its nine-transistor circuit is powered by seven standard pen-light cells. The rugged case is of black impact plastic and measures 6⅞"x 2½"x 1⅜". The transceiver comes complete with leather case and shoulder strap, belt clamp, earphone and earphone case, batteries, and crystals.

V.H.F. NAV/COM SYSTEM

38 Aircraft Radio Corporation has introduced a new crystal-controlled, lightweight, local-control v.h.f. Nav/Com system for light planes as the Model 317A.

The new system, designed to TSO Category B requirements, offers broad receiving and transmitting coverage of VOR, LOC, and communications frequencies. It transmits on 360 channels and receives on 380 channels. All crystals are supplied with the original equipment, with no modifications required later. Transmission range is from 118 to 135.95 mc. in 50-kc. steps. It receives VOR and LOC from 108 to 117.9 mc. plus 180 communications channels from 118 to 126.95 mc. in 50-kc. steps.

PORTABLE CB UNIT

39 Polytran Industries Inc. has recently introduced a portable two-way unit for use in CB service.

The completely transistorized transmitter-receiver, designated the "CI-200," operates in pairs or with existing mobile and base equipment. Power is supplied from standard 9-volt dry batteries or rechargeable nickel-cadmium batteries.

The unit measures 1¼"x 2¾"x 5" and weighs 9 ounces. The circuit features a press-to-talk switch and an eight-section telescoping antenna.

NEW HAM RECEIVER

40 National Radio Co., Inc. has added the Model NC-190 receiver to its line of short-wave, military, and amateur receiving equipment.

The new unit features an exclusive dial selector which provides calibrated bandspread for the popular international broadcast bands as well as excellent amateur bandspread. Dual conversion on all bands above 1 mc. eliminates the possibility of unwanted image signals in all tuning ranges. Three selectivity positions are provided: 600 cycles, 3 kc., and 5 kc.

The unit is housed in a steel chassis and a duo-tone blue cabinet with steel panel.

MONITOR RECEIVERS

41 **Outercom Electronics, Inc.** is now offering a split-channel monitor receiver which provides clear, strong reception of two-way radio communications even under the most congested signal conditions.

Available in two models, the MR 30-X and the MR 50X, the units can be installed wherever standard 117-volt a.c. is available. A built-in whip antenna provides adequate reception in most areas, with terminals provided for an external antenna if required.

The Model MR 30-X is designed for 25-54 mc. while the MR 50-X covers 147-174 mc. The standard model is single channel but an optional feature is a four-way switch that permits selection of 2, 3, or 4 pre-selected two-way radio channels with a spread of 1% of channel frequency.

FM SIGNAL GENERATOR

42 **Microdot Inc.** is now offering an FM signal generator which has been specifically designed for checking out command receivers in the 400-550 mc. band.

The Model 412 features direct six-place digital readout of frequency, accurate to within 1 kc.

Continuous frequency coverage is provided by a single tuning control and .0002% accuracy prevails throughout the frequency range. Frequency stability is .0005% per hour.

The instrument can be used for frequency search, receiver alignment, bandwidth testing, discriminator measurements, sensitivity measurements, and check out of command receivers as well as for impedance and filter attenuation measurements.

MANUFACTURERS' LITERATURE

INDUSTRIAL RELAY DATA

43 **General Electric Company** has issued a 12-page bulletin which describes a new 10-amp, 300-volt industrial relay designed to cut control-panel space requirements. The publication (Bulletin GEA-7329) discusses the elimination of the need for a wiring trough, includes a photo with call-outs which explain how the new relay is designed to make wiring and installations easier, and incorporates text material explaining features and advantages. Ordering information and outline drawings are included.

ELECTRONIC CHEMICALS

44 **Injectorall Co.** is offering a six-page catalogue covering an extensive line of chemicals for the electronics industry.

Included in the two-color catalogue are photos and descriptions of cements, lubricating oils, yoke remover spray, glues, dial-cord compounds, circuit freezer, cleaners and polishes of various types, among other items.

SILICONE MOLDING FACILITIES

45 **Dow Corning Corporation** has established a new customer service facility to render complete and comprehensive engineering service to end users and fabricators of parts made from silicone molding compounds. The company has prepared a well-illustrated 8-page brochure describing this new service and facilities which it is offering to interested persons on request.

MOLDED WAFER CAPACITOR

46 **AMP Incorporated** has published a two-page product information bulletin which describes a new silicone rubber molded wafer capacitor. In addition to covering this new item in detail, the bulletin also describes other of the thousands of capacitors produced by the company. Representative specifications are given on the line.

PRECISION WIREWOUNDS

47 **Kelvin Electric Company** is currently offering copies of its Bulletin O-1 which provides electrical and mechanical specifications on its complete line of stable, encapsulated precision wirewound resistors. The single-page data sheet lists general specifications and details on both axial-lead and radial-lug types.

CLOSED-CIRCUIT TV DATA

48 **Kin Tel Division** has just published an 8-page, 2-color catalogue covering general applications of closed-circuit television systems. The booklet includes photographs of actual installations, block diagrams of systems for various applications, and a general discussion of the uses for such CCTV equipment.

HI-FI AUDIO TUBES

49 **General Electric Company** is now offering copies of its Bulletin ETD-2622 entitled "High-Fidelity Audio Tubes." This 12-page brochure describes the extent and features of the firm's growing line of audio tubes designed especially for hi-fi. Included are specifications on the current line of 26 amplifier, preamplifier, and rectifier tubes as well as information on design features and manufacturing processes.

R.M.S. VOLTMETER

50 **John Fluke Mfg. Co., Inc.** has announced the availability of a technical data bulletin describing its new true r.m.s. voltmeter. This instrument, which measures virtually all waveforms over a broad (10 cps to 7 mc.) bandwidth and provides 100 μv. sensitivity, is pictured and described in considerable detail.

P.A. AMPLIFIERS/SYSTEMS

51 **Harman-Kardon, Inc.** has issued a four-page folder describing and illustrating its "Commander" series of p.a. amplifiers and systems. The catalogue details the features and applications of 12-, 35-, and 100-watt amplifiers, a phonograph top common to all units, locking panel covers, and a combination mixer-preamp.

QUARTZ CRYSTAL DATA

52 **Texas Crystals** has announced the availability of its new catalogue and price list No. 961 which includes diagrams of oscillator circuits, a history of the manufacture and use of quartz crystals, as well as details on crystals for CB use, low-frequency crystals, ham units, plated and pressure-type crystals, special prototype models, and a list of the company's representatives.

STEREO BROCHURE

53 **Electronic Instrument Co., Inc.** is now offering copies of its 4-page, 2-color illustrated brochure entitled "Why Stereo?". The booklet contains pictures and diagrams to make the entire stereo concept clear and simple. ▲

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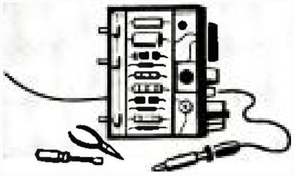

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REACTANCE REMINDER

By JIM KYLE

AUDIOPHILES, service technicians, and home experimenters alike frequently need to know the reactance of a capacitor at a specific frequency. Some make use of the reactance formula, some use a chart, and still others prefer to consult a reactance table. One of the fastest methods, though, is by use of the figure 159.

This figure is the reactance, in ohms, of a 1-μf. capacitor at a frequency of 1000 cycles. Since reactance decreases with an increase in either capacitance or frequency, it is only a few seconds' mental work to obtain reactance for any capacitance or frequency. Simply multiply the capacitance (in microfarads) by the frequency (in kilocycles) and divide this product into 159.

For example, using this technique, let's find the reactance of a .1-μf. capacitor at 5 kc. Multiplying 5 by .1 gives 0.5 and dividing this into 159 yields 318 ohms. The more cumbersome reactance formula comes out with 318.1 ohms—less than one-half ohm difference. ▲

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ANSWERS TO QUIZ
(Appearing on page 109)

1. F	6. B	11. I
2. A	7. G	12. M
3. O	8. N	13. D
4. H	9. J	14. L
5. K	10. C	15. E

Answer to Puzzle
Appearing on page 117

T	H	E	Y	■	■	■	■	■	P	A	I	R
R	I	G	■	P	D	■	P	O	■	H	V	E
A	M	■	W	A	C	■	A	R	C	■	Y	L
N	■	F	I	■	■	■	■	■	N	R	■	A
S	■	O	S	C	I	L	L	A	T	E	■	Y
I	■	R	E	C	E	I	V	E	R	S	■	S
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Z	I	P	■	■	O	X	E	N	■	L	S	D
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1AX2	.62	2EN5	.45	3V4	.58	5BE8	.83	6AB4	.46
1B3	.79	3A3	.76	4AU6	.54	5BK7	.82	6AC5	1.05
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1G3	.79	3AF4	1.02	4BC5	.58	5BR8	.79	6AF3	.73
1H5	.54	3AL5	.42	4BC8	.96	5BT8	.83	6AF4	.97
1J3	.79	3AU6	.51	4BN6	.75	5CG8	.76	6AG5	.68
1K3	.79	3AV6	.41	4BQ7	1.01	5CL8	.76	6AH4	.81
1L4	.68	3BA6	.51	4BS8	.98	5CM8	.90	6AH6	.99
1LC5	.59	3BC5	.54	4BU8	.71	5CQ8	.84	6AK5	.95
1LD5	.69	3BE6	.52	4BZ6	.58	5CZ5	.72	6AL5	.47
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1LN5	.59	3BU8	.78	4CS6	.61	5EU8	.80	6AM4	1.50
1R5	.62	3BY6	.55	4DE6	.62	5J6	.68	6AM8	.78
1S2A	.76	3BZ6	.55	4DK6	.60	5T4	.79	6AQ5	.53
1S4	.59	3CB6	.54	4DT6	.55	5T8	.81	6AR5	.55
1S5	.51	3CF6	.60	4EW6	.58	5U4	.60	6AS5	.60
1T4	.58	3CS6	.52	5AM8	.79	5U8	.81	6AS6	.80
1U4	.57	3DG4	.85	5AN8	.86	5V3	.90	6AT6	.43
1U5	.50	3DK6	.60	5AQ5	.52	5V6	.56	6AT8	.79
1V2	.50	3DT6	.50	5AS8	.86	5X8	.78	6AU4	.82
1X2B	.82	3Q4	.63	5AT8	.80	5Y3	.46	6AU6	.52

EACH TUBE INDIVIDUALLY & ATTRACTIVELY BOXED

Qty. Type	Price	Qty. Type	Price	Qty. Type	Price
6AU7	.61	6J6	.67	12D4	.69
6AU8	.87	6J7	.62	12DB5	.69
6AV6	.41	6K6	.63	12DE8	.75
6AW8	.90	6L6	1.06	12DL8	.85
6AX4	.66	6N7	.98	12DM7	.67
6AX5	.74	6S4	.51	12DQ6	1.04
6AX7	.64	6S8	.76	12DS7	.79
6AX8	.92	6SA7GT	.76	12DT5	.76
6BA6	.50	6SG7GT	.41	12DT7	.79
6BA7	.84	6SH7GT	.49	12DT8	.79
6BA8	.88	6SJ7	.88	12DW8	.89
6BC5	.61	6SK7GT	.74	12DZ6	.56
6BC7	.94	6SL7GT	.80	12EG6	.54
6BC8	.97	6SN7GT	.65	12EK6	.56
6BD5	1.25	6SQ7	.73	12EL6	.50
6BD6	.57	6T4	.99	12EM6	.79
6BE6	.55	6T8	.85	12EN6	.78
6BF5	.90	6U8	.83	12EZ6	.53
6BF6	.44	6V6GT	.54	12F8	.66
6BG6	1.66	6V8	.86	12FA6	.79
6BH6	.65	6W4	.60	12FM6	.43
6BH8	.87	6W6	.71	12FR8	.91
6BJ6	.62	6X4	.39	12FX8	.85
6BJ7	.79	6X5GT	.53	12GC6	1.06
6BK7	.85	6X8	.80	12J8	.84
6BL7	1.00	6Y6G	.65	12K5	.65
6BN4	.57	7A8	.68	12L6	.58
6BN6	.74	7AU7	.61	12S8	.62
6BQ5	.65	7B6	.69	12SA7	.92
6BQ6	1.05	7EY6	.73	12SF5	.50
6BQ7	1.00	7F8	.90	12SF7	.69
6BR8	.78	7Y4	.69	12SH7	.49
6BS8	.90	8AU8	.83	12SJ7	.67
6BU8	.70	8AW8	.93	12SK7	.74
6BX7	1.02	8BH8	.90	12SL7	.80
6BY5	1.15	8BN8	.75	12SN7	.67
6BY6	.54	8BQ5	.60	12SQ7	.78
6BY8	.66	8CG7	.62	12U7	.62
6BZ6	.55	8CM7	.68	12V6	.53
6BZ7	1.01	8CN7	.97	12W6	.69
6BZ8	1.09	8CS7	.74	12X4	.38
6C4	.43	8CX8	.93	17AX4	.67
6C8	.90	8EB8	.94	17BQ6	1.09
6CB6	.55	8SN7	.66	17D4	.69
6CD6	1.42	9CL8	.79	17DQ6	1.06
6CE5	.57	11CY7	.75	17L6	.58
6CF6	.64	12A4	.60	17W6	.70
6CG7	.61	12AB5	.55	18FW6	.49
6CG8	.77	12AC6	.49	18FX6	.53
6CK4	.70	12AD6	.57	18FY6	.50
6CL8	.79	12AE6	.43	19AU4	.83
6CM6	.64	12AE7	.94	19BG6	1.39
6CM7	.66	12AF3	.73	19T8	.80
6CM8	.90	12AF6	.49	19V8	.79
6CN7	.65	12AJ6	.46	21EX6	1.49
6CQ8	.84	12AL5	.45	25AV5	.83
6CR6	.51	12AL8	.95	25AX4	.70
6CS6	.57	12AQ5	.60	25BK5	.91
6CS7	.69	12AT6	.43	25BQ6	1.11
6CU5	.58	12AT7	.76	25C5	.53
6CU6	1.08	12AU6	.51	25CA5	.59
6CY5	.70	12AU7	.60	25CD6	1.44
6CY7	.71	12AV6	.41	25CU6	1.11
6DA4	.68	12AV7	.75	25DN6	1.42
6DB5	.69	12AX4	.67	25EH5	.55
6DB6	.51	12AX7	.63	25L6	.57
6DE6	.58	12AY7	1.44	25W4	.68
6DG6	.59	12AZ7	.86	25Z6	.66
6DK6	.59	12B4	.63	32ET5	.55
6DN6	1.55	12BA6	.50	32L7	.90
6DQ6	1.10	12BA7	.84	35B5	.60
6DT6	.53	12BD6	.50	35C5	.51
6DT8	.79	12BE6	.53	35L6	.57
6EA8	.79	12BF6	.44	35W4	.42
6EB5	.72	12BH7	.77	35Z5	.60
6EB8	.94	12BK5	1.00	36AM3	.36
6EM5	.76	12BL6	.56	50B5	.60
6EM7	.82	12BQ6	1.06	50C5	.53
6EU8	.79	12BY7	.77	50EH5	.55
6EW6	.57	12BZ7	.75	50L6	.61
6EY6	.75	12C5	.56	5763	1.00
6F5GT	.39	12CN5	.56	70L7	.97
6F6	.69	12CR6	.54	7025	.69
6GK6	.79	12CU5	.58	84/6Z4	.46
6GN8	.94	12CU6	1.06	807	.70
6H6	.58	12CX6	.54	117Z3	.61
6J5GT	.51				

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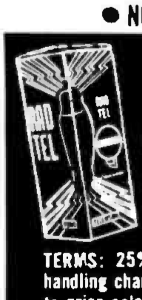

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160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179
180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199
200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219
220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239

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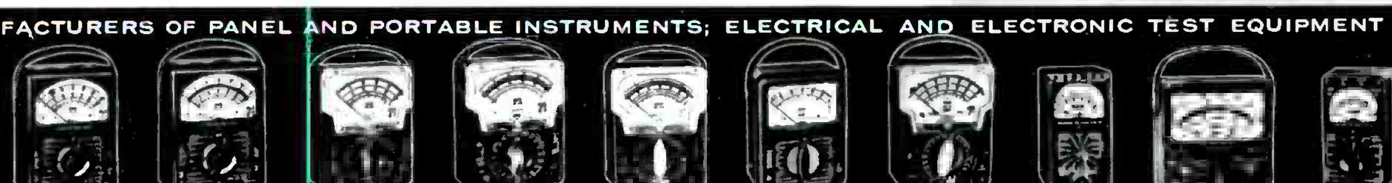

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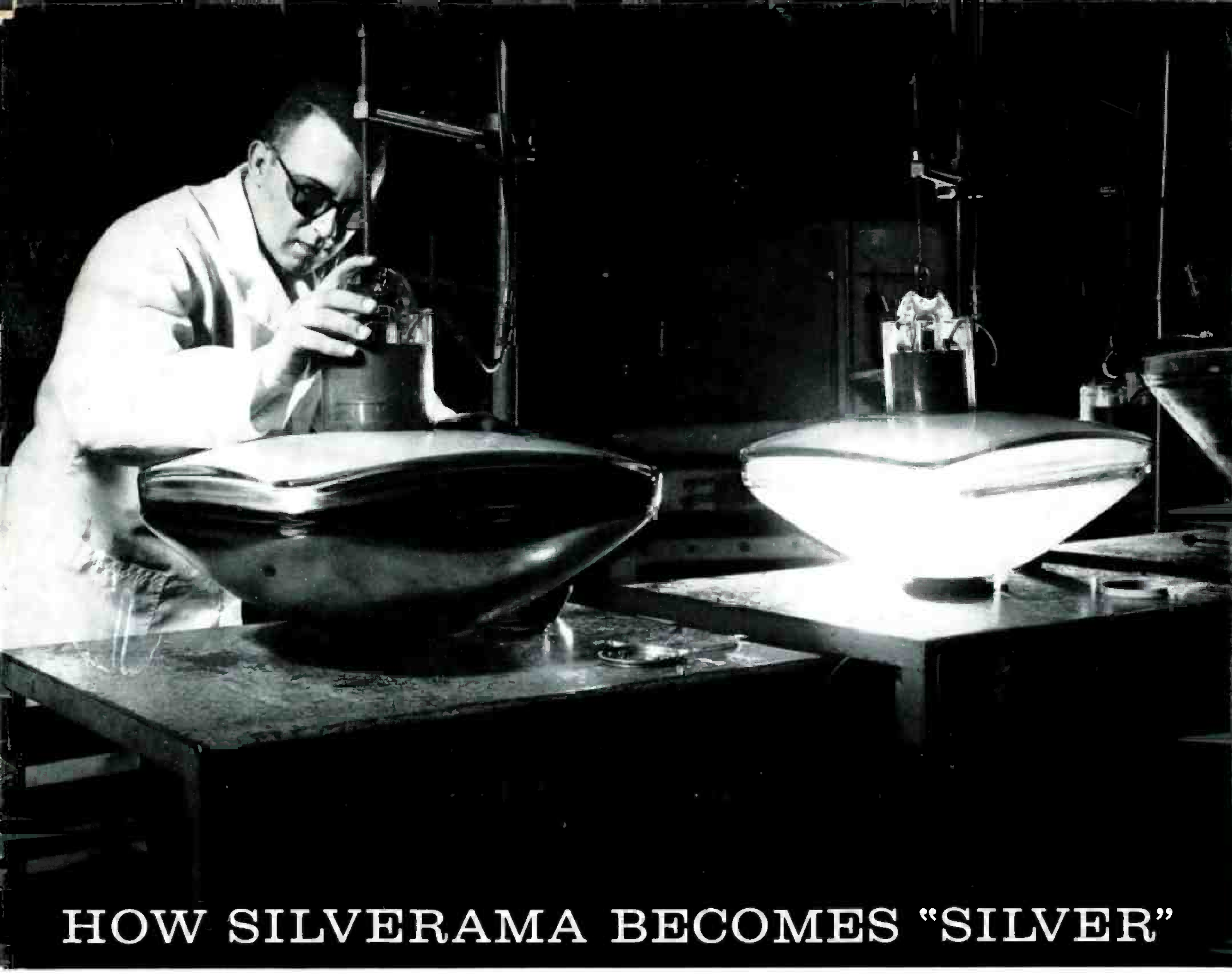

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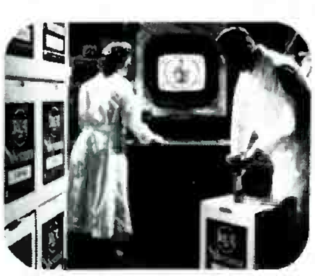
High-Vacuum Aluminizing Assures Sharpest TV Picture Possible

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.

Equally important is the fact that RCA is a picture tube manufacturer. This means that your customers can take advantage of the latest innovations in picture tube design and manufacture when they buy RCA Silverama. It is made with a precision electron gun, the finest parts and materials, plus a reused envelope.



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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