Electronics World

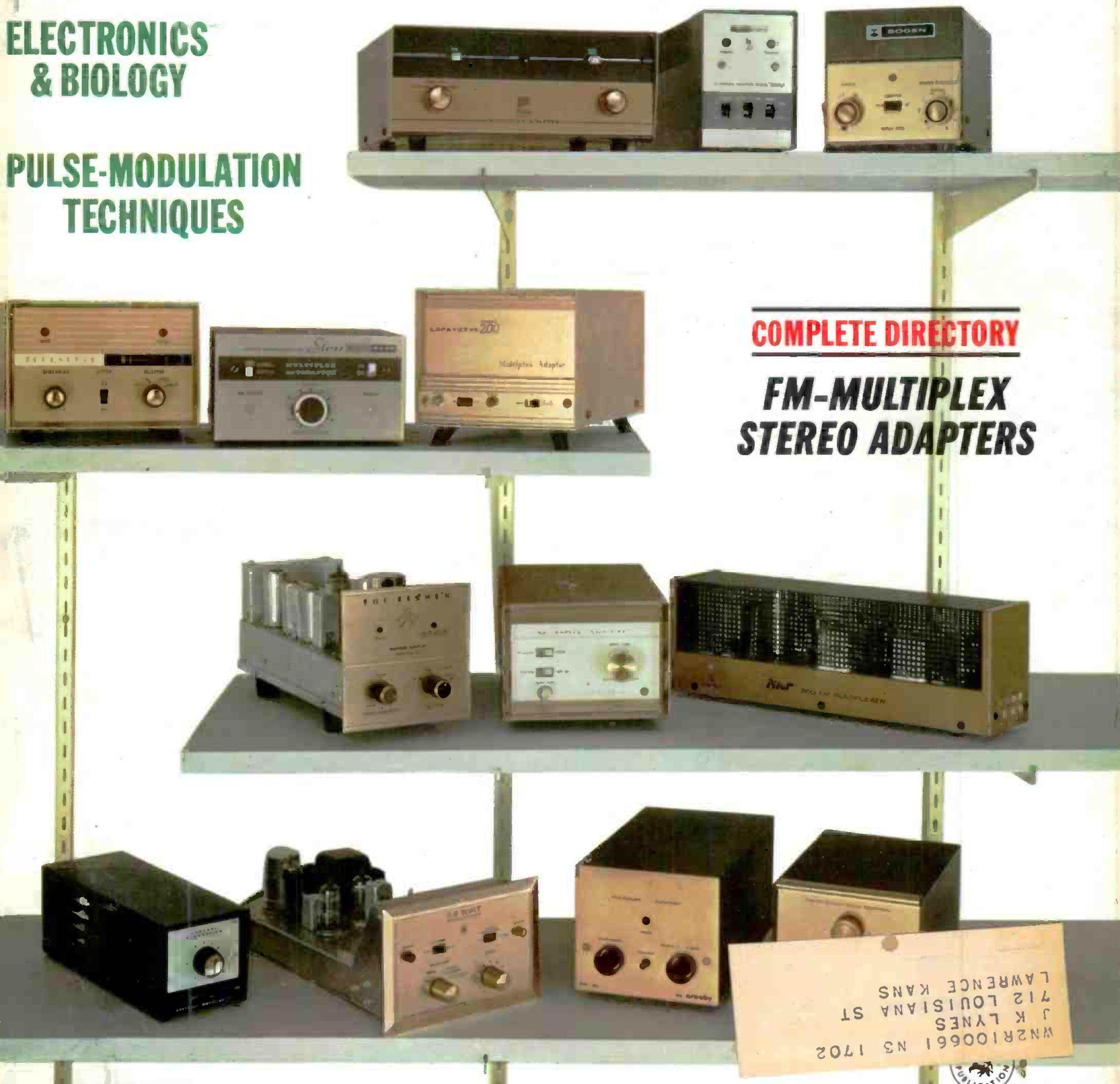
FEBRUARY, 1962
50 CENTS

DESIGN DETAILS ON TRANSISTORIZED CB TRANSMITTERS

TECHNICIAN TRAINING—REQUIREMENTS FOR CAREER ADVANCEMENT

ELECTRONICS & BIOLOGY

PULSE-MODULATION TECHNIQUES



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SPRAGUE CERAMIC CAPACITORS

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That's why the Sprague Ceramic Line is varied and broad—it includes capacitors with electrical and mechanical characteristics to meet practically every replacement requirement.

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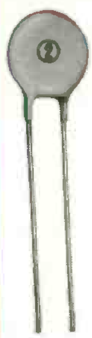


CERA-MITE® CAPACITORS

Tiny, tough, dependable. Silvered flat-plate construction for high by-pass efficiency, high self-resonant frequency. Available in the following types to meet specific requirements:

- *General Application,* for by-pass and coupling
- *High-K,* for applications requiring guaranteed minimum capacitance values
- *Temperature-Stable,* for minimum capacitance change with temperature
- *Temperature-Compensating,* for applications requiring negative temperature coefficient
- *NPO,* for use where capacitance change with temperature is undesirable
- *AC,* rated at 125 VAC
- *Buffer,* rated at 2000 WVDC
- *Low-voltage,* for by-pass and coupling in transistorized circuitry
- *TV Yoke,* rated at 3000 and 5000 WVDC

HYPERCON® CAPACITORS

Ultra-miniature discs for use in transistorized circuitry. Designed for by-pass and coupling applications in low voltage circuits where high capacitance and low power factor are important considerations. Superior in size and performance to comparably-rated aluminum electrolytic capacitors.

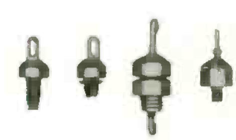
"UNIVERSAL" CAPACITORS

Have multiple leads. Quick-fix capacitors for on-the-spot repairs. By using certain leads for terminals, connecting certain leads together, and removing certain leads, various ratings may be obtained. Available in General Application as well as High-K types.

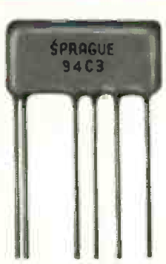
DOORKNOB CAPACITORS

Available in 20 and 30 KV ratings. Molded guard rings lengthen surface creepage path. Complete with variety of screw-in terminals to meet all replacement requirements.

BUTTONHEAD CAPACITORS



Screw-mounting units with flat disc capacitor elements seated in hexagon head. This series includes feed-thru capacitors for filtering leads through chassis, as well as standoff capacitors for by-pass applications.



BULPLATE® CAPACITORS

Rugged multiple-section units which combine in one compact assembly all the capacitors used in one or more stages of a radio circuit. These space-saving capacitors are ideal for miniature sets.

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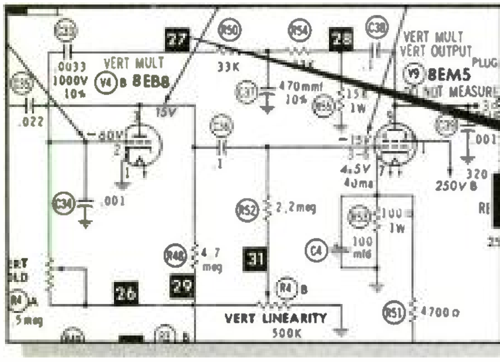
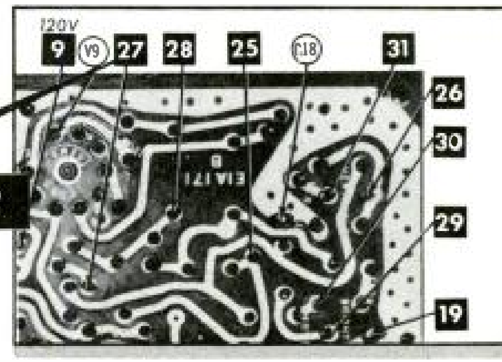
handiest, most-complete data ever published to speed and simplify servicing—equally useful for troubleshooting in the home or on the bench...



CIRCUITRACE®

exclusive Sams standardized, uniform system for fastest, easiest printed board trouble-shooting...



Here's how CircuiTrace works: All test points are clearly shown on the schematic and each is plainly coded (see illustration at left). The same test points are similarly coded on the printed board photo (see illustration at right) so you instantly know where to make your measurement! No more costly hunting for test points ...no more guesswork...no need to look at both sides of the board—identifies tubes, transistors, and foil connections of parts throughout circuits. CircuiTrace makes printed board servicing a breeze!

TIME-SAVING SERVICE AIDS for field or shop

FIELD SERVICING NOTES

SAFETY GLASS REMOVAL (MODEL KC366)

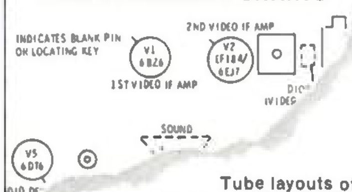
Remove 4 screws holding the trim strip at the top e... the safety glass. Tilt glass out and remove.

FUSE AND FUSE DEVICE

TV: Sweep - ½ Amp. (M1) Radio
LV Supply - Fuse Wire (M2)
Filament - Fuse Wi...
See "Tub...

Valuable instructions for making all necessary adjustments in the home, locating fuses, removing safety glass, etc.

TUBE PLACEMENT CHARTS



Tube layouts of top and bottom of chassis show sync and sound paths, tube keyways, fuses, rectifiers, etc. Helps you trace signal path to localize the trouble.

TUBE FAILURE CHECK CHART

POWER SUPPLY FAILURE
No raster, no sound Fuse Wire (LV Power), Fuse ...

SWEEP FAILURE
No raster, has sound Fuse (Sweep), V8, V9, V10,
No vertical deflection V7
Poor vert. linearity or foldover V7
Poor horiz. linearity or foldover ...
Narrow picture V8, ...

Points out probable causes of common troubles, tells you which tubes to replace to correct the symptom. Also shows series-string filament connections.

DISASSEMBLY INSTRUCTIONS

TV CHASSIS REMOVAL

1. Remove 10 push-on type knobs
2. Remove 12 wood screws in

You get step-by-step procedure for removing chassis, CRT, speakers, knobs, hidden bolts and connections. Avoids parts damage—saves valuable time.

HORIZONTAL SWEEP CIRCUIT ADJUSTMENTS

Set the Horizontal Hold Control to ... Horizontal Frequency Slug (B1) ... tally. Keep turning B1 in the ... out of sync. Reverse th...

Detailed instructions help you solve the troublesome problem of adjusting the horizontal circuits (oscillator, linearity, and width)—avoids guesswork!

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FEBRUARY 1962/VOL. 67 NO. 2

Electronics World

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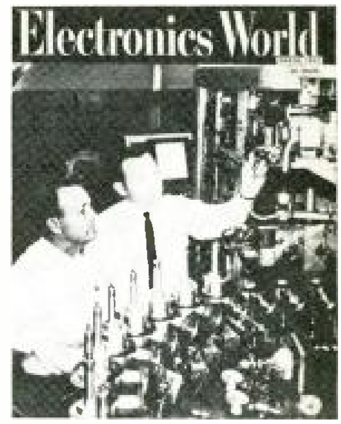

THE TECHNICIAN'S ROLE IN INDUSTRY
Automation and the remote-control of industrial processes is giving the technician a big boost toward greater recognition and higher pay. This is the situation at one nation-wide manufacturer of precision components, as related by a technician who has "arrived."

TRANSISTORIZED FM-MULTIPLEX STEREO ADAPTER
Now that silicon planar transistors are reasonably priced, you can build a simple switching-type adapter which provides 25 db separation at 1 kc. A signal input of .5 to 1 volt r.m.s. is needed from your tuner.

TRANSISTORIZED METAL LOCATOR
A tested design for a compact, lightweight unit that weighs only 28 ounces with batteries. This beat-frequency instrument provides both loudspeaker and output meter indication.

VERSATILE ELECTRONIC SWITCH
Here is an easy-to-build transistorized circuit that will operate a relay over a frequency range of 16 seconds per cycle to 14 cps. The circuit is designed to permit it to be used either for testing or as a chopper.

SIGNAL-STRENGTH METER FOR CB
How good are the CB signals you are receiving? This handy indicator will provide useful, dependable, comparative signal reports.

VALUE CHECKER FOR ELECTROLYTICS
Direct indication of capacitance values from 5 to 200 µf., often without removing the capacitor in question from its circuit, are obtained with an instrument that is simpler, more portable, and easier to operate than a conventional bridge circuit.

NEW WESTINGHOUSE TV CIRCUITS
Currently available receivers from this company feature a number of interesting innovations—including a re-broadcaster for private TV sound from an AM radio, an "instant-on" arrangement to minimize warm-up problems, and an unusual system for adjusting picture width and linearity. Here is an inside view of these new circuits.

All these and many more interesting and informative articles will be yours in the March issue of ELECTRONICS WORLD . . . on sale February 22nd

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...for the Record

By **W. A. STOCKLIN**
Editor

HIRSCH-HOUCK LAB REPORTS

WE RECENTLY heard a technical paper presented by two audio engineers on the design of a 100-watt stereo amplifier. Their experiences in measuring the power output of this amplifier by use of music-power and continuous sine-wave methods were so interesting that we felt it extremely desirable to pass this information on.

Their original assignment was to design a 100-watt (dual 50-watt) stereo power amplifier that would give the best possible results without any consideration of its cost. This assignment, one that all audio engineers would like to have since cost is one of their biggest problems, was accepted with enthusiasm. The best components possible went into its design with all power supplies being completely voltage regulated. When completed, the amplifier did produce 50-watts continuous sine-wave power on each channel and, in view of the voltage-regulated power supplies, the music-power measurement was also 50-watts per channel.

Their next attempt was to reduce cost, yet try to maintain their 50-watt-per-channel music-power rating. Substitutions and simplifications were made one at a time. The first step was the elimination of the regulated power supplies. From that point on, filter chokes were dropped in favor of resistive type filtering. Measurements were taken as these changes were made and the amplifier, in its final form, was still able to produce 50-watts music-power output per channel. The interesting point is that the continuous sine-wave power dropped to only 15 watts per channel.

This example points up one of our major problems in setting standards of measurements for the Hirsch-Houck Lab reports.

There is some standardization in the hi-fi industry today relating to the exact method of specifying power output. Yet, there is still confusion. The EIA standard of measurement is based on the music-power method and the power rating is given at 5% harmonic distortion. Companies making packaged hi-fi equipment, like *Admiral*, *Magnavox*, *Motorola*, *Zenith*, etc., use this standard. The IHFM, composed of component hi-fi manufacturers, also specifies music-power rating in addition to steady-state power rating, but the amount of distortion is not specified. Most IHFM manufacturers rate their amplifiers at no more than 2% harmonic distortion.

Let's not forget that in making continuous sine-wave measurements, we would use the original power supply designed for the unit, but for music-power measurements we substitute external power supplies having perfect regulation. Let's also remember that the final version of the amplifier described above is only capable of reproducing 15 watts of power output when a continuous sine-wave tone, similar to some extent to that available from an organ, is reproduced. At the same time, this same amplifier would be capable of reproducing 50 watts of power output when short duration tones, such as those obtained from a piano, are reproduced. Our own feeling is that, since every amplifier is used for both types of sound, it should be rated by its continuous sine-wave capabilities.

Another problem is that many manufacturers not only rate their amplifiers by their music-power capabilities, but they also report performance with only one of the two channels being driven. We feel this is not realistic in that stereo amplifiers are actually used with *both* channels operating simultaneously. Hence, this is the way they should be tested.

In all Hirsch-Houck Lab reports on power amplifiers, then, we will use the continuous sine-wave method of measurement with both channels being driven simultaneously. There is nothing wrong with this method, since there are no definite standards in our industry to the contrary, but it is the most severe of all the methods that can be employed. Also, in all our tests we will quote maximum output power at 2% harmonic distortion at 1000 cps.

Since our methods are so severe, we would like to take this opportunity to point out to our readers that on all our future Lab Reports prepared by Hirsch-Houck on power amplifiers, our results on the output ratings will invariably be lower than those published by the manufacturer. This is quite natural if manufacturers use different methods of rating equipment.

One should not find fault with these companies for following the procedures that they do. The sales disadvantage for any one of them, regardless of how good their products are, would likely lead to disaster. If it is a standard practice among only a few in the industry to use a more lenient method of measurement that gives higher power ratings, it is imperative that the rest follow.

As editors, we have two goals: (1) to be as informative to our readers as possible while being fair to the manufacturers in judging each piece of equipment on an equal basis; and (2) to help our readers to become more technically knowledgeable so that they are familiar with the various methods that are used for testing. Only in this way can they become truly adept at judging such equipment. ▲

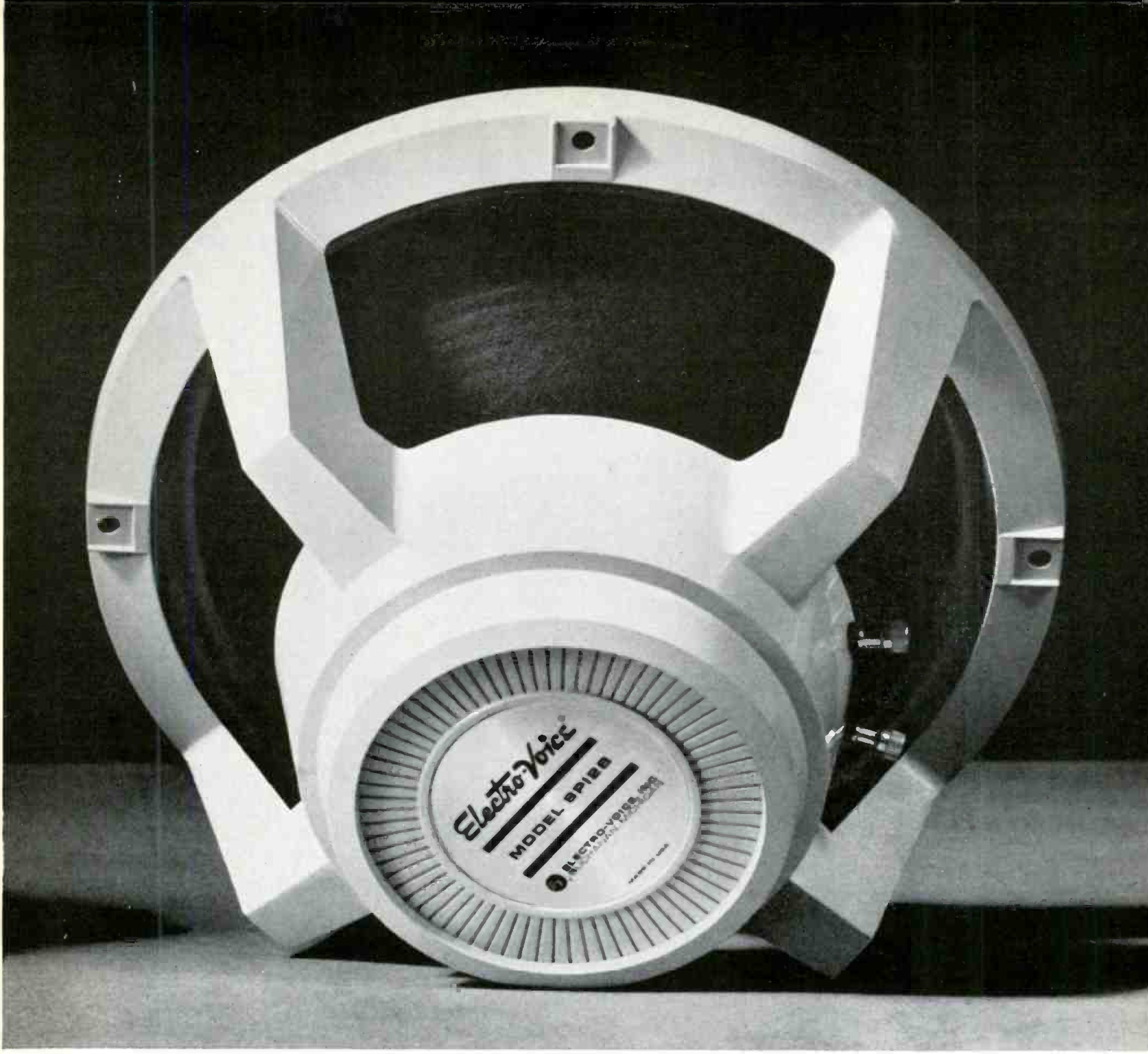
Now, One Look Tells You... The Best Buys

Take a close look at the all-new Electro-Voice SP12B and 12TRXB custom loudspeakers. Speakers with the honest beauty of precision... created by the sure, deft hand of a master designer.

Here is beauty with a reason... beauty that actively mirrors the superb performance of these famous speakers. Chosen for over a decade as "best buys" by listeners and laboratories alike, now the SP12B and 12TRXB look better and sound better than ever before.

No mystery about why they sound so good. Every detail of design has been refined, every manufacturing tolerance tightened to assure the highest level of musical performance and engineering integrity in your high fidelity system.

We urge you to carefully judge the SP12B and 12TRXB on every basis ... on facts and figures, on appearance, and finally with your own critical ear. In every way these speakers give a full measure of satisfaction. And the real beauty is that they are very modestly priced.



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MODEL SP12B Coaxial Full-Range Loudspeaker. Features Radax dual cone plus long-throw, high-compliance suspension. Ideal for built-in and custom installations. $35.00.

MODEL 12TRXB 3-Way Loudspeaker. Includes diffraction tweeter for extended range, wider sound distribution. Provides optimum sound in minimum space. Perfect for stereo. $66.00.

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LETTERS FROM OUR READERS

V.O.M. CALIBRATION STANDARDS

To the Editors:

I expect that you will receive a number of anguished letters about Tom Jaski's article "Calibration Standards for the V.O.M." in your October issue.

A *Weston* standard cell is *not* suitable for use with a v.o.m. Probably more *Weston* cells have been ruined by someone using a v.o.m. than from any other cause. The *maximum* current ever permitted from a *Weston* cell is 0.1 ma., and good practice requires that currents be limited to less than this. Obviously a 1000 ohms/volt meter across a 1-volt source will draw 1 ma., or ten times the maximum permissible.

Even a 20,000 ohms/volt meter draws too close to the maximum to be safe. *Weston* cells are for use on bridges, which draw little or no current.

Standard cells are frequently used as voltage reference standards in industrial control instruments. Here, too, the serviceman should be warned never to "check" the standard cell with his v.o.m. It may read correctly on his voltmeter, but it will never be the same again.

Roy V. Hughson
Flushing, N. Y.

Author Jaski was theoretically correct in including Weston *cells in a discussion of accurate d.c. voltage standards. Practically speaking, qualifications in use should have been pointed out. The preference for a bridge or other instrument that draws little or no current for direct cell measurement is unquestioned. In the absence of such equipment, direct use of a v.o.m. that meets certain conditions (many do) is feasible.*

A meter rated at no less than 20,000 ohms per volt on a d.c. range reading at least 1.5 volts full scale would draw well under half the cell's rated maximum current of 100 μa. Better yet, a v.t.v.m. (which would draw one-thousandth of this maximum value or less) could be calibrated against cell voltage directly and then used for the v.o.m. calibration. Taking a quick reading will minimize drain.

If this procedure produces any measurable change in the cell's continued accuracy, the difference would be insignificant for v.o.m. calibration. Remember, we are not dealing here with an ultra-precise, laboratory standard meter.—Editors.

* * *

BELOW THE BROADCAST BAND

To the Editors:

In reading Mr. R. Genaille's article "Below The Broadcast Band" (September 1961) I notice he made no mention of the United States Navy's world-wide precision frequency and time synchronized transmitting system. This system was conceived and developed by scientists at the Naval Research Laboratory in Washington, D. C. with the result that the Navy's v.l.f. transmitters are controlled by precision oscillators having a frequency stability of one or two parts in 10^{11}.

These high-powered transmitters operate twenty-four hours a day (except during maintenance down periods) as follows:

NAA	Cutler, Maine	14.7 kc.
NBA	Summit, C. Z.	18.0 kc.
NLK/NPG	Jim Creek, Wash.	18.6 kc.
NPM	Honolulu, Hawaii	19.8 kc.
NSS	Annapolis, Md.	22.3 kc.

A number of commercial laboratories and others are already using the stable frequency transmissions from some of these stations for the calibration of their laboratory oscillators, thereby avoiding propagation problems associated with high-frequency standard-frequency transmissions. A number of papers have been published on suggested techniques.

In addition to these Navy precision frequency stations, GBR transmits a precision oscillator-controlled carrier on 16.0 kc. from a site near Rugby, England. Their operation is in cooperation with the Navy network.

If, at a later date, it may be necessary to reassign one of the Navy stations to another frequency, the oscillators used will insure that it will operate to the same high degree of precision. The Navy precision frequency transmissions are now heard around the world and provide a definite service to the scientific community where accuracy is required.

Lester C. Harlow
Lieutenant-Commander,
United States Navy
Alexandria, Virginia

There has been much interest in the article referred to above. We certainly appreciate Commander Harlow's additional information.—Editors.

* * *

STEREO HEADPHONES

To the Editors:

This is to inform you that the article in your November issue titled "Listening to Stereo with Headphones" omitted the *Roberts* stereophonic headset from your table of available models.

The headset, Model No. 54-04, is a dynamic-type with an impedance of 8 ohms. It is priced at $24.95.

Rex Backus
Chief Engineer
Roberts Electronics, Inc.
Los Angeles, California

Thanks to Reader Backus for bringing this omission to our attention. We have

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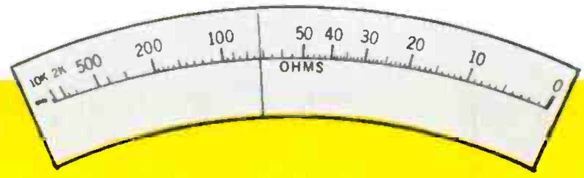

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All scales, including the ohms scale, are *direct reading.* You do not have to multiply. Saves time and trouble. Gives you the right answer immediately. Ohms-adjust control includes switch that automatically shorts out test leads for "zero" set.

Every scale in the V O Matic 360 is the same full size . . . *and only one scale is visible at any one time,* automatically. Supplemental ranges are also provided on separate external overlay meter scales.

This new-type automatic VOM is another innovation by B&K that gives you features you've always wanted. Outdates all others.

Net, $59^{95}

Includes convenient stand to hold "360" for correct viewing in 4 positions.

Ranges:

DC Volts	— 0 - 3, 15, 60, 300, 1000, 6000 (20,000 Ω/v)
AC Volts	— 0 - 3, 15, 60, 300, 1000, 6000 (5,000 Ω/v)
AF (Output)	— 0 - 3, 15, 60, 300 volts
DC Current	— 0 - 100 μa, 5 ma, 100 ma, 500 ma, 10 amps
Resistance	— 0 - 1000 ohms (3 Ω center)
	0 - 10,000 ohms (50 Ω center)
	0 - 1 megohm (4 k Ω center)
	0 - 100 megohms (150 k Ω center)

Supplemental Ranges: 18 separate external overlay meter scales for:
DC Volts— 0 - 250 mv
Capacitance—100 mmfd to 4 mfd
Audio Power Output—up to 56 watts
DB (decibels)
Peak-to-Peak AC (sine) Volts— 0 - 170, 850

Polarity Reversing Switch and **Automatic Ohms-Adjust Control**

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Complete with 1½-volt and 9-volt batteries and test leads

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also learned of a few other manufacturers of stereo headphones since the preparation of the table for our article. These manufacturers are Ampex, Jensen *and* Monarch.—*Editors.*

* * *

BETTER AM REJECTION ON FM SETS

To the Editors:

In connection with the article "Reducing FM Multipath Distortion" by Patrick Halliday, I would like to corroborate the method suggested for improving AM rejection in FM detectors. I have followed the method shown for adding an AM rejection pot to a particular high-quality FM tuner in which the balancing resistor of the unbalanced ratio detector is usually a 470-ohm one. This I often change to another value using a resistance-substitution box to determine the proper resistance in order to better the AM rejection, which it does.

I have been puzzled for a long time as to why no American manufacturer incorporates one of these AM rejection pots in his sets.

R. S. MacCollister
San Francisco, California

Some American TV sets do have buzz controls which regulate the AM rejection of their FM sound detectors. To our knowledge, however, this technique is not used in high-fidelity FM tuners, although it might be useful in improving AM rejection.—Editors.

* * *

ANTI-STATIC SOLUTIONS

To the Editors:

I do not recall seeing any article on the care of vinyl records, such as: how to clean them and how to treat them to keep them from attracting dust. Although there are a number of anti-static solutions on the market, I would like to know about some simple home remedies for the same purpose.

J. D. Douglass
Cleveland, Ohio

Insofar as an anti-static solution is concerned, one record manufacturer that we know of suggests the following: Add one teaspoon of liquid detergent, such as "Joy," to one quart of water. Wipe this solution over the record surface and allow to dry.—Editors.

* * *

P.A. SYSTEM TRANSFORMERS

To the Editors:

I have read your magazine for more than two decades, being especially interested in the articles covering sound. However, I would like to challenge a small part of the circuitry appearing in your article "Impedance Matching in Public-Address Systems" (November 1961 issue). In Figs. 17 and 19, I believe that the wattage taps are not identified properly.

John McAllister
Port Huron, Michigan

Although the text is quite correct, Reader McAllister is right about the wattage markings on the matching transformers. The markings shown in both figures should indicate the lowest value of power with the greatest number of primary turns.—Editors. ▲

Electronics World LAB TESTED

Product Test Report

PREPARED BY HIRSCH-HOUCK LABORATORIES

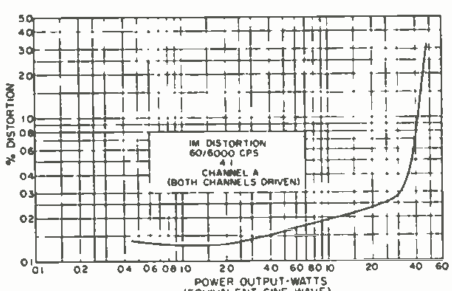
Pilot Model 248 Integrated Stereo Amplifier
RCA WG-360A Phase Checker
Sencore SM112 Combination V.T.V.M.—V.O.M.

Pilot Model 248 Integrated Stereo Amplifier

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

THE Model 248 is *Pilot's* most powerful and elaborate integrated stereo amplifier. It is rated at 30 watts per channel with less than 0.5% harmonic or intermodulation distortion from 25 to 20,000 cps. It is a rather husky amplifier, which in spite of its compact dimensions (14½" wide x 12½" deep x 5" high) weighs some 38 lbs. It comes complete with a black metal cabinet and the brushed brass panel which characterizes the *Pilot* line.

The circuits of the 248 are fairly conventional, with a pair of 7591's in each push-pull output stage. The power sup-



plies use silicon rectifiers throughout. There is a separate d.c. heater supply for all tubes except the output stages and this supply also delivers fixed bias to the output tubes. There is a full complement of input circuits including microphone, tape head, FM-AM tuner, multiplex, and tape-recorder preamplifier, plus two magnetic phono inputs. The latter are selected by a front-panel slide switch separate from the input-selector switch, and are convenient for systems using both a record changer and a turntable. There are also tape recorder output jacks ahead of the tone and volume controls, and a switch for monitoring directly from the tape when a recorder with separate recording and playback amplifiers is used.

The usual volume, balance, and concentric tone controls are provided. A special feature is the output system, which allows for driving two complete sets of stereo speakers. A front-panel switch selects either or both pairs of speakers. The output transformers are connected in such a manner that a third, or center-channel, speaker can be connected to provide a monophonic signal from a stereo program, or to fill in the center when widely spaced stereo speakers are used.

Pilot is one of the few manufacturers who not only does not use the so-called "music-power" ratings, but actually rates its amplifiers for output and distortion while driving both channels simultaneously. Since this is the way we normally test amplifiers, a good correlation should be expected between its ratings and our test results, and this proved to be the case. In fact, the manufacturer's ratings appear to be very conservative in all respects. Each 248 amplifier is accompanied by a test sheet giving its distortion and frequency response under a number of test conditions, and we verified these figures in all except one minor detail (we measured slightly less power output at 20 kc. than *Pilot* did).

Each channel delivered 34 watts at 1000 cps, and 30 watts (−.5 db) or better at 20 and 20,000 cps, at 2% distortion. Even at 0.5% distortion there was no significant difference in power response except below 30 cps and above 15 kc. Even here response was down less than 1.5 db at 20 cps and less than 1 db at 20,000 cps. Intermodulation distortion was below 0.3% up to 32 watts output. The flattest frequency response occurred with both tone controls at their 2 o'clock positions rather than at the indicated flat settings. The loudness compensation offers two degrees of bass boost as the volume control setting is lowered, with no effect on highs. The turnover frequency, at which boost commences, is well chosen and the subjective results are excellent. The loudness compensation can be switched out entirely if desired.

The following additional test data was obtained:

Sensitivity for 10-watts output: 50 mv. on high-level inputs, 1.5 mv. on phono input (at 1 kc.).

Hum level: Measured at standard gain settings, 1-volt input on high-level inputs, 10 mv. on phono at 1000 cps, for 10 watts output. −68.5 db on high-level inputs, −61 db on phono, referred to 10 watts output.

Tone-control range: bass: +15 db, −17 db at 50 cps; treble: +14.4 db, −10 db at 10 kc.

Rumble filters: −22 db at 30 cps.

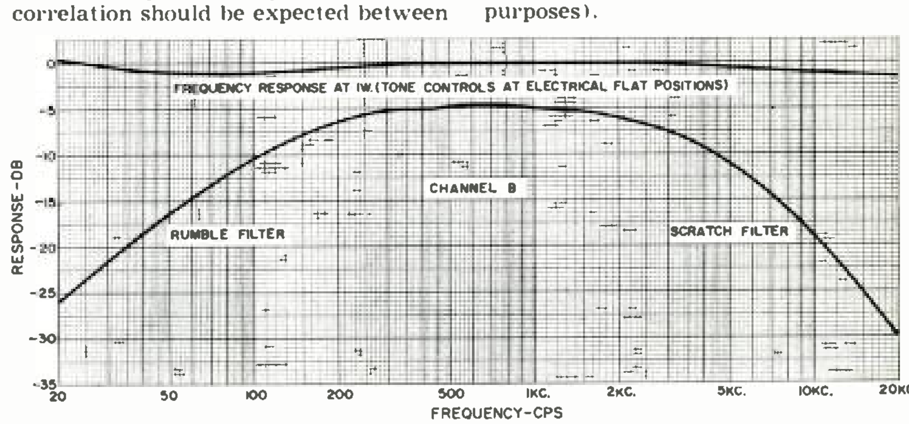
Scratch filters: −19 db at 10 kc. Both filters were too gradual in their action, having an appreciable effect on program material as well as on rumble and scratch.

Phono equalization: +1.6 db, −1.1 db from the RIAA curve from 30 to 15,000 cps.

Power-line leakage: 80 microamperes (negligible).

Stereo crosstalk: −47 db at 1 kc., −37 db at 10 kc.

Crosstalk from radio to phono input: −42 db at 1 kc. (adequate for most purposes).



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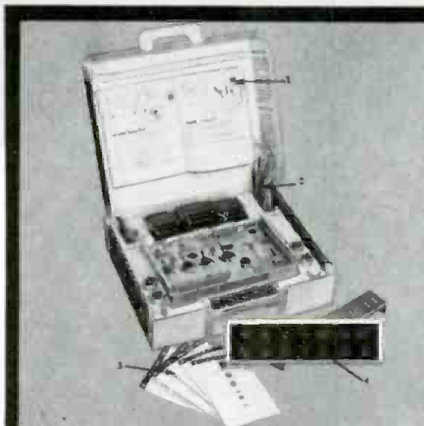

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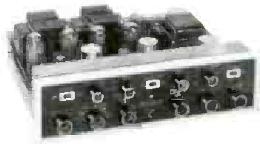

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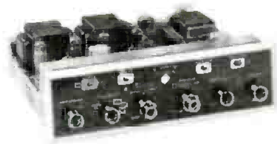

LK-48 48 Watt Stereo Amplifier Kit —
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Tubes and capacitors were operated conservatively, within their ratings. When driven to full output at very low frequencies, there was some buzzing from the metal cabinet caused by magnetic attraction to the output transformers, but this condition is unlikely to occur in practice. The only operating weakness we found was the sensitivity to induced hum at the "Phono Selector" and "Tape Monitor" switches. Bringing the hand near them caused a noticeable hum in the speakers. However, unless these switches are actually being operated, there is no occasion to bring one's hand near them.

In listening, the 248 sounds as good as it measures. It is clean and stable with capacitive loads, contributes no coloration to the signals, and has the feeling of solidity and lack of strain which is a property of a very good, high-powered amplifier. For all practical purposes, the performance of this amplifier is equivalent to that of a separate preamplifier and a top-quality, basic amplifier, and is considerably superior to most integrated amplifiers.

The *Pilot* 248 sells for $249.50, complete with cabinet. ▲

RCA WG-360A Phase Checker

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

IN ANY multiple-speaker system, it is important that all cones handling the same frequencies operate in the same phase. Out-of-phase operation causes loss of output, particularly at low frequencies, and disturbing directional effects at higher frequencies.

In systems where the amplifier outputs are clearly marked, and where identical speaker systems are used, phasing is merely a matter of connecting like leads of the two speakers to corresponding amplifier outputs. When either amplifiers or speakers are dissimilar, the problem is not so easily solved. The usual method is to place the speakers close together and supply a monophonic signal at some low frequency to both speakers. A distinct increase in level will be heard when they are in phase, as compared to the out-of-phase condition.

The *RCA* WG-360A Phase Checker is a simple, fool-proof device which achieves the same result without the need for placing the speakers next to each other. It consists of two small speakers, which operate as microphones. They are in separate boxes, connected by a 15-foot lead. One box has terminals for connecting an indicating device, which may be a v.o.m., a v.t.v.m., or a cathode-ray oscilloscope. On this box is a switch which reverses the phase of one of the small speakers relative to the other. The two speaker outputs are connected in series, stepped up by a transformer, and connected to the indicating device. A crystal-diode rectifier is included in the unit for driving a d.c. microammeter.

To use the phase checker, the two pickup units are placed close to the

(Continued on page 20)

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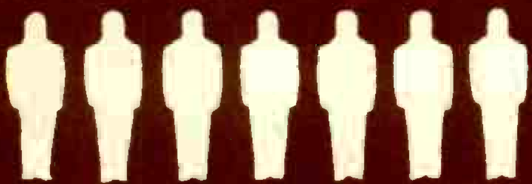

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BUILDING ELECTRONIC CIRCUITS on specially-designed plug-in type chassis, is the work of Robert H. Laurens, Hammonton, N. J. He is an Electronic Technician working on the "Univac" computer. Laurens says, "My NRI training helped me to pass the test to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

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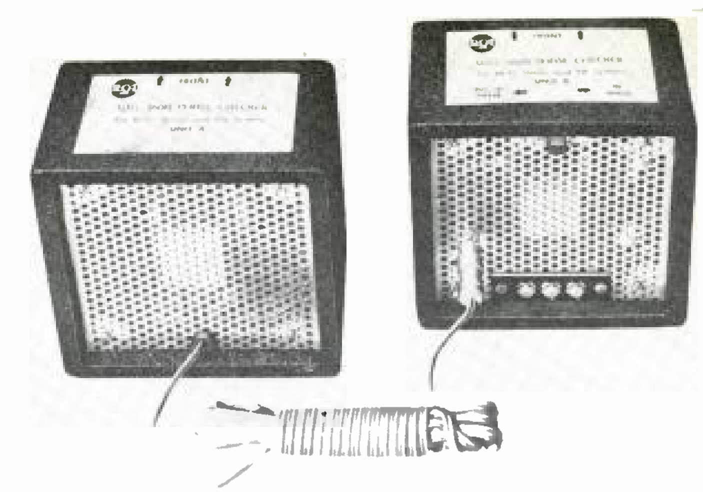

speakers which are to be phased, and an indicating device is connected to the output terminals. If a d.c. meter is to be used, one with a 50-microampere movement is recommended. An a.c. v.t.v.m. of 1.5 volts full-scale sensitivity or better, or an oscilloscope, may be used instead. The more sensitive the indicator, the more positive the indications will be.

Ordinary program material or, preferably, a low audio-frequency tone is supplied to both speakers. The switch on the pickup unit is placed in its "In Phase" and "Out-of-Phase" positions and the meter reading observed. If the reading is greater in the "In Phase" position, the speakers are operating in phase; otherwise they are out-of-phase.

In operation, the WG-360A Phase Checker performed properly at audio frequencies up to about 1.5 kc. Greatest sensitivity is obtained at about 120 cps. Frequencies around 160 to 200 cps are to be avoided, since the pickup speakers resonate in that region and the ratio between in-phase and out-of-phase readings will be small. At higher frequencies great care must be exercised to place the pickup units at the same distance from the speakers to avoid different path lengths which will cause a phase error.

With a sensitive v.t.v.m. or scope, satisfactory results can be had at moderate sound levels. When a 150-microampere v.o.m. was used, an uncomfortably loud level had to be employed for usable indications, but otherwise the unit performed as expected. A 50-microampere v.o.m., as recommended by *RCA*, should be usable at comfortable levels.

The WG-360A Phase Checker should be a valuable tool for the serviceman installing p.a. systems, or for the installer of high-fidelity systems. It removes the guesswork from one of the most critical operations in stereo-system installation.

The price of the *RCA* Phase Checker is $14.95. ▲

Sencore SM112 Combination V.T.V.M.—V.O.M.

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

MANY technicians use two meters for servicing: one a v.t.v.m. for taking accurate on-the-bench measurements in high-impedance circuits with a minimum of loading; and the other a v.o.m. for portable use, for readings without meter warmup or adjustments, and for long-time accuracy. The v.o.m. also provides current readings as well as voltage and resistance. The Sencore SM112 combines both v.t.v.m. and v.o.m. functions within a single instrument that uses one 200-μa. meter as indicator. A selector switch connects this meter to either the v.t.v.m. or to the volt-ohm-milliammeter circuits.

There is little skimping of ranges in spite of the use of a double-purpose meter. The v.t.v.m. has six d.c. ranges (from 3 to 1000 volts full-scale), six a.c. ranges (3 to 1000 volts r.m.s. and 8.4 to 2800 volts peak-to-peak), and six ohmmeter ranges. The circuit is a balanced bridge using a 12AU7, with a 6BN6 signal rectifier and power rectifier. The v.o.m. also has the same six d.c. and r.m.s. a.c. ranges, two ohmmeter ranges, and a single 1000-ma. current range. Although the v.o.m. sensitivity is only 5000 ohms/volt rather than the 20,000 ohms/volt commonly used in service v.o.m.'s, it is a simple matter to switch to the v.t.v.m. function when very high sensitivity is needed. The input resistance of the vacuum-tube voltmeter is 10 megohms.

After using the meter for awhile, it becomes obvious that it was designed for practical bench work with a minimum of wasted time and effort. For example, it is not necessary to change leads or to switch probes in changing from d.c. to a.c. or ohms measurements—or for that matter, in changing from v.t.v.m. to v.o.m. operation. A single, all-purpose probe is used for all measurements. Another time-saver is the use of scale-

(*Continued on page* 103)

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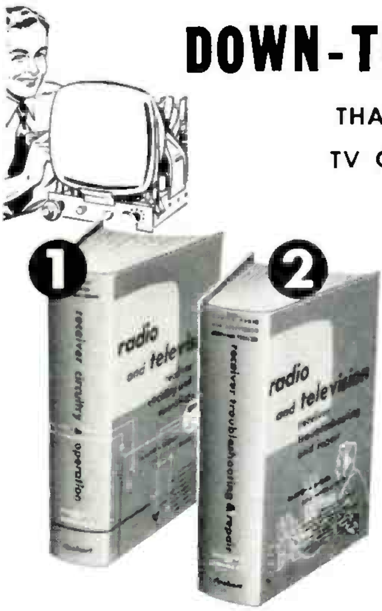

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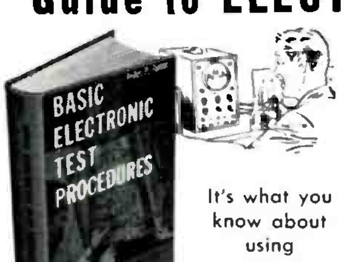

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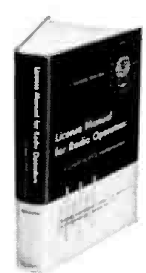

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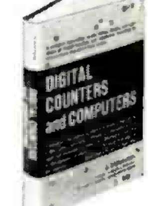

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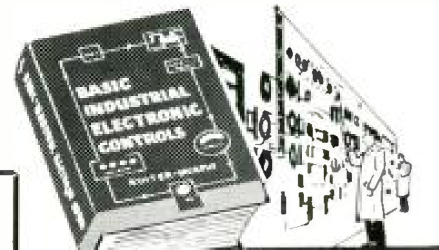

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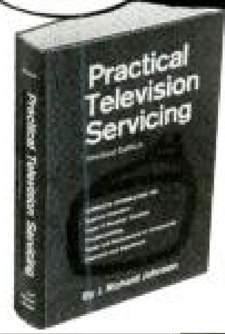

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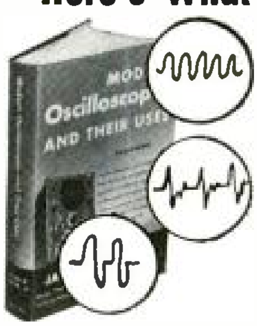

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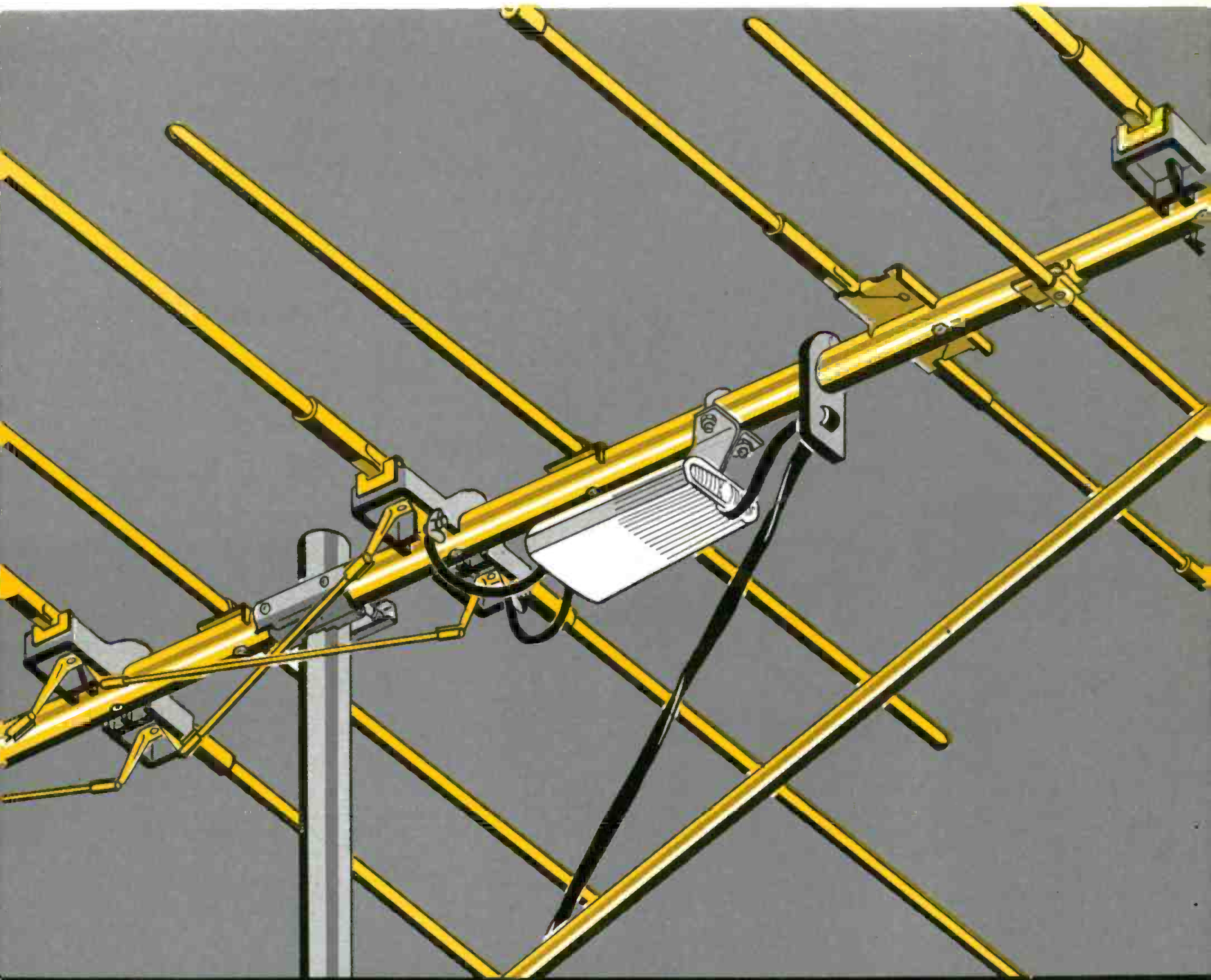

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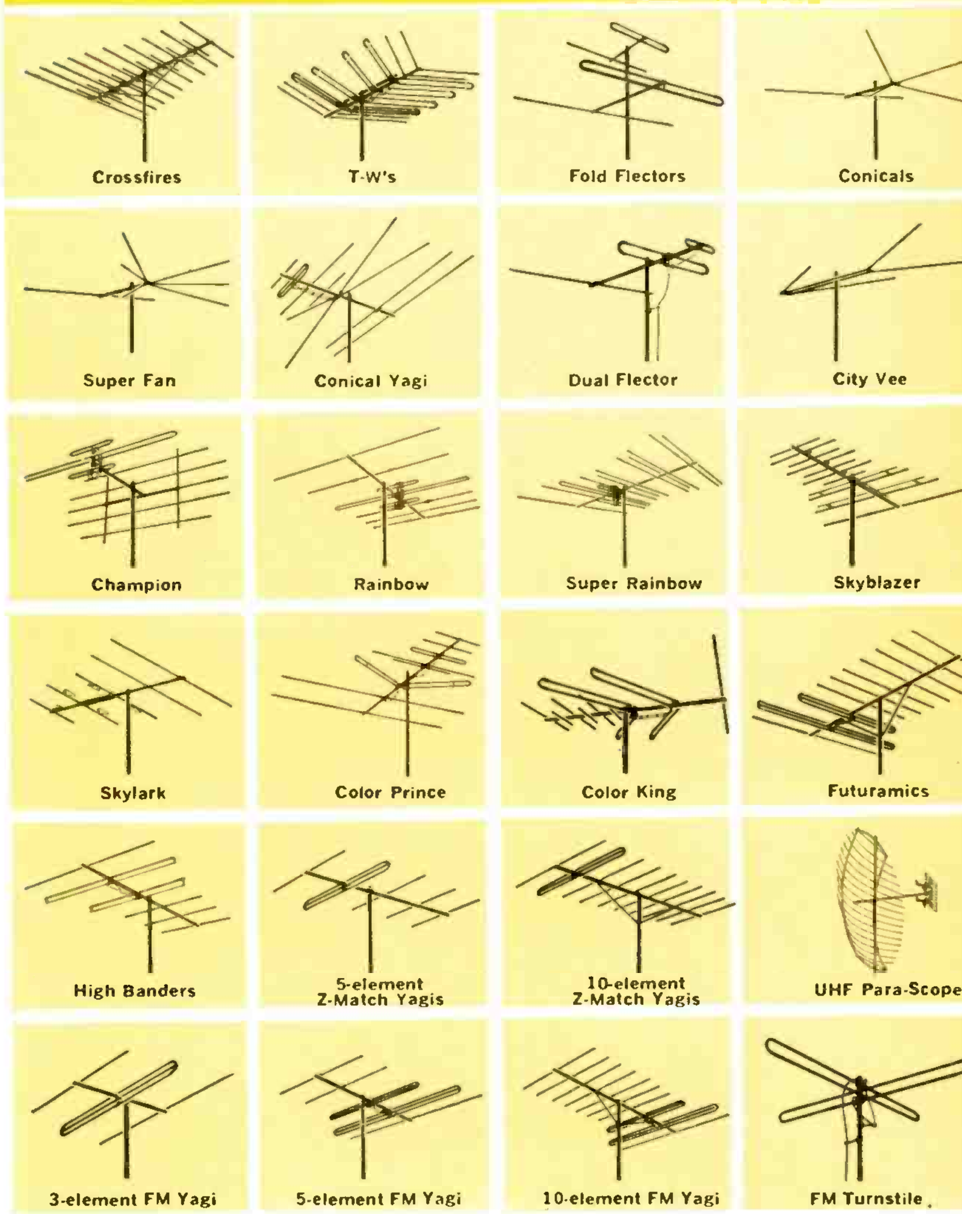

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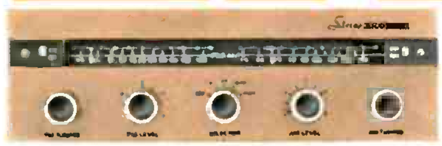

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ELECTRONICS & BIOLOGY

By TOM JASKI

Electronics is helping us to better understand living things. In turn, biology is helping us to build better computers. Here are some results of this interchange.

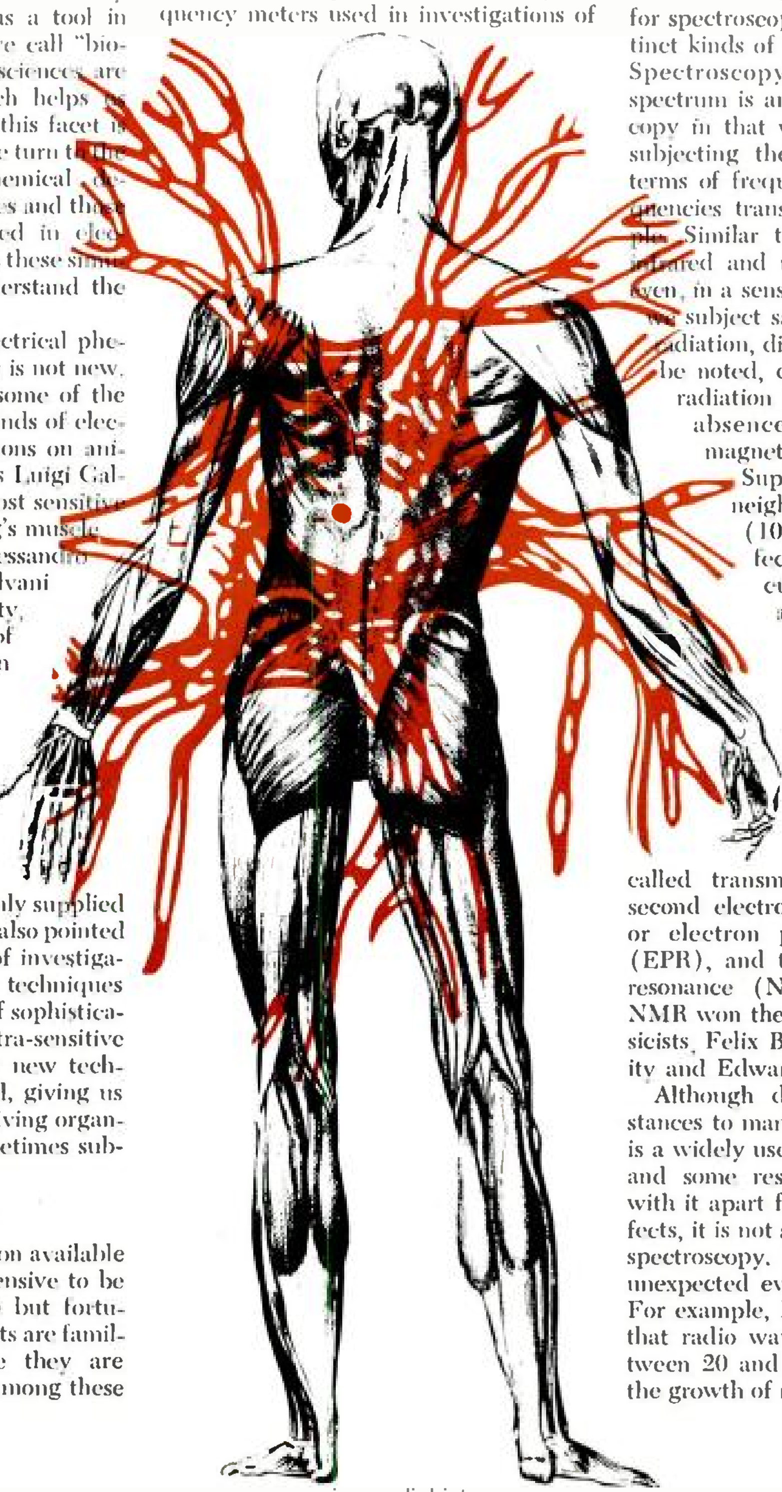
As technology develops, it is natural that there should be an exchange of knowledge and techniques among the various disciplines. Such a mutual exchange between biology and electronics is now beginning to demonstrate some tangible advantages. The exchange, incidentally, is a two-way street. Electronics is used as a tool in biology, resulting in what we call "bio-electronics." The biological sciences are furnishing information which helps us build better computers and this facet is called "bionics." In bionics we turn to the most astounding electro-chemical devices as found in living entities and those we understand are simulated in electronic equipment. Sometimes these simulators help us to better understand the original.

Such an association of electrical phenomena and living organisms is not new. In fact, we might say that some of the earliest awareness of some kinds of electricity came from investigations on animals. For instance, there was Luigi Galvani who, in 1786, used a most sensitive detector of electricity—a frog's muscle with nerve attached. And Allessandro Volta who argued with Galvani about the nature of electricity, turned to electric eels for proof of his contentions. Both men contributed a great deal to the beginnings of a new technology.

A major contribution to the beginnings of bio-electricity was made by Du Bois-Reymond, whose investigations into the nature of nerve activity not only supplied fundamental knowledge, but also pointed the way to new techniques of investigation. Today some of these techniques have reached a high degree of sophistication, thanks to modern, ultra-sensitive electronic equipment. Many new techniques have been introduced, giving us insight into the workings of living organisms at microscopic and sometimes sub-molecular levels.

Bio-Electronics

The array of instrumentation available for bio-electronics is too extensive to be discussed in a single article but fortunately many of the instruments are familiar to the technician since they are widely used in electronics. Among these we count oscilloscopes, pulse generators (used in bio-electronics for stimulation), Wheatstone bridges for accurate voltage measurements and resistance determination, high-gain amplifiers with recorders (as in the electroencephalographs and electrocardiographs), photoelectric circuits used in experiments on vision, frequency meters used in investigations of hearing, timers, counter circuits, and many others.



Another group is not so familiar partly because it includes instruments of relatively recent origin which are expensive and scarce. These units are concerned with some form of radio spectroscopy. Three distinct methods are being used for spectroscopy—representing three distinct kinds of activity in organic matter. Spectroscopy in the radio-frequency spectrum is analogous to light spectroscopy in that we examine the results of subjecting the sample to radiation in terms of frequencies absorbed and frequencies transmitted through the sample. Similar techniques are used with infrared and ultraviolet radiation (and even, in a sense, with x-rays). But when we subject samples to electromagnetic radiation, distinct types of activity can be noted, depending on the type of radiation used and the presence or absence of moderate or strong magnetic fields.

Super-high frequencies, in the neighborhood of the X-band (10,000 mc.), are likely to affect orientation of the molecules, particularly in an aqueous solution. Lower frequency microwaves plus a magnetic field will interact with the electrons of the substance, while still lower frequency radio waves and magnetic fields will affect the nuclei of atoms.

The first technique is called transmission spectroscopy, the second electron spin resonance (ESR) or electron paramagnetic resonance (EPR), and the last nuclear magnetic resonance (NMR). The discovery of NMR won the Nobel Prize for two physicists, Felix Bloch at Stanford University and Edward Purcell at Harvard.

Although direct irradiation of substances to manipulate their constituency is a widely used experimental technique and some results have been obtained with it apart from the usual thermal effects, it is not as polished a procedure as spectroscopy. Many of the results were unexpected even by the experimenters. For example, Hugh Fleming discovered that radio waves of a certain level between 20 and 100 mc. would stimulate the growth of microörganisms, but if this

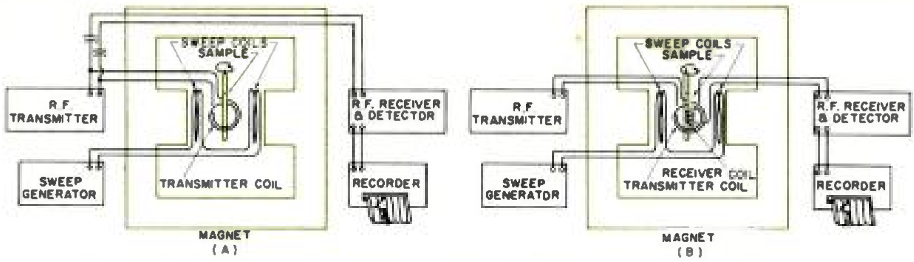


Fig. 1. (A) Nuclear magnetic resonance (NMR) equipment used by Purcell. Receiver detects reduction in amplitude when energy is absorbed by nucleus. (B) NMR equipment used by Bloch. Receiver detects voltage generated by the relaxing nucleus.

level were exceeded slightly, morbidity was high.

Dr. Heller at the New England Institute of Medical Research carried out experiments with paramecia—small organisms which can be influenced in their motions by electromagnetic radiations. Many such experiments have been attempted and a whole new approach to irradiation with radio waves is beginning to infiltrate scientific laboratories now that the task of establishing safe working levels for personnel has been completed.

Radio spectroscopy has a different application. At present, it is used primarily to analyze substances. With the various methods we can detect the presence (and the quantity present) of such minute amounts of a substance that they might escape detection with more conventional chemical analyses. By now everyone is familiar with the concept that very minute controlled quantities of impurities in semiconductor materials make them suitable or unsuitable for transistors or, with different quantities of impurity, suitable for tunnel diodes. Similarly, in the life processes of human and animal organisms, minute quantities of some substances, such as hormones, can drastically affect the survival of the individual. Thus these techniques assume an important role in biology.

NMR and ESR

The principle of NMR is relatively complicated but we can simplify the explanation by a familiar analogy. Recall, then, from your youth a spinning top or small gyroscope. When the top is

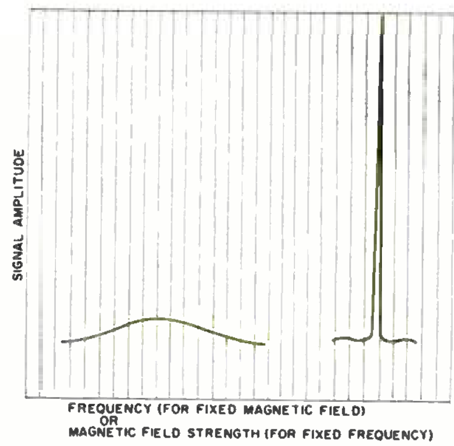


Fig. 2. NMR signals for solid material (left) and for liquid material (right).

placed at some angle, it will not fall over, provided it spins fast enough, but will circle in its tipped position. This circling is called "precession." It results from the centrifugal force of the top, which attempts to maintain it in one position, and from gravity, which tries to pull it over. The centrifugal force wins if the top spins fast enough.

The nucleus of the atom can be compared to the spinning top. It, too, spins rapidly. If we try to apply a magnetic field to pull it over or to "tip" it, the spinning nucleus will precess like the top. If we increase the magnetic field, we will increase the precession rate (as the top started to precess faster when losing speed) but will not succeed in tipping the nucleus. Now, if a second field is added to the first magnetic field—at right angles to it—and this second field is made a spinning (a.c.) field, which keeps pace with the precession, applying its force continuously in the same way to the nucleus, it will be tipped. As it tips, energy is absorbed. If we change either field and "relax" the nucleus, it will tip back to its original position and release the tipping energy.

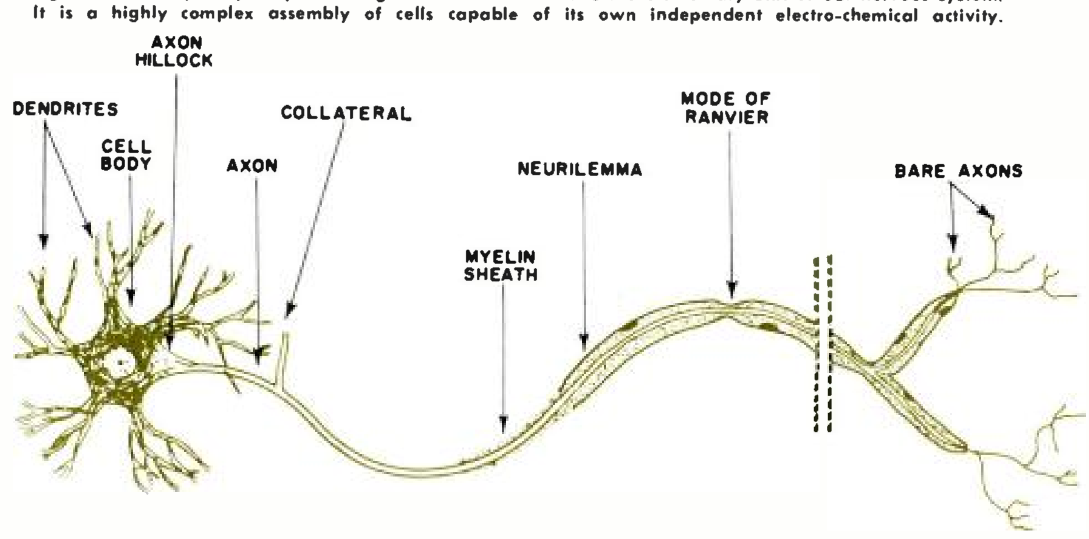
Thus, at a particular magnetic field strength, each substance has a certain "tipping" frequency and we can readily identify the substance by this frequency, which is unique for each kind of atom. How do we create the fields and how do we observe the energy "dip" or energy "pip" from absorption or release? The two methods are shown schematically in Fig. 1.

In Fig. 1A, which depicts Purcell's equipment, the receiver which is swept with the transmitter, will show a sharp decline in energy received when the nucleus absorbs its share. In the Bloch equipment (Fig. 1B), the receiver will not receive maximum signal until the nucleus releases the energy to the special pickup coil. The frequencies at which the nucleus tips depends on the substance, but ranges from a few to a few dozen megacycles.

Electron spin resonance is similar in principle but since the electron spins and precesses more rapidly (more rapid precession because it is a stronger magnet) it requires microwaves for "tipping."

Fig. 4 shows actual equipment of the Bloch type. It consists principally of the magnet (center) with the proper coils and sample holder and the magnet power supply. To the left is the transmitter-receiver-oscilloscope console which supplies the energy for the r.f. field and on which the resonance peaks can be observed. Fig. 2 shows two different kinds of responses. In liquids, the atoms are not packed as densely as in solids. Since each nucleus and each electron is also a small kind of magnet, the effects of external fields are much more pronounced in liquids where the atoms are relatively far apart than in solids where they are closer together—hence the difference in

Fig. 3. This deceptively simple-looking nerve cell (neurone) is the elementary unit of our nervous system. It is a highly complex assembly of cells capable of its own independent electro-chemical activity.



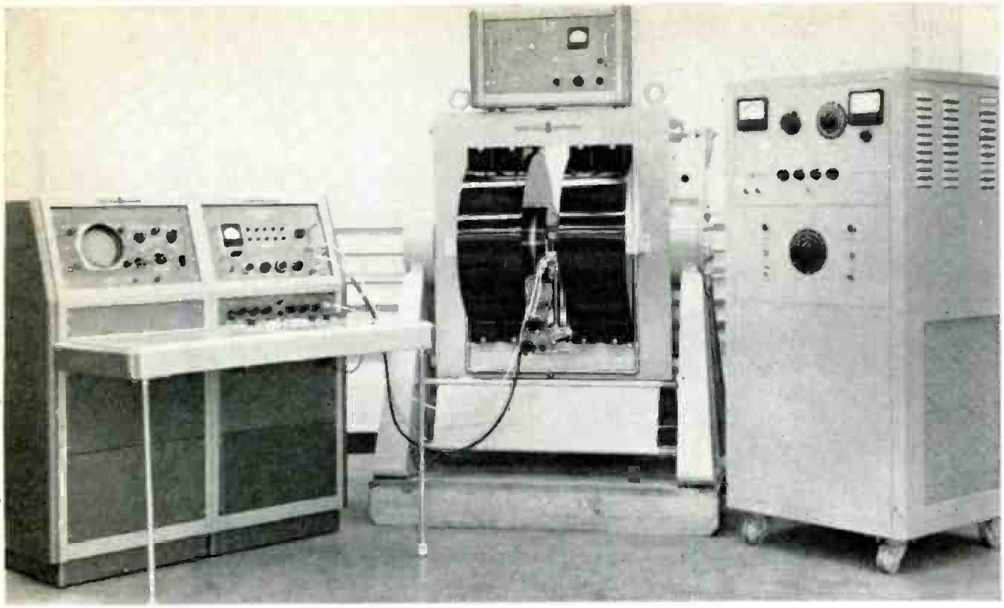


Fig. 4. Commercial nuclear resonance equipment designed by Varian Associates.

response. Complex substances will have a number of such resonance peaks at different frequencies for the different atoms in its makeup. Thus an array of peaks is like a "fingerprint" of the substance. Any "foreign" peaks will indicate the presence of an alien substance.

Radio Spectroscopy

Basically, transmission radio spectroscopy rests on the fact that different substances will have different dielectric properties. "Losses" in the substances will vary as the frequency is swept. No d.c. magnetic field is present. From microwave practice you may have observed that at such frequencies "insulators" may behave as conductors and what we normally consider to be a "conductor," if of the proper dimensions, may act as an insulator. Thus at certain frequencies some substances will behave differently than at other frequencies. The particular frequencies absorbed and transmitted by the sample indicates its constituency. This is originally established by examining very highly purified samples of single substances, as would have to be done for NMR and ESR.

Along with direct irradiation of matter, NMR, ESR, and transmission spectroscopy techniques are truly modern boons of electronic instrumentation to the life sciences, biology, histology, and to the basic sciences for which they were developed—chemistry and physics.

Now let's look at the other side of the picture—the side that shows how the life sciences are teaching us something about possible electronic circuitry.

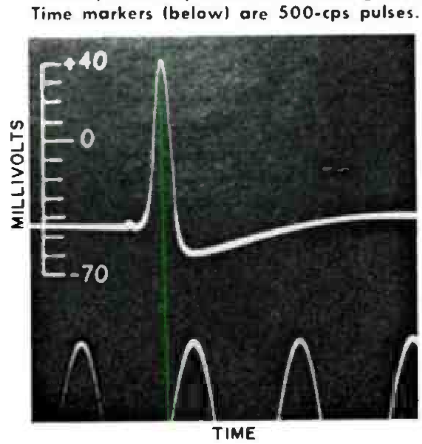
Bionics

Bionics is that field of electronic activity which is concerned with building analogues—models of parts of living organisms. Why has there been such an upsurge of interest in this field?

Our complex technology is demanding more and more of computers but there are only so many ways one can build a computer. Even the most complex, most sophisticated, and largest computers of today are simpletons compared to even a not-very-bright person. A computer can do simple repetitive operations very rapidly, provided it has been instructed in the exact sequence to be followed. But a computer does not have judgment. A certain number of conditions can be specified with which the computer can modify the program of operation. But such fine shadings as can be distinguished by human beings in their communication patterns would demand an impossibly complicated computer. Think, for example, how many times you speculate about how a person feels by the way he answers you! You can make "allowances" on very little data, or you can "speculate" and "imagine"—things no computer does today.

Computer engineers are looking enviously at the human brain which, in a space no larger than a small head of cabbage, packs more versatility, more memory, and more variety of operations than they could cram into a space the size of the Empire State Building. No wonder, then, that they would like to copy this compact mechanism if they could!

Fig. 5. The typical "nerve impulse" or "action potential" produced by a stimulated nerve cell. Amplitude and response are constant for each cell. Propagation velocity along cell axon is different for virtually each separate nerve fiber group. Time markers (below) are 500-cps pulses.



This scientific interest in the human nervous system is nothing new. Psychologists were the first to speculate about the functions of the "mind"—at that time still considered as a separate entity apart from the brain. Even today we have only a limited understanding of the brain—which we now hold to be the seat of the "mind."

The entire human nervous system is composed of deceptively simple looking cells, as shown in Fig. 3. We do not yet completely understand the functions of the single nerve cell, but the bio-electronic scientists have been able to obtain considerable information on the activity of the cells. Fig. 5 depicts a typical "nerve impulse," or "action potential" as it is called. Note that it is only millivolts with which we are dealing here.

Nerve-Cell Models

What are the special characteristics of nerve cells which can be simulated? The nerve cell can fire when stimulated but it has a threshold and such stimulation must exceed a certain minimum. This cell is an "all-or-none" affair. If it fires, it always has the same amplitude. The cell must recover from a pulse and the time required is called the "refractory period." Cells, under certain conditions, can fire spontaneously (as they do in the brain). Cells can be stimulated by "summated" pulses, that is, they have more than one input and if sufficient energy is supplied over all inputs they will also fire, although each separate input is below threshold. Similarly, because of the multiple inputs, cells can also be "inhibited"—prevented from firing.

To understand how a large group of such cells gives us the power to "reason," the characteristic of "intelligence," scientists have taken the first step by copying nerve cell activity. Several models have been made. The earliest attempt was by W. Grey Walter and his unit was built from neon tubes, resistors, capacitors, and batteries. See Fig. 6. It was a relatively poor model in that it did not provide for summation and inhibition. A much later version, made by Wolfe of *Bell Labs*, is shown in Fig. 7. This has all the characteristics specified for nerve cells, with one major difference. This circuit deals in *volts* not *millivolts* and is, of course, many thousands of times larger than a nerve cell.

There are a number of other, similar models of nerve cells designed for specific purposes. Suffice it to say that we can copy all the *known* nerve functions but there may be unknown ones we do not yet suspect. It is also doubtful that we can assume that if we assemble enough of these artificial neurones and connect them in some coherent pattern we will end up with a "brain" which can function even as well as that of an ordinary earthworm.

One scientist has proposed a "neuristor"—a single fiber of properly treated semiconductor material—which could be made to exhibit the characteristics of a nerve fiber. With the ability we now have of re-arranging the molecules in a slab of semiconductor material to obtain relatively complex circuits, such as flip-flops and molecular amplifiers, this is certainly within the realm of possibility. This would take care of the space problem, it would reduce the power requirements, but it still would not provide the final answer by any means.

Recognition & Learning

One whole area of bionic research is devoted to "recognition" circuits. A number of machines have been built which can recognize shapes and characters—irrespective of their size and position or whether or not they are neatly printed or sloppily handwritten. Some of these devices require an entire computer to themselves to decide what the character is but, then, the computer-reader combination can read as fast as 68,000 words per hour so perhaps it is worth all that equipment. The recognition circuits and equipment are too complex to discuss here since the space can be better employed in outlining some of the interesting facets of bionics.

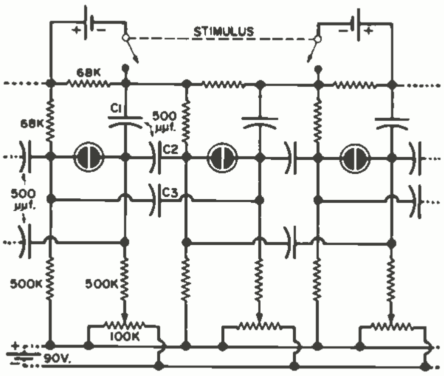


Fig. 6. Early model of electronic nerve cell by Grey Walter. Each unit fires in sequence after charging delay. 20 of these units represent 1" of nerve fiber.

One of the problems for psychologists—and if we want to make computers "smarter," of the computer engineers—is one of "learning." A computer which can read and can store (memorize) information still has no way of testing whether any decisions that it makes are good ones unless we give it the ability to recognize the results of its actions.

W. Grey Walter built a small robot which was equipped to search for a power source to recharge its battery. In addition, he designed a "conditioned reflex" circuit capable of learning to associate stimuli with a "neural" circuit. Classically, conditioned reflex learning is just that; the animal begins to associate some signal—a buzzer, a light, or an electric shock—with another stimulus—such as meat which makes it salivate. When the reflex has been conditioned, the buzzer or light which previously would evoke no such reaction will now cause salivation even if the meat is not presented. Obviously, this reaction involves some sort of "trace" or "memory" of the activity and this can be handled very well in terms of computers.

Although there are later and more complex models of "learning" machines (such as the one recently built by *Melpar*), in Fig. 8 we show one of the simpler and older types built by W. Grey Walter because it is easier to understand. It is an analogue of the "conditioned reflex." Briefly, here is how it operates.

Sound and light stimuli are obtained from preamplifiers. When a sound and light stimulus (both positive signals) arrive on the grid and screen of V_1, the tube conducts. Each time the tube conducts C charges a bit more and after a number of simultaneous stimuli the neon tube will conduct. The capacitor will then retain some charge (when the tube extinguishes) and this charge will leak off very slowly—which is comparable to an animal "forgetting." Subsequently, it will take only a few stimuli to regain the voltage at which the neon tube strikes. V_2 is a phase-shift oscillator biased to cut off and the potentiometer on the grid is set to a point where no oscillation occurs. When the neon tube strikes it provides a signal for short-term oscillation of V_2—a damped oscillation. During the oscillation period we can say the animal has "learned" or been "conditioned" for now the oscillation signal, together with the "neural" stimulus (in this case "sound") can make the tube V_3 conduct and the relay will be energized. Without the "neural" stimulus, V_3 remains cut off. Switches S_H and S_S are included only to test the circuit. A set of switches can provide for different responses if they are used to arrange the polarity of the input signals. In that way, either input can be made to "inhibit" the other.

This, then, is a simple "learning" model and since all learning is, as a rule, concerned with repetition of the same stimuli, it is quite a valid model. More refined versions, such as the one being constructed by *Melpar*, can take into account other factors such as the environment provided for its benefit or to its detriment. But, essentially, the basic idea is present in the older model.

Another area of interest to computer engineers and one which we find in living organisms is the so-called "property filters." We have such filters—our eyes see only light, our ears hear only sound and these two categories are separate. The eye also separates blues and reds and yellows and other colors and passes this information along to the brain. Here,

(*Continued on page* 89)

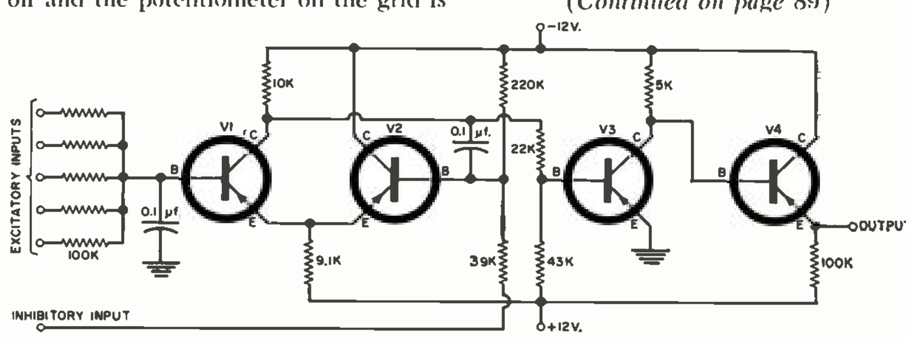
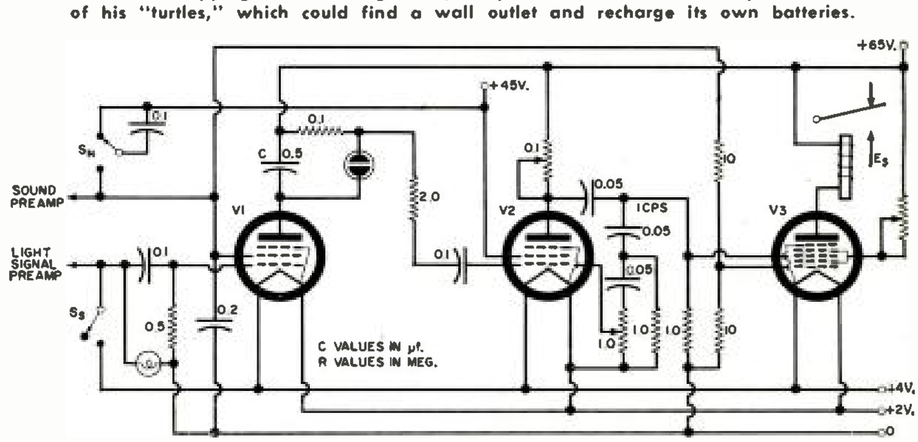


Fig. 7. Later model of nerve cell, by Wolfe of Bell Labs, more nearly reproduced nerve-cell functions. Basic circuit is a Schmitt trigger (V_1 and V_2) and a two-stage direct-coupled amplifier (V_3 and V_4). Multiple inputs provide for "summation."

Fig. 8. Early model of "conditioned reflex," a circuit which can "learn" responses to two overlapping stimuli. Designed by Grey Walter, this circuit was part of one of his "turtles," which could find a wall outlet and recharge its own batteries.



PARALLEL-LINE IMPEDANCE NOMOGRAM

By **JIM KYLE**

Here is a simple-to-use design chart that can be employed by industrial technicians, amateur radio operators, and engineers who must construct impedance-matching stubs.

INDUSTRIAL technicians, ham operators, and electronics engineers frequently find it necessary to determine the impedance of a parallel-wire r.f. transmission line, especially in the construction of impedance-matching transformers or of u.h.f. resonant circuits.

While this impedance can easily be calculated by a simple equation, the equation requires that you know the value of a logarithm—and log tables aren't standard equipment on most benches.

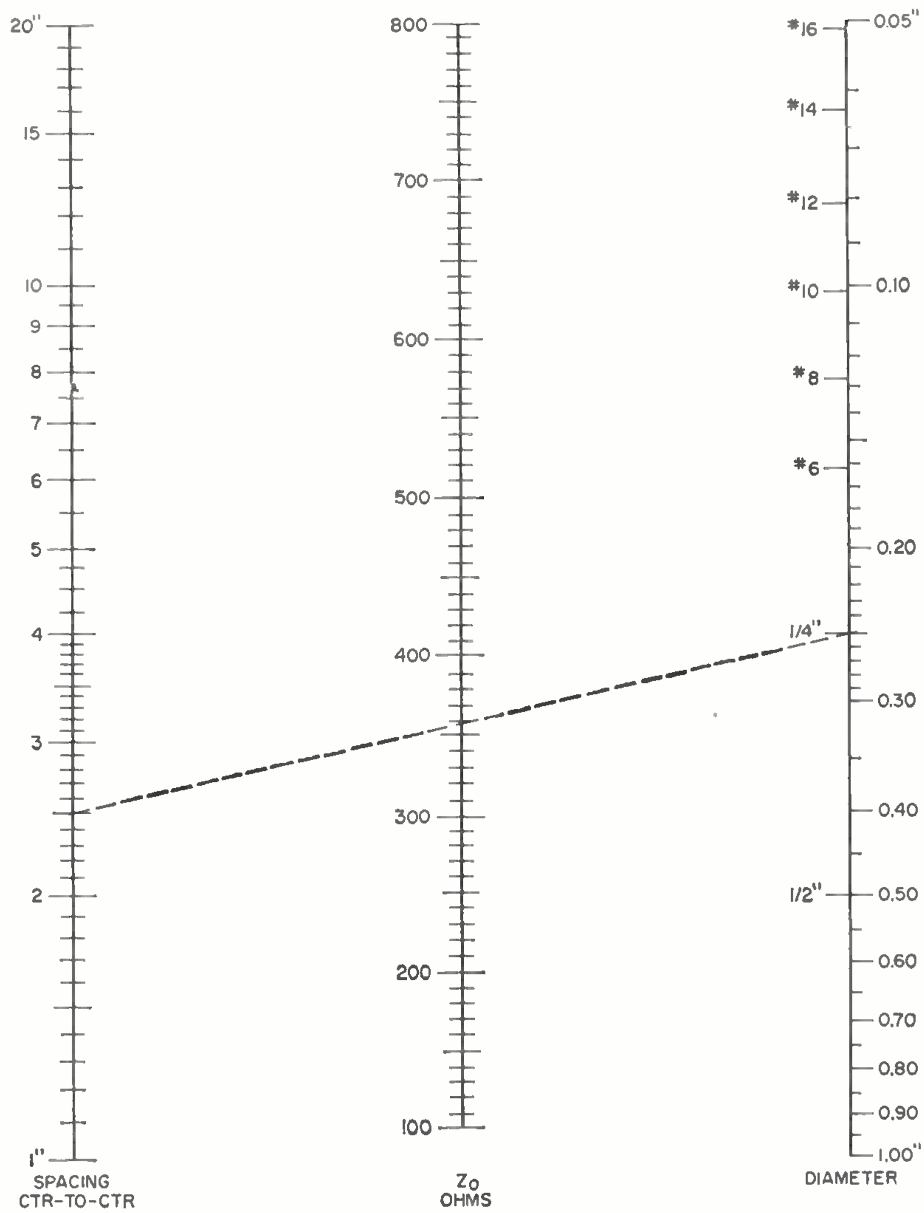
The accompanying nomogram will provide the answer for any air-dielectric parallel-wire line having conductors between .05 inch and 1 inch in diameter, spaced from one inch to 20 inches center-to-center. In addition, it allows you to pick the spacing necessary to build a line of any specified impedance, or to choose conductor diameter.

To use the chart, simply draw a straight line through the two known quantities and read the third quantity at the point where the line intersects its scale.

Example of Use

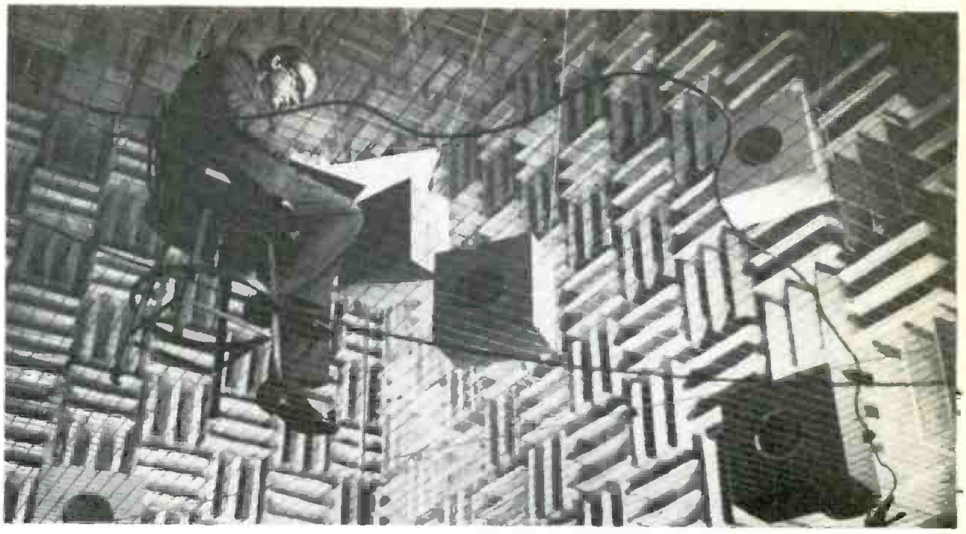
For example, suppose we have an air-dielectric parallel-wire line made up of ¼-inch tubing spaced 2½ inches center-to-center. Drawing a line from 2½ inches on the "spacing" scale to ¼ inch on the "diameter" scale, we find that it crosses the "Z_o" scale just below the 360 gradation. The impedance, then, of the line is approximately 359 ohms.

Had we been planning to build a 359-ohm line section, possibly for use as an impedance-matching transformer, using ¼-inch tubing, we would have drawn the same line—but this time we would read the center-to-center spacing as 2½ inches, from the appropriate scale. ▲

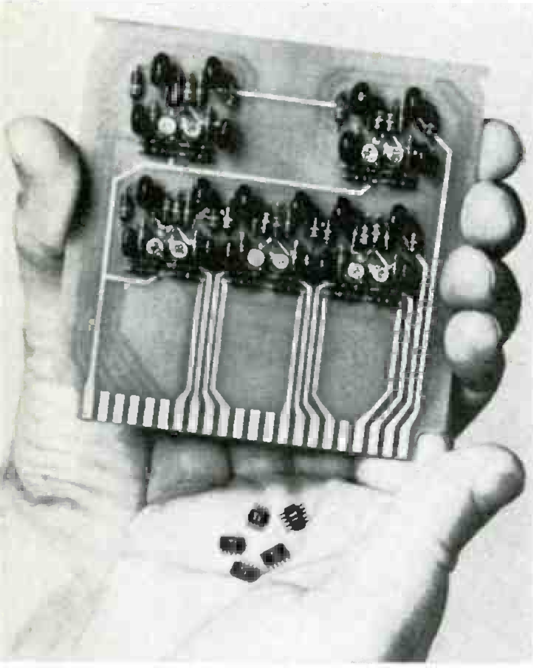


Computer-Simulated Auditorium Acoustics

A method of simulating the acoustics of concert halls and auditoriums in an electronic digital computer has been devised by a Bell Telephone Laboratories *scientist. With this new technique, the acoustics of a proposed auditorium can be listened to and evaluated before the hall is actually built. The architectural design can be modified, if necessary, and a final plan drawn up which will ensure that the completed auditorium will be acoustically satisfactory. The scientist, Dr. M. R. Schroeder, is shown listening in an anechoic room to music that has been processed through the computer programmed to simulate auditorium reverberation.*



RECENT DEVELOPMENTS IN ELECTRONICS

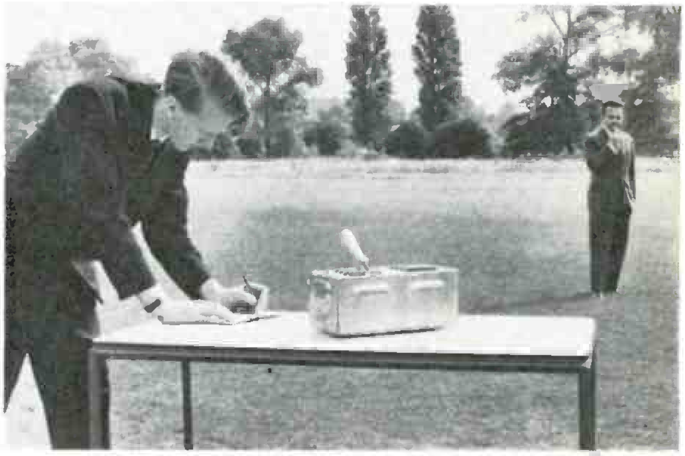


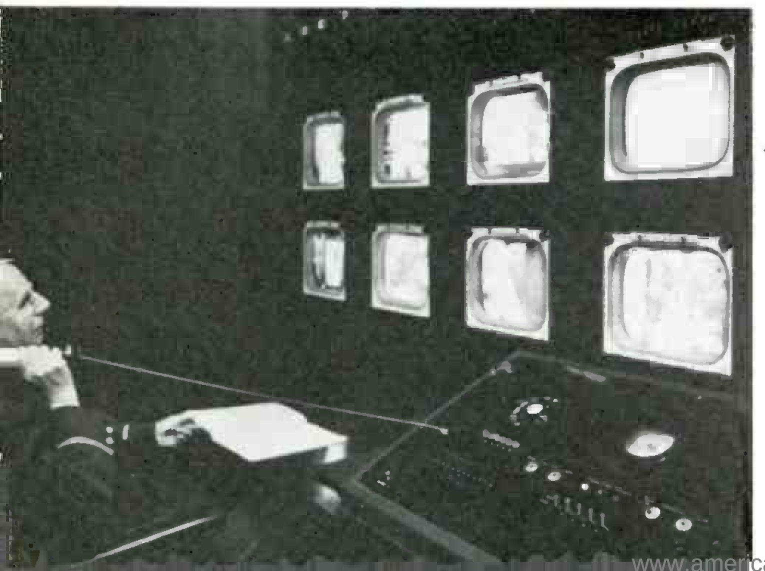
Microelectronic Circuits

A new Texas Instruments *Solid Circuit semiconductor network line consists of six microelectronic digital circuits, each containing the equivalent of some two dozen conventional components. The five networks shown with the conventional etched card above are the functional equivalent of the entire assembly.*

Transistor "Foghorn" for the Blind

A transistor-operated "foghorn" for the blind, developed by Standard Telephones and Cables Ltd., *British affiliate of* ITT, *is now undergoing tests. The blind person carries a small supersonic dog whistle. When blown, the whistle sound is picked up by a microphone on the device, which then rings a bell. The blind person can estimate his position in relation to the known location of the device by judging the direction and intensity of the sound of the bell. The range of the device is about 60 yards.*





CCTV Used in Banking

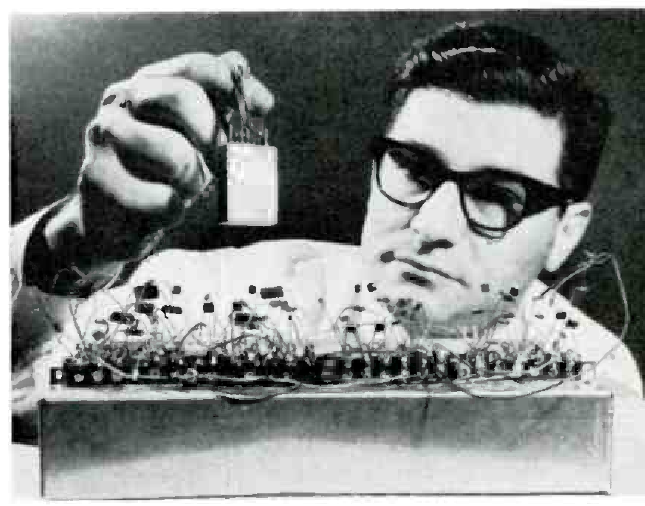
Nerve center for the closed-circuit television system recently installed at the Harris Trust and Savings Bank *in Chicago is this unique eight-monitor panel on the bank's ground floor. Bank guards are able to observe both personnel and customer activity through the eyes of twelve television cameras located on four floors and six departments of the bank. The CCTV system was manufactured by the* Dage Division *of* Thompson Ramo Wooldridge.

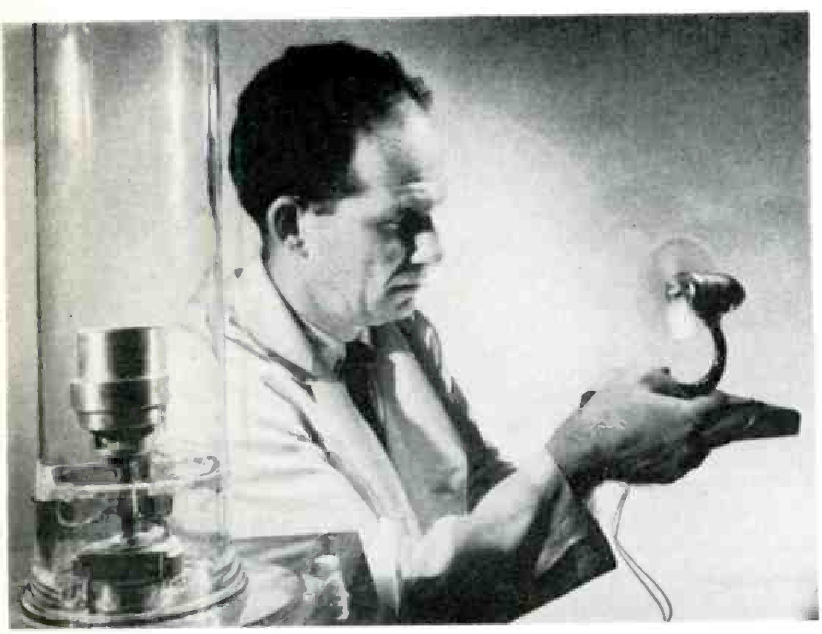
◀ Electrically Suspended Gyro

The round ball at the right in the photograph is the heart of an exotic new gyroscope under development by Minneapolis-Honeywell. *Made of beryllium, the ball becomes a gyro when it is suspended in a vacuum electrically and spun up to high speed. Here the ball is being measured electronically and the meter shows it has achieved the necessary tolerance of better than five-millionths of an inch in sphericity. The next step is to polish it to a shiny surface finish.*

Compact Computer Module ▶

The electronic jungle in the foreground is a haywire-assembled breadboard of a four-binary computer circuit. The compact module being held by Bulova Research and Development Laboratories' *engineer contains all the resistance and capacitance elements in the breadboard version. The module is being used in control equipment for missiles and space vehicles.*





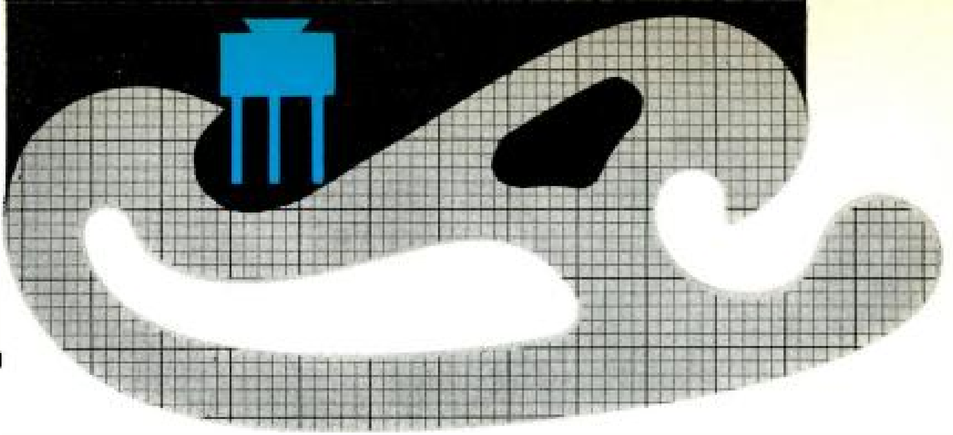
▲ High-Performance Thermoelectric Material

Shown in test at RCA's *Research Center is a new thermoelectric material that is said to produce more electricity directly from high-temperature heat on a practical basis than can the best previously known materials. Tests show that a generator using a square-foot, plate-like arrangement of the material heated to 1000°C. could produce up to 10 kw. of electricity. Here a small electric motor is being powered by a 3-watt test thermocouple, made up of two ¼ x ¼ x ½ inch elements of the new material, an alloy of germanium and silicon, mounted in a high temperature laboratory heater. The development was sponsored by the U.S. Navy Bureau of Ships.*

Do-it-yourself Electronic Oven

An electronic oven that permits cafeteria patrons to "cook" their own meals in seconds with radar energy was introduced recently by Raytheon. *Customers select pre-cooked, frozen dinners from refrigerated display cases and place meals in new oven for quick defrosting and heating. A fish fillet can be cooked in just 60 seconds, while a 6-ounce portion of roast beef can be heated in 30 seconds and a 4-ounce serving of meat loaf can be heated in 60 seconds. The new microwave oven sells for around $1300.*

▼



DESIGN OF TRANSISTORIZED CB TRANSMITTERS

By W. A. RHEINFELDER, / Applications Engineer, Motorola Inc., Semiconductor Products Division

Three Citizens Band transmitter circuits having modulated r.f. power outputs of 25, 130, and 250 mw. are made possible by use of an inexpensive mesa transistor. Suitable modulators suggested.

CITIZENS Band communications equipment has become increasingly popular, particularly with regard to good quality sets. Price is of course a factor, and budget-priced equipment, of necessity, had to use low-cost transistors. Now, however, premium-quality mesa transistors are available at a price that makes feasible their incorporation in Citizens Band equipment. The 2N741, for example, permits "deluxe" low-cost transmitters because of its high dissipation rating and linearity. This article will cover various 2N741 transmitter circuit configurations, as well as the necessary modulator circuits.

A number of circuit configurations were developed and are presented here.[1] In the "deluxe" version a separate crystal oscillator drives the final stage directly, using one 2N741 mesa transistor. Considerable r.f. power with very low envelope distortion is available. The power drain becomes high in this configuration and attention must be paid to the power supply since the limits for portable equipment are strict.

In a second circuit designed for lower power, the oscillator is modulated directly because an additional final stage is hardly justified unless very low distortion is required. In this case the first circuit may be used at reduced power input.

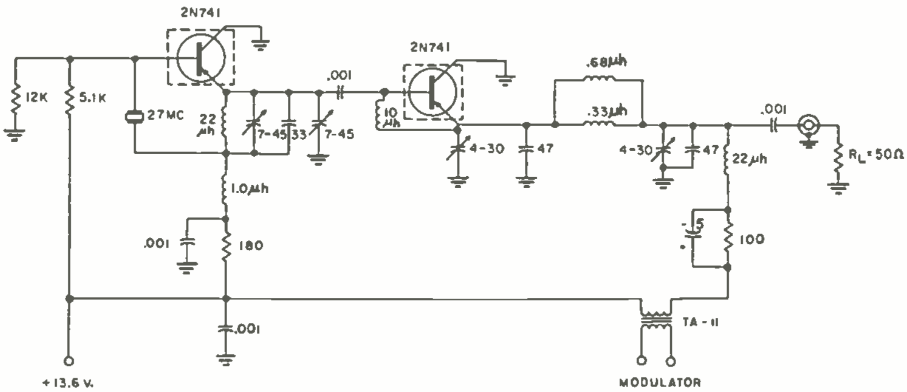
For the third circuit the power input to the modulated crystal oscillator has been adjusted to 100 milliwatts to meet FCC specifications for unlicensed CB transmitters.

"Deluxe" Transmitter

The schematic of the high-power transmitter is shown in Fig. 1. Since the 2N741 mesa is a "hot-can" unit with its case internally connected to the collector, a bootstrap circuit must be used for effective heatsinking. A bootstrap circuit generally is a circuit configuration which operates common-collector as far as d.c. is concerned. Of course it could still be common-emitter or common-base with regard to the a.c. signal.

The crystal oscillator is such a bootstrap circuit. While the d.c. configuration is common-collector, the a.c. circuit is common-base. Because input and output are not separated as well in an oscillator as in an amplifier, it is difficult to determine the common electrode by inspection. However, if we redraw the circuit it becomes obvious that we have a common-base Colpitts oscillator with the crystal operating in the series mode. Figs. 2A through 2C are progressive steps in redrawing the oscillator circuit. In Fig. 2C the polarity of the supply has been reversed. For the circuit to

Fig. 1. Schematic of the highest power transmitter. In this diagram as well as in the other schematics shown, all resistors and capacitors are as indicated on the figures. Resistors are all ½-w., 10% types unless otherwise indicated. Capacitors are disc ceramics for coupling and silver micas for the tuned circuits. Electrolytics are shown polarized. The r.f. chokes are Jeffers Electric types or their equivalents. The inductance values are not critical and minor variations will not affect circuit performance. The trimmers are Erie Ceramicons. The modulation transformer is a Stancor TA-11, with 48-ohm center-tapped primary and 8-16 ohm secondary. All transistors are Motorola types.



[1]All CB transmitters must be crystal-controlled according to FCC regulations. No license is required if the d.c. power input into the final transistor is 100 mw. or less. Powers up to 5 watts are possible by obtaining an FCC license. No test is required and only a simple form must be filled out. All frequency adjustments must be made by licensed commercial radio operators.

operate, a short-circuit must exist at the crystal position and a capacitor may be used instead. Therefore, the crystal operates in the series mode.

From the foregoing, it is evident that there is a total of 9 different configurations for a typical transistor circuit—18 if both d.c. polarities are counted. Each of these circuits has merit for a particular application. The circuit chosen has the advantages of good heat-sinking because the transistor case is connected to the chassis, high stability because the d.c. circuit is common-collector, high power because the tank circuit is connected between collector and base rather than emitter and base, and series-mode crystal because the crystal is in a location where a short is needed for operation. Series-mode operation is more stable than parallel operation. An additional advantage is that the output is taken from a small source resistance, resulting in stability with load changes.

The two Colpitts capacitors that provide the feedback are used simultaneously to provide matching to the final stage; a saving of several components.

pointed out that the circuit may be adjusted for more power output, but contrary to popular belief, this results in greatly reduced coverage. For instance, the average modulated power may be made 300 milliwatts, with the demodulated audio 1.1 volts at 10% distortion. Clearly, asking for maximum power output in an AM transmitter also yields poor performance and coverage. All that is obtained is high power dissipation in the final transistor at poor coverage.

An intelligent specification would ask for a certain demodulated audio power at a given percentage distortion. This is the real objective for good working distance. Nevertheless, there still abound many specifications which ask for maximum power output in an AM transmitter; let the reader beware. Much of the poor performance of present-day communications transmitters, as in nearly all aircraft transmitters, can be traced to this kind of obsolete specification. To repeat, asking for maximum power output in an AM transmitter also produces bad coverage because of low audio signal and poor intelligibility, and high dissipation in the final stage (poor efficiency).

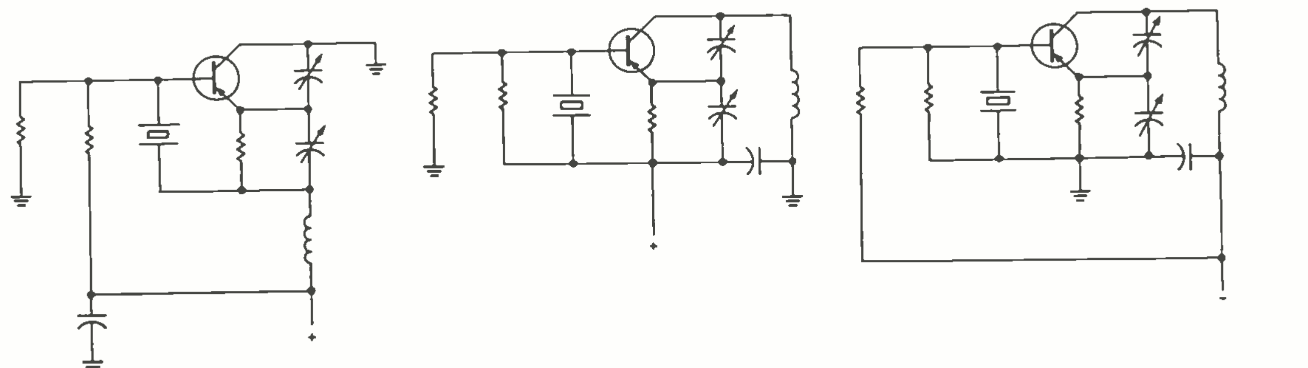
When users ask for high power output, they generally mean great operating distance. To get this, they must ask instead for maximum demodulated audio power at low distortion.

The adjustments of the circuits shown here have been made using this latter specification. It is found that the adjustments for least distortion are considerably sharper and therefore more accurate than just peaking the r.f. circuits using a power meter. Also, as just discussed, more audio power at lower distortion will be developed in a receiver if the demodulated audio power rather than the r.f. power is peaked.

Lower Power Transmitters

The circuit of the lower power versions of a CB transmitter is shown in Fig. 3, with performance given in Table 1. In this circuit the oscillator is modulated directly and the Colpitts capacitors are used for feedback and matching simultaneously. This compromise simplifies the circuit greatly.

The schematic of a 100-mw.-d.c.-power-input transmitter is shown in Fig. 4 and its performance in Table 1. The



(A) BOOTSTRAP (B) INVERTED SUPPLY (C) STANDARD

Fig. 2. Three versions of the common-base (common-collector for d.c.) Colpitts oscillator configuration discussed.

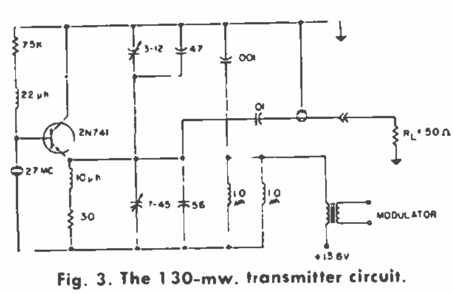


Fig. 3. The 130-mw. transmitter circuit.

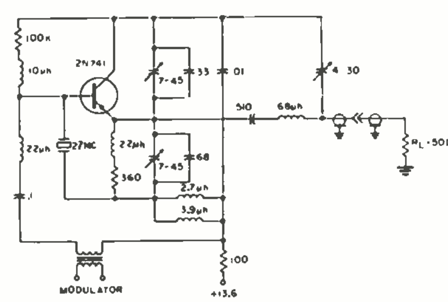


Fig. 4. Circuit of the 100-mw. d.c. input (25-mw. average modulated r.f. power output) modulated oscillator transmitter.

The crystal oscillator is also modulated at a small percentage, as discussed in the literature.[2]

The final stage operates common-collector in both a.c. and d.c. circuits. While common-emitter a.c. operation gives more power gain, it also involves an interstage transformer. For linear operation mutual-conductance coupling is difficult to control. After a thorough evaluation it was found that common-collector operation has more than ample power gain and the linearity is about the same as a common-emitter. The circuit is greatly simplified, of course.

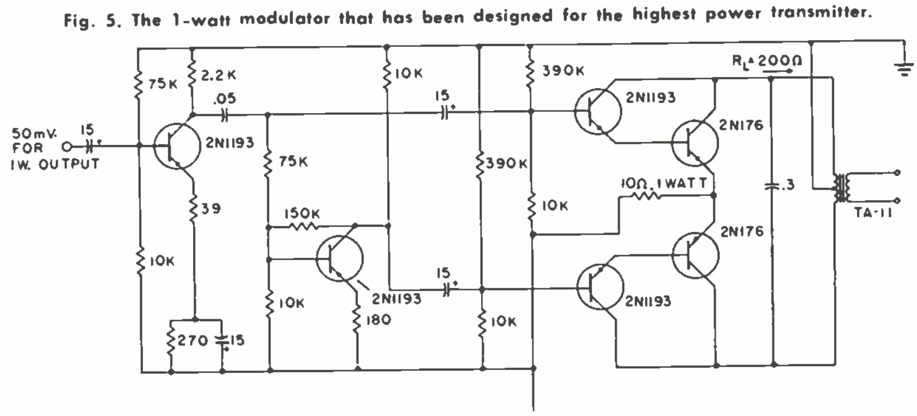
For matching into the antenna, a *pi*-network is used for simplicity. Since all coils used are small, commercially available r.f. chokes, the circuit may be built up very compactly.

The performance of the various circuits is shown in Table 1.

Performance of "Deluxe" Circuit

As can be seen from Table 1, the circuit performance of Fig. 1 is of very high quality, permitting full 100% modulation at very low distortion. This means high intelligibility and therefore good working distance. It should be

Fig. 5. The 1-watt modulator that has been designed for the highest power transmitter.



[2]Application Notes, Motorola Semiconductor Products Inc., Phoenix, Ariz.: AN-106 "Description and Alignment of 120-mc. Transmitter" and AN-114 "Modulation of Driver Stage to Increase Power Output of AM Transmitter."

Characteristic	Fig. 1	Fig. 3	Fig. 4	Unit
Average power, unmodulated P_o	185	115	22.5	mw.
Average power, modulated P	250	130	25	mw.
Peak power, modulated P_p	740	355	52	mw.
Max. modulation index number	100	75	50	%
Envelope distortion	1.25	1.75	2.0	%
Demod. signal across 50 ohms	2.2	1.25	0.34	v.
Supply voltage	13.6	13.6	13.6	v.
Supply current	95	65	10	ma.
Modulation power required	1000	300	10	mw.
Load seen by secondary of modulation transformer	100	200	3000	ohms

The average power, unmodulated, is the r.f. power as indicated on a bolometer with the modulation off. Similarly with average modulated power. The peak power at 100% modulation is four times the unmodulated power. All powers are measured with a 50-ohm bolometer.

The FCC specification for unlicensed CB radio calls for 100 mw. d.c. power input to the final stage, not the final circuit. The total d.c. power input in the third column, for instance, is 136 mw. with 13.6 supply voltage and 10 ma. supply current. However, the d.c. power input into the transistor is only 100 mw. because the collector-emitter voltage is only 10 volts under these conditions.

Table 1. Performance data for the three Citizens Band transmitters described.

demodulated audio output voltage available is roughly proportional to the d.c. power input, although the maximum modulation percentage drops. Modulation of more than 50% in Fig. 4 causes severe distortion and spurious outputs; the modulator must therefore be designed to provide peak clipping at this level. While the reach of these lower power transmitters is, of course, not as good as the circuit of Fig. 1, the efficiency and quality compare favorably. These circuits are not only cheaper, but have the advantage of low power drain and weight—important in portable equipment. The saving applies to the modulator circuit as well.

Modulator for "Deluxe" Circuit

It takes a fairly high quality audio amplifier to match the circuit shown in Fig. 1. This audio amplifier should have

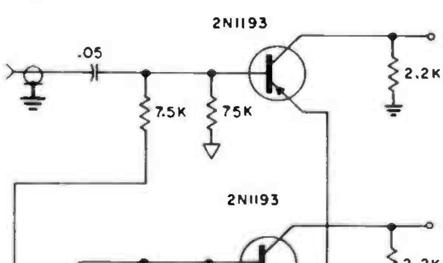


Fig. 6. Alternate phase inverter for the 1-watt modulator shown in Fig. 5.

a distortion of about 1% at 1 watt and a limited frequency response from 300 to 3000 cps for good intelligibility. In addition, it must provide peak clipping which has very short attack and release times to avoid overmodulation, so as not to introduce intermodulation products. An amplifier with these specifications is shown in Fig. 5. Its design objective is simplicity. Only one transformer is used; the modulation transformer in the output. This means that the circuit may be very compact and lightweight. The transistors used are of the low-cost variety. The output operates push-pull class B in the Darlington configuration. The load impedance has been chosen to provide clean clipping at 1 watt by bottoming. Since very small resistances are involved, this action is nearly instantaneous and provides precise clipping without parasitics.

To drive this push-pull output circuit various input configurations were tried, using not more than two additional transistors. The first circuit used a regular amplifier stage followed by a phase splitter. It was found that a phase splitter does not provide enough signal to drive the push-pull output stage.

An emitter-coupled phase inverter is shown in Fig. 6. The performance is better than that of the phase splitter at the output voltages required, but marginal because of the high inherent loss in the unbypassed emitter resistance.

In the final circuit a modified form of

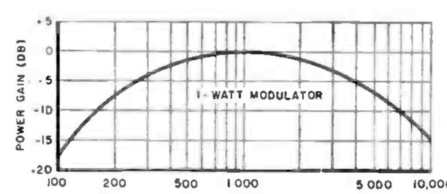


Fig. 7. Power response of 1-w. modulator.

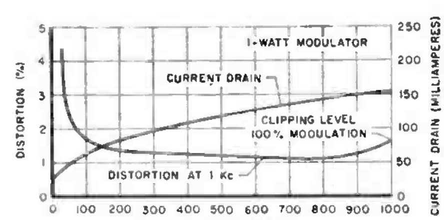
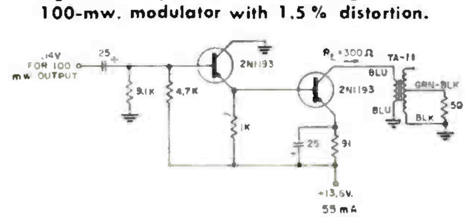


Fig. 8. Distortion and current drain of the modulation circuit shown in Fig. 5.

Fig. 9. Complete schematic diagram of 100-mw. modulator with 1.5% distortion.



the self-balanced paraphase inverter was used. This circuit is capable of delivering the required output signal at low distortion and the degree of balance is high.

The performance of the complete circuit shown in Fig. 5 is given in Figs. 7 and 8. The rise in distortion at low levels (crossover distortion) is unimportant in a modulator in even a deluxe-quality transmitter because modulation is kept near 60% average. This is possible because of the precise peak clipping action incorporated in the modulator. The response was limited by the coupling capacitor following the first stage and the shunt capacitor across the output transformer. The circuit may at first seem unduly complex but it should be noted that it uses only one transformer (the largest component), two low-cost power transistors, and four low-cost GPA transistors.

Low-Power Modulator

A typical circuit for a low-power modulator is shown in Fig. 9. This particular circuit uses low-cost GPA *Motorola* 2N1193 transistors and the power output is 100 milliwatts at 1.5% distortion. Again, peak clipping may be used by proper adjustment of the effective load resistance. It is also possible to use a zener diode of proper voltage across the primary of the transformer. For higher power output a power transistor must be used in the output. This circuit is shown merely to indicate the performance possible with low-cost transistors in a single-ended design. A push-pull version is hardly justified for a low-power, low-cost CB transmitter.

Alignment Procedures

The circuits as shown in the various diagrams have been designed to provide minimum distortion. In the final adjustment all that is required for satisfactory performance is the proper peaking of the variable trimmer capacitors to provide optimum coverage.

While the ultimate in alignment can be achieved only through the use of laboratory instruments, such as a distortion analyzer and bolometer, excellent results can be achieved simply by monitoring the transmitter output with a CB receiver. To do this, merely adjust the trimmer capacitors, one at a time, for maximum receiver volume. It may be necessary to repeat the adjustments several times in order to achieve best results.

Summary

The circuits described here show the range of CB transmitters possible with the 2N741 transistor. The three configurations cover types from a high-quality, high-power "deluxe" transmitter to a simpler 100-mw. class D version requiring no license. These circuits feature low distortion at high modulation percentages and demonstrate the 2N741's flexibility.

In line with the low-cost theme, the 2N176 power transistors and the 2N1193 general-purpose audio transistors are also inexpensively priced. ▲

DIRECTORY OF
FM-Multiplex Stereo Adapters

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

Many FM tuners will need some type of adapter in order to pick up the new stereo broadcasts. Here is complete information on available products.

SINCE last June, when the FCC officially sanctioned the present system of FM stereo using the multiplex technique, there has been a slow but steady increase in the new service. Almost immediately after the June okay, hi-fi component manufacturers had adapters ready for the market or being developed in their laboratories for early appearance.

A few stations, notably those tied in with *Zenith* and *G-E*, the developers of the approved FM stereo system, started stereo programming immediately. Within a mere four months, some FM stereo was being broadcast by no less than 20 stations. Such areas as those around New York City, Los Angeles, Chicago, Philadelphia, Detroit, Boston, San Francisco, Houston, Seattle, Cincinnati, Dallas, Albany, Columbus, and Spartanburg, S. C. had FM stereo, and this coverage is increasing every month.

In the New York City area alone, the giant *New York Times* "good-music" station, WQXR-FM is now broadcasting 20½ hours of FM stereo a week; 1-kilowatter WDHA-FM (Dover, N.J.) is on for their full 17-hour/day broadcasting schedule with stereo, and 1-kilowatter WLIR-FM (Garden City, N.Y.) is transmitting 34 hours of stereo a week. Recently, another station in New York City, WTFM, went into operation with its entire 24-hour-a-day schedule devoted to FM stereo.

Adapters and Tuners

For those without FM receiving equipment who want to pick up FM stereo, the best bet is to obtain a tuner or receiver with built-in facilities for the new multiplex system. Others who already have FM tuners must obtain adapters for use with their tuners.

Recent model tuners that were designed with stereo in mind should do a good job with an adapter. Such tuners can be recognized by the presence of a "multiplex output" jack on their chassis. This jack makes connection to the detector output of the tuner, but ahead of the de-emphasis network. The network must be bypassed, otherwise it will attenuate the frequencies above the main stereo channel to such an extent that there will be no L—R "difference" signal. Suitable tuners must also have a broad enough passband so that the difference signal is detected. In addition, the tuner must have a good linear phase response over its passband so that phase distortion will not degrade stereo separation. Finally, the output circuit of the tuner should have a fairly low impedance so that connecting cable capacitance will not roll-off the high-frequency difference signal.

These requirements are strict enough to preclude the use of many early FM tuners with stereo adapters. Such tuners sometimes sacrifice bandwidth for sensitivity and they have no provision for a "multiplex output." Hence, it would not make too much sense to convert these early FM tuners to stereo.

Types of Circuits

There are several basic types of circuits used in FM stereo adapters. We have referred to these in our table as (1) *matrixing* type, (2) *switching* type, (3) *envelope-detection* type, and (4) a *combination* of two of the preceding types. A recent article, "Stereo FM Multiplex Detection Methods" by Norman H. Crowhurst in last month's issue, described these circuits and covered their operating principles in far more detail than we have room for here. This article also showed how the composite FM signal could be analyzed in either one of two ways: (1) as a sum signal on the main channel and a difference signal amplitude-modulating a 38-kc. suppressed subcarrier, or; (2) as a left-only and a right-only signal alternately sampled or switched at the rate of 38 kc. The matrixing circuit is based on the first method of analyzing the signal, while the switching and envelope-detection circuits are based on the second.

Matrixing type. Most of the early hi-fi component adapters used a matrixing-type circuit. This was the circuit proposed, among others, by Murray Crosby, who did much of the development work on a type of FM stereo system which

DeWald P-400

General Electric MA-2G

Automatic MD-80

Altec 359A

Bell MXA-1

ADAPTERS DESIGNED FOR SPECIFIC FM TUNERS

These adapters will match the indicated tuners, manufactured by the same company. Unless otherwise stated, the adapters will fit inside the tuner and there are no operating controls.

NAME	ADAPTER MODEL	TUNER MODEL
Bell	MXA-1	All models in present stereo component line
Crosby	MX-80	R-80
Dynaco	FMX-3	FM-1
General Electric	MA-2G	FA-12 to FA-17[1]
Harman-Kardon	MX500[2, 3]	F-500, ST-350, ST-360, ST-360A
	MX600[3, 4]	TA-224, TA-230, TA-260
	Citation MA[2, 3, 5]	Citation III
Knight-Kit	KS-11[6]	All deluxe models
Sherwood	A3MX[2]	S-2200, S-3000 III

1. May have to be externally mounted; 2. Plug-in type; 3. For controls, see other table; 4. Snap-on type; 5. Control protrudes through opening in tuner panel; 6. Built on printed-circuit board.

had the sympathy and support of many in the hi-fi component field. Adapters using the matrix circuit employ a low-pass filter to recover the 50-15,000 cps main-channel L+R sum signal, and a bandpass filter to recover the 23-53 kc. subcarrier-channel L—R difference signal sidebands. After restoration of the 38-kc subcarrier, suppressed at the transmitter, the detected difference signal is combined with the sum signal in a matrixing network. This network adds the two signals to produce a left-only output, and subtracts the two signals to produce a right-only output. These outputs are then de-emphasized and applied to the stereo amplifier and speakers.

Advantages of this circuit are its familiarity to many circuit designers and its flexibility, which permits exact adjustment of sum and difference signals to be made. However, a disadvantage is that it is impossible to design simple filter circuits to be phase-linear over their entire operating frequency range. If there is phase distortion here, then there will be a loss of separation.

Switching and envelope-detection types. In the *switching*-type circuit, neither filter circuits nor matrixing circuits are used. Instead the entire composite signal is converted directly to left-only and right-only outputs by means of a time-division multiplex technique. In adapters using switching-type (sometimes called "time-division") circuits, two detectors are alternately switched on and off at the 38-kc subcarrier rate. Special beam-deflection tubes (such as the 6AR8, developed for use as a synchronous detector in color TV sets) or diode bridges may be switched in this manner.

The third type of circuit uses *envelope detection.* Here again filters and matrix networks are not used. The arrangement may be considered to be a type of switching circuit in which first one and then a second diode are switched on. In this circuit, the subcarrier is added to the composite signal in such a way that the upper edge of the signal envelope is the left waveform and the lower edge is the right, or *vice versa.* Then the top and bottom of the envelope are detected separately, and the result is a left-only and a right-only signal in the output.

The switching and envelope-detector circuits, without filters and matrixing, are much simpler than the matrix-type arrangement. However, this simplicity may be misleading. For example, it is important that the switching waveform and the detector characteristics be carefully controlled in order that the left and right signals have exactly the proper amplitudes and there be no loss of separation. Sometimes this cannot be done readily, so some matrixing is used in order to restore the proper balance of left and right signals.

Combination type. In this type of arrangement, a matrixing circuit is used to add a small amount of the L+R sum signal to the switching or envelope-detector circuit. This requires the use of a low-pass filter to separate out the sum signal. This type of circuit has some of the characteristics of the two basic types of which it is made up.

As to which of the circuits is best, it is still too early to say. We haven't been testing any multiplex adapters yet because of the shortage and high cost of multiplex test equipment. However, we feel that it is not the specific type of circuit used that is so important as the knowledge and care that goes into the specific design that counts. It is possible to have a very well-designed matrix-type adapter just as it is possible to have a poorly designed one. Likewise, switching circuits may be well designed or they may be poorly designed. Remember, too, that manufacturers must always design their products with a given selling price in mind, and this frequently determines the quality that can be put into any product. Our feeling right now is that there is no such thing as a "best" circuit and that any of the types mentioned, if well designed, should be able to do its job.

Problems and Solutions

Regardless of which circuit is used, (*Continued on page* 68)

COVER STORY

THIS month's cover shows a number of representative FM-multiplex stereo adapters. The units shown are the following:

- **A. Paco MX-100**
- **B. Harman-Kardon MX700**
- **C. Bogen PX60**
- **D. Realistic MPX-215**
- **E. Eico MX-99**
- **F. Lafayette LT-200**
- **G. Fisher MPX-100**
- **H. Sherwood S3MX**
- **I. Pilot 200**
- **J. Heath AC-11**
- **K. Scott 335**
- **L. Crosby MX-101**
- **M. Knight KN-MX**

(Cover photograph: Bob Loeb)

Listing of FM-Multiplex Stereo Adapters

Name	Model No.	Type of Circuit	Self-Powered?	No. of Tubes	No. of Semi-conductor diodes	Stereo Indicator?	Operating Controls	Size (Inches w x h x d)	With Cabinet?	Kit or Factory-Wired	Price
ABC	600	Matrixing	No	3	2	No	C	6 x 3 x 6	No	Wired	$39.95
	611	Matrixing	Yes[9]	0[10]	2	No	C	3½ x 5½ x 4½	Yes	Wired	$39.95
	650	Matrixing	Yes	3	3*	No	C	5 x 8 x 6	Yes	Wired	$44.95
Altec	359A	Combination[6]	Yes	4	2*	Yes	B,C,F	5½ x 5½ x 9½	Yes	Wired	$89.50
Automatic	MD-80	Env. Det.	Yes[9]	0[11]	4	No	M	6½x2⅜x4¾	Yes	Wired	$49.95 (approx.)
Bell	MXA-1[1]	Switching	No	1[2]	2	No	—	2⅛ x 2⅞ x 4¼	No	Wired	$39.95
	MXP-2	Switching	Yes	2[2]	2	No	A	5½ x 4¼ x 4¾	Yes	Wired	$59.95
Bogen	PX60	Matrixing	Yes	4*	1	No	A,B,C	4½ x 4½ x 9	Yes	Wired	$69.50
Crosby	MX-101	Matrixing	Yes	4*	2	No	A,B,C	5½ x 4½ x 9	Yes	Wired	$69.95
	MX-80[1]	Matrixing	No	3	2	No	—	4½ x 4¼ x 6	Yes	Wired	$49.95
DeWald	P-400	Matrixing	Yes	3*	2	No	A,B,C	9⅛ x 4¼ x 3⅝	Yes	Wired	$57.95
Dynaco	FMX-3[1]	Switching	No	2	4	No	—	4 x 3 x 5	No	Kit	$29.95
Eico	MX-99	Combination[6]	Yes	6*	6	Yes	A,B,C	6 7/16 x 3 9/16 x 9¼	Yes	Kit/Wired	$39.95/$64.95
Fisher	MPX-100[3]	Switching	Yes	5	10*	Yes	D,H	4⅞ x 4⅞ x 12	Yes	Wired	$89.50[4]
General Electric	MA-2G[1]	Combination[5]	Yes	2	3*	No	—	10 x 3 x 2¼	No	Wired	$39.95
Harman-Kardon	MX500[1]	Matrixing	No	2	2	No	D	8½ x 3½ x 3¼	No	Wired	$39.95
	MX600[1]	Matrixing	No	2	2	No	D	5¾ x 3¾ x 2	No	Wired	$49.95
	MX700	Matrixing	Yes	3*	2	Yes	A,B,D	3 x 4 x 8	Yes	Wired	$59.95
	Citation MA[1]	Env. Det.	No	3	2	No	E	4½ x 3½ x 3	No	Wired	$79.95
Heath	AC-11	Matrixing	Yes	3	3*	No	A,C	3½ x 3⅜ x 9⅞	Yes	Kit/Wired	$32.50/$56.25
Karg	MX-3	Switching	Yes	4*	4	No	I	5⅜ x 5 x 10¼	No	Wired	$79.50
Kenwood	KD-1	Matrixing	Yes	4*	1	Yes	B,D,F,G	7⅞ x 4¾ x 7⅝	Yes	Wired	$49.95
Knight	KN-MX	Combination[6]	Yes	2	1*	No	A,C	5 x 4⅞ x 7⅝	Yes	Wired	$44.50
Knight-Kit	KS-10	Matrixing	Yes	3	1*	No	—	9½ x 2¼ x 3½	Yes	Kit	$19.95
	KS-11[1]	Matrixing	No	2	—	No	—	6 x 2 x 3	No	Kit	$17.95
Lafayette	LT-200	Combination[6]	Yes	4*	2	Yes	A,B	5 9/16 x 4 9/16 x 11	Yes	Wired	$54.50
Paco	MX-100	Matrixing	Yes	4*	2	No	A,C,D,J	9 x 4 x 8¼	Yes	Kit/Wired	$49.95/$69.95
Pilot	200[7]	Switching	Yes	4*	9	Yes	—	14 x 5 x 3	Yes	Wired	$79.50
	100	Switching	Yes	3*	9	No	B	12 x 5 x 3	Yes	Wired	$49.50
Realistic	MPX-215	Matrixing	Yes	3	2*	No	C,L	6½x6½x8½	Yes	Kit/Wired	$29.95/$39.95
	MPX-230	Switching	Yes	1	1*	No	A	4 x 3 x 5	Yes	Kit	$19.95
Scott	335	Switching	Yes	5*	8	Yes	B,D,F,K	6½ x 4⅜ x 13⅝	Yes	Wired	$99.95[4]
Sherwood	S3MX	Switching	Yes	3	5*	No	A,B,C,F	5¾ x 4 x 10½	Yes	Wired	$69.50[4]
	A3MX[1]	Switching	No	2	4	No	—	4¾ x 3½ x 4¼	No	Wired	$49.50
Stromberg-Carlson	MPX-2/MX-477	Env. Det.	Yes	0[8]	2*	No	—	3 x 1½ x 5	No	Wired	$39.95

OPERATING CONTROLS:
A. "On-Off" power switch; **B.** "Normal" & "Main Channel" (adapter in or out); **C.** "Separation"; **D.** "Noise Filter" on-off; **E.** Selector Switch ("On-Off"; "Normal FM"; "FM Stereo, SCA Filter Out"; "FM Stereo, SCA Filter in"); **F.** "Volume Control"; **G.** Selector Switch ("On-Off," "FM," "Stereo," "MPX Mono," for checking purposes); **H.** Selector Switch ("On-Off," "Tuner," "Stereo-Mono Automatic," "Stereo Manual"); **I.** Single Control ("On-Off" & "Volume"); **J.** Selector Switch ("Mono," "Stereo Max.," "Stereo Dimension"); **K.** Selector Switch ("On-Off," "Mono," "Stereo with Filter In," "Stereo with Filter Out"); **L.** Selector Switch ("On-Off," "FM," "Stereo," "Sub-Channel"); **M.** "Balance" and "Input Sensitivity."

FOOTNOTE REFERENCES:
* Includes rectifier(s); **1** Recommended for use only with manufacturer's own tuners; **2** Includes triple-function Compactron tube; **3** Relay-type automatic switching from mono to stereo; **4** Additional charge for cabinet; **5** Envelope detection and matrixing; **6** Switching and matrixing; **7** Diode-type automatic switching from mono to stereo with remote stereo-indicator lamp; **8** Seven transistors are used; **9** Battery operated; **10** Four transistors are used; **11** Six transistors are used.

A MINIATURE, TRANSISTORIZED OSCILLOSCOPE

By THOMAS J. BARMORE

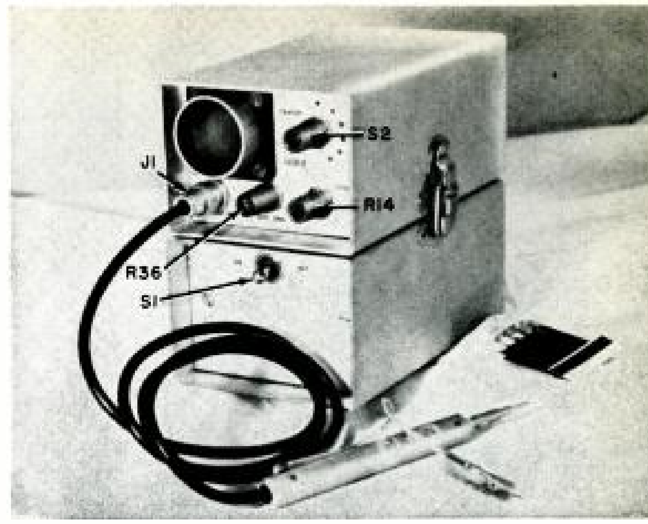


Fig. 1. Greatest dimension of the handy unit complete with power pack, its depth, is less than the width of this page.

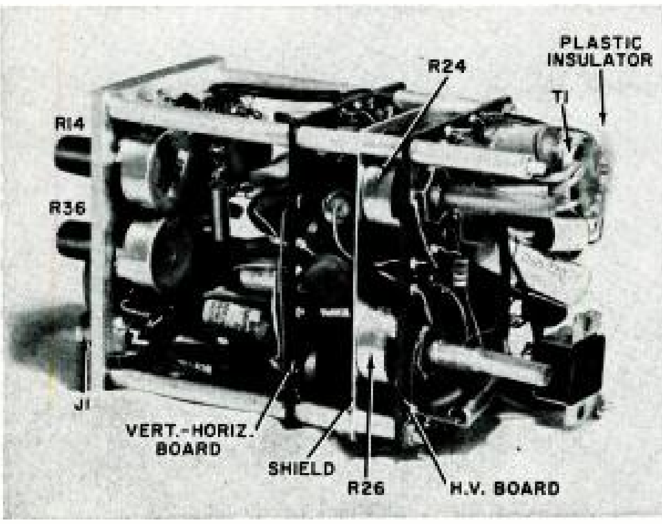


Fig. 2. Shown out of its housing, the complete scope chassis is lying on one side, with its front facing left. Note the mounting and spacing of the two chassis boards and the shield.

Look at this portable's specifications before you let its size, weight, cost, and operation from self-contained, low voltage deceive you.

A COMMONLY used instrument today, the versatile oscilloscope has been extended to many functions beside that of merely examining waveforms. Considering its potential, it would be handy to carry one wherever testing may be needed. Unfortunately, size, weight, and the need for line voltage have limited use to the fixed test bench.

The scope described here is the author's answer to the problem. About the size of two boxes of kitchen matches, using transistors and self-powered by batteries, it is lightweight and fully portable. Operating controls (Fig. 1) as well as size have been cut to a minimum. Vertical gain (R_{36}) and horizontal frequency (S_2, R_{14}) are adjusted at the front; brightness and focus at the rear. Sweep width and centering are fixed without controls. Synchronization is also automatic, without external control. The instrument obviously falls short of deluxe laboratory instruments, but it meets or exceeds the modest capabilities one might expect in a carry-about unit.

Vertical-channel response is only 1 db down from 10 cps to 1 mc., 3 db down from 5 cps to 1.5 mc. (See Fig. 5.) Sensitivity is excellent (.004 volt r.m.s./inch at 1 kc.); input impedance is 1 megohm at 1 kc.; and rise time is .25 microsecond. Sweep frequency, provided in six overlapping, switched steps and a vernier control, ranges from 5 cps to 50 kc. The 1½-inch scope tube is a 913 or equivalent. A 45-volt battery and 4 flashlight cells provide the necessary power.

Of the problems involved, an important one was the requirement of most CR tubes for a higher deflection potential than can be obtained reasonably with transistors. This was solved by substantially lowering accelerating voltage. Satisfactorily bright traces were nevertheless obtained, and deflection sensitivity went up significantly. For the rest, nine transistors, not expensive, are used in conventional configurations. See Fig. 4.

Vertical Amplifier

Vertical-input stage V_1 uses a 2N170 as an emitter-follower to keep input impedance reasonably high; the latter ranges from 1 megohm at 20 cps to 50,000 ohms at 100 kc. V_1 output, developed across R_1, is coupled through C_2 to driver V_2, whose base bias is furnished by R_2. High-frequency compensation is obtained by bypassing R_3 with a smaller capacitor (C_3) than is normally used. This capacitor's reactance,

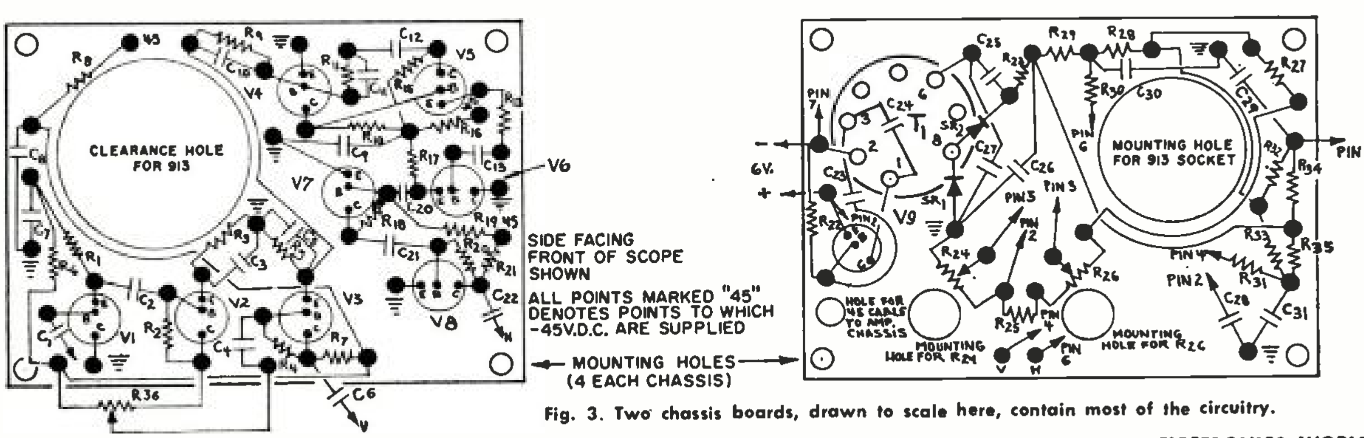


Fig. 3. Two chassis boards, drawn to scale here, contain most of the circuitry.

high at low frequencies, becomes a few ohms at higher frequencies, permitting stage gain to increase. V_2 output is developed across vertical-gain control R_{36}, from which signal is tapped off and applied through C_4 to the vertical-output stage.

Output stage V_3 is operated like its preceding driver. A synchronization signal, developed across R_5, is applied to the horizontal oscillator. Two decoupling networks (R_6-C_7 and R_8-C_8) serve to isolate the driver and output stages from other circuits.

Horizontal Circuits

The horizontal oscillator (V_4 and V_5) is a multivibrator, with R_{10}, R_{13}, and C_{12} furnishing the operational mode for the generated pulse. The time constant is varied by the resistors R_{12} and R_{14} in conjunction with capacitors C_{14} through C_{19}, which form the integrated, sawtooth waveforms. Synchronization is furnished by applying a signal from V_3, as already noted, to the base of V_4 through the network consisting of R_9 and C_{10}. C_9 and R_{16} form a decoupling

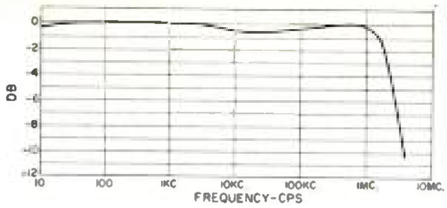


Fig. 5. Response of the vertical channel.

network to isolate the oscillator from other circuits. Oscillator output from V_5 is coupled through R_{13} and C_{13} to the base of V_6.

Since impedance of the oscillator output is relatively high, the first stage in the horizontal amplifier, V_6, is a 2N170 employed in a grounded-collector configuration to give the necessary high input impedance. The signal, developed with unity gain across R_{17}, is coupled through C_{20} to driver V_7.

The driver and succeeding horizontal-output stage, V_8, are conventional. Base bias is furnished respectively by R_{18} and R_{20}. V_8 output is then coupled to the horizontal deflection plate through C_{22}.

Note that gain of the horizontal amplifier is set to maximum by adjustment of the value of R_{18}. No gain control is used because output voltage of the amplifier must be as high as possible in order that horizontal sweep will be of sufficient amplitude.

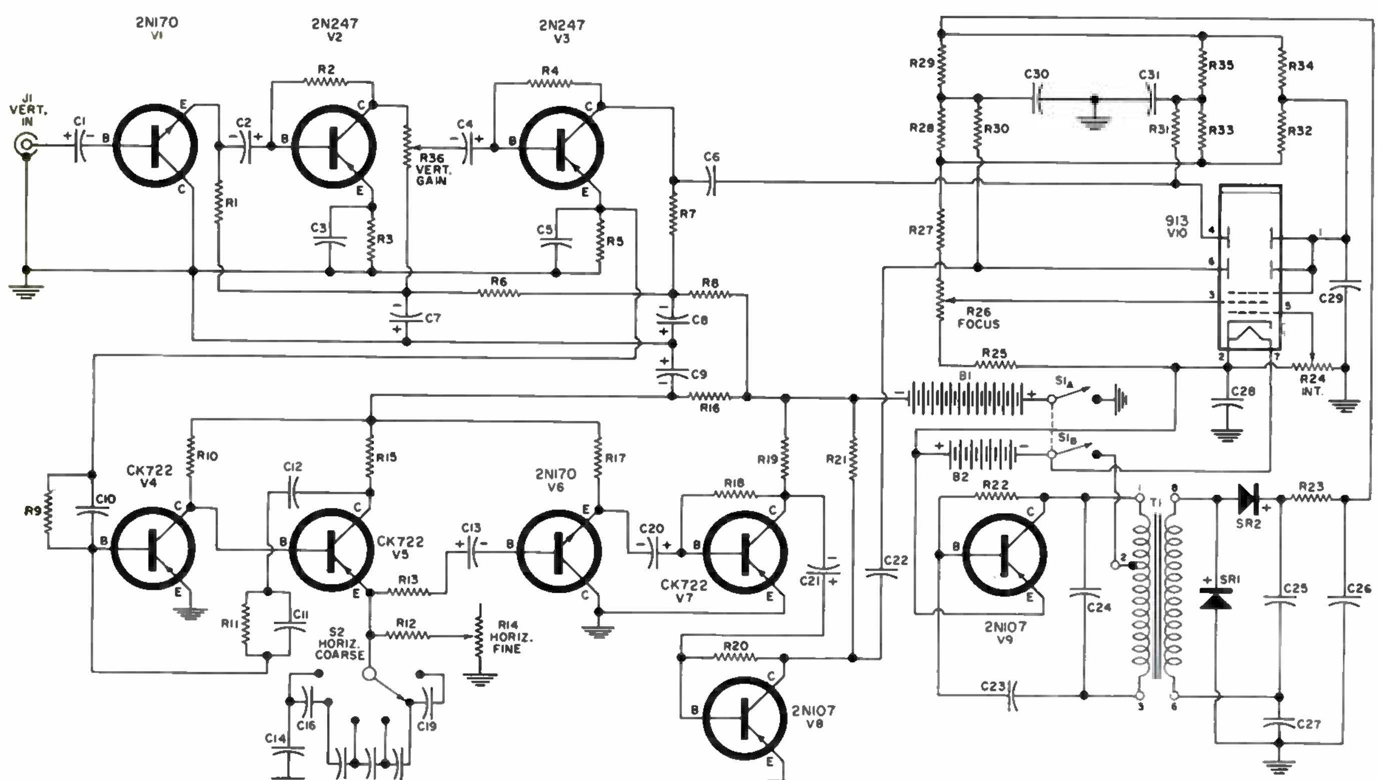
The Power Supplies

The high-voltage supply uses a 2N107, V_9, as a Hartley oscillator, whose tuned circuit is made up of T_1 and C_{21}. Output voltage is controlled by the feedback loop consisting of R_{22} and C_{23}. The T_1 secondary feeds a voltage doubler that includes rectifiers SR_1 and SR_2 in conjunction with capacitors C_{25} through C_{27} and resistor R_{23}. The transformer is normally a line-to-grid audio unit, a *UTC* "Ouncer." This little supply develops about 300 to 400 volts d.c. at 100 microamperes, which is sufficient for good trace brightness.

High voltage is then distributed through a divider network consisting of resistors R_{21} through R_{29}. Two of these are controls: R_{24} for intensity and R_{26}

(Continued on page 72)

Fig. 4. The small CRT, two semiconductor rectifiers, nine common transistors, and a miniature transformer are the major components.



R_1, R_{17}, R_{23}—100,000 ohm, ½ w. res.
R_2, R_{32}, R_{34}—47,000 ohm, ½ w. res.
R_3, R_5—100 ohm, ½ w. res.
R_4—330,000 ohm, ½ w. res.
R_6, R_7, R_{16}—10,000 ohm, ½ w. res.
R_8—560 ohm, ½ w. res.
R_9—150,000 ohm, ½ w. res.
R_{10}—22,000 ohm, ½ w. res.
R_{11}—82,000 ohm, ½ w. res.
R_{12}—150,000 ohm, ½ w. res.
R_{13}—10 megohm, ½ w. res.
R_{14}—10 megohm pot.
R_{15}—6800 ohm, ½ w. res.
R_{18}—56,000 ohm, ½ w. res. (see text)
R_{19}—8200 ohm, ½ w. res.
R_{20}—820,000 ohm, ½ w. res.
R_{21}—18,000 ohm, ½ w. res.
R_{22}—820 ohm, ½ w. res.
R_{24}—200,000 ohm linear taper pot.
R_{25}—470,000 ohm, ½ w. res.
R_{26}—500,000 ohm linear taper pot.
R_{27}, R_{30}, R_{31}—2.2 megohm, ½ w. res.
R_{28}, R_{29}, R_{33}, R_{35}—1 megohm, ½ w. res.
R_{36}—10,000 ohm linear taper pot.
C_1, C_4—20 µf., 25 v. elec. capacitor
C_2—75 µf., 25 v. elec. capacitor
C_3—.002 µf., 200 v. capacitor
C_5, C_{17}—.005 µf., 200 v. capacitor
C_6—.01 µf., 400 v. capacitor
C_7, C_{20}—5 µf., 25 v. elec. capacitor
C_8—10 µf., 50 v. elec. capacitor
C_9—5 µf., 50 v. elec. capacitor
C_{10}, C_{18}—500 µµf., 200 v. capacitor
C_{11}—20 µµf., 200 v. capacitor
C_{12}—.02 µf., 200 v. capacitor
C_{13}—1 µf., 25 v. elec. capacitor
C_{14}, C_{28}—.1 µf., 200 v. capacitor
C_{15}—.01 µf., 200 v. capacitor
C_{16}, C_{23}—.03 µf., 200 v. capacitor
C_{19}—100 µµf., 200 v. capacitor
C_{21}—20 µf., 25 v. elec. capacitor
C_{22}—.1 µf., 400 v. capacitor
C_{24}—.22 µf., 200 v. capacitor
C_{25}, C_{27}—.01 µf., 600 v. capacitor
C_{26}—.03 µf., 600 v. capacitor
C_{29}, C_{30}, C_{31}—.005 µf., 400 v. capacitor
T_1—Line-to-grid trans. pri: 50-500 ohms, sec: 50,000 ohms (UTC 0-2 "Ouncer")
S_1—D.p.s.t. toggle switch
S_2—6-pos. non-shorting rotary switch
SR_1 SR_2—Silicon rectifier, 600 p.i.v. (Sarkes Tarzian F-6 or equiv.)
B_1—45-volt battery (Burgess XX30 or equiv.)
B_2—Four size "D" flashlight cells
J_1—BNC panel connector (Type UG-262/U)
V_1, V_6—"n-p-n" transistor (G-E 2N170)
V_2, V_3—"p-n-p" transistor (Sylvania 2N247)
V_4, V_5, V_7—"p-n-p" transistor (Raytheon CK722).
V_8, V_9—"p-n-p" transistor (G-E 2N107)
V_{10}—913 cathode-ray tube (or equiv. If unavailable, the electrically similar 2AP1 can be used with minor changes in a somewhat larger housing.)

Do educational gaps limit your career growth in electronics? There are ways around the roadblock.

As RECENTLY as ten years ago, most technicians in the electronics industry were engaged in servicing radio and TV receivers. The rapid growth of our industry has, since then, produced a wide range of specialties and with it a demand for technicians who are specialists. As soon as most of the "old timers" had advanced from radio servicing to TV, they found that the electronics industry had grown additional branches. Jobs opened up in industrial electronic controls, computers, medical electronics, communications, and other, even more specialized fields. These jobs promise not only good wages but also advancement as the fields themselves grow. Many of today's apprentice technicians may be tomorrow's managers.

Technicians who consider themselves "lost" in a particular job often ask what they can do. More money, as well as more interesting work, and a chance for advancement are usually the main aims. Most of these men are not prepared to go through four years of college, with its attendant expense. Evening classes are not available everywhere and, in any event, eight years is a long time. By understanding the fundamentals of radio and TV, these men have shown above-average intelligence. It would be a waste not to use this "know-how."

This article deals with the problems of the technician who already has a foothold in the electronics industry and who wants to advance himself. In an industry that depends so much on technical innovation, the one sure road to advancement is expanding technical knowledge. Such knowledge is urgently needed in every branch of electronics: many employers go to great lengths to obtain qualified personnel. In addition to on-the-job training, many companies sponsor evening classes and even pay tuition for attendance at technical schools. Recognizing the need for specialized technical training, most of the established schools now offer advanced courses in particular branches of electronics for students already familiar with the fundamentals. Before describing the training available, we want to dispose of the most frequently asked question.

Who Needs a Degree?

This elusive question concerns the prerequisite of a college degree in various branches and job levels of the electronics industry. We know of companies whose chief engineers have no degrees, but who won't classify anyone new at the engineering level unless a college degree has been obtained. Conversely some companies publicize the fact that their customer service engineers do not usually have college degrees. Because of these variations within the industry and even within individual companies, it is difficult to draw a hard and fast rule. It is, however, safe to say that for design engineering work degrees are generally required. Personnel lacking college degrees are classified as technicians or engineering aides in research, development, and design groups.

In the areas of production engineering, quality control, standards laboratories, test engineering, field service, installation, and engineering sales, the line between the degree holder and the technically competent technician is indistinct. Anyone having sufficient technical knowledge and the particular personal abilities required for the job can enter these areas of electronics without a degree.

We know many sales engineers, manufacturers' representatives, and parts salesmen whose technical backgrounds consist of some years as ham operators. The same applies to electronics buyers employed by all the large companies. These men combine a basic technical knowledge with an understanding of business.

When we consider other non-degree fields, however, fundamental electronics knowledge is no longer sufficient. A field service engineer on digital computers must know more than basic radio theory. He must be proficient in digital techniques, have an understanding of algebra, know binary notation, and be familiar with computer logic.

Similarly, the man servicing industrial electronic controls will find himself lost unless he knows basic servo theory, feedback principles, and is familiar with production processes. For servicing radar equipment, one must know the fundamentals of radar, pulse circuitry, and microwaves. In short, the fundamentals of electronics must be implemented by specialized, advanced technical training. Not only is this necessary for field engineering but it is often required for production and test engineering and many other engineering activities that are not directly concerned with the original design. In most civil-service positions practical experience, trade-school training, and the passing of an examination can be substituted for a college degree.

To sum up, a college degree is required principally in design and development laboratories but is not required for a number of other positions that carry the word "engineer" in the title. Technical training, in addition to the fundamentals, is a necessity for many engineering jobs, especially those involving actual work on electronic equipment.

What Kind of Training?

Having mastered the fundamentals of radio and TV, the technician often feels he has gone as far as he can without entering the esoteric realms of "higher math" and similar forbidding subjects.

ADVANCED TRAINING FOR TECHNICIANS

By WALTER H. BUCHSBAUM
Industrial Consultant, ELECTRONICS WORLD

It is true that something more complex than arithmetic is required, but the amount of "higher math" and its difficulty is grossly overestimated. Anyone who can understand the principles of radio transmission and reception, the synchronization of television signals, and the conversion of electrical energy into sound has already taken the fundamental step of grasping something abstract, something that can be explained logically but cannot be seen, felt, heard, or smelled. Advanced technical courses, based on such abstract knowledge, merely add a little more to it. Once a person has understood the principles of electronics, their particular applications to computers, industrial controls, communications, and other specialties are not nearly as hard to learn.

Before describing some of the material that will be taken up in these advanced courses, we want to assure the student that the hardest part of the studying is behind him once he has grasped the fundamentals. Studying techniques are already established in his mind; he already knows much of the terminology; and he already has demonstrated above-average intelligence. There is no reason to be afraid of any subject, no matter how difficult or forbidding it may seem at first. Just remember how complex the circuits of a TV receiver appeared the first time you saw them.

Typical of the courses running two to three years at many technical institutes is the "Advanced Electronic Technology" course at *RCA Institutes*. Mathematics up to and including calculus is taught and courses are offered in technical writing, as well as in such subjects as electro-acoustics, pulse circuits, microwaves, analog computers, digital circuits, and transistors. The student has a choice of specializing in one of several fields such as industrial electronics, communications, and computers with heavy course concentration in the field of his choice.

At *Capitol Radio Engineering Institute* and *Milwaukee School of Engineering*, the curriculum for an associate degree also goes up to calculus and includes options in such major fields as control systems and communications. All of these study programs contain college-level physics, some English, including technical writing and the preparation of reports, and appropriate electronics lab courses. While some basic knowledge of radio and TV is helpful, only a high-school level education is prerequisite since electronics fundamentals are offered to those who have not yet had them. These extensive programs, given in residence schools, are not usually available as home-study programs.

Typical of the latter are courses available from *CREI* in specialized communications technology, in aeronautical and navigational technology, in servo mechanisms and computers, and one in automation and industrial electronics. These courses, which consist of from 15 to 86 separate lessons, are available in a variety of combinations. The *Cleveland Institute of Electronics* offers a section in applied electronics that teaches such varied subjects as radar, digital and analog components, automation, radio telemetry, and aviation electronics. The curricula of technical institutes and schools offering electronics courses allow the student to choose the particular training suited to his purpose. In most schools, there are options for the student who wants to go deeper into mathematics and physics or to concentrate on English and technical writing, or other areas, according to his desires.

Advanced technology students practice spectrometer measurement techniques in the laboratory of a resident school.

Because of the number of institutions and variety of study programs they offer, including electives or options, virtually anyone can tailor advanced education to meet his individual requirements, whether he can attend a resident school or must confine himself to home study. A glance at Table 1 will confirm this.

Where schools call attention to special recognition, this has been included in the column marked "Other Information." "NHSC" indicates accreditation by the National Home Study Council. "ECPD" indicates recognition by the Engineers' Council for Professional Development. The latter is an accrediting body set up by the American Institute of Electrical Engineers and other technical and educational groups. "Accel" indicates an accelerated or condensed curriculum for resident students, generally running from two to three years. Other abbreviations are explained in the footnotes to the table.

Most institutions offering accelerated programs, instead of breaking the school calendar into conventional years or semesters, divide it into quarters, with the summer recess eliminated. This makes it possible to admit new students four times a year. Thus a student in a hurry would have to wait no more than three months, at worst, to get started. Since most schools, whether resident or correspondence, require a high-school diploma (or equivalent), no special mention has been made of this point. Where more or less is required, this is indicated under "Other Information."

Many of the college-level courses that do not lead to a degree or lead to an "associate" degree have nevertheless won wide acceptance as being equivalent to engineering degrees. Frequently these condensed courses offer all the technical material that would be covered for a regular degree but eliminate or reduce conventional requirements in the social sciences, English, the arts, and other general, non-technical subjects. If a student who has taken one of these accredited programs later decides to enter a college or university to obtain a regular diploma, he will often receive credit or advanced standing for the ground he has already covered.

Working with actual, commercial analog computers, students qualify for jobs they will seek when studies are over.

After training of the type discussed, Richard Kerian became data-processing service engineer with Minneapolis-Honeywell.

Most courses offer extensive work in such universal circuits as those found in TV, including the role of test instruments.

Some schools that offer training only in specific areas are listed in Table 1 because their courses may correspond with the specialized needs of many stu-

Institution & Address	Study Programs	Type of Instruction	Other Information
American Technical Writing Schools **5504 Hollywood Blvd., Hollywood 28, Calif.**	Tech writing, electronics	Cor	Prerequisite: interest in electronics; includes military specifications, instruction in electronics, and writing projects
Capitol Radio Engineering Institute **3224 Sixteenth St. N.W., Washington 10, D.C.**	College level: servo & computers; electronic engineering; aero & navigational; automation & industrial; nuclear engineering	Res (D&E), Cor	Accel (27 mos. for associate degree) ECPD, GI, entrance exam
Central Technical Institute **1644 Wyandotte, Kansas City 8, Mo.**	General electronics incl. FCC prep	Res, Cor	NHSC
Cleveland Institute of Electronics **1776 E. 17th St., Cleveland 14, Ohio**	General electronics: master (intermediate) & advanced (college-level) courses; FCC prep	Cor	Prerequisite: previous electronics education or experience; NHSC; FCC license guaranteed; branches in Honolulu, Jacksonville, Norfolk, Providence, San Diego, San Francisco, Seattle, & Waukegan
Coyne Electrical School **1455 W. Congress Pkwy., Chicago 7, Ill.**	Specialized courses incl. automation, thermoelectricity, semiconductors	Res	Prerequisite: previous background; entrance exam; GI
DeVry Technical Institute **4141 Belmont Ave., Chicago 41, Ill.**	Associate degree, advanced technology; electronic instrumentation; communications (incl. FCC prep)	Res (D&E)	Accel (24 mos. for advanced technology), ECPD, GI
	Other specialized vocational courses	Res, Cor	NHSC
Grantham School of Electronics **1505 N. Western Ave., Hollywood 27, Calif.**	Communications electronics (FCC prep)	Res (D&E), Cor	FCC license guaranteed; branches in Hollywood, Kansas City, Seattle, & Washington (D.C.)
Indiana Home Study Institute **924 E. Columbia Ave., Fort Wayne, Ind.**	Engineering mathematics	Cor	Choice of two math curricula
Indiana Technical College **9121 E. Washington Blvd., Fort Wayne 2, Ind.**	B.S. or B.E. degree	Res	Accel (27 or 36 mos.), GI, Dorm
Milwaukee School of Engineering **1025 N. Milwaukee St., Milwaukee, Wisc.**	B.S. or Associate degree; communications, power, computers	Res (D&E), Cor	Accel (18 mos. for associate degree, 36 mos. for B.S.), GI, Dorm
National Radio Institute **3939 Wisconsin Ave., Washington 16, D.C.**	Industrial electronics; communications, FCC prep	Cor	NHSC
National Technical Schools **4000 S. Figueroa St., Los Angeles 37, Calif.**	General electronics, master technician	Res, Cor	NHSC
Pacific Internat'l College of Arts & Sciences **5719 Santa Monica Blvd., Hollywood 38, Calif.**	E.E. degree, option in electronics	Cor	Primarily home study, but resident classes available
RCA Institutes **350 West 4th St., New York 14, N. Y.**	College level: advanced technology incl. industrial electronics with computer option	Res (D&E)	Accel (27 mos. for advanced technology), ECPD, GI; resident classes also at Los Angeles branch
	Technical writing course	Res (D&E)	
	Other specialized vocational courses	Res, Cor	
Sparton School of Aeronautics **Municipal Airport, Tulsa, Oklahoma**	Electronic engineering technology, incl. FCC prep	Res (Day)	Accel (18 mos. for E.E. technology), ECPD pending, GI, Dorm
	Electronics technician (vocational; less mathematics and theory than in technology course)	Res (Eve)	
Tri-State College **16121 College Ave., Angola, Ind.**	B.S. degree	Res	Accel (27 mos.), Dorm
Valparaiso Technical Institute **Valparaiso, Ind.**	B.S. or Associate degree	Res	ECPD, GI, Dorm

NOTES:

Accel = Accelerated or condensed program (admissions usually 4 times per year).
Cor = Home study courses.
D&E = Either day or evening classes available.
Dorm = Dormitories available for resident students.
ECPD = Accredited by Engineers' Council for Professional Development.
FCC prep = Training for FCC license examinations.
GI = Approved for veterans' benefits.
NHSC = Accredited by National Home Study Council.
Res = Residence School.

Table 1. Courses and schools listed here are adaptable to most of the specialized and general career objectives discussed.

dents. For example, a skilled technician who has had no experience with transmitters or transmission theory may hope to enter broadcast work or some other aspect of communications. He will also have to qualify for an FCC license at one level or another. Courses offered for this need are thus listed. In some cases, excellent courses in certain specialties are available from training institutions established by electronics manufacturers. Although they have not been listed, they are well suited to certain career objectives. The *Philco Technological Center*, P.O. Box 4730, Philadelphia 34, Pa., offers five advanced, home-study courses in such areas as semiconductor technology and computer or radar electronics. The *Motorola Training Institute*, 4501 Augusta Blvd., Chicago 51, Ill., offers an extensive, well-regarded course in two-way radio.

How Much? How Long?

Many who have considered going in for advanced training have been discour-
(*Continued on page* 110)

Tunnel Diode Bias Supplies

By **HAROLD REED**

Practical battery and a.c. power supplies to provide the technician and engineer with measured d.c. parameters.

TO THE electronic technician the tunnel diode reported during 1958 is now about where the transistor was several years after its announcement in 1948. The diode is available but the cost of most units is still quite high. Also, simple experimental tunnel-diode circuits are appearing in electronics magazines.

One of the least expensive tunnel diodes at this writing is the *G-E* 1N2941 which has been purchased by the author

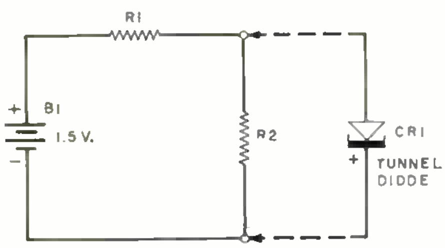


Fig. 1. Basic bias supply for tunnel diode consists of battery and resistive divider.

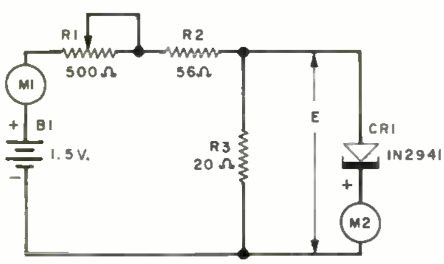


Fig. 2. Practical battery bias supply with control for varying bias. The battery may be either a flashlight cell or mercury type.

for $4.15. It may well become the experimental tunnel-diode "workhorse" as was the *Raytheon* CK722 transistor.

The tunnel diode requires a low-impedance, stable d.c. bias supply. Whether used in amplifier or oscillator circuitry, it is necessary to bias the diode in the negative-resistance region of its characteristic curve. This negative-resistance region is non-linear, therefore, small changes in bias will result in conductance variations with considerable variation in circuit gain.

As with transistors, small batteries are a logical source of bias supply for the tunnel diode because of its low voltage and current requirements. A battery also provides the required low-impedance, stable supply. Suggested bias supplies for germanium tunnel diodes using batteries are similar to the circuit shown in Fig. 1. Here, a resistive network composed of R_1 and R_2 is placed across the battery. R_2 of this low-resistance voltage divider, across which the diode is connected, will have a low value, say 18 to 22 ohms and the value of R_1 is selected to provide proper bias for the diode, between 125 and 150 mv. (.125 to .150 v.) for germanium tunnel diodes.

A practical battery bias supply is given in Fig. 2. A resistive network comprising R_1, R_2, and R_3 is connected across the battery with the diode across the 20-ohm resistor R_3. Since tunnel diode characteristics vary somewhat, variable control R_1 is included to adjust the bias of any particular diode to the optimum point in the negative-resistance region. To give the technician an example of what to expect with this bias supply the following measurements, which were made using the 1N2941 diode, are described. Current meters were inserted in the circuit at the points indicated in Fig. 2 for these tests.

Starting with all the resistance in control R_1, as this control is turned up,

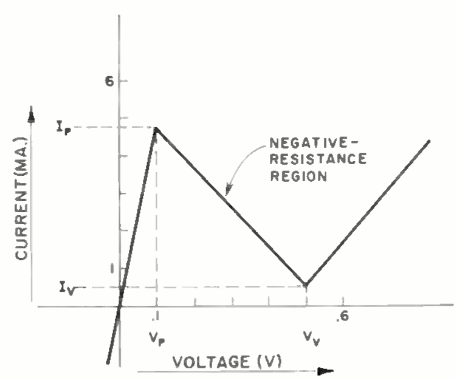


Fig. 3. Curve showing results of measurements made with the bias-supply circuit of Fig. 2 and a G-E 1N2941 tunnel diode.

voltage across the diode and current through it gradually increases, as indicated by meter M_2. When E reached 100 mv. (0.1 v.), the peak-point voltage V_p, the peak-point current I_p was 4.8 ma. and then suddenly decreased placing diode operation in the negative-resistance part of its characteristic curve. When the voltage was increased to 500 mv. (0.5 v.), the valley-point voltage V_v, meter M_2 indicated 0.5 ma., the valley-point current I_v, and then the current began to rise again with further voltage increase. These results for the 1N2941 are shown by the curve of Fig. 3. Measured data was similar to the manufacturer's specifications. With bias set for an optimum value of 130 mv., current through the diode was 3.6 ma. Meter M_1 indicates the total circuit current, which turned out to be 6.3 ma. for the 130 mv. bias condition. Control R_1 varied the voltage across the diode from 50 to 550 mv.

The battery may be a regular flashlight battery or penlight cell. A mercury cell is preferable because of its longer life and more constant voltage output during its life span. For continuous use or prolonged experimentation battery life is considerably shortened due to the low-impedance voltage divider required for tunnel diode biasing. This can be noted by the difference in current readings given for M_1 and M_2.

An a.c. supply used with the 1N2941 is shown in Fig. 4. In this circuit a 6-volt

(*Continued on page* 69)

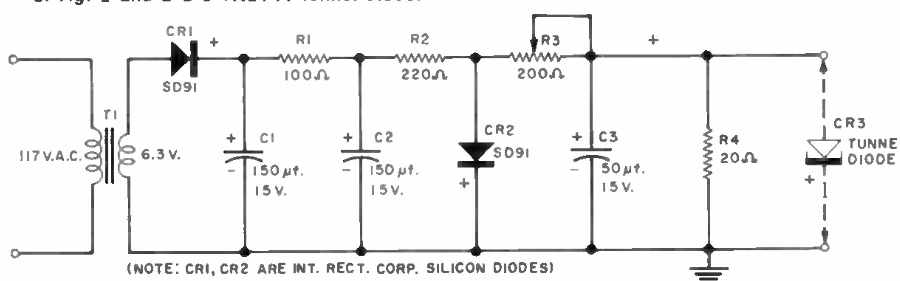
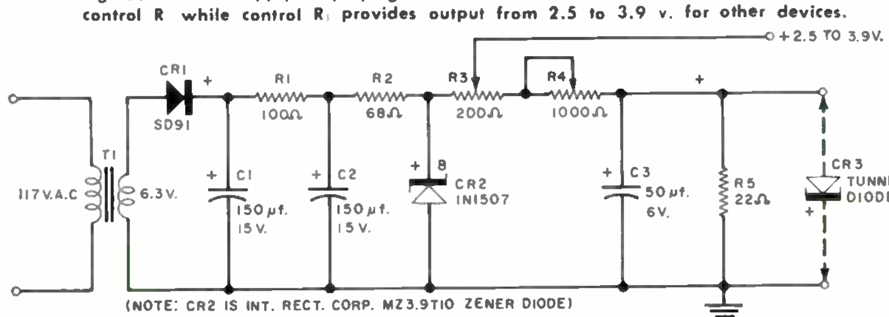


Fig. 4. An a.c. bias supply using a silicon diode for rectification and another for stabilization. The stabilizing diode is forward-biased and presents low impedance.

Fig. 5. An a.c. supply employing zener diode stabilization. Output is varied by control R while control R provides output from 2.5 to 3.9 v. for other devices.



ZENITH COLOR-TV FEATURES

A new receiver design has interesting innovations in circuitry, components, layout, and operation.

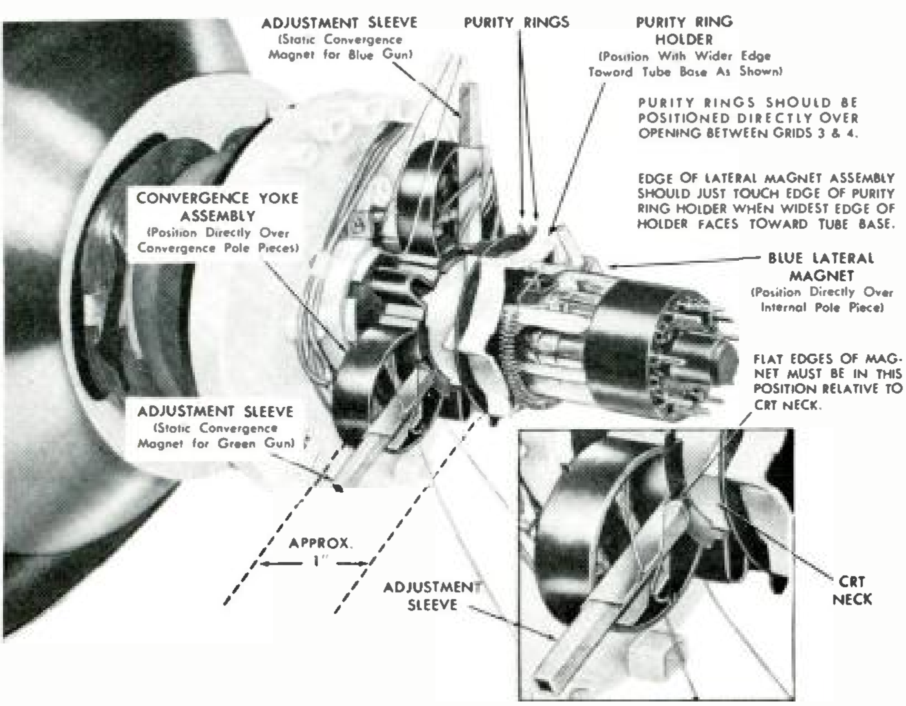
HOW FAR the current upsurge of interest in color TV will carry cannot be predicted, but its existence is genuine. Increased sales have outstripped production of one leading manufacturer for the first time, leading to expansion of facilities. Almost all major TV makers and several lesser ones have entered the market. New designs are appearing.

Zenith's decision to set sail in tinted waters aroused more than ordinary interest. This leading monochrome manufacturer, claiming it would stick to development until it could produce a set whose performance, reliability, and serviceability met high standards, is offering its first receiver eight years after FCC approval of current transmission standards. The 29JC20 chassis, its own design, incorporates many features that will interest both viewers and the men who must keep the sets going.

The CRT used is the latest three-gun, shadow-mask tube with high-efficiency phosphors. On its neck, behind the deflection yoke, is a new "cloverleaf" static convergence assembly, followed by adjustable-magnet purity controls and a PM centering system. Other features include a simplified focus adjustment, an improved color killer, an automatic color-level circuit to compensate for signal variations, and a two-tube color demodulator using specially designed tubes. A removable, perforated plate at the bottom of the cabinet permits underside access to most of the hand-wired, horizontal chassis for service.

In the black-and-white portions of the circuit, *Zenith* has adhered to prevailing philosophy: refinements have been added to conventional circuits for superior performance with respect to bandwidth, stability, and other factors. The two-tube tuner and 3-stage i.f. strip are followed, not by a single detector, but by two semiconductor diodes. The first, a sound-sync detector, feeds an amplifier that provides signal for the sync clipper and sound i.f. stages. The second, driven by the last i.f. stage through a separate transformer, includes an adjustable filter to tune out 920-kc. beat interference. From this detector, three outputs go to the a.g.c./sync-clipper stage, the color-signal amplifier, and the luminance or *Y* section.

Fig. 1. Mounted on the CRT neck behind the deflection yoke are a new "clover-leaf" convergence assembly, adjustable purity rings, and other permanent-magnet controls.



The latter, a two-stage circuit, is rather more elaborate than the corresponding video amplifier in a monochrome set. The first stage, a triode cathode-follower, presents a high input impedance to avoid loading the detector. This preserves detail and over-all quality of the video signal. The contrast control, in the follower's output, drives the pentode luminance amplifier through a delay line. Also connected to the pentode's grid is the brightness control, a bias adjustment that determines stage gain. Thus two important controls are kept away from the CRT itself, which will have enough associated adjustments of its own. *Y* amplifier output is then direct-coupled to the three CRT cathodes. It goes to the red-gun cathode through only a peaking coil, but also passes through separate gain controls for the blue and green cathodes, so that output of the three guns may be balanced.

The a.g.c.-sync stage uses a 6HS8. Along with its single cathode and control grid, this tube has two separate plates, each with its own suppressor grid to which an additional control signal is applied. Thus, with inputs sampling such different points as the *Y* detector-amplifier and the sync-sound amplifier, stable operation of sync and gain-controlled stages is maintained over a wide range of conditions. Gated a.g.c. output to the tuner is delayed for low noise.

The Deflection Circuits

The vertical oscillator-sweep section is conventional except that extra output-transformer secondaries provide wave-shaping voltages for dynamic convergence. The horizontal oscillator-a.f.c. circuit uses a pair of multi-section tubes. A twin diode-triode serves as a.f.c. phase detector and control (reactance) stage. The first section of the second tube, a twin triode, is a modified Hartley oscillator, with the second acting as a discharge tube. Despite the fact that there are only two tube envelopes, the circuit recalls the lavish design practice in earlier post-war TV receivers.

The horizontal-output/high-voltage section is a mixture of old and new. A 6DQ5 output tube drives a flyback transformer with many secondaries and taps. Associated with it are an h.v. rectifier (a 3A3 for 24,000 volts) a damper, and the horizontal yoke coils. In addition, there are a focus-voltage rectifier (1V2), a voltage regulator (6BK4), three controls, and take-off taps for burst amplifier, color killer, and convergence circuits.

The focus control, a variable inductor, is set for 4900 volts d.c. from the focus rectifier. A potentiometer in the grid of the regulator, which shunts the h.v. output, is adjusted for 24 kv. The variable horizontal-efficiency coil, associated with damper and regulator, is set for minimum current. The last two controls need generally be used only after tube replacements. To discourage heater-cathode breakdown, d.c. is superimposed on the normal a.c. voltages applied to heaters of the damper, regulator, and CRT.

All twelve dynamic-convergence controls, for tracking adjustment of the three guns at the top, bottom, right, and left raster areas, are on a conveniently removable service panel. Before they are used, however, proper setting of static-convergence and other controls on the CRT neck (Fig. 1) should be confirmed.

Manipulated for center-screen convergence only, the three static controls, one for each gun, are magnets with adjustable sleeves. Mounted on the cloverleaf assembly, two are visible in Fig. 1. The blue lateral magnet, farther back on the CRT neck, compensates the blue beam for lateral shifts that may occur in the red and green beams. With center convergence achieved, blue and green guns are disabled by turning down their screen controls so that purity may be obtained using a red field. The tabs on the purity rings (Fig. 1) are rotated away from each other until the CRT face is uniformly red.

Color-Signal Processing

Of greatest interest are the circuits devoted exclusively to color. Except for CRT details, the entire color channel is shown in Fig. 2. Input to the 1st color amplifier comes from one of the three outputs of the video detector noted earlier, through a 4.5-mc. trap (L_{15}) to suppress beat interference. Another input to this grid is d.c. voltage ("ACC Bias") developed by the twin diode "ACC-Killer Phase Detector." Without immediate consideration of details concerning the latter circuit, we can say that its output depends on the level of part of the incoming signal. Thus gain of the first color amplifier is controlled, in a manner resembling a.g.c. action, so that color level does not have to be adjusted manually to compensate for slight changes in the incoming signal.

The plate load of the 1st amplifier, L_{25}, is tuned to 3 mc. Output is applied to the burst amplifier through C_{68} and to the 2nd color amplifier through C_{69}. Output of the latter stage is tuned to 3.6 mc., so that the two amplifiers constitute a stagger-tuned strip providing the desired bandwidth characteristic.

In addition to signal input, the 2nd amplifier receives output from the plate of the color killer. When there is no color being transmitted, the latter's output is −50 volts, sufficient to cut off the second amplifier and thus disable succeeding color circuits, permitting only a black-and-white picture to be produced. In the presence of color signal, there is no disabling output from the killer.

The externally available "Color Level" control in the cathode of the second amplifier sets gain for the stage, permitting the viewer to adjust the picture anywhere from slight tinting to well-saturated color. Pulling this control knob outward closes "Color Off" switch S_3, which grounds the grid of the killer. Highly negative killer output then cuts off the 2nd amplifier whether color is being received or not.

Color detection is accomplished by a pair of demodulators operating 90 degrees apart, corresponding to the red

(*Continued on page* 80)

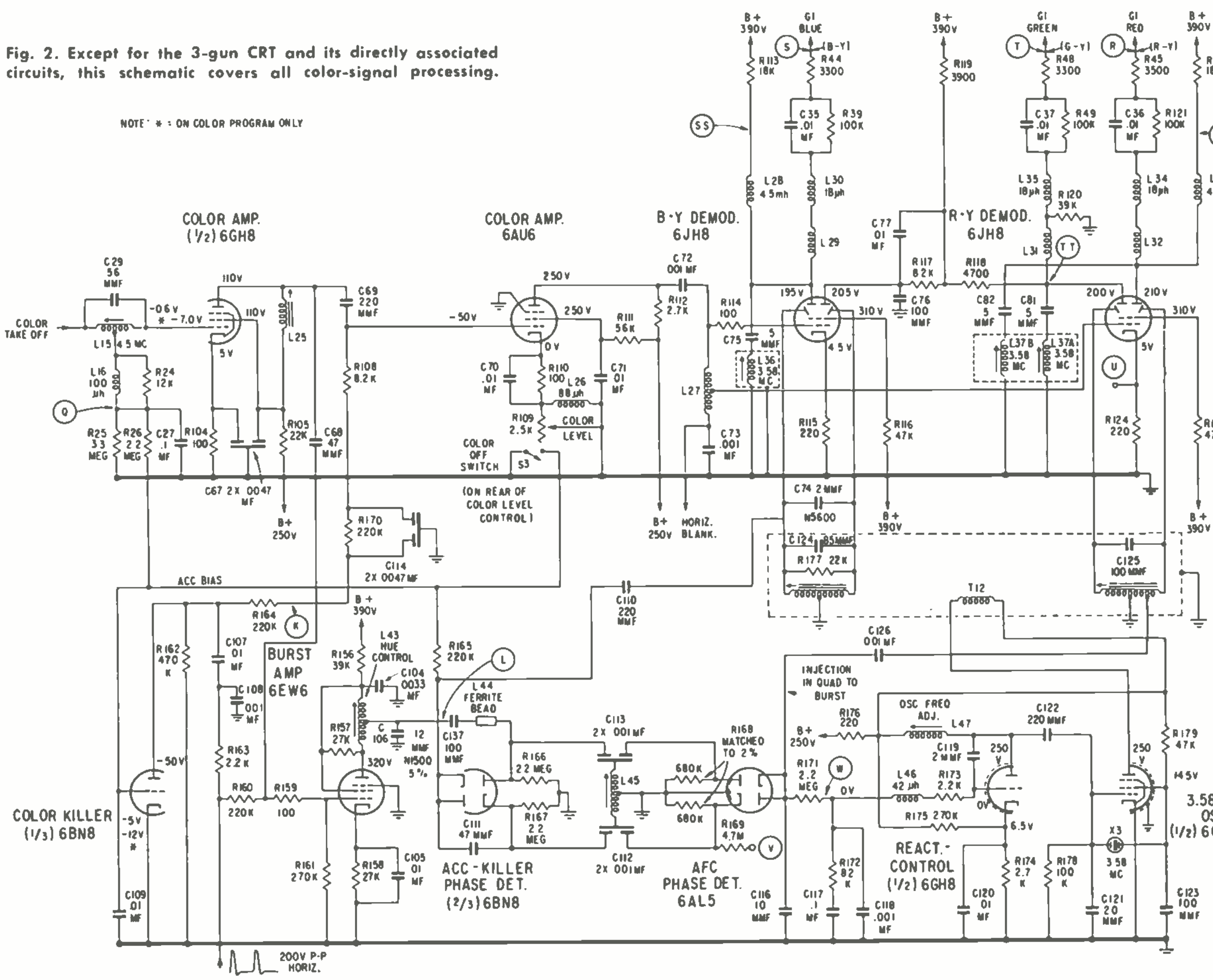
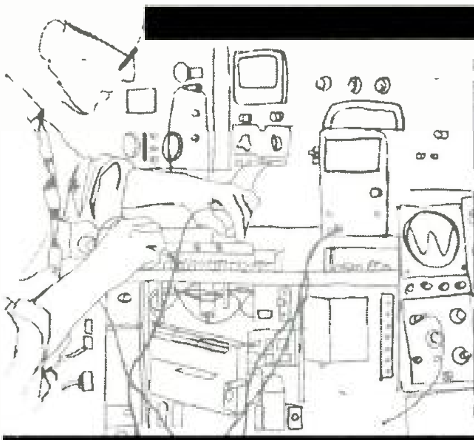


Fig. 2. Except for the 3-gun CRT and its directly associated circuits, this schematic covers all color-signal processing.



MAC'S ELECTRONICS SERVICE

LIGHT SERVICE WORK

"DOGGONE this little stinker anyway!" Barney exploded as he shoved the small a.c.-d.c. radio chassis to the back of the bench.

"Ah-ah, temper, temper!" Mac, his employer chided with a mocking grin. "I remember only yesterday you were telling me tube radio service bored you because it was so easy—'didn't offer any challenge' was the way you put it."

"I hate people with good memories for the wrong things," Barney growled; "anyway, that was yesterday. This little monster has a hum in it bad enough to cause distortion; yet the filter capacitors are all OK; it can't be heater-to-cathode shorting because changing tubes doesn't help; the a.c. line bypasses are all right; there are no chassis grounds on the a.v.c. bus or the tuning capacitor; and the loop antenna isn't open. What else *can* cause hum?"

"Hm-m-m-m, would you call that a 60- or 120-cycle hum?" Mac asked.

"I'm not sure. It sounds kinda funny, sort of half-way between."

Mac picked up the v.t.v.m. probes and checked the voltage on the grid pin of the output tube. It was five or six volts positive. He snipped loose the lead coming to this point from the printed-circuit Couplate unit. The hum stopped abruptly, and the voltage on the grid dropped to zero. Next he put an .01 μf. capacitor in series with the cut lead and clipped a half-megohm resistor between the grid connection and the "B-minus" point. The radio played perfectly.

"I can't decide if I prefer feeling mad and frustrated as I did before or just plain stupid as I do now," Barney reflected slowly. "I was so sure the distortion was coming from the hum—as is so often the case with open filter capacitors—that I never once thought of checking for a leaky coupling capacitor. What was causing the hum?"

"I'm not certain myself," Mac admitted; "but I suspect it was actually a low-frequency motorboating resulting from trouble in the Couplate unit. That was what tipped me off; the hum didn't sound like 60- or 120-cycle. But you needn't feel too stupid. Those little printed circuit coupling units give trouble so seldom that it's mighty easy to overlook them entirely."

"You can say that again. I don't think I ever saw one go bad in a radio before, although I have replaced integrator units in TV receivers. If all printed circuits performed like these little jewels, there would be little squawking about them."

"They probably are a good example of how dependable a printed circuit can be, and it's really no wonder. I believe the Couplate was the very first application of the printed circuit technique to household electronic equipment. Its immediate ancestor was the printed circuit in the proximity fuse, a spot where ruggedness and dependability was most essential; and when the Couplate was designed, the boys had not yet started seeing how much they could cut the cost and still make the printed circuit work.

"Actually the Couplate gives so little trouble because the board itself is small and of good quality. The three resistors and five capacitors in this unit are printed right on the board and are an integral part of the circuit. It is not a case of conventional components being soldered to printed wiring. The entire printed assembly is protected from mechanical injury and moisture by a heavy coating. All possible connections are made internally, and the seven leads from the board are firmly anchored to it to afford strain relief and good permanent connections are made to the circuit. The board is supported only by these leads; so no flexing or warping strains are imposed upon the circuitry. In short, the Couplate is a printed circuit at its best."

"I'm convinced. Guess I may as well trim the leads of the resistor and capacitor and solder them in place, huh?"

"No, I'd replace the entire Couplate. The cost is small, and I don't like to take a chance with a unit in which one capacitor has developed leakage. But before we leave the subject, I think there is one other lesson to be learned from this experience, and that is this: symptoms that point in one direction in a wired receiver do not always point the same way in a printed circuit. Leakage between printed conductors can feed a 60-cycle a.c. hum voltage to a sensitive grid; and a thermal intermittent is often produced by an expansion break in a printed conductor. Come to think of it, that's kind of funny. I always used to grin to myself when a customer brought in a radio and said he thought the trouble was 'a broken wire.' Chances of his being right were about one in a thousand; but now, with printed circuits, the odds in his favor are much better. Just keep in mind, though, that printed circuits can come up with some entirely new symptoms and also with symptoms that seem familiar but may have an entirely different cause than would be the case with a wired receiver."

Barney nodded and set to work replacing the Couplate. He was unusually quiet, though, and Mac knew the youth had something on his mind. When the radio was finished and back in its case, Barney suddenly blurted out: "Hey, Mac, I've got to tell you something, and I hope it doesn't make you mad."

"I hope it doesn't either, for I don't like to get mad, but out with it."

"Well, I guess it's pretty stupid to encourage business competition, but that's exactly what I was doing last night."

"Go on."

"It all started about five-thirty last evening when I got a telephone call from a man I didn't know. He said he was ill and needed some advice and wondered if I could come over to see him. Well, you know how I am when anyone is dumb enough to ask *me* for advice; so I went over after supper to his home on the West Side. It turned out he is in his early thirties and has a wife and two kids. The kids aren't very old. Anyway this guy is a carpenter, but he is just getting over a heart attack and has been told he can never do any heavy work again. Before he had the attack he had been taking a radio and TV course by correspondence. He's an ambitious cuss and has really been trying hard to get ahead. Maybe that's what brought on the heart attack."

"What about wanting advice?"

"Well, he realized he couldn't wrestle heavy TV chassis around, and he was wondering if I thought he could do any good in service work by hiring someone to do the lifting for him while he did the actual troubleshooting and repairing."

"What did you tell him?"

"The truth. I said I seriously doubted he could get started that way. A really hot-shot of a technician might be able to do all right with an arrangement of this sort, for he could turn out enough work to keep the cheap help busy and pay for it. But a new technician would naturally be slow. His helper would be sitting around reading comic books most of the time—and drawing his pay. It is very important that the overhead be kept low when you're getting started, and hiring a non-productive helper is no way to keep the overhead down."

"After you had thrown that wet blanket on the poor devil's hopes, what did you do: put on your hat and go home?" Mac asked sarcastically.

"No, I suggested he go on and finish

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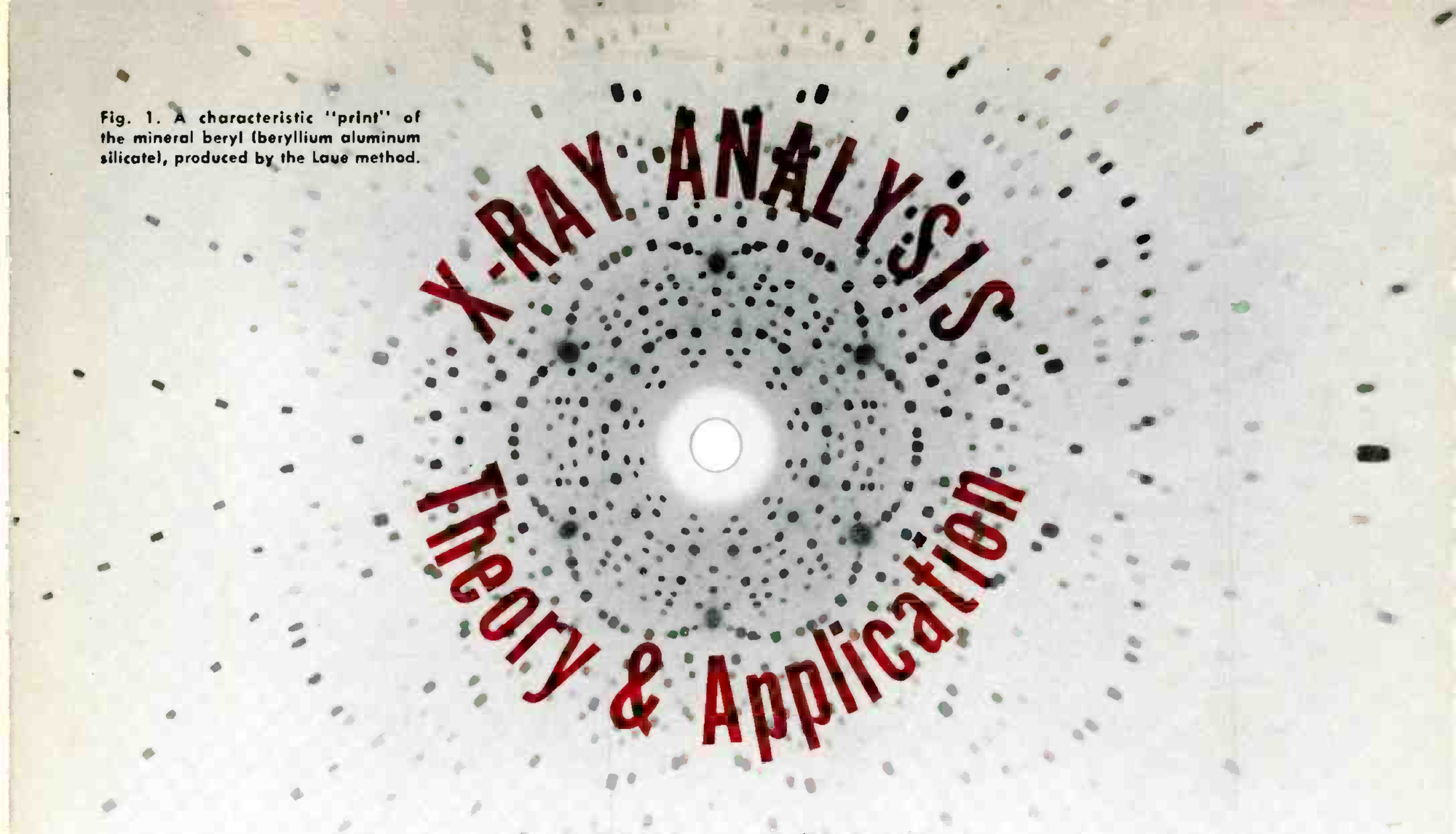


Fig. 1. A characteristic "print" of the mineral beryl (beryllium aluminum silicate), produced by the Laue method.

X-RAY ANALYSIS Theory & Application

By JOHN R. COLLINS

Distinctive patterns reveal the basic structure of unknown materials when subjected to radiation.

EDITOR'S NOTE: *As the author pointed out in our December issue ("Industrial X-Ray Analysis"), this type of radiation can be used to "see through" inanimate objects as well as living creatures. Of greater interest to many will be the techniques of developing characteristic radiation patterns or "fingerprints" to reveal the nature of unknown materials.*

MANY recent advances in semiconductors, thermoelectric alloys, ferrites, and other solid-state devices can be traced directly to intimate knowledge of the basic structure of these materials made possible by x-ray analysis. Analytical methods formerly used only for basic scientific research are now applied to problems in product development and quality control. Such x-ray analysis has nothing to do with the shadow pictures that reveal flaws in castings or defects in welds. It involves not so much the penetrating power of x-rays as their characteristic radiation patterns.

Two distinct approaches to x-ray analysis are in common use, each based on a different principle. *X-ray diffraction* makes use of the special way in which x-rays are reflected from crystalline materials. *X-ray fluorescence*, apparatus for which is pictured in Fig. 2, is concerned with the radiation given off by many materials when they are bombarded with x-rays. The two methods are complementary, each providing the best solution for a particular range of problems encountered in analysis.

Electronic technicians encountering x-ray instrumentation for the first time find the technology compatible with their previous training. Since x-rays are a form of electromagnetic radiation like radio waves, many components and subassemblies are the same in x-ray as in radio apparatus. Differences do exist, however, and some guidance is needed before an electronic technician can safely handle x-ray equipment.

X-Ray Spectra

X-rays result from the conversion of kinetic energy into radiant energy when high-speed electrons strike the target of an x-ray tube. The radiation produced in this manner covers a broad range and includes x-rays of many different wavelengths. The shortest wavelengths, which represent the greatest energy, are produced by electrons that strike the nuclei of atoms on the surface of the target, since in that instance the entire kinetic energy of the electron is converted into x-ray radiation. Other electrons which do not collide with surface nuclei will dissipate part of their energy in penetrating the target, and they thus yield longer wavelengths. The result is the *continuous spectrum* (broken line), pictured in Fig. 3, which is made up of waves of all possible lengths.

A mathematical relationship exists between wavelength and energy, so it is possible to calculate precisely the shortest wavelength that can be produced with a given accelerating potential. If the number 12,398 is divided by the energy of the bombarding electrons in electron volts (which will be equal to the plate voltage of the x-ray tube), the result will be the minimum wavelength in angstrom units (1 angstrom unit = 0.00000001 cm.). With an accelerating potential of 50,000 volts, therefore, the shortest x-rays produced will have wavelengths of about 0.248 angstrom unit. While x-rays with longer wavelengths will also be produced, a higher accelerating potential is needed to produce any with shorter wavelengths.

If 12,398 is divided by the wavelength in angstrom units of a desired x-ray, the energy in electron volts needed to produce it can be found.

The electron bombardment of the target also produces a *line spectrum*, consisting of a series of well-defined lines whose wavelengths are characteristic of the material from which the target is fabricated. The line spectrum is caused by the conversion into x-rays of the energy released when electrons from the inner orbits of target atoms are displaced by electron bombardment. The amount of energy released (and hence the wavelength) depends on the binding forces of the particular atom. Since only a limited number of orbits can participate, the spectrum consists of comparatively few lines. A copper target produces two lines, as shown in Fig. 3, at wavelengths of 1.39 and 1.54 angstrom units.

The continuous spectrum is often called *white x-ray* because of the similarity to white light which is composed of all colors or wavelengths. X-ray beams of a single wavelength are called *monochromatic*. They are produced by filtering line spectra to eliminate all but a single line. Various materials act as filters with sharp cut-off characteristics. A thin sheet of nickel interposed in the x-ray beam emanating from a copper target will absorb the 1.39 angstrom line but will not affect the 1.54 angstrom line.

Both white and monochromatic x-rays are useful for x-ray analysis.

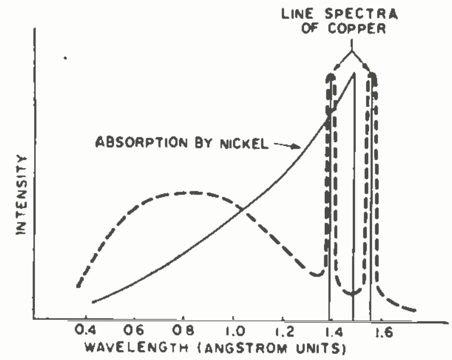


Fig. 3. Continuous (broken curve) and line spectra. Absorption of nickel shield, used as filter, in solid line.

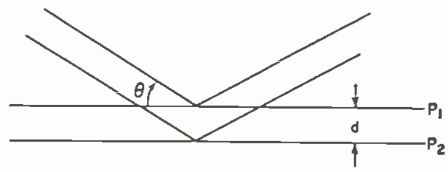


Fig 4 In one analysis method, x-rays are diffracted by the planes of a crystal of the material that is under study.

X-Ray Diffraction

Radio technicians often think of crystals in terms of the quartz, silicon, and germanium devices with which they are most familiar. Actually, almost all pure elements and compounds may be found in crystal form—that is, a regular, symmetrical arrangement of molecules repeated over and over like a wallpaper pattern. If a narrow beam of white x-ray is directed against such a crystal, each individual wavelength will be diffracted differently. A photographic film used to record the result will show an intricate arrangement of dots of various sizes, called a *Laue pattern*. The characteristic print of the mineral beryl (beryllium aluminum silicate), made by the Laue method, is shown in Fig. 1. While the Laue pattern demonstrates that x-rays are diffracted by crystals, the result generally is too complicated for practical use. Hence monochromatic beams are almost always used for diffraction analysis.

The principle on which x-ray diffraction is based is illustrated in Fig. 4. The atomic planes of a given crystal are always a constant distance d apart. If a train of x-rays falls on a set of planes at a glancing angle θ, each plane will reflect a small part of the wave train and let the rest through to the next plane. The reflected wave trains from successive planes will usually be out-of-phase with each other. This will cause destructive interference and there will be no net reflection. However, in the special case where the *path distance* of the wave passing from plane to plane is equal to the wavelength of the x-ray (or a multiple of the wavelength), the reflected wave trains will be in-phase, and a net reflection will occur.

An analysis of the conditions necessary for reflection will show that it can occur only when $\sin\theta = n\lambda/2d$, where θ = the angle between the incident ray and the atomic planes; λ = wavelength of the x-ray beam; d = distance between the atomic planes; and n = an integer.

The integer n may take the successive values 1, 2, 3, etc. It indicates that reflection may occur not only at the basic wavelength, but also at various "harmonics."

The above formula, called the Bragg Law, is the basis on which an instrument known as the Bragg spectrometer (Fig. 6) operates. In this instrument, x-rays from a copper target are filtered through a nickel sheet and directed against the crystal to be analyzed. A scintillation counter, similar to those used for nuclear explorations, is used to detect the reflected beam and measure its intensity. The spectrometer is precisely calibrated so that the exact angles at which reflections occur can be determined.

In operation, the crystal is rotated so that the x-ray beam will strike it successively from all angles. At the same time, the detector is rotated at twice the speed of the crystal in order to maintain it always in the proper position to record all possible reflections. In automatic equipment, the output of the detector is fed to a recorder where both the angles and the intensity of reflections are recorded.

Diffraction spectrometers of this kind are used for the comparatively simple task of orienting quartz crystals to find the proper angle at which to slice them in the manufacture of piezoelectric crystals. But beyond this they are also used for complex work on crystal structures of many kinds, to identify unknown materials, for the analysis of the way in which various elements form compounds, and for the identification of trace impurities.

Powder-Camera Method

A different way of studying the diffraction properties of crystals is the powder-camera method. It is based on the principle that, if the sample crystal is ground into a fine powder, the probability is high of having individual crystal fragments lying in all possible directions from which reflection can occur.

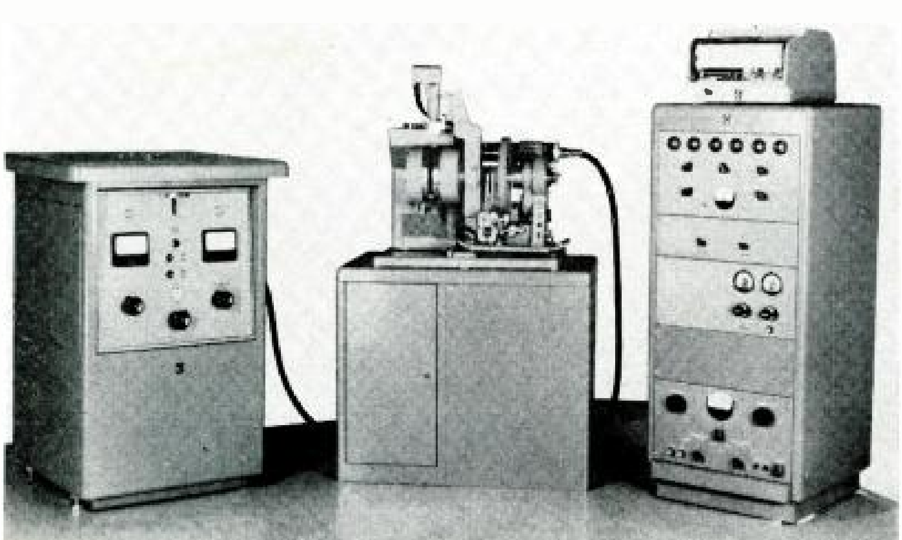
The powder may be placed in a thin glass tube or glued to a glass fiber suspended in the center of a metal cylinder. A strip of photographic film is placed around the inner surface of the cylinder, and a fine beam of monochromatic x-rays is directed against the powder sample. The diffracted rays diverge from the sample in sets of cones, to form dark, curved lines on the film strip. Powder-camera photographs of lead nitrate, tungsten, salt, and quartz are shown in Fig. 5.

The powder-camera record is like a fingerprint of a material. Identification of an unknown substance is made by comparing its powder-camera photograph with those of known substances. The American Society for Testing Materials (ASTM) maintains a file on many thousands of substances, including minerals, metals, and alloys, and both organic and inorganic compounds. The file is being continually expanded as new substances are investigated. To facilitate identification, the data is recorded on cards which are arranged according to the spacing of the three most intense lines.

Powder-camera methods are used for purposes other than the identification of materials. It has been observed, for instance, that when a metal has been strained or its crystal structure otherwise damaged, the diffraction lines become large and poorly defined. Proper heat treating will correct the defect and return the metal to its former state. Powder diffraction methods can be used not only to locate the defect but to study the most effective annealing procedure.

The crystals of some materials tend to arrange themselves in a preferred di-

Fig. 2. An x-ray fluorescence spectrograph, consisting of a power supply (left), a spectrographic attachment (center), and an analyzing-recording cabinet (right).



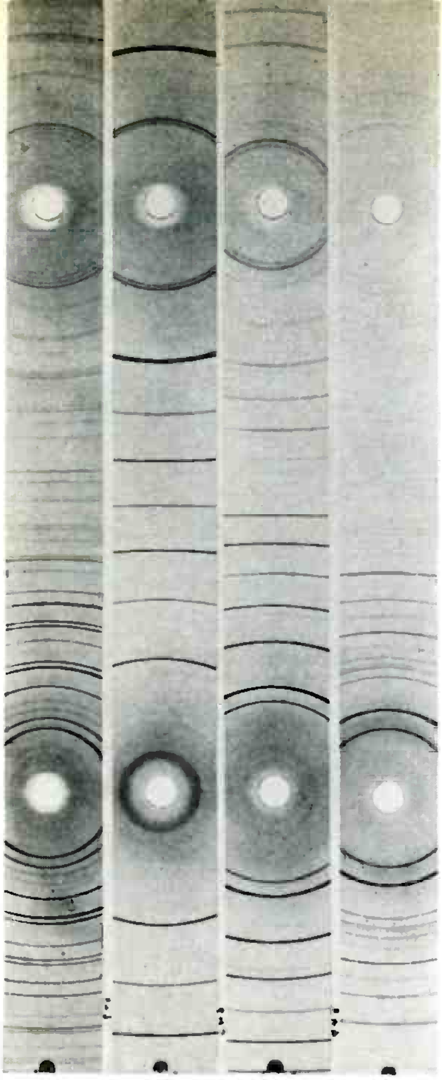


Fig. 5. Powder-camera "fingerprints" (left to right) of lead nitrate, tungsten, sodium chloride, and of quartz.

rection when ground into a powder, and this characteristic may be important when drawing fine wires or rolling thin sheets of foil. The tendency can be detected in powder-camera photographs by differences in the patterns obtained when the sample is photographed from different angles or is rotated.

Fluorescence Spectrograph

The fact that x-ray diffraction equipment can be used only with materials in crystal form is a serious limitation, since many substances do not form crystals. However, many non-crystalline substances can be analyzed through the use of the x-ray fluorescence spectrograph, shown in Fig. 2. A simplification of how it works appears in Fig. 7.

The sample to be analyzed is bombarded with high intensity x-rays, causing it to fluoresce or give off a characteristic line spectrum. Fluorescence occurs when the wavelength of the bombarding x-rays is slightly shorter than the wavelength of the emitted radiation. White x-rays are therefore used to assure that waves of the proper length to produce fluorescence will be present.

The line spectra given off in fluorescence are similar to those obtained when a target is bombarded with electrons, although not as strong. Since they are different for each element, they provide positive identification of the substance under study.

The equipment used to measure the wavelength and intensity of the line spectrum is quite similar to the Bragg spectrometer previously described. The fluorescent radiation is directed against a known *analyzing crystal* (usually made of quartz, salt, or lithium fluoride). While the analyzing crystal is rotated at a constant speed, a scintillation counter is rotated at twice the speed to pick up the reflections. Measurements are made of the angles at which reflections occur and their intensity.

The information obtained in this manner is used to determine both the elements present in the sample and their concentration. The Bragg formula, used for diffraction, applies also to fluorescence. However, in diffraction, the wavelength λ of the radiation was known and the equation was solved to find the spacing d of the crystal planes. In fluorescence analysis, the spacing of the crystal planes is already known (since a known analyzing crystal is used) and the formula is solved to find the wavelength of the radiation.

The intensity of the reflected beam varies with the amount of the element present in the test sample, but usually not in a linear manner. Quantitative analysis therefore generally requires that the instrument be calibrated against samples of known composition.

Unlike x-ray diffraction, x-ray fluorescence gives no information regarding the structure of the material under study nor of the way in which it forms compounds. Its function is to identify and measure the *elements* which go to make up the sample, and it can be applied to many substances. It has been used to measure such things as the amount of lead in gasoline, sulfur in oil, and even the hemoglobin (iron) in blood. It permits rapid analysis of ores, and portable equipment has been developed for field use.

There are several limitations. It cannot be used to identify all elements—only those between atomic number 12 (magnesium) and number 98 (californium). Thus, it cannot test for such elements as boron (5) and carbon (6). Also, while it will correctly identify trace elements, its accuracy for measuring the exact percentage of minute quantities is limited. Since the longer x-rays are absorbed by air, vacuum techniques are needed to analyze elements with an atomic number below 22 (titanium).

In combination, x-ray diffraction and x-ray fluorescence equipment represent great advances in modern laboratory and industrial technology. They are more rapid than wet chemical processes, are non-destructive, and provide types of information on atomic structure that cannot be obtained by other means. ▲

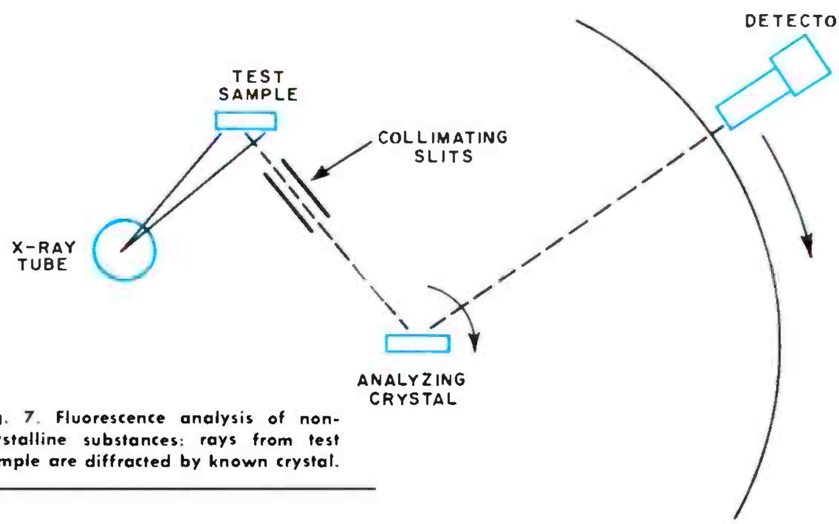


Fig. 7. Fluorescence analysis of non-crystalline substances: rays from test sample are diffracted by known crystal.

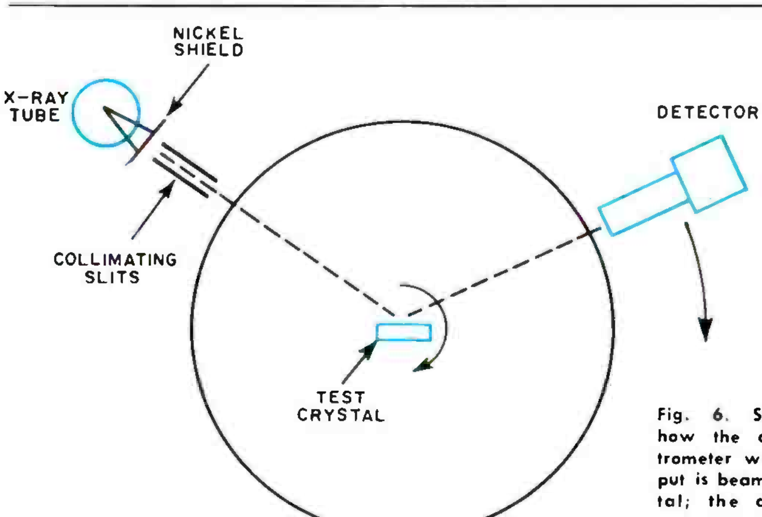
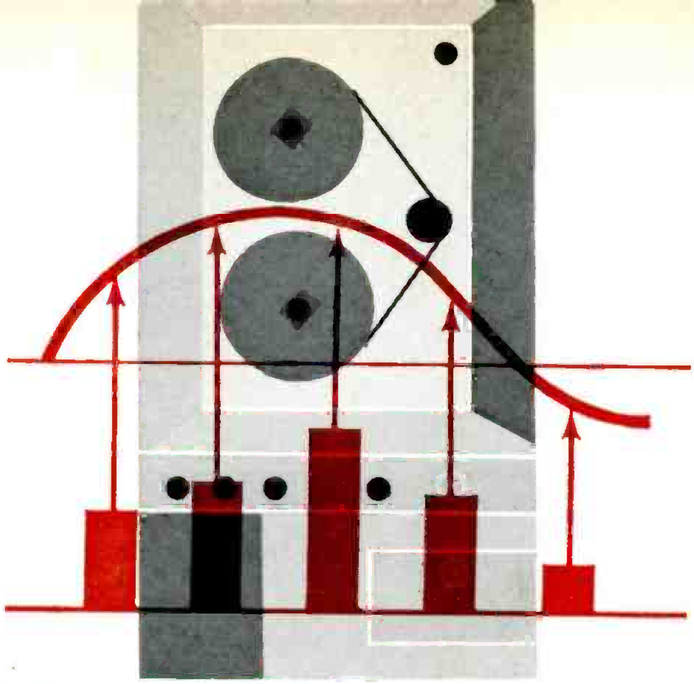


Fig. 6. Simplification of how the diffraction spectrometer works. X-ray output is beamed against crystal; the diffracted rays are sensed by detector.



PULSE-MODULATION TECHNIQUES

By R. L. BULINSKI

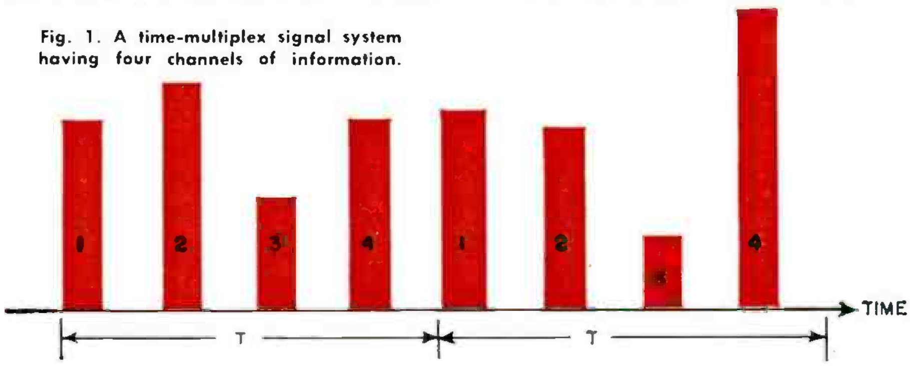
Pulses are widely used to transmit data from one point to another. Here is how the various pulse systems work and how they are able to carry the information.

PULSE-MODULATION techniques are widely used for information transmission. This article will discuss the various methods employed, define them, and give the fundamental characteristics of each technique.

It is assumed that the reader is familiar with the basic concept of modulation, that of superimposing intelligence on a carrier. We have the familiar techniques of using a carrier wave to transmit information by means of amplitude modulation (the AM of broadcast-band radio programming), frequency modulation (the technique employed in **FM** radio and in the sound portion of television), and phase modulation (PM, as used mainly in industrial control).

The standard techniques of transmission have certain shortcomings when applied to data transmission. One such consideration is efficiency. Data systems, employed in such fields as radar, telemetry, and tele-processing, are required to transmit numeric or, at most, alphabetic information, which by its nature is discrete and hence easily permits a similarly discrete representation. By contrast, carrier transmission (particularly c.w., or continuous wave) is more conveniently continuous in order to convey speech, music, or other continuous phenomena. Thus, the economy of "packing" data signals on a compressed time-scale becomes evident with data systems. Normally, the "packing" idea is put to best use when the transmission capacity is greater than the rate at which data from a single source becomes available.

Fig. 1. A time-multiplex signal system having four channels of information.



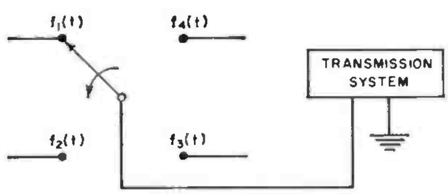


Fig. 2. Basic principle of multiplexing.

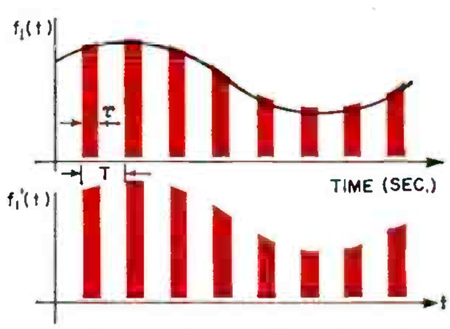


Fig. 3. Sampled output of single channel.

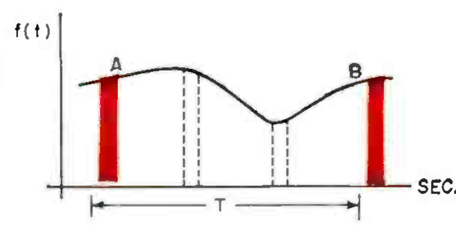


Fig. 4. Information is lost and output is distorted if the sampling rate is too low.

Sampled Signals

Information-transmission systems are designed to handle periodically sampled signals; they are then called sampled-data systems. Sampling of a signal or of a channel means that there are times in which no information is being transmitted through the system; hence, it is possible to transmit information from other sources during the vacant intervals. Transmission of samples of information from several signal channels concurrently through one communication system, with different channel samples staggered in time, is called *time multiplexing.* Fig. 1 shows a time-multiplex signal system having four information channels, with a sampling interval (for completion of the 4-channel sampling cycle) of T units of time. The bars numbered 1 represent successive signal-samples taken at interval T from Channel 1; the 2's represent successive samples at interval T from Channel 2, etc.

Two further considerations place a strong preference on a modified data-transmission system, over carrier-wave modulation. These are, in fact, strongly interdependent. One reason for using time-multiplexed sampled-data systems is that the samples are ordinarily available in the form of discrete pulses, and may readily be adapted or used directly for digital-computer processing. More significantly in the data-transmission field, the samples may be coded into pulses having two of the following characteristics uniform and one varying with the sampled signal: pulse height, pulse width, or occurrence of the pulse on the time scale. The pulses can then be reshaped to the fixed dimensions at intermediate points and at the receiving terminus in order to "repair the damage" caused by noise and interference, thereby increasing substantially the validity and reliability of the incoming signal. This operation is also facilitated greatly by the very fact of the transmission of "bursts" of energy in pulses, in that the signal-to-noise ratio is high. And, although instantaneous power is great, the pulses being of brief duration relative to the quiescent interval between pulses, the average power requirement is modest.

Pulse-Time Modulation

The simplest type of sampled-data system incorporating time-multiplexing may be thought of as a multi-channel input, connected through a multi-position switch to the transmission system. In Fig. 2 a mechanical switch is shown for simplicity although, in practice, electronic switching is used.

The $f_1(t)$ represents terminations of four input channels whose message information is transmitted intermittently. As noted previously, a series of discrete pulses carries the message from each channel through the system, on an interlaced pattern with respect to time. In the following diagrams, only a single input signal, $f_1(t)$, is illustrated in order to make it easier to visualize the behavior of the system; the actual composite pulses fed into the transmission system from the four inputs of Fig. 2 might be similar to those of Fig. 1. Assuming that the switch rotates uniformly at the rate of $1/T$ times per second and remains on each position τ seconds, the sampling times and the sampled output corresponding to channel $f_1(t)$ appears as in Fig. 3.

From the figure it is evident that sampling is a means for representing a continuously varying curve, such as speech, by a series of single values, *i.e.*, by a series of pulses. This is the general technique of *pulse-time modulation*, used in the long-distance telephone cable, and microwave transmission of many conversations concurrently.

Sampling Rate

Since the commutator action of the multiplexing switch "chops" the message wave into segments of τ second each, its frequency of rotation is generally spoken of as the chopper frequency, denoted $f_r = 1/T$. It is common practice to use f_m to denote the significant bandwidth of the message, *i.e.*, the band limit on input signal.

There is no theoretical upper limit on f_r. Practically, however, sampling a channel more often (at the same sample-duration τ) results in less time available between samples. Fewer channels can be multiplexed until, as f_r approaches infinity, the input becomes practically continuous.

On the other hand, the lower limit on sampling frequency is highly significant. If we sample at too low a rate, the signal may change radically between sampling times. We lose information and produce a distorted output, as Fig. 4 indicates.

If the sample rate is $1/T$, it is evident that we have lost detail on the performance of the waveform between A and B. This detail can be recovered by decreasing the sample interval by at least one-third, as indicated by the dotted pulse widths.

Successive instantaneous measurements of magnitude made upon a continuous wave at the rate of $2f_m$ measurements per second (f_m measured in cycles per second) provide enough information to allow reconstruction of the original wave. Sampling at exactly $f_r = 2f_m$, called the Nyquist rate, however, requires filters of infinite cut-off characteristics in demodulation, *i.e.*, in reconstructing the wave at the receiver. Now, such filters are idealized from theoretical considerations, but are impossible to achieve in practice. See Fig. 5A. For example, voice transmission is normally limited to 3.3 kc. The Nyquist sampling rate would be 6.6 kc., but a sample rate of 8 kc. is most frequently used, providing a filter guard band of 1.4 kc.

Marker Pulses

It is apparent that the pulses derived from each input must be correctly associated at the receiver. In other words, the successive pulses obtained from Channel 1 must be identified in order to be re-assembled into a usable message, as must those of Channel 2, Channel 3, etc. To accomplish this purpose, one of the pulses sent per sampling-cycle (and at the same relative time within

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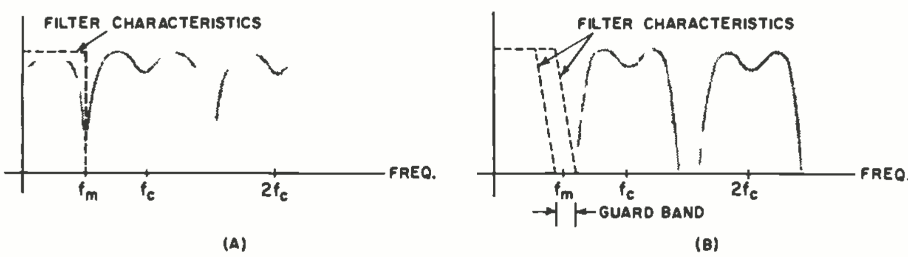


Fig. 5. Pulse spectra produced by sampling (A) at the Nyquist rate, where the chopper or sampling frequency (f_r) is made exactly equal to twice the rate of the number of measurements per second ($2f_m$), and (B) at a higher sampling rate. In (A), idealized filters of infinite cut-off characteristics are required, while (B) permits a more practical filter design whose cut-off characteristics fall within the guard band.

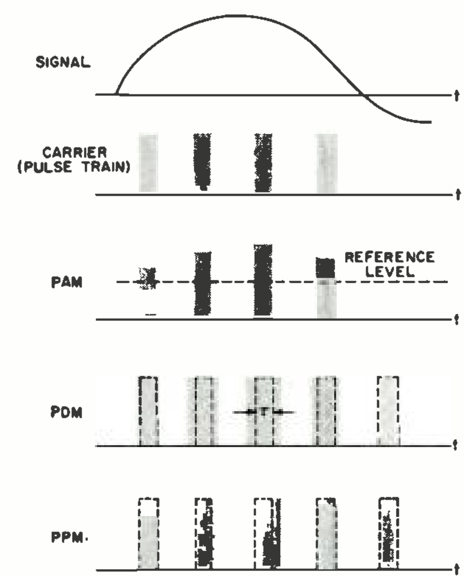
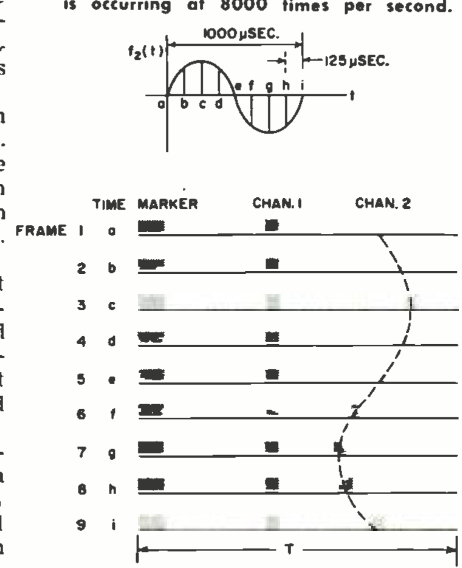


Fig. 6. Summary of pulse techniques.

Fig. 7. In this example a 1000-cps sine wave appears on Channel 2. The sampling is occurring at 8000 times per second.



SOLVING SQUARE-WAVE TEST PROBLEMS

By ROY HARTKOPF

The reasons for misleading results sometimes obtained in audio and video testing and how to avoid pitfalls at the source — plus a "foolproof" generator design.

EDITOR'S NOTE: *For performance checks of broadband amplifiers of all kinds and frequency ranges, square waves have proven themselves to be extremely useful. The technique has become highly popular with many people in recent years, but is firmly resisted by others. Pitfalls for the unwary, often inherent in the square-wave source, are the usual causes for unsatisfactory results. Thus the author, instead of repeating the often-done treatment of square-wave analysis, takes a fresh look at the waveforms themselves and discusses the design of a reliable generator.*

IN THAT primitive era of electronics before oscilloscopes and TV sets, the chief possessions of every good technician were, apart from his multimeter, accurate and reliable signal generators. With this equipment, when he had to, he could make checks of frequency, bandwidth, sensitivity, and distortion, even though this often involved him in a slow and painful process. With the advent of the oscilloscope and new techniques relating to it, it became possible to do many of the old jobs with greater accuracy and less time. However, the new methods brought new problems. The ones of concern here relate to the testing of amplifiers and other circuits with an oscilloscope and a square-wave generator.

On paper the testing procedure is quite simple. For an amplifier to pass a good quality square wave, it must have reasonably good response from about 1/10 to about 10 times the fundamental frequency of the square wave. When the bandwidth is much less than this, a distortion of the square wave becomes noticeable. Thus it would seem that all one needs to do is to feed square waves at various frequencies into the amplifier and note when and how the output becomes distorted. Textbooks show the "characteristic" traces with nicely drooping tops or prettily rounded curves, indicating fall-off at low and high frequencies respectively. In practice, one can get the most peculiar patterns even if the amplifier is satisfactory and sometimes a reasonable-looking square wave when it is not.

In order to understand why these things can happen, let us look at the basic waveforms shown in Fig. 1. Fig. 1A shows a triangular waveform; Fig. 1B shows a square waveform and Figs. 1C and 1D show pulses. Now in spite of the fact that these have different shapes, they are quite closely related to each other. If we look at the triangular waveform, we see that it rises at a steady rate from minimum to maximum and then falls at the same steady rate at which it rose. In other words, we can say it has a steady *slope* or *gradient*. If it were flattened out until it were horizontal, like a level highway, we could say the slope was zero; on the other hand, if it rose vertically we would say that the slope was infinitely great. If it rises at 45 degrees, as is shown in Fig. 1A, we call it a slope of 1, and the fall at 45 degrees a slope of minus 1.

Suppose we now plot a graph of the *slope* of this triangular wave. We find that the first half of the cycle, when it is rising at a slope of plus 1, will be represented by a horizontal line one unit above the horizontal axis. Then when the slope suddenly changes to minus 1 for the second half of the cycle, this will be represented by a sudden switch to a horizontal line one unit below the horizontal axis. In other words, the plot of the slope of the triangular waveform of Fig. 1A is the square waveform of Fig. 1B.

If, in turn, we try to plot the slope of the square waveform of Fig. 1B, we find that, for the first half of the cycle, there is zero slope as the line is horizontal.

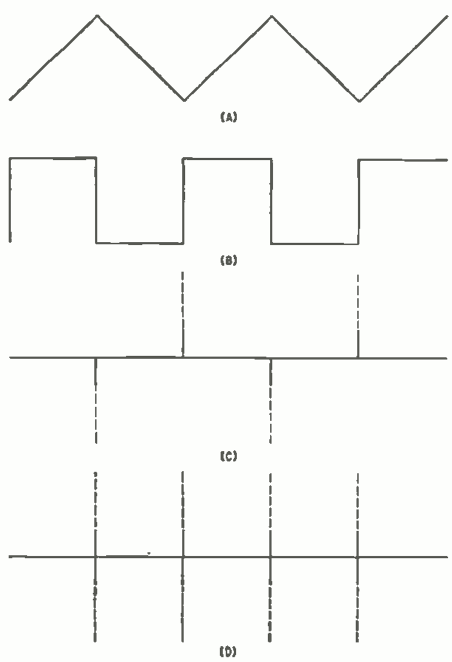
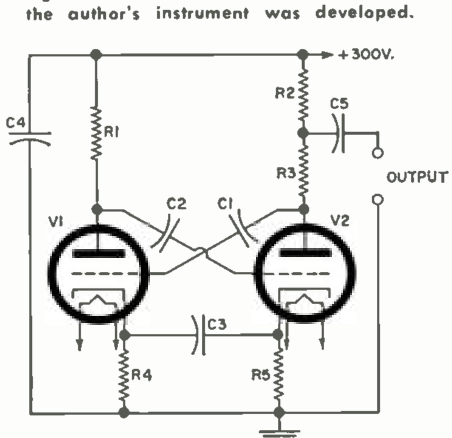


Fig. 1. These four waveforms are closely related, electrically and mathematically.

Fig. 2. Basic multivibrator from which the author's instrument was developed.



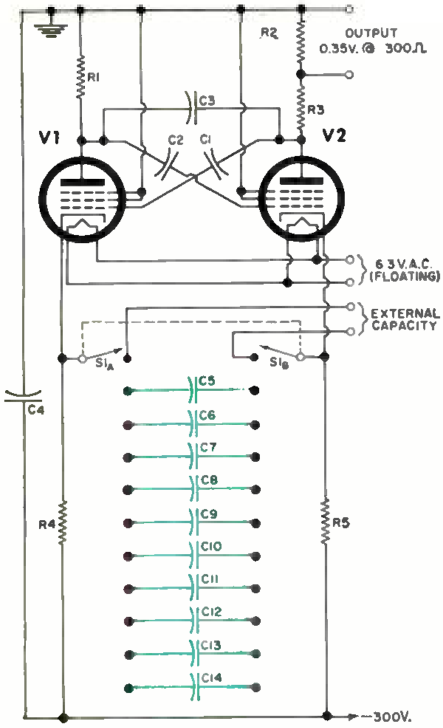
Then there is a vertical, infinitely steep slope downwards, followed by the second half of the cycle—again with no slope at all. Then a vertical, infinitely steep slope upwards, and so on. (We must be careful here to avoid getting confused between the infinitely steep *slope* of the square waveform and the *amount* by which it has dropped: in this case, two units.) The perfect square wave we have shown with a vertical, infinitely steep drop and rise would have to be represented by a series of negative and positive spikes stretching to infinity. The general appearance of this waveform is as is shown in Fig. 1C. The broken lines represent infinite amplitude.

Many readers will realize that we have been performing an operation known in mathematics as differentiation, the basis of the differential calculus. The other half of the calculus, the integral calculus, is basically differential calculus in reverse. The integral of the spiked waveform of Fig. 1C is the square waveform of Fig. 1B; and the integral of the square waveform of Fig. 1B is the triangular waveform of Fig. 1A. (It is worth noting that, if we differentiate the spiked waveform of Fig. 1C, we get another spiked waveform, with each spike stretching to infinity in both the negative and the positive directions, as in Fig. 1D. After this, any further differentiation gives exactly this same waveform over and over again.)

Instead of doing integration and differentiation by mathematics or by plotting, we can do it electrically by means of the simple networks shown in Fig. 4A and B. The explanation of how this happens is as simple as the networks themselves. If we apply a sudden increase of voltage (*i.e.*, the leading edge of a square wave) to the input of Fig. 4A, we can see that, to charge C_1 to the new voltage, a current, gradually decreasing, must flow through R_1. This current will cause a decreasing voltage drop across the resistor so that, as long as C_1 is being charged, there will be a steadily rising voltage across the latter. Thus the square-wave input will be integrated into the triangular type of waveform of Fig. 1A.

If the input voltage does not drop again quickly enough, the output voltage will eventually flatten out to a constant value equal to that across the input. Thus it is necessary that an effective integrating circuit should have a very long time constant compared to the input frequency it is handling, otherwise the integration will be only partial. Oscillograms of slightly, moderately, and almost completely integrated square waves are shown opposite the integrating network in Fig. 4A.

The differentiating network of Fig.



R_1—5000 ohm. ½ w. carbon res. ± 5%
R_2—300 ohm. ½ w. carbon res.
R_3—4700 ohm. ½ w. carbon res. ± 5%
R_4, R_5—100,000 ohm. ½ w. carbon res. ± 5%
C_1, C_2, C_4—.001 µf. ceramic capacitor
C_3—2.2 µµf. ceramic capacitor (see text)
C_5 thru C_{14}—See text
S_1—D.p. 11-pos. wafer switch
V_1, V_2—954 acorn tube (see text)

Fig. 3. Final version features direct, low-Z output and overshoot suppression.

4B works in the opposite way. Here the sharp voltage rise across the resistor caused by the leading edge of the square wave appears immediately across the output, then tapers off. But if the time constant of C_2 and R_2 is very *small* compared to the frequency of the input waveform, capacitor C_2 will discharge very quickly and the voltage across R_2 will rapidly drop back to zero. Thus the square wave will have been differentiated into the spiked waveform of Fig. 1C. Again examples of slight, moderate, and almost complete differentiation of a square wave are shown in Fig. 4B.

It should be noted that similar circuits can be made up using resistance and inductance instead of resistance and capacitance. Since all circuits are made up of some resistance, capacitance, and inductance, it is rather surprising that any square waves ever manage to get through without being distorted out of all recognition. Often, of course, they are distorted; and this brings us back to where we came in—the problems associated with the testing of amplifiers by passing square waves through them.

It may seem obvious and unnecessary to say that the first essential requirement is to make certain that true square waves, free from rounding or overshoot, *are* in fact being fed into the equipment under test. In practice, however, this apparently simple and obvious requirement is very often overlooked.

Fig. 5A shows a circuit arrangement that is used in the output of some square-wave generators and even more commonly in the input, coupling, and output stages of amplifiers. After getting past any stray capacitance (C_1) associated with the input and/or the source, the signal passes through blocking capacitor C_2 into R_1. The required amount is tapped off by the slider of R_1 and, after getting past stray capacitance C_3, the unfortunate signal—or what is left of it—probably has to go through a similar process in the *next* stage of the amplifier.

In the circuit of Fig. 5A, we see first that C_1 will tend to filter out high frequencies. Then we notice that C_2 and R_1 form a differentiating network (as in Fig. 4B) which is modified by C_3.

If the slider of R_1 is set part of the way down, the resistance of the top part of R_1 and stray capacitance C_3 form an integrating circuit (as in Fig. 4A), with the bottom part of R_1 in parallel with C_3, just to create further confusion! Finally when the slider of R_1 is nearly at the bottom and C_3 is shunted by a very low resistance, the differentiating effect takes over again. It is caused by stray capacitance C_1, but the effect is complicated by the top half of R_1 being in parallel with it. The net result is that we get a differentiated spike imposed on the top of a fairly normal square wave.

The oscillograms of Fig. 5B show some of the "57 varieties" of waveforms we can get out of the circuit of Fig. 5A at different settings of R_1 and at different frequencies. Don't imagine, of course, that every network of this type will have such disastrous results. The network used to produce the oscillograms of Fig. 5B had component values designed to produce a distorted output rather than to minimize it. The blocking capacitor—in order to produce a marked differentiating effect—was cut to .001 µf. when it normally should be about 1 µf. Potentiometer R_1 was 1 megohm when a more suitable value for high frequencies would have been a few hundred ohms; and stray capacitance C_3 was lifted to .001 µf. That is quite

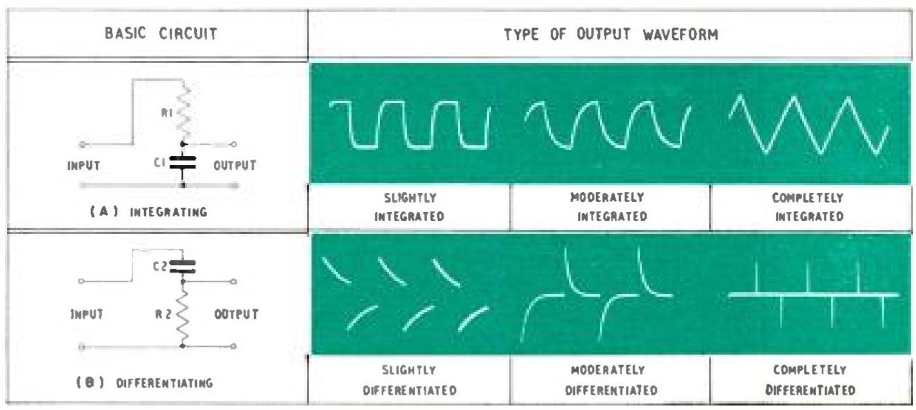


Fig. 4. Degrees of distortion produced by integrating and differentiating networks.

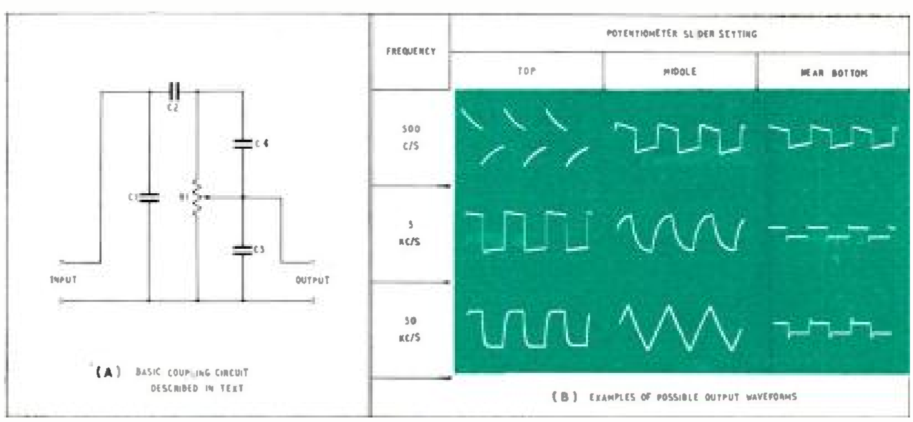
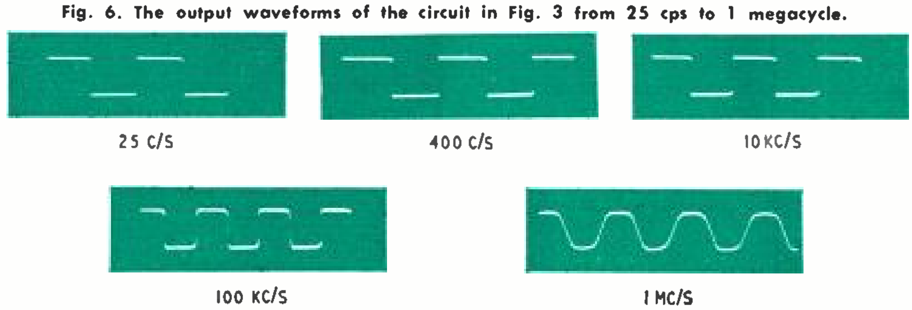


Fig. 5. Customary generator output circuit (A) and the possible "square" waveform outputs that may result at various combinations of gain setting and frequency.

Fig. 6. The output waveforms of the circuit in Fig. 3 from 25 cps to 1 megacycle.



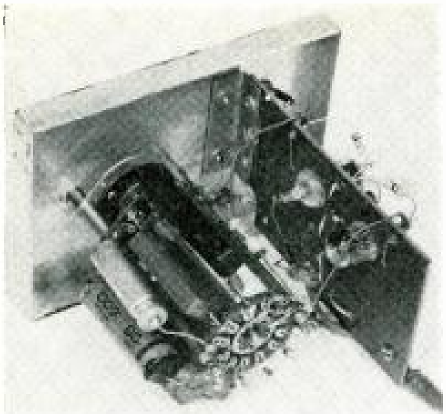


Fig. 7. Note back-to-back mounting of acorn tubes to minimize wire capacitance.

a bit of "stray" capacitance indeed!

Nevertheless it is a very wise precaution, when using a square-wave generator with a variable output, to try it direct on the oscilloscope first at various output levels over the full range of frequencies and loads that are likely to be used. If there is the slightest suspicion about the oscilloscope, check that too. One simple precaution is to see that a high-level output from the square-wave generator, attenuated by the oscilloscope control, gives exactly the same waveform as a medium- and low-level output with little or no attenuation at the oscilloscope. The latter instrument, of course, must be reliable.

In any normal set-up, there is bound to be some departure from an absolutely perfect shape. The main thing is to be able to recognize the type of distortion, and have some idea of its severity and its possible causes. For this there is nothing like personal experience: a couple of hours spent experimenting with a simple network like the one in Fig. 5 will do more than weeks of theoretical study to show just what waveforms one can get and how they change from one type to another. This experience actually makes the subsequent reading of literature on the subject easier and more profitable. Considering the abundance of such literature on square-wave analysis and interpretation, the subject will not be treated here.

A Practical Generator

Square waves are usually generated either by amplifying and clipping sine waves or else by using some form of flip-flop or multivibrator circuit. The clipping method can produce excellent shape but is relatively difficult and expensive, particularly if a wide range of frequencies is to be covered. There are several types of multivibrator circuit, but one of the best and simplest is shown in Fig. 2. (Except for C_3 and C_5, part numbers correspond to Fig. 3.) This has a fast rise time and stable output, both practically independent of frequency, and it can be made to operate from a few cycles per second to over 1 mc. (actually to about 5 mc.) merely by altering the value of the cathode coupling capacitor.

To understand how the circuit works, let us assume that V_1 of Fig. 2 is just beginning to conduct. As current starts to flow through V_1, a voltage drop appears across both plate resistor R_1 and cathode resistor R_1. This causes the plate voltage to drop, and the drop is transferred through C_2 to the grid of V_2, driving the latter negative. At the same time, the voltage rise at the cathode is transferred through cathode coupling capacitor C_3 to the cathode of V_2, driving the latter positive. Thus V_2 is completely cut off. The voltage at the plate of V_2 rises, and this rise is transferred through C_1 to the grid of V_1,

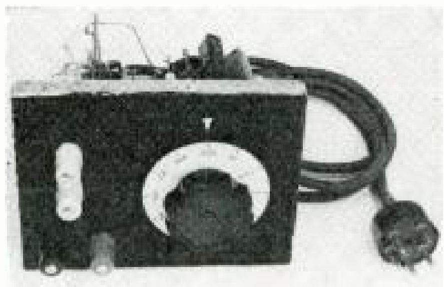


Fig. 8. Author's compact version has a power plug for an external supply.

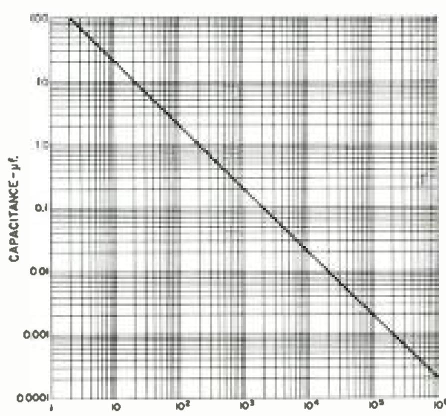
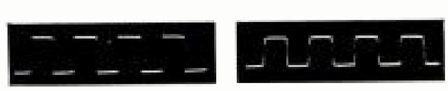


Fig. 9. Chart shows capacitor values for desired square-wave frequencies.



LOADED WITH 500Ω   LOADED WITH .005µF.

Fig. 10. Abnormal loading of generator leaves a 10-kc. square wave unchanged.

making the latter fully conducting.

Nothing further happens until the discharging of cathode coupling capacitor C_3 has reduced the voltage at the cathode of V_2 sufficiently for that tube to begin to conduct again. Then the whole procedure mentioned above happens in reverse, with V_2 conducting and V_1 cut off. The rate at which these change-overs take place depends on the time constants of R_1 and C_3, and R_5 and C_6. (This, incidentally, creates another possible use for the circuit. If one cathode resistor is made small compared to the other, a pulse type of output can be obtained.)

The circuit of Fig. 2 has two fairly important shortcomings. One is that the negative half of the square wave has a tilt due to the changing rate of flow of current as cathode coupling capacitor C_3 discharges. This tilt can be about 5 per-cent. The other and more serious shortcoming is the marked degree of overshoot generated. Overshoot is perhaps one of the worst faults a square-wave generator can have. A square wave with a marked overshoot has little in common, either in frequency or amplitude, with the signal that is supposed to be there. At low frequencies, because of the fast rise time, the overshoot is often not visible on the oscilloscope, but its presence can cause a perfectly good amplifier to exhibit all kinds of unusual and misleading symptoms. And, of course, if the amplifier itself is developing overshoot, it is impossible to detect it. A reliable square-wave generator should be completely free from overshoot—even at the expense of tolerating some rounding of the corners.

The schematic of the square-wave generator developed by the author is shown in Fig. 3. The most noticeable difference between this circuit and that of Fig. 2 is that pentodes are used instead of triodes. The immediate result of this change is an almost complete removal of the tilt in the negative half of the waveform. A pentode is a constant-current device and, since there is a clamping action between the grid and cathode of each tube (although they are not actually connected), the discharge of the cathode coupling capacitor leaves the current through the pentode largely unaffected.

Another virtue of the pentode is the reduced interelectrode capacitance between cathode and plate. At each change-over, the cathode of each tube carries a pulse of about 15 volts with a rise time of about .1 microsecond or less. It takes very little stray capacitance indeed for part of this voltage to be transferred to the plate where, it must be remembered, the voltage change is very small anyway, the plate resistor being only 5000 ohms while the cathode resistor is 100,000 ohms.

But when the pentode circuit was originally wired and tested, it was found that a small amount of overshoot still appeared on the negative peak of the waveform. This was finally found to be due to a cathode peaking effect caused by stray capacitance from the cathodes to ground. It was mainly in the wafer switch used to select the various cathode coupling capacitors.

This effect can best be described by considering the tube as a generator with the cathode and plate resistors in series, but with the cathode resistor having a small capacitance across it. We then get something similar to the potentiometer set-up in Fig. 5 when the slider is near the bottom.

The most effective way of removing this slight overshoot is to connect a very small capacitor, 2.2 µµf. (C_3 in Fig. 3), across from one plate to the other. Small as it is, this causes rounding of the waveform at megacycle frequencies; but, as can be seen from Fig.

(*Continued on page 85*)

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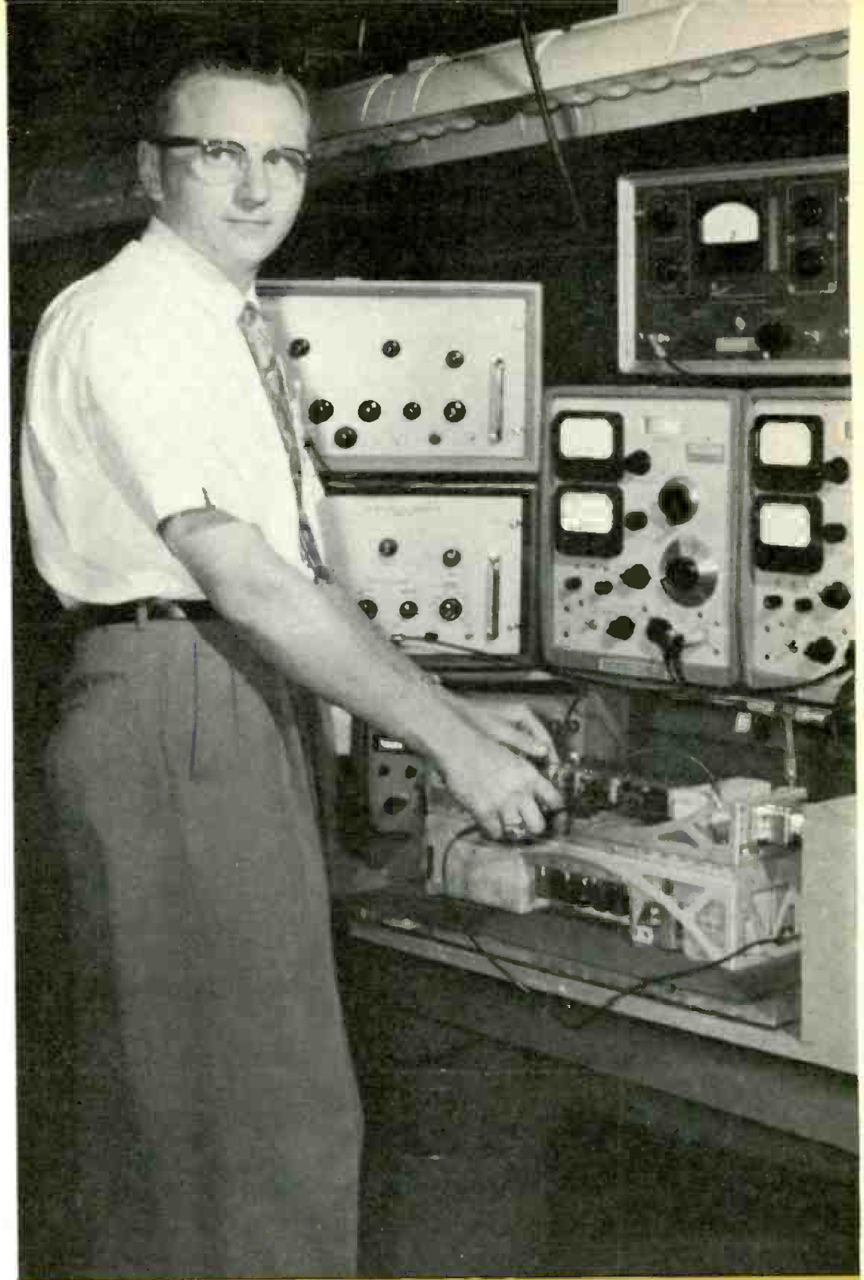

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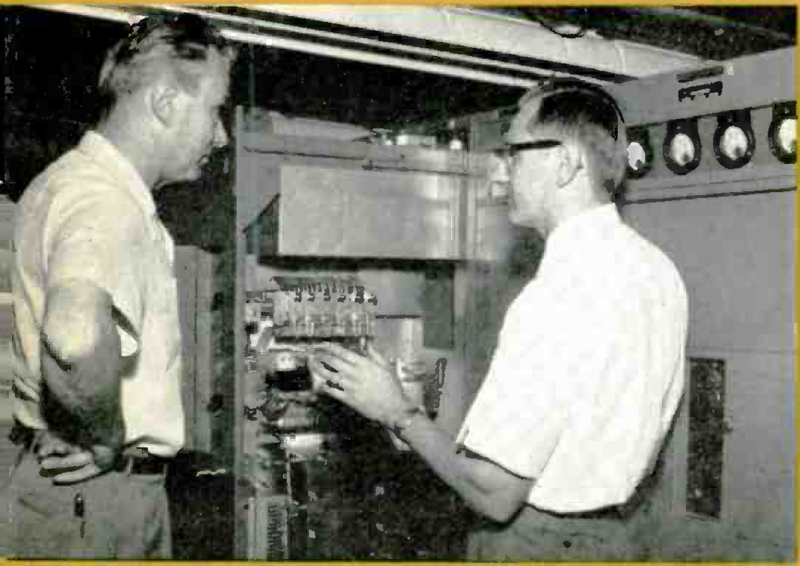

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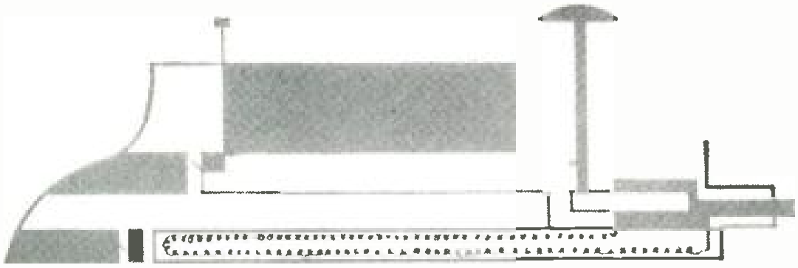


AUTOMATIC STEAM IRONS

By **DAVID R. ANDERSON**

Relative simplicity of these appliances and the potential of extra profit justify the side line.

AN IMPRESSIVELY large number of small appliances, electric but non-electronic, are sold in this country every year, and they are in regular use. Eventually they break down and must be serviced. Even where the radio and TV technician does not solicit such business, he is likely to have it offered to him. The service installations devoted exclusively to this type of work are scattered. Aside from manufacturer service or the repair operation of a department store, there are not many places the appliance owner can go to. To the user, the TV repair shop seems like a logical place.

The pros and cons concerning this type of auxiliary business, which are many, have been discussed before. (See the author's "Small Appliance Service: Toasters," page 70, in our issue for May 1961.) Each shop owner must decide for himself whether this modest type of diversification will benefit him. For those who are interested but have done nothing about it until now: the repair of steam irons, as is the case with many small appliances, is not particularly difficult. Furthermore, many thousands are sold each year. Most need service sooner or later.

Principles of Operation

Despite the many makes and models, all operate on the same general principles. The heating element, which has its temperature controlled by a thermostat, heats the sole plate (the bottom, metallic surface that comes into contact with the material being ironed) and water stored in the iron is also heated to produce steam. As steam is formed, it builds up pressure, which then forces the steam out through holes in the sole plate. A control is provided that allows steam to be turned on or off, as desired.

There is a choice of several, specific methods for producing the steam, but two of them account for the great majority of automatic steam irons in use. One of these popular methods involves the use of a boiler, as shown in Fig. 1. Here the water tank is placed directly over the heating element. The heating water is evaporated to form steam and build up pressure. The pressure forces the steam out through the indicated holes. Irons using this method can be recognized quickly by the fact that steam production does not occur as soon as the sole plate comes up to operating heat. The water must also become hot enough to produce steam.

The other method is to mount the water tank away from the heating element, usually well above it. Water is then slowly fed to the steam chamber below (Fig. 2) through a small opening, usually a drop at a time. As each drop strikes the sole plate, which is usually part of the steam chamber, it is vaporized immediately and forced out through the holes in the sole plate. This is the steam-generator type of iron. With this method, steam production begins as soon as the sole plate is hot enough for ironing. In such a design, the steam control permits the user to choose dry ironing without emptying the water tank, simply by turning off the flow of water to the steam chamber.

The electrical system of any steam iron is quite simple, and will not depend much on differences in steam generation. A typical arrangement is shown in Fig. 3. The thermostat cycles on and off to keep sole-plate temperature fairly constant at a pre-selected level. Although specific thermostats may vary with make and model, very few work on any principle other than that of the bimetal strip. Connected in series with the heating element, the thermostat is also positioned close enough to sense the heat from this element.

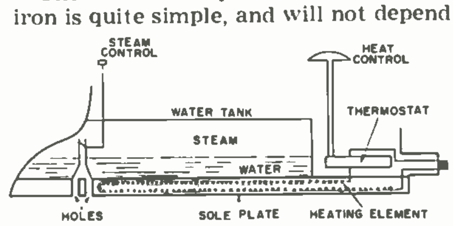
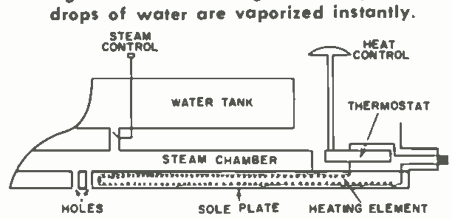


Fig. 1. How the boiler-type steam iron works. The diagram has been simplified.

Fig. 2. In the steam-generator system, drops of water are vaporized instantly.



Because the strip is made of two dissimilar metals that have different rates of expansion and contraction when they are heated or cooled, it bends as it gets hot, causing the contacts, initially closed, to open at a pre-set temperature. This cuts off current to the heating element, which begins to cool. The bi-metal strip also cools, until it bends back to close the contacts and start the cycle of operation all over again.

The operating temperature may be controlled by adjusting the thermostatic gap. The control with which this is accomplished, made externally available to the user, is conventionally marked with the types of material that should be ironed at the various settings rather than directly in temperature. However, actual temperature is of interest when an iron is checked for proper operation. It is useful to know, then, that the high setting (for linen) is in the vicinity of 500° F, whereas the low (rayon) setting will probably be 275° F or somewhat lower.

Equipment Requirements

In addition to what is doubtless in the service shop already, a few items of auxiliary equipment will make working on irons easier, and they are both simple and inexpensive to assemble. For example, it is a good idea to put together an iron holder, like the one shown in Fig. 4. This will keep a disassembled iron in convenient order and facilitate checking. It will also prevent scratching of the smooth, bottom surface of the sole plate or other possible damage.

The materials for the holder can be three pieces of scrap wood and a soft cloth. The bottom piece, number 1, should be large enough to accommodate any iron and may be cut square. The cloth is stretched flat on top of it. In addition to being soft, the cloth should be fairly heavy—padding or several thicknesses may be used—and synthetic fabrics should be avoided as they do not tolerate as much heat as other types. An iron can be used as a template for determining the shape to which pieces 2 and 3 should be cut. These pieces are then fastened to the first piece with screws. If desired, the holder may be fastened to the work bench.

To use the holder, the iron is simply placed in the shaped opening and slid forward until it is held securely. Since the sole plate is the base on which most of the components are mounted, this arrangement is convenient for service once the cover has been removed.

Another useful device is a simple iron tester. The schematic for one appears in Fig. 5. Parts may be laid out in any way that is convenient. A block of wood is convenient for mounting. Such types as #41 or #43 should be suitable for the 2.5-volt lamp. Together with its resistive shunt, it will give useful indication without altering iron operation, because it will not alter voltage and current to the iron significantly.

A suitable value for the shunt will be less than one ohm—about a third of an ohm, in fact, for most irons—and it will have to pass a current of several amperes. It can best be made up from nichrome or other resistance-type wire. If a standard replacement heating element for use in electric heaters and hot plates, usually available at low cost in dime stores, is obtained, it can serve as the raw material. With total resistance (perhaps 25 ohms) known, short lengths of desired value can be measured off experimentally with an ordinary inch rule.

To handle the heavy current safely, it is better to use three somewhat longer strips connected in parallel across the 2.5-volt lamp. The long element provides surplus material for trimming and experimenting until the right value is achieved.

Another helpful accessory is a simple test-probe set made up of several feet of ordinary line cord, terminated in an a.c. plug at one end. The other end can simply be the exposed tips of the two wires in the cord or a pair of insulated prods with exposed tips can be used. Care should be taken to avoid shorting the tips or making contact with them in use, as full line voltage will appear across them if the switch at the 7.5-watt, 117-volt lamp should be closed. Remember that the switch will have to carry at least 10 amperes.

Basic Procedures

Actual troubleshooting of a steam iron is quite simple: taking the appliance apart to find the defect and putting it together again will account for most of the time involved. For disassembly and re-assembly, the manufacturer's instructions are most helpful. Since these are not generally at hand and since specific procedures vary from model to model, the technician will work on his own, more often than not. Fortunately, despite variations, he will seldom run into complications. The object is to get the upper, covering portion of the device out of the way to expose inner parts. Noting the position of each part as it is removed will ease the problem of getting the iron together later.

One of the most common checks on the iron's electrical system will be for shorted or open conditions. When checking for continuity, the tester's on-off switch is placed in the off position, putting the 7.5-watt lamp in the circuit; the iron is plugged into the tester's a.c. receptacle; and the appliance's heat control is turned on. The 7.5-watt lamp will light only if there is continuity.

To check for shorts or leakage, the tester switch is left in the off position, but the test probe is inserted in the receptacle. One lead or prod of this probe is touched to one prong of the iron's line-cord connector and the other lead is touched to the iron's body or other metallic parts, with the iron turned on.

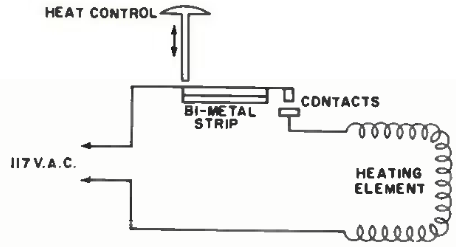


Fig. 3. In all types, the electrical system, as shown above, is quite simple.

Lighting of the lamp now indicates a short.

Operation of the thermostat can also be checked with the tester. This time the iron is plugged directly into the receptacle, but the on-off switch is closed to short out the 7.5-watt lamp. When the iron is cold, the thermostat contacts should normally be closed. If they are, the 2.5-volt pilot bulb will light. The iron is then allowed to heat up. If the thermostat is working, the bulb will extinguish when the proper temperature is reached, indicating that the thermostat contacts have opened.

Common Symptoms

Some of the usual complaints associated with the appliance are water leakage, failure to steam, inability to maintain proper temperature, sputtering, and staining of the materials being ironed. The first symptom is usually caused by a leaky steam control, but there is also the possibility of a leaky tank. Visual inspection should determine the cause quickly once the interior of the appliance is exposed to view. An improperly operating control may merely be due to deposited foreign matter, which can be cleaned away, rather than an actual defect.

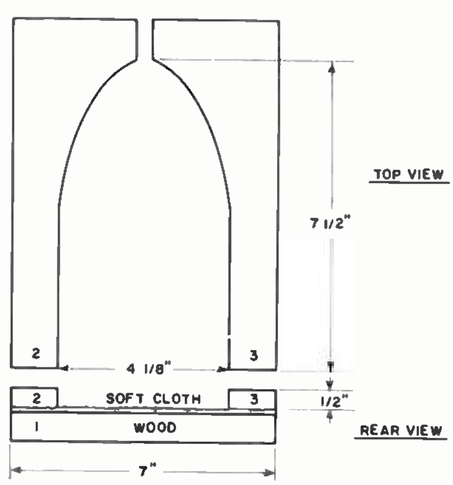
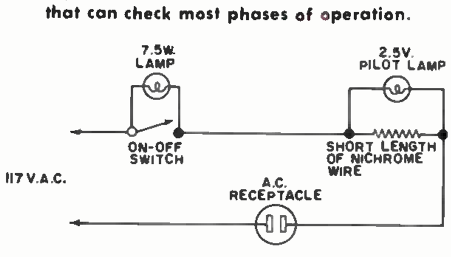


Fig. 4. An easily built holder cuts the inconvenience of disassembly and service.

Fig. 5. Circuit for a universal tester that can check most phases of operation.



Failure to steam most often results from either of two causes: the thermostat is out of calibration or the steam passages have become clogged. Commercial testers are available for checking the temperature about which the thermostat operates, but the technician may feel that the amount of iron repair he will handle does not justify an extra investment. A rough but adequate indication can be obtained with the tester of Fig. 5 and a thermometer having a temperature range between 250° F and 510° F. A common oven thermometer will do.

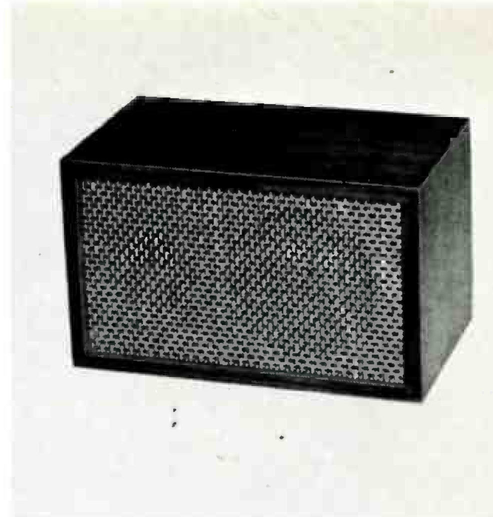
To check temperature at which the thermostat operates, the iron is plugged into the tester and the 7.5-watt bulb is shorted out. The thermometer is put in contact with the sole plate and the iron is allowed to heat up. When the 2.5-volt bulb extinguishes, the thermometer reading is noted, since this is the temperature at which the thermostat opens. It is also a good idea to take another reading when the lamp goes on again, to make sure that there is not an excessive temperature drop before the thermostat closes again. If operating temperature is incorrect, there is usually an adjustment available to correct this. Once more, although the manufacturer's service data is the best guide, it should not be difficult to find and re-set the adjustment without help.

If failure to steam is the result of clogging in the steam passages, the iron has probably been used with tap water for some time, instead of the recommended distilled water. The impurities in tap water eventually build up a deposit in the narrow passages. Often these passages can be cleared with a narrow, sharply pointed tool; in other cases the damaged part must be replaced.

Inability to maintain proper temperature or sputtering are both due, as a rule, to improper calibration of the thermostat. The check procedure for these symptoms, involving the tester and a thermometer, have already been described.

Staining of materials is caused by impurities that have accumulated in the water tank and steam passages and which are expelled with the steam during use. Cleaning out deposits and flushing the iron should eliminate this complaint. One way to flush the iron is to open the steam control valve and fill the iron with water while it is cold, flooding all steam passages. The iron is then turned on and set to generate steam. As steam is forced out under pressure, it will carry out impurities with it. Inexpensive chemical compounds are available in many groceries and supermarkets for addition to the water to promote this cleaning action while flushing. These are of some help. The water used, of course, should be distilled.

All in all, service requirements for steam irons should not prove difficult for a technician who can successfully handle such a complex device as a TV receiver. The extra profit this side line can provide ought to make a worthwhile difference to all but the most successful shops, and the customer good will can be of help to any shop. ▲



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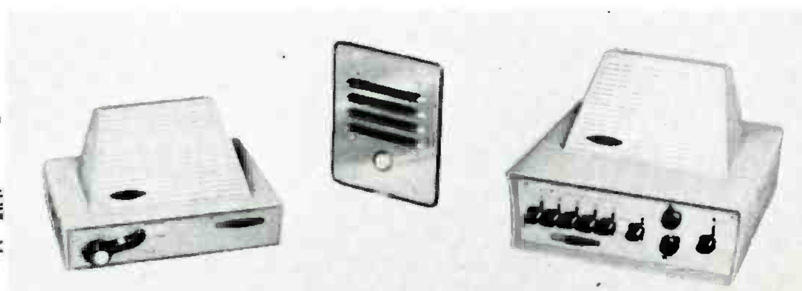

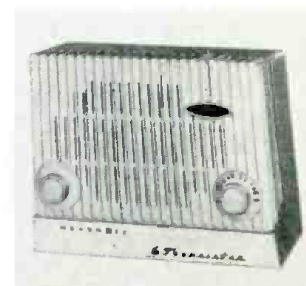

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CALENDAR of EVENTS

JANUARY 23-27
Third Annual ERA Convention & Management Conference. Sponsored by Electronic Representatives Assn., Hollywood Beach Hotel, Hollywood Beach, Fla. Details from ERA headquarters, 600 S. Michigan Ave., Chicago 5, Ill.

FEBRUARY 7-9
1962 National Winter Convention on Military Electronics. Sponsored by PGMIL and L.A. Section of IRE. Ambassador Hotel, Los Angeles. Details from IRE Los Angeles Office, 1435 S. La Cienega Blvd., L.A., Calif.

FEBRUARY 9-11
Pacific Electronic Trade Show. Shrine Exposition Hall, Los Angeles. Information on exhibits and program available from PETS, 2216 S. Hill St., Los Angeles 7, Calif.

FEBRUARY 14
Color TV Seminar. Sponsored by Precision Apparatus Co., Inc., General Electric Co. and Voorhees Technical Institute. Meeting at Voorhees Technical Institute, 67th St. at Second Avenue, New York City, 7:30 p.m. Details from Precision Apparatus, Inc., 70-31 84th St., Glendale, N.Y.

FEBRUARY 14-16
International Solid-State Circuits Conference. Sponsored by IRE, AIEE, and University of Pennsylvania. Campus of the University of Pennsylvania and Sheraton Hotel, Philadelphia. Details available from the IRE, 1 East 79th St., New York 21.

FEBRUARY 27-MARCH 1
Symposium on Application of Switching Theory in Space Technology. Sponsored by Lockheed Aircraft Corp. and AFOSR/General Physics Div. Contact Dr. J. P. Nach, c/o Lockheed, Sunnyvale, Calif. for details.

MARCH 1-2
Eighth Scintillation and Semiconductor Counter Symposium. Sponsored by PGNS, AIEE, AEC, NBS. Shoreham Hotel, Washington, D.C. Program information from Dr. George A. Morton, RCA Labs, Princeton, N.J.

MARCH 7-11
San Francisco Home and High Fidelity Show. Sponsored by Magnetic Recording Industry Assn. Cow Palace, San Francisco. Open to the public. Stereo FM multiplex broadcasting and receiving equipment will be featured.

MARCH 14-16
Twelfth Annual Conference on Instrumentation for the Iron & Steel Industry. Sponsored by Instrument Society of America. Hotel Roosevelt, Pittsburgh, Pa. Details from H. M. Gravatt, Allegheny Ludlum Steel Corp., Research Lab., Brackenridge, Pa.

MARCH 20-25
1962 Los Angeles High Fidelity Music Show. Sponsored by Institute of High Fidelity Manufacturers, Inc. The Ambassador Hotel, Los Angeles. Open to public March 21-25th.

CIRCUIT QUIZ

By JOE TERRA

THE circuit is perhaps the most important constituent part of any electronic device. Can you identify the following circuits? Match the types of circuits given in the first column with their respective descriptions given in the second column, then check your answers on page 98.

1. Bridge
2. Clamping
3. Decoupling
4. Differentiating
5. Equivalent
6. Grid
7. Ground-return
8. Hazeltine Neutrodyne
9. Integrating
10. Isochronous
11. Link
12. Push-pull
13. Reflex
14. Rejector
15. Scaling

A. Used in analyzing the function of electronic devices such as vacuum tubes and crystal cartridges.
B. RC circuit used to separate two functions or frequencies.
C. Two-tube amplifier circuit; grid and plate of one tube operates 180 degrees out-of-phase with the grid and plate of the other tube.
D. Parallel-resonant circuit which suppresses the frequency to which it is tuned.
E. Keeps either amplitude extreme of a waveform at a certain potential level.
F. Closed circuit containing one or more coils; used to couple radio-frequency circuits.
G. The input circuit of a vacuum tube.
H. Utilizes the earth as a conductive path.
I. Voltage amplitude at the output is proportional to the rate of change of voltage at the input.
J. Used to record pulses from Geiger tube when pulse frequency is extremely high.
K. Circuits operating at the same resonant frequency.
L. Mesh circuit consisting of a number of branches including one source of potential.
M. Early form of radio-frequency amplifier circuit.
N. Signal is amplified both before and after detection in the same amplifier tube or tubes.
O. Network of resistors and capacitors used to separate or bypass signals that would ordinarily flow in a common circuit.

FM-Multiplex Adapters

(Continued from page 38)

it is important that phase distortion be kept low and that the subcarrier be reinserted in exactly the right phase. Adapter manufacturers are aware of this requirement and everything is done to maintain proper phase relations. If there is phase error, separation suffers and there may even be a complete interchange of signals in the two channels, with the left signal coming out of the right speaker, and *vice versa*.

Another problem is that of noise and interference. Because of the added information that is transmitted when a station is broadcasting stereo, there is a loss of signal-to-noise ratio compared to monophonic reception. Hence, everything must be done to keep signal strength high. This means that the user may have to switch to an outdoor or more highly directional antenna, and that a little more care will have to be exercised in tuning. A tuning indicator will be helpful here.

Noise may also come in along with the 19-kc. pilot signal and appear as amplitude modulation of the 38-kc. subcarrier. The detectors in the adapter have no way of knowing whether this is "signal" or "noise," hence noise may appear in the output. Some adapters have built-in noise filters that may be switched in if they are needed. Also, because of the possibility of noise in the stereo circuits, these are usually bypassed completely, either automatically or manually, when a mono signal is being received. Interference from the SCA storecasting channel, if used, may also be a problem. Proper detector design and the use of trap circuits will eliminate this source of interference. These same techniques will also prevent interfering beat notes between harmonics of the subcarrier frequency and bias oscillators in tape recorders that may be used to record FM stereo programs.

One question may arise as to how the listener will know when an FM station is broadcasting stereo. The obvious way is to hear the stereo effect and note the characteristic spread of sound. To make it a little easier for the user to know when a stereo program is on, some of the adapters have a stereo indicator. This is usually a lamp that lights whenever the 19-kc. pilot signal is being detected, thus indicating the presence of a stereo signal.

All the problems just mentioned are minor and they can be solved by good adapter design and a proper FM receiving installation. The money that the user spends for his stereo adapter will buy him a good many hours of enjoyable stereo listening—and all with "broadcast quality." ▲

Tunnel Diode Bias Supplies

(Continued from page 45)

filament transformer is employed and the a.c. supply is rectified by silicon diode CR_1. A ripple filter circuit R_1, C_1, and C_2 follows the rectified output. The output is then stabilized by the forward-biased diode CR_2 connected to the power supply output through resistor R_2. A low-resistive voltage divider R_3 and R_4 for diode biasing is connected across the stabilizing diode. Additional filtering is provided by capacitor C_3. Bias voltage across the tunnel diode CR_3 may be varied from 40 mv. to 600 mv. by variable control R_3 and output voltage across the stabilizing diode remained constant when operating the tunnel diode throughout its negative-resistance region.

Another a.c. bias supply set-up used by the author is shown in Fig. 5. The a.c. supply is again furnished by a 6-volt filament transformer. After rectification and filtering, the output at the filter network is stabilized by zener diode CR_2. The zener diode will also help to reduce the ripple component. Bias is obtained across the 22-ohm resistor R_2. It is adjustable from 30 mv. to 500 mv. by R_1. An added feature of this supply is the variable control R_3. This provides a separately controlled d.c. source for transistors or other solid-state devices to be used in conjunction with the tunnel-diode circuitry. With the 1N2941 biased at 150 mv., output available from control R_3 can be varied from 2.5 volts to 3.9 volts.

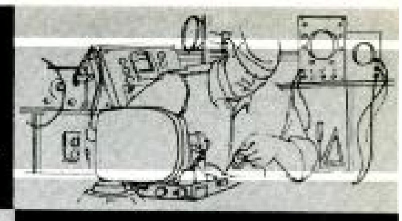
The technician, when working with tunnel diodes, should take the usual precautions recommended for other diodes and transistors—such as observing maximum ratings and dissipating heat when applying the soldering iron to its leads if a socket is not used. Since results will vary with different type diodes, the manufacturer's specifications concerning V_p, V_v, I_p, and I_v values should be checked. ▲

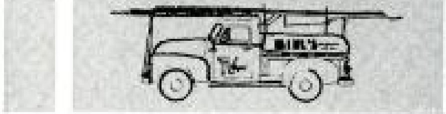
SYLVANIA CRT IMPROVEMENT

A new soldering technique for the base pins of TV picture tubes, now in use by Sylvania Electric Products Inc., has been adopted to counteract a long-standing service problem. The strain produced by the rocking and twisting needed to remove or replace CRT socket connectors often results in cracked tube bases or defective connections between tube base pins and internal leads. When this occurs, set owner and technician must choose between scrapping an otherwise operative, expensive component and attempting a delicate repair.

With the "tip-to-top" technique, solder is extended well into the core of the base pins, almost filling these cavities. Conventionally, a small amount of solder is used to anchor the leads. The added solder provides maximum contact between the pin and the internal wire, reduces electrical resistance, and improves mechanical strength. The chance of a defective base or pin is reduced drastically. ▲

SERVICE INDUSTRY NEWS





THE Indiana Electronic Service Association, one of many in the country that has spent several years actively trying to "do something" about service licensing under the law, is now trying to "do something else." In the absence of the governmental regulation it has sought and continues to seek, IESA is issuing its own license certificates to qualified members. Although its announcement in the "Hoosier Test Probe" reads, "Radio-TV Service Licensing Now a Reality," the program is effectively similar to the certification systems tried by other groups.

Since there is nothing mandatory about the plan, IESA is trying to promote the license idea with the public. Releases are going out to newspapers in all areas throughout the state where local affiliates are active. Members are being asked to display their license certificates prominently, to refer to them in advertising, and to talk them up with their customers.

The new plan does not mean the Hoosier group has given up on legislation. On the contrary, there appears to be some hope that, if public acceptance of the alternate plan can be promoted, the climate for legal regulation will be improved. The license steering committee of the state group is keeping itself very busy with the matter of pushing its goal with the new session of the state legislature.

Attacking the problem from as many angles as possible, the Hoosiers are also supporting a local licensing ordinance for South Bend, introduced in the South Bend Common Council by a local councilman. The proposal took the immediately affected IESA affiliate, ARTS of St. Joseph Valley, by surprise, since it was not made with their prior knowledge. However, it may properly be called the fruit of their own efforts. The ordinance is similar to one that ARTS had supported over a year ago. The St. Joseph Valley local had only recently affiliated with IESA.

CRT Laws Disillusioning

Far more successful in getting legislative support than proponents of licensing, the sponsors of bills requiring identification of picture-tube condition at the time of sale have met with success in at least three states over a relatively short span of time. The nature of these sponsors is doubtless a factor: they are the glass manufacturers who produce the shells for CRT's. Since the bills require that tubes using all new or old glass be differentiated clearly to the buyer, as new or rebuilt, the glass industry is a principal beneficiary. Service associations, however, have generally supported passage of such legislation.

Where the laws already exist, service people have hegun to express doubts about them. Irving Toner, NATESA's eastern vice-president and long active in New York State service groups, indicates the industry in his state does not feel that the law has proven very effective. This conclusion is based on early returns of a survey co-sponsored by the *Kimball Glass Co.*

Going into more detail on this matter is an editorial in "Springfield TESA News." Ohio, like New York and Pennsylvania, has a CRT law. The editorial points out the fact that most picture tubes offered for replacement sale, regardless of brand or quality, use old glass. Under the law, many a high-priced, top-quality CRT line is indiscriminately labeled as "rebuilt" along with low-priced products of inferior quality. Beneficiaries of this situation are the low-quality rebuilders. These people, reports the editor, "are putting this law to their advantage, since they can truthfully assure their customers that practically all replacement CRT's are rebuilts. They tactfully avoid any reference to quality, while concentrating on the low price as a sales gimmick."

The Springfield writer considers the situation acute. The real question in his mind, evaded by the law, is the quality of the rebuilt tube.

Incidentally "Springfield TESA News" is being discontinued in favor of a new monthly by the state group, TESA of Ohio, which will cover local affiliates.

NATESA Administrative Matters

Incumbent NATESA President Ralph Woertendyke may have sounded the keynote he plans for his term of office in a recent issue of "NATESA Scope." Finding no fault with existing programs and policies, he intends no great revisions in that area. He is turning his attention to the improvement of organizational and administrative functioning. Eschewing the word "reform," he states, "Our organizational set-up is a well-thought-out, well-executed chain. Certainly it contains all the essentials for a smooth-running, efficient organization."

He sees opportunities for improvement and strengthening, however, in two areas. In the interests of increased grass-roots understanding and participation, he urges all affiliates to devote time to explaining the machinery of internal organization. On this point, he says, "I have been amazed at the number of NATESA members who are only vaguely familiar with such terms as 'Director,' 'Zone Governor,' and even 'Divisional Vice-President.' Only by understanding of internal organization can the absolute democracy of this NATESA machinery be realized and appreciated."

He also seeks a thorough-going review of the constitution and by-laws. "Through many re-writings through the years, some very important items have been accidentally omitted. Also, many NATESA members have expressed a sincere desire for clarification on many vital items. Certainly, one of the most important of these is a clear-cut statement of the duties of the officers and executive council." Work on the latter project is already under way, with the hope that suggested amendments based on findings of the responsible committee will be available for discussion to affiliates well in advance of the directors' meeting this spring.

NCFEA Executive Secretary

The North Carolina Federation of Electronic Associations has taken action on the proposal to advance its aims by establishing the part-time paid office of executive secretary. (For the background on this situation, see this column in our December 1961 issue, page 93.) Duties include editing and handling all detail work pertaining to the NCFEA monthly, "The Printed Circuit," taking care of correspondence and other regular office work such as origination of vouchers, authorization to sign checks (with either the president or treasurer), otherwise conducting the business of the organization under the general direction of the president and directors, and maintenance of an office for the federation. Also important is the availability of this officer for handling immediate problems of member groups and individuals, particularly with respect to the formation of new affiliates.

Jim Hornady, already editor of "The Printed Circuit," is first to hold the new position. He has established liaison with people in two areas, Roxboro and Burlington, who want to form new locals, and is soliciting contact with others of like mind. His first report contains some sound, practical advice on the mechanics of setting up the framework for a new group.

Successful Phone-Book Ads

The San Francisco TV Service Association reports marked success with its version of advertising in the yellow pages of the phone directory. Instead of listing individual members, this group runs a single ad on its own behalf assuring quality service. Incoming calls are referred to the member who is nearest to the caller. As many as eleven calls in a single day are handled on this basis. Members benefit and the association image is enhanced. ▲

INVITATION TO AUTHORS

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

A Miniature Oscilloscope

(Continued from page 41)

for focus. Vertical and horizontal positioning is fixed, centering being established by the values of R_{33}-R_{35} and R_{28}-R_{29} respectively. Normally the CRT is constructed symmetrically enough so that, if balanced voltage is applied to the deflection plates, the trace will be centered. If values of the resistors mentioned are adjusted to accomplish this, where necessary, controls can be eliminated.

Power for the high-voltage oscillator and the CRT filament is obtained by four flashlight cells in series, B_2. The other circuits draw on a small, 45-volt battery, B_1. Both sources are switched on and off simultaneously by S_1, a d.p.s.t. switch.

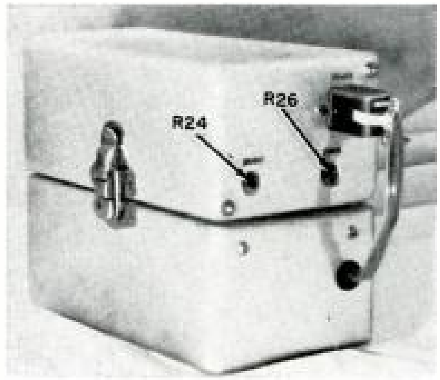


Fig. 6. Rear view of twin case assembly shows the intensity and focus controls.

Construction

Although it might appear a bit out of the ordinary, construction of the oscilloscope was chosen to accommodate standard components in small space. Most components and wiring were contained on two cloth-based phenolic boards, 1/16-inch thick, measuring 2½ by 3½ inches each. They are shown in Fig. 3 about three-quarters of life size, but drawn to scale. Hollow brass eyelets were used as tie points by the author. The horizontal and vertical channels were built on one chassis, with the high-voltage oscillator, divider, and positioning networks on the other. When mounted, the chassis boards are separated by an aluminum shield of the same size.

The case in which the scope is housed is simply an aluminum box measuring 2½ by 3½ by 6 inches, open at one end, with openings made at the rear (Fig. 6) for the brightness and focus controls and for mounting the power connector. Another case just like it is used to house the batteries.

The CRT bezel, horizontal coarse- and fine-frequency controls, vertical-input jack, and vertical-gain control (Fig. 1) are all mounted on the front panel, because these are the ones that will be most frequently used. The rear controls may be adjusted by shaft-extending plastic sleeves that protrude from the rear.

Once the chassis boards are wired, assembly is in the following order: front panel, horizontal-vertical chassis, shield, and high-voltage chassis, as shown in Fig. 2. The chassis and shield are held apart by aluminum spacers (the author cut sections of gas-burner pipe), through which four 6-inch lengths of threaded, aluminum welding rod are inserted. The straightforward arrangement in the battery case is shown in Fig. 8.

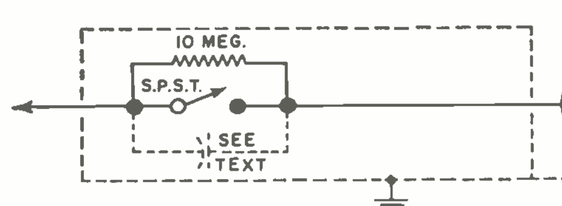
Since the instrument is very sensitive, the builder will probably want to construct an attenuator probe, as did the author. His, shown in Fig. 1 connected to the oscilloscope, includes a switch so that the probe may be used direct or with attenuation. In the latter position, of course, it increases input impedance of the instrument.

The probe circuit (Fig. 7) is quite simple. A resistor, bypassed with a small capacitor, is in series with the center conductor of about three feet of RG-59/U coaxial cable. About 10 megohms of resistance should be used for every 20 db (10 times) of desired attenuation. The capacitor is used for cable compensation. A small, variable unit may be used; the author employed a "gimmick" of five twists of #30 enamel wire. The probe housing should be metal for shielding.

Fig. 8. Battery layout in bottom case.

The compensating capacitor is adjusted, once the scope is operating, by applying a 1000-cps square wave through the probe and working for waveform edges that show neither peaking nor rounding. The degree of attenuation built into the probe is best determined with some experimentation based on the amplitude of waveforms that the user is likely to be investigating. ▲

Fig. 7. Attenuator probe should be shielded. A gimmick may be used as compensating capacitor.



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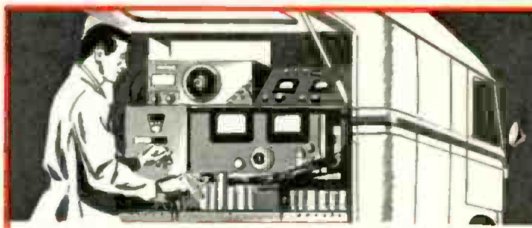

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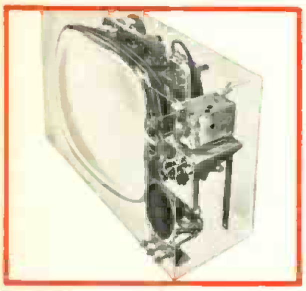

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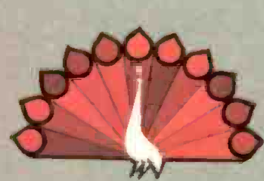

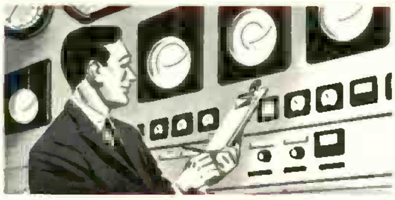

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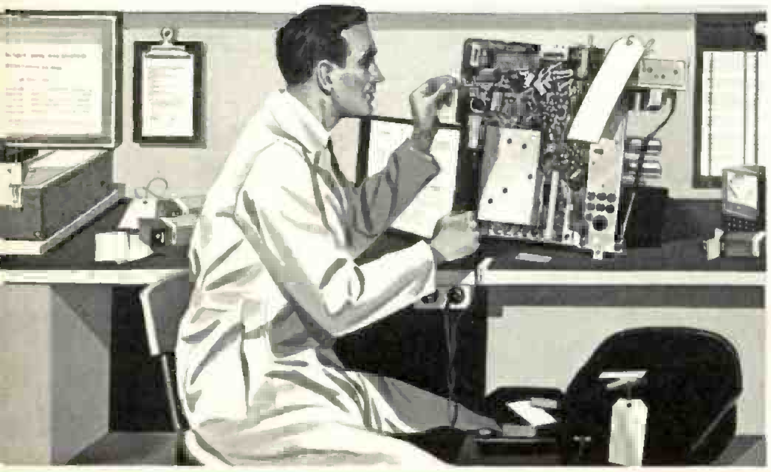

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I	Technical Writing (V-10)	High School Graduate	Day 9 mos. (L.A.) Eve. 2¼ yrs.(L.A.) 3 mos. (N.Y.)
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RCA The Most Trusted Name in Electronics

SOLID-STATE CROSSWORDS

By LUTHER A. GOTWALD, JR.

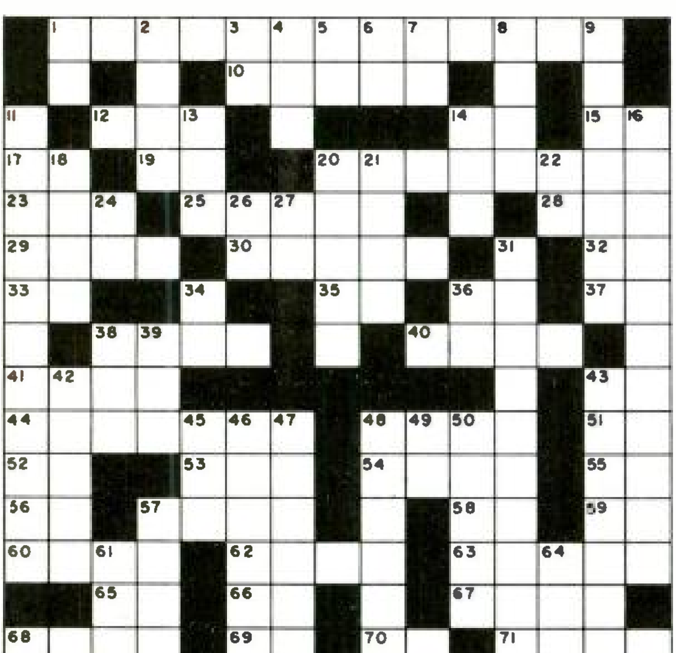
(*Answer on page 98*)

ACROSS

1. Basic solid-state material.
10. Deposit on anode (two words).
12. "Black ____."
14. Equals watts (formula).
15. In proximity to.
17. Radioactive element (abbr.).
19. Multiples of ten (suffix).
20. Construction method.
23. Legal representative (abbr.).
25. Sharp breakdown diode.
28. Corroded.
29. Minimum.
30. Classifies.
32. Conjunction.
33. A rare mineral (abbr.).
35. Opposite (abbr.).
36. Together (prefix).
37. Paper measure (abbr.).
38. Frequency meter.
40. Chemical generator.
41. Luminous body.
43. Signal voltage.
44. Four-element transistor.
48. Part of a building.
51. Weight measure (abbr.).
52. Metal used in relays (abbr.).
53. Contact point.
54. Soft mineral.
55. Output current.
56. Load resistance.
57. Arrange compactly.
58. Preposition denoting rate.
59. Custodian of funds (abbr.).
60. Lowered.
62. One-eighth ounce.
63. Units of e.m.f.
65. A constant.
66. Anode voltage.
67. Early canal.
68. Tetrode junction.
69. Type of switch (abbr.).
70. Good conductor (abbr.).
71. Active.

DOWN

1. Basic solid-state element (abbr.).
2. Argument.
3. Calcium (abbr.).
4. Unit.
5. Magnetic metal (abbr.).
6. Perform.
7. A negative prefix.
8. Muscle.
9. Atomic machine.
11. Two-junction devices.
13. Three axes.
14. State (abbr.).
16. Temperature-regulated resistors.
18. Small particle.
20. A remote control.
21. Skills.
22. Anode current (abbr.).
24. Score (abbr.).
26. Signal voltage.
27. Switch position.
31. Transistor "plates."
34. Used in diodes (abbr.).
36. Rare mineral (abbr.).
38. Rodent.
39. To sin.
42. American electrician.
43. Transistor "cathode."
45. Choose.
46. Rectifiers.
47. Involve.
48. Very minute.
49. Amplifying system (abbr.).
50. Serve.
57. Pass over.
61. Transistor sandwich.
64. To utter.



PIONEER WIRELESS STATION

By HOWARD S. PYLE

Description of Marconi Wireless' "high-power" Alaska radio station KPB, a radio giant of the year 1913, by an Old Timer who was one of the station's operators.

ALASKA! In earlier days what a name to conjure with—the mere pronouncement of the word was rhythmic! If you closed your eyes and said "Alaska," a mental picture immediately associated it with long, bitterly cold winters with but an hour or two of daylight; short summers with an almost never-ending brightness where it was actually possible to read a newspaper at midnight without the aid of artificial illumination. Truly, the "Land of the Midnight Sun."

It was in a setting such as this that the *Marconi Wireless Telegraph Company of America* chose to locate one of its then "high-powered" stations in 1913 after having earlier acquired all of the assets of the then-defunct *United Wireless Telegraph Company*.

At that time the only existing telegraphic communication between the United States and the some 5000 people who inhabited this vast northern Territory was by means of an underwater cable which was installed, owned, operated, and maintained by the U.S. Army Signal Corps through their agency known as Washington-Alaska Military Cable and Telegraph System (WAMCATS). The cable had been laid with great difficulty several years before and ran from Seattle, Washington to its northern terminus at Skagway, Alaska—headquarters of the Yukon gold rush of 1898. Cable "drops" were provided at Ketchikan, Juneau, Fort Wm. H. Seward, and a number of intermediate points.

Maintenance of such cable through the treacherous waters under which it ran proved as difficult as its initial installation. It was necessary to keep an Army cable ship available on immediate call, to pick up the cable and repair the frequent breaks. The cable was the life-line of the Territory—food, supplies, steamship and fisheries, business communications, personal messages as well as military traffic—all were dependent upon the WAMCATS cable. Let it be chronicled here that the Army accomplished a yeoman job in spite of the terrific handicaps and great cost of maintaining such communication.

The *Marconi Wireless Telegraph Company of America*, always alert to expand its rapidly growing system of world-wide communication wherever it appeared profitable to do so, saw opportunity here. Wireless required no cable, no wires, no interconnecting medium other than the ether which Nature supplied and maintained.

Alaska's population was rapidly increasing and the fisheries industry, with on-the-spot canning, was becoming "big business" calling for much communication between the various cannery superintendents in the far north and their home offices in Seattle, Portland, and San Francisco. Shipping interests as well, as the freight and tourist trade increased, were finding greater need for fast communication between the Territory and the world outside.

Antennas

Thus was KPB, the "high-power" station of *Marconi Wireless* born at Ketchikan, Alaska. Once the decision was made, it was not long before four graceful, self-supporting steel towers, each 300 feet high, were erected two miles north of the city of Ketchikan and on the shore of Revillagigedo Channel.

The towers were located at the four corners of a rectangle, 400 feet by 600 feet, with the long axis pointing directly toward Astoria, Oregon—some 600 air miles to the south. At Astoria, an identical station was being erected to provide the southern terminus of the link. Between the two northern and the two southern pair of towers, triatic stays were stretched to support a twenty-wire antenna. From the southern stays a "rattail" lead-in, also of twenty wires, led down to the corrugated steel transmitter building for the high-power equipment—the building being centered on the long axis of an extension between the towers, some 300 feet south of the southern pair. Atop each of the four towers, a 15-foot wooden topmast supported a single wire encircling all four towers and leading down to the operating building. This served the dual purpose of receiving antenna, as well as transmitting antenna for the 5-kw. marine transmitter used to communicate with ships.

Equipment Used

One of the two rooms in the small operating building, some 75 feet north of the transmitter house, accommodated the 5-kw., 240-cycle non-synchronous rotary-spark marine transmitter. In the other room were operating controls for both the marine transmitter and the 25-kw. "high-power" transmitter in the corrugated steel building.

Receiving equipment was also located in the control room and consisted of standard *Marconi* receivers of the loose-coupled type, using crystal detectors. Two separate tuners, one with a range of from 100 to 4000 meters and the other 100 to 7000 meters, were used with long-wave loading coils permitting tuning up to 18,000 meters. For crystal-type receivers (De Forest's "Audion" had not been widely accepted by commercial interests at this time), the Ketchikan receivers were remarkably efficient. The *Marconi* station in Honolulu was easily readable in the daytime and Bolinas, Cal. could be copied on a typewriter.

Perhaps greatest historical interest, however, centers in the high-powered, long-wave transmitting equipment used to work with the southern terminus of the circuit at Astoria, Oregon. Rated at 25 kilowatts, this was of the synchronous rotary-spark-gap type. Power at 2300-

volt, 60-cycle a.c. was supplied to the station from the city of Ketchikan and ran underground into the building from a terminal pole 300 feet away. It was then distributed through a switchboard to the various heating, lighting, and power transformers.

In the steel-and-concrete transmitter building, which was about thirty feet square, were located the high- and low-tension switchboards, a rotary converter which furnished direct current for operating keying relays—the shaft of the converter also serving to drive the three-foot disc of the rotating spark gap. Remote-control oil switches and all power transformers, the solenoid relay key, and miscellaneous equipment were arranged around the inner walls of the building. The center of the room was occupied by a huge bank of earthenware tanks, thirty in all, in which alternate glass and metal plates were immersed in transformer oil. Each tank was about 10" x 18" and stood approximately four feet high. Interconnections were made on top of the bank by heavy copper strap, the whole comprising the high-voltage secondary capacitor.

The oscillation transformer was of the spiral-wound type using heavy copper ribbon and consisted of two such spirals hinged so that the coupling between them could be varied by swinging them closer together or farther apart. Each coil was about five feet in diameter.

A novel keying arrangement was used in that the 60,000-volt secondary circuit was broken by a solenoid-operated lever about three feet long fitted with contacts at each end with an air gap of several inches between them. A 15-pound blast of compressed air played continuously between the contacts while keying, serving to extinguish the heavy arc which followed each break. Action of this key was, of course, rather sluggish and, as it required two solenoids—one to "make" and one to "break" the contact—a similar double-action hand key was manipulated manually by the operator. Speed of transmission was necessarily slow and rarely exceeded 25 wpm, usually being closer to 20 wpm.

The station ground system consisted of some 3000 pounds of zinc plates buried around the steel transmitter building. Three strips, each four feet wide, ran down to the beach to low-tide level—one strip being routed for about 100 feet through the bed of a small creek.

This station proved very efficient both on the longer waves of 3000 to 4000 meters employed with the 25-kw. transmitter and on 300, 600, 1700, and 3000 meters used with the 5-kw. marine transmitter. The latter had a regular range of about 1200 miles while the 25-kw. installation could be easily read at all Alaskan points, including the Pribiloff Islands in the Bering Sea, southern California, Honolulu, and on occasion, its signals were reported very readable in Japan.

The Navy Takes Over

At the outbreak of World War I, the U.S. Navy took over all commercial wireless telegraph stations, including the *Marconi* installations at Ketchikan and at Astoria, Oregon, staffing them with Naval operating personnel or, where expedient, accepting *Marconi* operators into Naval Reserve service.

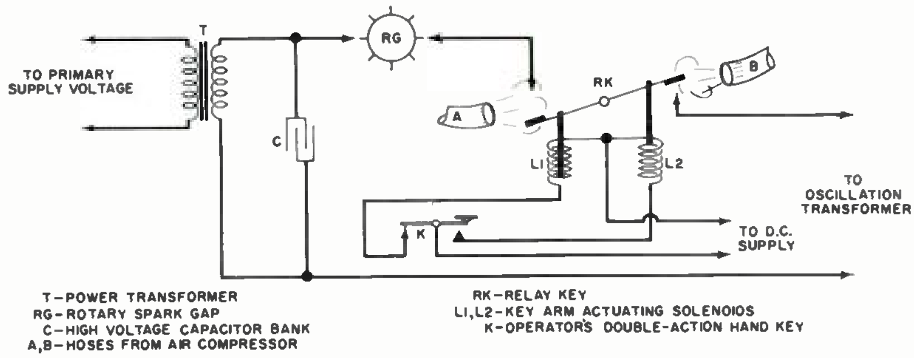
The Navy made a few improvements at each station. The 5-kw. marine transmitters were relocated from the operating building to the main transmitter building and the ground system was extended by laying a web mat of copper wire on the underbrush between the four towers. The *Marconi Company's* receiving equipment of the crystal type was replaced by the recently developed Navy SE-143 receivers with "Audion" detectors and two-stage audio amplifiers, which enormously increased the sensitivity and receiving range at both stations.

The duplex dwellings which the *Marconi Company* had erected to house their Chief Operators and their families, as well as providing similar accommodations for the senior assistant operators, were also taken over by the Navy and served to house the equivalent Naval operating personnel.

This writer, as a Chief Radio Electrician USN, was assigned to the Ketchikan station whose original KPB call letters had been changed to the Naval call, NVH, in 1919. After a two-year tour of duty at NVH, the author was transferred to NPC at Puget Sound Navy Yard (Washington) and not long thereafter the Navy turned the Ketchikan station over to the Alaska Communication Service of the Army (ACS), successor to the older Signal Corps WAMCATS. The ACS soon replaced the somewhat obsolete 25-kw. rotary-spark equipment with a 30-kw. *Federal* arc installation and made other major changes including, some time later, dismantling two of the 300-foot towers.

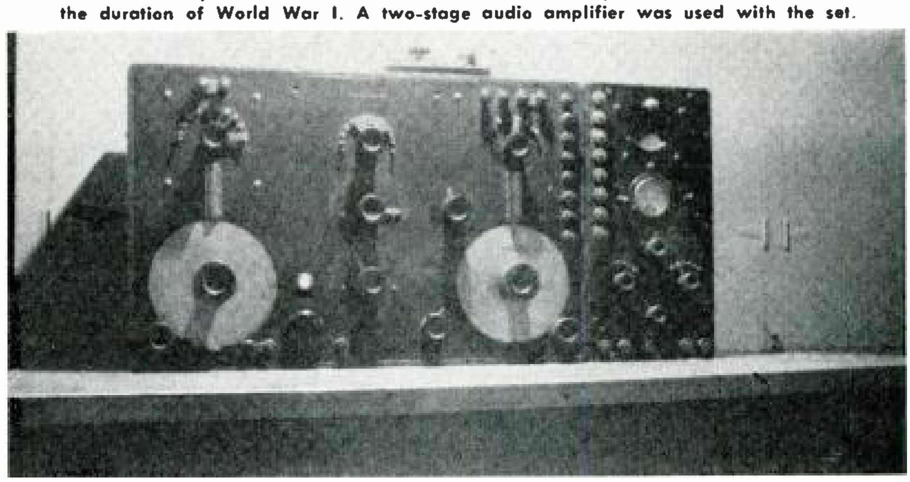
Operating under the Army call letters ALE, Ketchikan is still in service although many changes have taken place in the past few decades. Modern vacuum-tube equipment of both radiotelegraph and radiotelephone type has long since replaced the arc and marine spark type of transmitters and automatic transmission and reception has greatly increased the traffic capacity of the station to meet the demands of increasing population—both prior to and subsequent to Statehood.

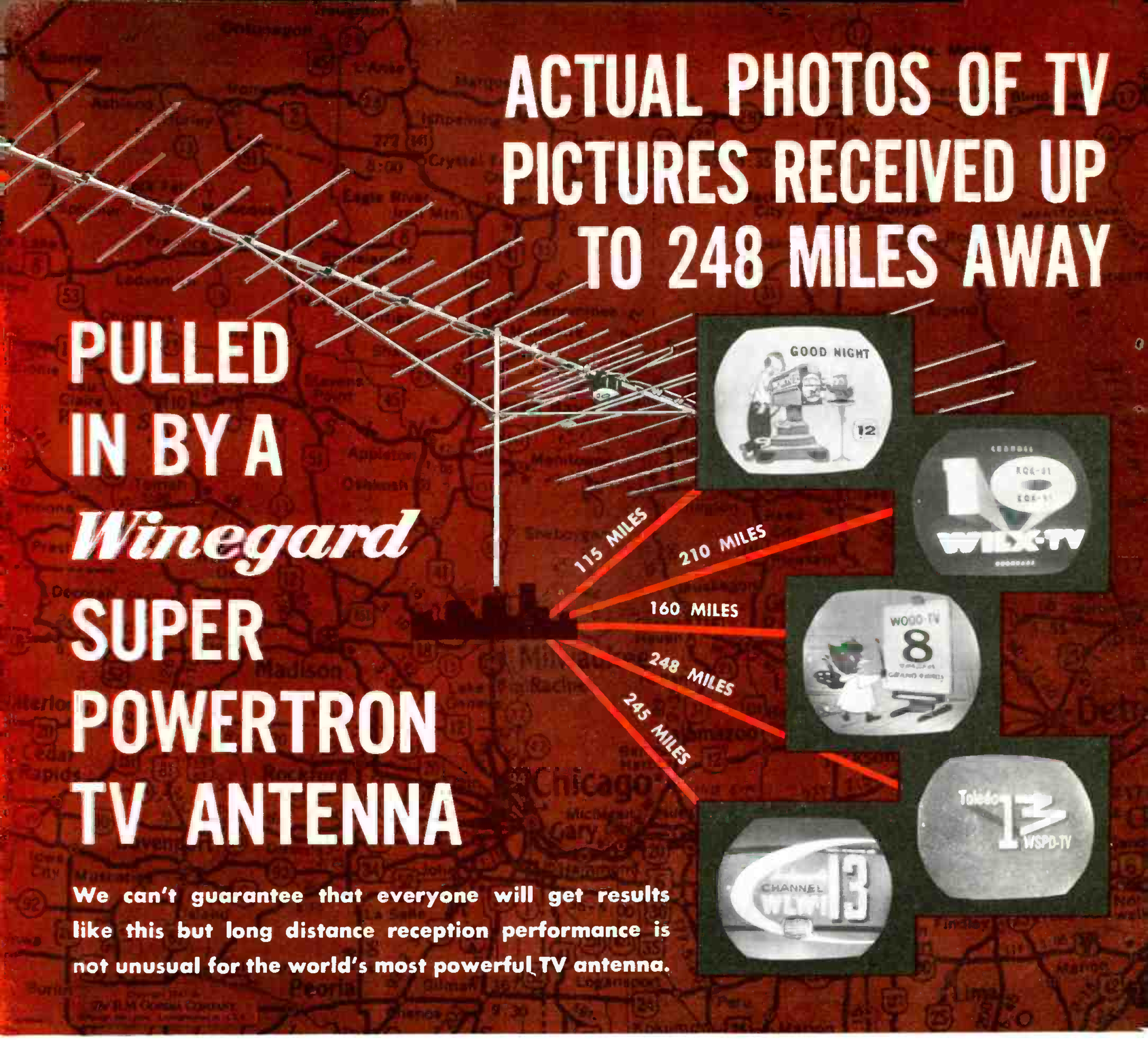
The two graceful steel towers still remain—standing as a monument to one of the early pioneers in high-power, point-to-point wireless telegraphy. ▲



The novel keying method that was employed at the Ketchikan, Alaska radio station.

The famous Navy SE-143 receiver with audion detector box. This receiver replaced the Marconi Co. crystal receivers at Ketchikan when the Navy took over the station for the duration of World War I. A two-stage audio amplifier was used with the set.





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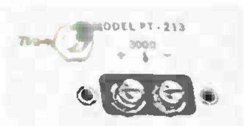

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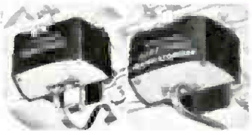

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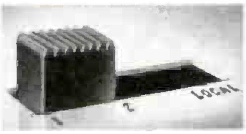
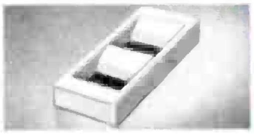
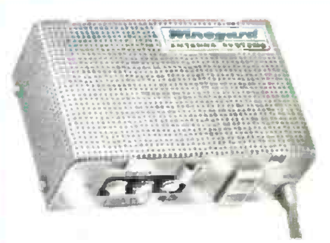


ONLY POWERTRON HAS RANGE AND POLARITY CONTROL SWITCH TO PREVENT OVER-DRIVING ON STRONG CHANNELS.

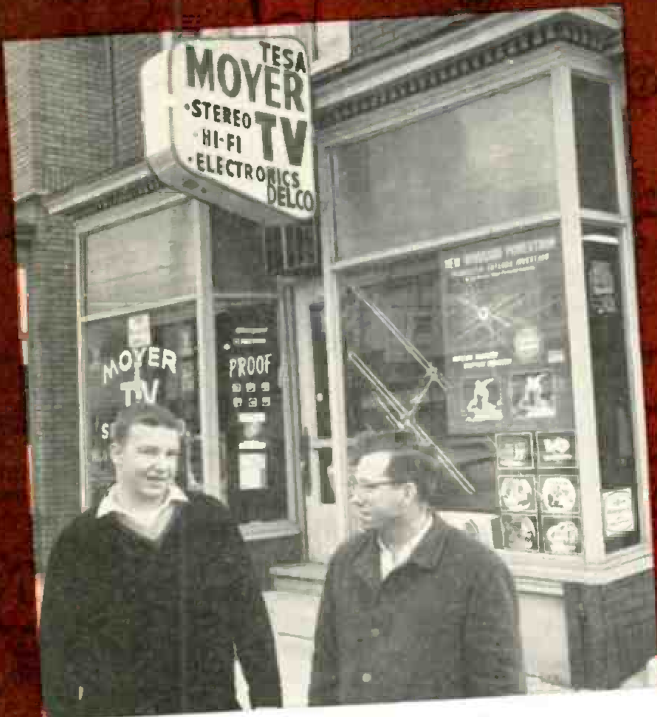


ONLY POWERTRON HAS AC PLUG-IN OUTLET FOR TV SET BUILT INTO THE POWER SUPPLY.



POWERTRON POWER SUPPLY IS ALL AC—SAFE, SHOCKPROOF.
Transistorized Model has rectifier and filter in power supply—not in amplifier, where servicing is difficult. No nuisance batteries. Costs 27c to operate for a full year.

Read what Charles J. Milton of Moyer TV, Milwaukee, has to say about the Winegard Super Powertron...



Charles Milton and Jim Moyer
In front of Moyer TV

Of course, everyone can't get reception results like Charles Milton has experienced. Each area has its own unique reception characteristics and problems. But one thing we can promise, the Powertron will deliver more clean pictures on your TV screen than any antenna you can own.

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MILWAUKEE 8, WIS.
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HIlltop 4-0740

Winegard Company
3000 Kirkwood
Burlington, Iowa

Gentlemen:

I would like to thank the Winegard Company for building the Super Powertron SP-44X.

With this antenna, reception at the local station level is perfect in both black and white and color. At medium range, the Powertron outperforms all others. Channel nine from Chicago, about 90 air miles, comes in clear and regularly. This is the Cubs baseball station and the one Milwaukeeans are willing to pay big money to get.

When the "Big Winegard", as it is affectionately called around the shop, is on long range it probes the unknown alone. All other antennas have fallen far behind. I have picked up eleven stations over 100 air miles away. The farthest of these is WWJ, Channel Four, Detroit, an unbelievable 251 miles. I have included a few pictures that I took off the TV with a Rolliflex F 3.5 at one second using Verichrome Pan.

We use the pictures in a window display and I use a set of pictures to explain the advantages of a Winegard to prospective customers. Believe me the pictures work -- and so does the "Big Winegard."

Sincerely,

Charles J. Milton

POWERTRON IS 100% CORROSION-PROOFED

ANTENNA IS GOLD ANODIZED, ALL HARDWARE IRRIDIZED, AMPLIFIER HOUSING OF HIGH IMPACT POLYSTYRENE.

PHOTOGRAPH YOUR OWN TV STATION PICTURES AND SEND THEM IN!

If you own a Powertron, chances are you too are experiencing unusual results. Why not photograph the stations you receive and send them in to us. We are always interested in hearing from Winegard antenna dealers and owners. We will be glad to enlarge your camera shots so that you can make your own window or store display like Moyer TV has done. The photos make great sales persuaders to prospects and can be used in many ways to sell more Powertrons.

If you have never tried a Winegard Electronic Powertron, give it a test and be agreeably surprised. Don't take our word for it—let your eyes and ears and field strength meter tell the story. For full details and spec sheets, ask your distributor or write.

Winegard
ANTENNA SYSTEMS
Winegard Co., 3003-2A Kirkwood St., Burlington, Iowa

Zenith Color TV Features

(*Continued from page* 47)

(*R-Y*) and blue (*B-Y*) signals. The 6JH8 sheet-beam tubes used here have been specially developed for this application. In addition to the conventional cathode and control grid, each has focus electrodes to form the electron stream into the required sheet beam, an accelerating electrode, a pair of deflecting electrodes, and a pair of plates.

Consider the *B-Y* demodulator. Amplified color information is applied to its grid. Its deflectors are connected to opposite ends of a coil that is a secondary of T_{12}, through which the suppressed color subcarrier, obtained from the 3.58-mc. oscillator, is re-inserted. In this push-pull connection, the deflectors are 180 degrees out-of-phase, each being activated on alternating half cycles of 3.58-mc. Thus they alternately switch the electron beam between the plates. Output in the desired phase from one plate is fed to the CRT's blue-gun grid. Its amplitude varies with that of the grid input to produce varying degrees of blue coloration. Opposite-phase output from the other plate is used elsewhere, as will be described.

The grid of the *R-Y* demodulator also accepts input from the 2nd color amplifier, attenuated through L_{27} to complement transmission standards. Its deflector plates are also connected to opposite ends of a coil that is another secondary on quadrature transformer T_{12}. The latter coil is adjusted so that the 3.58-mc. signal it picks up is 90 degrees out-of-phase with the signal accepted by the coil for the *B-Y* demodulator. One of the plates of the *R-Y* demodulator applies red signal to the grid of the corresponding CRT gun. Output from the other, out-of-phase plate passes through R_{118}, from which it is fed to the green grid in combination with corresponding output from the *B-Y* amplifier. The correct addition of these two signals produces the proper color-difference signal for green in the CRT.

The two demodulators, which may be called synchronized switching detectors whose plates are alternately turned on and off at the right intervals by the 3.58-mc. signals, offer several advantages. Their high-level outputs eliminate the need for additional amplification. The balanced outputs, positive and negative, from each pair of plates eliminate the need for phase-inverter stages. The *G-Y* signal may be derived without additional, active circuitry.

Color Synchronization

For correct color reproduction, the locally generated 3.58-mc. re-insertion signal must accurately match the frequency and phase of the color subcarrier, filtered out at the transmitter, whose place it takes. To insure adequate control the oscillator, in the lower-right corner of Fig. 2, receives considerable support.

Following its operation may be easier if we remember that the horizontal oscillator in any monochrome receiver presents a similar problem: it must be synchronized to the transmitted picture. In black and white, special horizontal sync pulses are sent out for this purpose between intervals of picture information. In color transmissions, special burst signals, each consisting of several cycles at 3.58-mc., are sent out riding on a portion of each horizontal sync pulse. These are actually fragments of the same 3.58-mc. subcarrier that is suppressed during the video-information intervals to avoid interference.

A keying pulse from the horizontal circuit (lower left, Fig. 2) is applied to the burst amplifier so that the latter will conduct only during the pulse intervals. Another input to the grid of this stage comes from the plate of the 1st color amplifier, and thus includes the 3.58-mc. bursts along with other composite-video information. Output of the 6EW6 is thus amplified burst signal. Variable inductor L_{43}, in its plate circuit, is externally available as the "Hue Control." It is a phasing coil that permits the viewer to adjust his set so that the proper colors will be reproduced.

One output from the burst amplifier goes to the "ACC-Killer Phase Detector," which we will bypass once more. Another output goes to the "AFC Phase Detector." The role of the latter is similar to that of the phase detector in the horizontal oscillator. When there are any differences between the frequency or phase of incoming bursts and output of the 3.58-mc. oscillator, it develops a correction voltage that is applied to the following reactance-control stage. The latter then re-tunes the oscillator correctly. Coil L_{41}, in the reactance stage, is adjusted close to the desired frequency. In addition a 3.58-mc. crystal, X_3, is used in the oscillator grid to maintain stability.

One function of the automatic color control (ACC) phase detector—adjusting for variations in signal level—has been noted. Another output goes to the grid of the color killer. One input to this detector, from the 3.58-mc. oscillator *via* one of the T_{12} secondaries, is relatively constant. Another input, from the burst amplifier, depends on transmission of burst signals during color broadcasts. Without the latter, negative d.c. output is too low to cut off the killer, whose output then disables color circuits on monochrome broadcasts. When the burst input is active, this signal adds in the ACC detector to the in-phase, synchronized input from the 3.58-mc. oscillator. The increased, negative output from the detector then cuts off the killer. Since the latter produces no output in this condition, the color amplifiers are permitted to operate.

While the highlights presented here are extensive, they do not by any means cover everything noteworthy in the 29JC20 color chassis. For those interested, however, *Zenith's* service manual for this design is quite thorough, including its coverage of alignment, adjustment, and troubleshooting techniques. ▲

Stereo Tape Head Tips on Adjustments and Measurements

By HAROLD REED

HALF-TRACK and quarter-track tape-recorder heads can present some special problems to the serious-minded audiophile and service technician. In stereo recording and reproduction these problems should be given careful consideration.

Azimuth Alignment

Azimuth adjustment, the process of correctly positioning the head with respect to the magnetic tape as it travels across the head, is best done with a standard alignment tape. The output of the high-frequency signal from this tape is observed on the recorder vu meter or external audio voltmeter connected to the recorder output. Head adjustment is then made to obtain maximum meter reading.

In a dual-track stereo system it may be found that optimum adjustment for one head track is not the best for the other. The output reading of one channel may reach peak output when the other channel has passed through its peak and dropped down 2 or 3 decibels. In many cases an improved azimuthal setting can be attained by first adjusting for the peak point of the track with the greatest output then slowly adjusting for a rising output of the other track while watching the meter reading of the higher output track previously peaked. Often, with this method the lower output track can be raised to a higher level, sometimes approaching the level of the other track, with a reduction in the output of the higher level track of only a fraction of a decibel. This method requires the use of both channel vu meters, simultaneously, or two external output meters if there are no vu meters in the system.

Output Level Variations

Output level variations between tracks with the same head may occur when recording and playing back. The author investigated a number of complaints concerning this condition and observed variations of as much as 8 db in the output from one track compared to the output from the other track. It is desirable to hold this deviation to at least within 2 db. Many times considerable improvement can be obtained, and often the deviation can be held to within 2 db, by a slight adjustment of the recording bias. Most recorders use a small trimmer capacitor for bias adjustment. Maximum bias level to the recording head does not necessarily result in maximum normal recording level on the tape. This adjustment is made to obtain an output level from a recorded and played-back tape that approaches the output level from a standard alignment tape and is performed as follows.

A standard alignment tape, such as *Ampex* #5563, contains a 250-cps signal recorded at normal, maximum recording level. With the dual-track, stereo recording system in the playback mode, adjust the recorder volume controls to obtain zero vu on each of the channel vu meters, or a convenient reading on external output meters if used, when playing the standard tape. Do not change the setting of the recorder volume controls for the duration of this test. Replace the standard alignment tape with a blank, unrecorded tape. Connect a signal generator, set for 250 cps, to the input of one of the channels of the recording system. Adjust the signal generator output for normal recording level (zero vu on the meter) and record on the blank tape.

Now, play back this tape and observe the meter reading. Ideally, it should be zero VU, matching the output reading from the standard tape. If it deviates more than 2 db make a slight adjustment on the bias control of this channel, re-record and play back, noting the meter to see if the output rises or falls. If there is no improvement, try turning the bias control in the opposite direction and check again. Most often the output is below that of the standard tape and can be brought up when optimum bias adjustment is attained.

Perform the same tests on the other track and stereo channel. The final goal is to obtain a close output level balance between the channels and to have them within 2 db of the standard alignment tape output level.

Crosstalk

Crosstalk, that undesirable condition of the signals from one stereo channel or tape-head section coupling into the other, may be checked by the following method.

Connect an audio voltmeter to the output of one channel, say channel 2. Feed a signal generator set for 1000 cps to the input of this channel and record and play back a tape, adjusting the channel controls to obtain zero vu on the channel meter. Note the reading on the audio voltmeter. Now, connect the signal generator to the input of channel 1 and record the 1000-cps signal on this channel. Play back this recording with the controls of the recorder adjusted to obtain zero vu on the channel-1 meter. Observe the reading on the voltmeter at the output of channel 2. This is the crosstalk level.

Crosstalk can occur in both the dual-track sections of the tape head and in the wiring of the stereo amplifier, particularly in leads associated with switching components. If it is unusually high, wiring should be checked. It may be that original lead dress was disturbed during some service work with the result that there is considerable coupling between certain wires in the circuit. ▲

Within the Industry

JOHN H. DUMMER, director of foreign operations and affiliates for *International Resistance Co.*, has been named vice-president of the firm.

He came to the United States from England in 1951 to join *IRC* as a buyer in the purchasing department. A year later he was appointed administrative assistant to the president. In 1955 he was named manager of licenses and contracts and was later promoted to director of foreign operations and affiliates. The company has licensees in ten free-world countries.

During World War II, Mr. Dummer was a member of the United Kingdom Technical Mission to the U.S., serving in Washington for an approximate two-year period.

* * *

ADMIRAL ARLEIGH A. BURKE has been elected to the board of directors of *Capitol Radio Engineering Institute* of Washington, D.C. He recently retired as Chief of Naval Operations and member of the Joint Chiefs of Staff, Department of Defense . . . **PAUL B. WISHART** has been elected chairman of the board and chief executive officer of *Minneapolis-Honeywell Regulator Company* . . . The Electronic Tube Division of *Sylvania Electric Products Inc.* has named **WILFRED E. BLANCHARD** to the post of coordinator-distributor sales . . . **HAROLD F. ERDLEY** is the new assistant general manager of the guidance and control systems division of *Litton Systems, Inc.* . . . *Semicon, Inc.* of Bedford, Mass. has named **ROLLAND V. ROBISON** as president. He will also continue as sales manager . . . **FRANK P. VENDELY** has been named general sales manager of the distributor division of *P. R. Mallory & Co., Inc.* . . . *General Instrument Corporation's* Semiconductor Division has named **JULIAN HILMAN** director of reliability . . . **HAMILTON O. HAUCK** has been named assistant general manager of *Raytheon's* Missile & Space Division, Santa Barbara Operation . . . **DR. R. E. FOX** is the new manager of the physics department of the *Westinghouse* research laboratories . . . *International Resistance Co.* has named **OTTO C. KEBERNICK** to the post of director of marketing . . . **ROBERT R. STEPHENS** has been appointed chief electronics engineer for *Vitro Electronics*, Silver Spring, Maryland . . . **PAUL GARRISON** is the new general manager of *Technical Appliance Corporation*, a wholly owned subsidiary of *Jerrold Electronics Corporation* . . . Promotion of **RALPH W. WIGHT** to vice-president of the *Westrex Recording Equipment Division* has been announced by the parent firm, *Litton Systems, Inc.* . . . *Oak Manufacturing Co.* has named **R. W. PEIRCE** to the post of manager, new products . . . Two veteran executives of *British Industries Corporation* have been upped to vice-presidencies. **FRANKLIN S. HOFFMAN** has been named vice-president, sales while **ARTHUR M. GASMAN** is the new vice-president, promotion . . . **SYDNEY MINAULT** is the new vice-president, marketing at *Dunn Engineering Corporation.*

* * *

ROBERT NEYMAN has been named technical manager of electronics and communications projects at *Cannon Electric Company* in Los Angeles.

He received a BS from the U.S. Naval Academy in 1936 and an MSEE from MIT in 1944. He completed his graduate business management and engineering work at Rensselaer Polytechnic Institute in 1951.

Captain Neyman served in the U.S. Navy for 25 years and prior to joining *Cannon* was operations manager for *Elgin Micronics.*

* * *

RAYTHEON COMPANY and **JAPAN RADIO CO., LTD.** of Tokyo have completed plans to form and operate a new electronics company in Japan to be known as **NEW JAPAN RADIO COMPANY**. It will engineer and produce a complete line of microwave tubes . . . **HEWLETT-PACKARD COMPANY** has acquired **HARRISON LABORATORIES** which will be operated as a wholly owned subsidiary . . . **ATLAS SOUND CORPORATION** is now operating as a division of **AMERICAN TRADING AND PRODUCTION CORPORATION** of Baltimore, Md. The new subsidiary will continue to operate under its present management at its present location in Brooklyn, N.Y. . . . **DAMON ENGINEERING, INC.** has been established at 240 Highland Ave., Needham Heights, Mass. to design and manufacture crystal filters . . . **DON BOSCO ELECTRONICS, INC.** of Hanover, N.J. has been acquired as a wholly owned subsidiary by **HOWELL ELECTRIC MOTORS COMPANY** of Howell, Mich. . . . **DATA-TRONIX CORPORATION** has been established in King of Prussia, Pa. to engage in research, development, and production of advanced telemetry components and systems . . . **JOSEPH WALDMAN & SONS** has established a new firm, **INTERMETALLIC PRODUCTS, INC.**, for the manufacture of bismuth telluride and gallium arsenide compounds and cooling modules. The new firm will be located at 119 Coit Street, Irvington, N.J. . . . **ELECTRONIC ASSISTANCE CORPORATION** of Red Bank, N.J. has acquired **INDUS-**

TRIAL INSTRUMENTS DIVISION of **SPECIALTIES, INC.**, Syosset, Long Island . . . **FILM RESISTORS, INC.** has been acquired by **NYTRONICS, INC.** and will be operated as a wholly owned subsidiary of the Berkeley Heights, N.J. firm.

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I. M. ELLIS has been named to the newly created post of field sales manager at *General Electric's* national two-way radio headquarters. He was formerly West Coast regional manager for mobile communication equipment with offices in Redwood City, California.

In his new post Mr. Ellis will be responsible for coordination of regional and district activities involving all field two-way radio salesmen throughout the country. In addition, he will be in charge of the company's manufacturer's representative program which includes several hundred sales engineers who handle the firm's transistorized and standard two-way radios, portable units, and miniaturized personal communications devices.

* * *

E. M. NYHEN has been named director of the Electronics Division, Business and Defense Services Administration, U.S. Department of Commerce. He succeeds **DONALD S. PARRIS** who has been promoted to head the new Office of Industrial Equipment . . . *Hammarlund Manufacturing Company, Inc.* has appointed **STUART MEYER** to the post of vice-president in charge of engineering . . . **JOSEPH P. SWANSON** has been named chief engineer of the newly created products division of *Radiation at Stanford* . . . **ROY DALLY,** phono cartridge engineer for *General Electric's* Audio Products Operation in Decatur, Illinois, was named winner of the Emile Berliner Award for 1961, presented annually by the Audio Engineering Society . . . **ROBERT J. McDONALD** has joined *Blonder-Tongue Laboratories* as merchandise manager . . . Appointment of **RICHARD A. HAGBERG** as vice-president and general manager has been announced by *Triad Transformer Corporation* . . . **GEORGE MENA** has been promoted to the post of distributor sales manager of *Stancor Electronics, Inc.* He was previously a field sales manager for the firm's distributor division . . . **STEPHEN A. KELLER** is the new executive vice-president of *Telex, Inc.* . . . The Department of the Army has named **COL. CHARLES W. FLINT,** Signal Corps, as Deputy Director of the Armed Services Electro-Standards Agency . . . **ROBERT L. BORCHARDT** is the new national service manager for *Motorola Communications and Electronics, Inc.* . . . The Institute of Radio Engineers has appointed **W. REED CRONE** to the newly created post of Student Affairs Secretary, handling the activities and services for the approximately 17,000 student members of the association . . . **DR. S. ROY MORRISON,** senior staff sci-

(*Continued on page* 84)

entist at the *Minneapolis-Honeywell Research Center* in Hopkins, Minn., has been promoted to assistant director of the center . . . **HERB HOROWITZ** has been named president of *Empire Scientific Corporation.*

* * *

WILLIAM G. ROYCE has been appointed director of engineering at *Cimron Corporation*, San Diego, California.

He is a former project engineer, design specialist, and applications engineer at the *Kin Tel Division* of *Cohu Electronics, Inc.*, is the author of numerous articles on electronic instrumentation, and a pioneer in the field of chopper-stabilized direct-current amplifiers.

In his new post, Mr. Royce will be responsible for the developmental research leading to the design of instruments to augment the firm's line of digital instrumentation.

* * *

SYLVANIA ELECTRONIC SYSTEMS has dedicated a new headquarters and applied research laboratory facility at Waltham, Mass. . . . **DUNN ENGINEERING CORPORATION** has completed its move to new and larger quarters at 38 Henry St., Cambridge, Mass. . . . **BURNELL & CO., INC.** has dedicated its new Guillemin Research Laboratory in Cambridge, Mass., honoring Dr. Ernst A. Guillemin, MIT scientist and vice-president in charge of research for the firm . . . Occupancy of the new advanced research center of **AUTONETICS**, a division of **NORTH AMERICAN AVIATION, INC.** has been completed in Anaheim, California . . . The Semiconductor Division of **SYNTRON COMPANY** has moved into its new half-million-dollar facility in Homer City, Pa. . . . **ELECTRONIC APPLICATIONS, INC.** has moved to 80 Danbury Road, Route #7, Wilton, Conn. . . . **HEWLETT-PACKARD COMPANY** has announced plans to establish a manufacturing plant in Colorado Springs, Colorado . . . **HARVEY ELECTRONICS-SYRACUSE, INC.** has been established in the Pichard Building, East Molloy Road, near Syracuse, as an upstate New York outlet for the New York City distributor . . . **MINNESOTA MINING AND MANUFACTURING CO.** has opened a new instrumentation, audio, and video tape manufacturing plant at Freehold, New Jersey . . . **COMMUNICATIONS COMPANY, INC.** has completed an expansion program which more than triples its original floor space at 300 Greco Avenue, Coral Gables, Florida . . . **ASSEMBLY ENGINEERS, INC.** has acquired new and enlarged quarters at 3650 Holdrege Ave., Los Angeles . . . **GENERAL ELECTRIC COMPANY** has established a television picture tube warehouse and testing facility at 601 Twenty-fourth Street, Bakersfield, California.

* * *

BURNELL & CO. INC. has acquired 80 percent of the common stock of **GLP ELECTRONICS, INC.**, Bristol, Conn. manufacturer of tantalum and aluminum foil capacitors . . . **JOHN WILEY & SONS, INC.** and **INTERSCIENCE PUBLISHERS, INC.** have merged to establish one of the world's largest publishing houses devoted exclusively to the production of books and journals in the various fields of natural and behavioral sciences, technology, and engineering . . . **HOOVER BALL AND BEARING COMPANY** of Ann Arbor, Mich. and **INSTITUT DR. FORSTER** of Reutlingen, Germany have formed **FORSTER/HOOVER ELECTRONICS, INC.** which will manufacture and sell electronic products developed by the German firm . . . **AUDIOPHONICS CORPORATION** has purchased certain audio products, manufacturing facilities, and inventories from **CBS ELECTRONICS** . . . **PALL CORPORATION** has acquired **VECTOR LABORATORIES, INC.** of Montreal, Canada.

* * *

SAMUEL J. McDONALD has been appointed distributor sales manager for the semiconductor division of *Sylvania Electric Products Inc.*, moving up from the post of assistant distributor sales manager.

He will maintain offices in Woburn, Massachusetts. He joined the company in 1943 as supervisor of personnel and in 1956 was named eastern-region distributor sales manager. Prior to this association he was with *Lever Brothers Company*.

Mr. McDonald holds a BA from Brown University and has taken graduate work at MIT, Boston University, and Harvard. ▲

Gov. David L. Lawrence of Pennsylvania officiated at the opening of this new Fisher Radio Corporation plant located at the 20-acre Fisher Park in Milroy, Pa. The building contains 62,000 square feet and is designed to permit unlimited expansion. The new plant will be operated in addition to the firm's Long Island City factory while speaker manufacturing facilities will be maintained at the plant in Belleville, N.J. The dedication also marked the beginning of the firm's 25th year in high fidelity.

Square-Wave Test Problems
(*Continued from page* 56)

6, has practically no effect at frequencies as high as 100 kc.

Construction Notes

Actual construction is quite simple and can also be quite inexpensive. Choice of pentodes for V_1 and V_2 is scarcely limited to the 954 acorn tubes used. These were selected because, as is the case with many another experimenter, the author happened to have some in his junk box and they are ideal for the job on other grounds—they can be wired up without sockets, thus greatly reducing stray capacitance. They are widely available on the surplus market at very low prices.

As shown in Fig. 7, it was most convenient to mount them so that one is upside-down with respect to the other. Also note the wiring of the cathode capacitors directly on the two-wafer switch. The choice of capacitor values and the number of positions on the switch will be up to the user's needs. Selection of values will be discussed shortly.

The 100,000-ohm cathode resistors, R_1 and R_5, should be matched within 5 per-cent so that the mark-space ratio will not be affected adversely. This is the width ratio between the flat, upper and lower portions of the square wave. If there is too much difference between R_1 and R_5, an asymmetric, rectangular pulse rather than a square wave will be produced. While a switching position for an external capacitor has been provided, this facility should be used with caution because of the cathode peaking effect already mentioned.

The cathode coupling capacitors are not at all critical as to type. Mica, ceramic, paper, and electrolytic types all work well without affecting waveshape. If electrolytics are used, two must be wired in series, back to back, for each position so that polarity is no problem. As to the values of these, C_8 to C_{14}, the user will choose them according to his needs with respect to the square-wave frequencies he will find most useful.

In the author's unit, the lowest frequency (25 cps) was obtained with a pair of 15-μf., 15-volt electrolytics. At the other end of the range, a 200-$\mu\mu$f. capacitor gave about 1 mc. For all practical purposes, frequency is inversely proportional to the value of the capacitor. From the graph of Fig. 9, the capacitor value for any frequency from 2 cps to 1 mc. can be read directly, and the graph could be extended for higher frequencies. The approximate, required capacitance can also be determined with simple mathematics. Dividing 200 by the desired frequency, in cps, yields the capacitance value, in microfarads. Thus for 400 cps we would need 200/400, or .5 μf., which is confirmed on the graph.

If the constructor finds he cannot get down below 20 or 30 cps or if the mark-space ratio goes awry at low frequencies, it is probable that one or both of the plate-grid coupling capacitors (C_1 and C_2 in Fig. 3) are leaking. This affects the clamping action of the grids.

The version built by the author (Fig. 8) is compact and without its own power supply. Two pairs of connectors on the panel are for the output signal and the external capacitor. Filament and d.c. voltages are brought in through a separate cable and plug. As with the capacitors, power-supply and power-switching arrangements are left to individual constructors.

Value of "B+" should be 300 volts or more. The author used the separate supply he described in an earlier article in this publication ("Adjustable D.C. Power Supply," June 1961). With less than 300 volts, marked rounding of the waveform begins to develop. Output frequency also varies with "B+": the former falls as the latter is raised. Frequency deviation can be up to 5 per-cent for a variation of 50 volts—nearly 17 per-cent — in voltage. However, frequency precision is normally unimportant in square-wave testing.

Amplitude of the output waveform is also slightly affected by "B+" variation. Thus if the power supply is not reliable, it may be wise to check during any test sequence to make sure that "B+" is relatively constant, say between 300 and 310 volts. Within these limits, output amplitude will not change over the full range of frequencies.

The specified output of .35 volt is within the handling capacity of most amplifiers. It may be changed by lowering or raising the value of R_2. The latter can be doubled without noticeable effect on the waveform. However, it is a good idea to keep the resistor as low as convenient and fixed. Most amplifiers tested will have gain controls of some kind, and another control complicates matters, besides providing a possible source of distortion from the causes discussed earlier. Another component that can well be left out, for similar reasons, is an output blocking capacitor. This elimination has been facilitated by grounding "B+" to the chassis. Hence, the matching power supply should not employ a grounded "B−" output.

Waveshape is also unaffected by any reasonable load—or even unreasonable ones, as Fig. 10 shows. The waveform at the left is a 10-kc. trace with another 300-ohm resistor connected across the output. Amplitude, of course, is halved. With the output loaded by a .005-μf. capacitor at the same frequency, there is a barely perceptible increase in rounding of the corners, as shown to the right in Fig. 10. A more normal load would be in the order of 50 $\mu\mu$f., about one-hundredth the value illustrated.

Apart from the need to avoid stray capacitance in the cathode circuits, there is nothing critical about construction. The constant output at all frequencies, stability, and freedom from overshoot provide a known standard by which other equipment can be safely judged. Since this unit was built, at least one "wideband" oscilloscope, previously trusted, is on a shelf in disgrace, awaiting overhaul of its vertical amplifier. ▲

AN ECONOMICAL 813 FINAL FOR THE HAM

By **HARTLAND B. SMITH,** W8VVD

Construction of a bandswitching power amplifier for c.w., AM, and SSB with half kilowatt average plate input power.

IN ORDER to keep up with the trend toward more versatile amateur transmitting equipment, the author recently decided to up-date his rig by adding a bandswitching final for c.w., AM, and sideband. The completed amplifier is shown in Fig. 1. With a suitable power supply it is capable of 500 watts average input or 1000 watts peak-envelope power as an AB_2 sideband linear. It will also run 500 watts c.w. or 400 watts AM phone in class C service.

Since the author is an avid trader and surplus shopper, it was possible to scrounge up all the necessary components for less than thirty dollars. A similar unit can be built with new material for a little less than one-hundred dollars. Thus, even though you have a sparsely filled junk box and are unable to make use of very many bargain parts, this particular circuit will provide a husky signal for a relatively small investment.

Construction

A 10" x 17" x 3" chassis with a bottom plate was decided upon as a foundation for the amplifier. Because it was low in cost and easily drilled, ⅛" Masonite, backed with a thin aluminum sheet, was employed for the 9" x 19" front panel. To shield the amplifier against TVI, an enclosure was built from .051" aluminum. A 6" x 7½" rectangular hole cut in the top of the shield for ventilation was covered with perforated aluminum removed from an old TV receiver cabinet. A number of 3/16" holes were drilled in one end of the enclosure to admit air. Perforated aluminum was also used to cover several large ventilation holes cut in the chassis bottom plate.

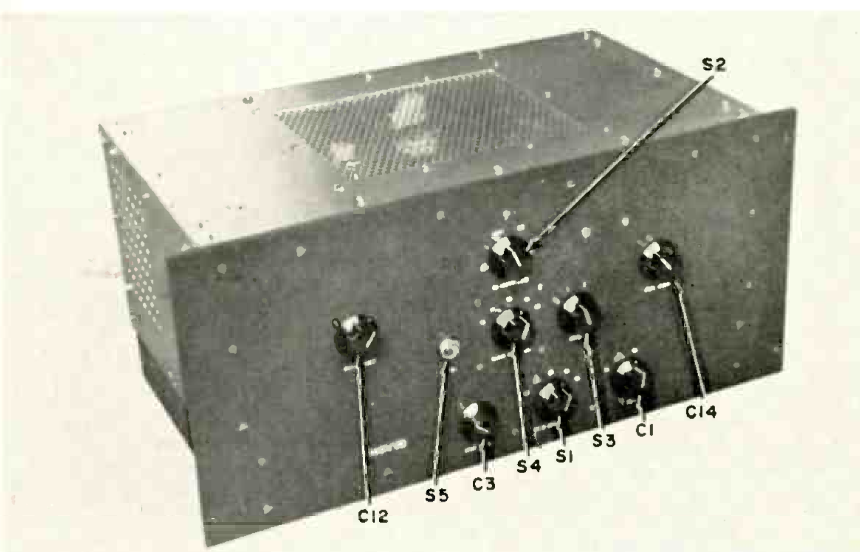
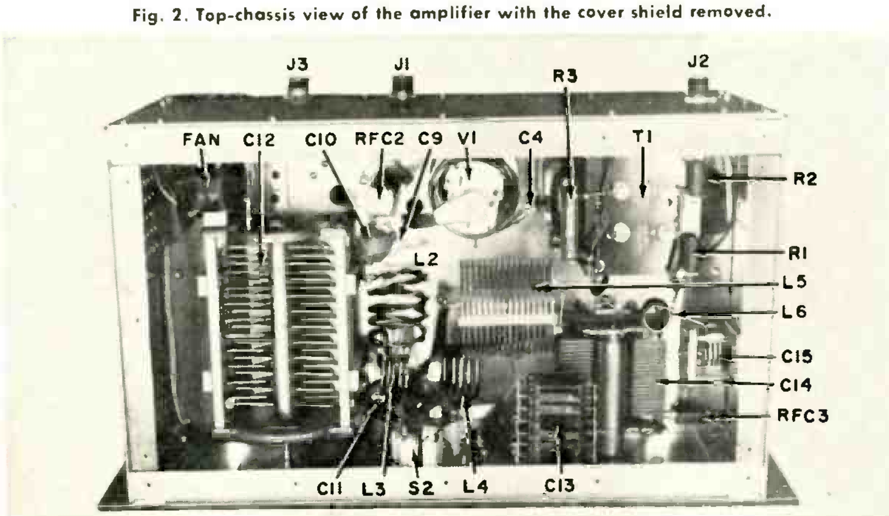


Fig. 1. The completed home-built half-kilowatt final power amplifier.

Fig. 2. Top-chassis view of the amplifier with the cover shield removed.



If you live near a big city, you can obtain sheet aluminum from scrap metal dealers for 10¢ to 30¢ per square foot. In those localities where aluminum isn't available, thin galvanized sheet metal may be used as a substitute.

A small tube-cooling fan was built from a discarded phonograph motor. It stirs up the air inside the case to some extent, but a commercially built fan would undoubtedly be quieter and more efficient.

Although a number of excellent new transmitting tubes have been developed in the past few years, the author settled on that inexpensive old workhorse, the 813. Since this tube has a reputation for taking off on its own, especially at the low bias and high screen voltages required in linear operation, several precautions were observed while building the amplifier.

Minimum inductance was assured by the use of copper strip in place of ordinary hookup wire for all leads carrying r.f. However, ⅜" tinned shield braid can be used as a substitute, if you have no source of copper strip.

A hole somewhat larger than the diameter of the 813 was cut in the chassis and the socket was mounted with aluminum brackets below this hole so that when the tube was plugged in, the top of its metal base was even with the top of the chassis. A small piece of aluminum, fastened to the chassis and bent at a slight angle presses against the metal base of the tube for grounding purposes.

C_3, a 25 $\mu\mu$f. mica capacitor, was connected with as short leads as possible between pin 4 of the 813 and ground. This capacitor provides a low-impedance v.h.f. path from grid to ground. It tends to short out TVI-causing harmonics and helps to bypass high-frequency energy which might otherwise result in parasitic oscillations.

C_1, C_2, and C_4 were used in a capacitance-bridge neutralizing circuit. C_4 was formed by the capacity between the 813 plate and about 5 inches of stiff wire supported beside the tube on a feed-through insulator. Since the optimum adjustment of the bridge changes from one band to another, C_1 was made variable and mounted on the front panel. As a result, the amplifier may be conveniently and correctly neutralized for any operating frequency.

All power leads emerging from the amplifier were TVI-filtered by r.f. chokes and disc ceramic capacitors. These were mounted in the small aluminum shield box visible in the lower, left-hand corner of Fig. 4. Within the amplifier itself, the bias, screen, and filament leads were run in shield braid which was grounded to the chassis at frequent intervals.

The grid and plate meters were mounted on the panel of the modulator rather than on the amplifier's panel. This arrangement made it unnecessary to fabricate special TVI shields for the meters, since the currents they indicate are thoroughly filtered before leaving the case of the amplifier.

High *LC* ratios in both the grid and plate circuits of the 813 plus a pi-output network were utilized to discriminate against TVI-producing harmonics. L_6 and C_{15} form a series trap which may be resonated on either channel 2 or channel 3 to further reduce TVI.

The filament transformer, T_1, was mounted in the amplifier case, rather than on the power-supply chassis, because it is much easier to filter the rather light current going to the primary of the transformer than it is to filter the heavy current of the secondary. Since the transformer found in the junk box was rated at 11.5 volts, R_3 was needed to reduce the output to the 10 volts required by the 813. If you use a 10-volt transformer, R_3 will be unnecessary. R_1 and R_2 may also be omitted if you employ a transformer with a center-tap which may be directly grounded.

The plate choke, RFC_2, was wound on a smooth porcelain antenna insulator. A *National* GS-4 stand-off would make a suitable substitute form, or you can purchase a *Raypar* type RL-100 choke if you'd rather not wind your own.

RFC_3 was included as a safety precaution. If C_{10} should break down, the r.f. choke will short the dangerously high plate voltage to ground and cause the power-supply fuse to blow. Without RFC_3 in the circuit, a faulty plate-blocking capacitor might allow as much as 2000 volts to appear on the transmitting antenna and its feedline.

In view of the heavy circulating current which results from the high-*C* plate circuit, L_2 was wound with two No. 10 wires twisted together. An even better way to keep the r.f. resistance of L_2 low would be to wind the coil with 3/16" copper tubing.

C_{13} is the coarse loading capacitor. The author used eight 250-$\mu\mu$f., 1200-volt mica capacitors connected in series-parallel to arrive at a value of 500 $\mu\mu$f. Two 250-$\mu\mu$f., 2500-volt mica capacitors wired in parallel should prove just as satisfactory. Don't try a single 500-$\mu\mu$f., 20,000-volt TV ceramic here. It will heat up and change capacity when subjected to the heavy r.f. current which appears at this point.

J_3, the high-voltage connector visible in Fig. 2, is an 83-1R chassis-type coax plug. A safer choice for this item would be a *Millen* 37001 high-voltage terminal.

Ganged switching is one feature of factory-built equipment that is hard to duplicate in the home workshop. Unless you enjoy playing with all sorts of Rube Goldberg arrangements of gears, shafts, and shielding, you'll find that it is much more practical to utilize separate switches for the grid and plate circuits. The grid bandswitch and the coarse-load switch, S_1 and S_3, may be of the phenolic type, but S_2 and S_4 should be well insulated ceramic types, such as are found in the surplus tuning units of the BC-375.

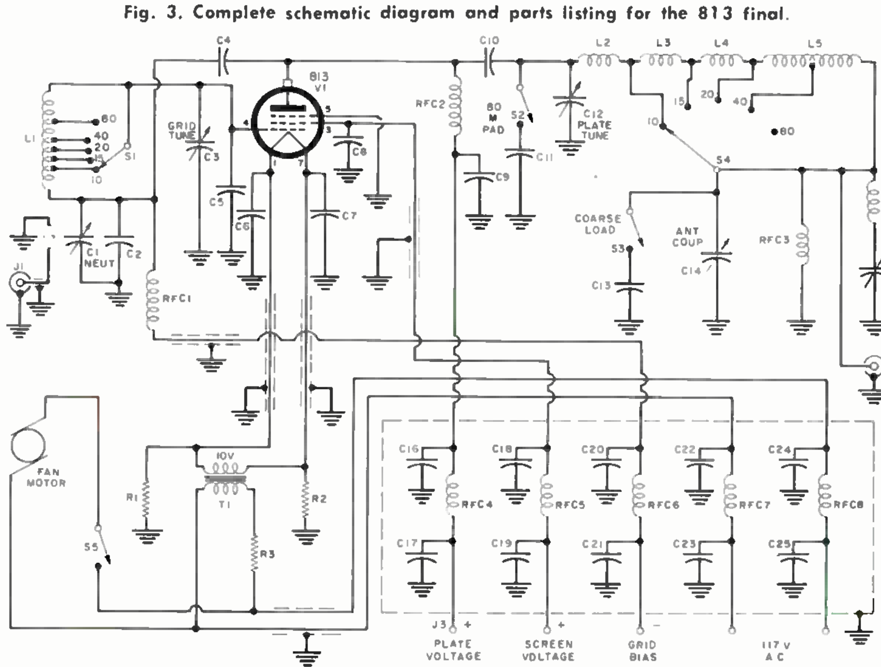
Fig. 5 is a block diagram which shows how the amplifier may be connected with other components to form a complete transmitter. In the author's shack, the final, modulator, and power supply are each on a separate chassis mounted in a relay rack. The exciter sits in a convenient spot on the operating desk. Rack and panel construction is recommended because it lends itself to easy modification and simplified troubleshooting. When you want to revise a circuit or find it necessary to replace a component, only the affected part of the rig needs to be removed and placed on the workbench.

Drive & Output Power

In class C AM and c.w. service, only about 6 watts are needed to drive the grid of the 813. Even less excitation is necessary for AB_2 sideband linear operation. These low drive requirements are what make beam-power finals so inviting to the fellow who wants to use a simple, inexpensive exciter.

The final is capable of 500 watts input on c.w. with a 2250-volt supply. However, since the author has only 1850 volts available, he usually runs on 400 watts c.w. and 350 watts phone. On sideband, it is possible to run 500 watts average input (approximately 1000 watts p.e.p.) before serious flat-topping occurs. When the amplifier is worked as a linear, 750 volts are applied, regulated

Fig. 3. Complete schematic diagram and parts listing for the 813 final.



R_1, R_2—15 ohm, 5 w. res. (see text)
R_3—35 ohm, 20 w. res. (see text)
C_1—600 $\mu\mu$f. var. capacitor (two-gang superhet unit with sections in parallel)
C_2—150 $\mu\mu$f. mica capacitor
C_3—140 $\mu\mu$f. var. capacitor
C_4—Neutralizing capacitor (see text)
C_5—25 $\mu\mu$f. mica capacitor
C_6, C_7, C_8—4700 $\mu\mu$f. 1000 v. disc ceramic capacitor
C_9, C_{10}—500 $\mu\mu$f., 20,000 v. ceramic TV filter capacitor
C_{11}—75 $\mu\mu$f., 7500 v. ceramic transmitting capacitor (Centralab 850S-75N)
C_{12}—100 $\mu\mu$f. var. transmitting capacitor, 3/16" plate spacing
C_{13}—500 $\mu\mu$f., 2500 v. mica capacitor (see text)
C_{14}—500 $\mu\mu$f. var. capacitor, .0245" plate spacing
C_{15}—15 $\mu\mu$f. var. capacitor, .0245" plate spacing
C_{16}, C_{17}—750 $\mu\mu$f., 6000 v. disc ceramic capacitor
C_{18}, C_{19}, C_{20}, C_{21}, C_{22}, C_{23}, C_{24}, C_{25}—1000 $\mu\mu$f., 1000 v. disc ceramic capacitor
RFC_1, RFC_3—2.5 mhy. r.f. choke
RFC_2—2½", #22 en. wire closewound on ¾" form (see text)
RFC_4, RFC_5, RFC_6—7 μhy. 1000 ma. r.f. choke (Ohmite Z-50)
RFC_7, RFC_8—55 t. #28 en. wire closewound on ⅜" dia. polystyrene rod
T_1—Fil. trans., 10 v. @ 5 amps (see text)
S_1—5-pos. rotary switch
S_2,S_4—6-pos. high-voltage rotary switch. (Ohmite heavy-duty, 6-pos. ceramic switches were obtained from Barry Electronics Corp., 512 Broadway, New York 12, N.Y. Since only two positions are required for S_2 and five for S_4, a number of terminals will remain unused.)
S_3—One section of Centralab PA-1460 rotary switch (see text)
S_5—S.p.s.t. toggle switch
J_1, J_2—Coax connector (83-1R)
J_3—High-voltage terminal (see text)
L_1—Pri: 6 t. #20 bare wire, 1" dia. (length ⅓"). Sec: 41 t. #20 bare wire, 1" dia. length 2⅓"), tapped at 3rd, 4th, 8th and 18th turns. B&W Miniductor 3015)
L_2—4 t. of twisted #10 en. wire, 1½" dia., 1¾" long (see text)
L_3—4½ t. #10 en. wire, 1" dia., ¾" long
L_4—6 t. #10 en. wire, 1½" dia., 1¼" long
L_5—16 t. #12 bare wire, 2½" dia., tapped 8 t. from C_{14} end (B&W inductor 3905-1)
L_6—10 t. #14 en. wire, 11/16" dia.
V_1—813 tube

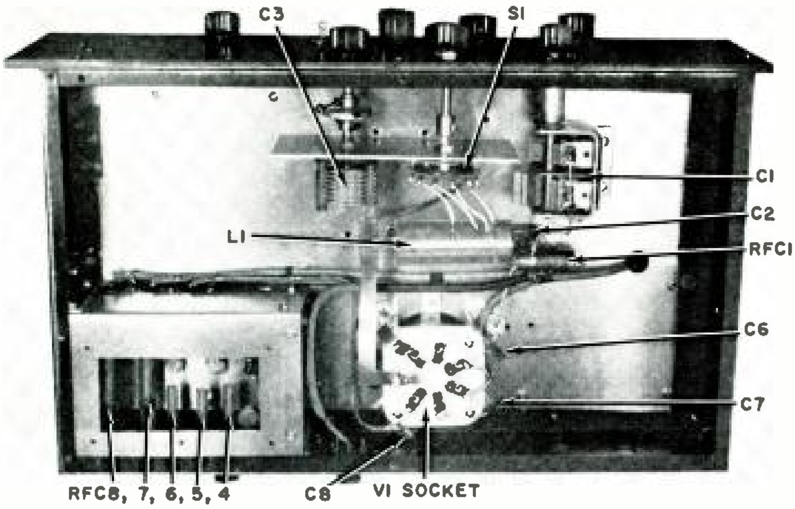


Fig. 4. Bottom view shows the shielded compartment housing r.f. chokes and bypasses.

by a string of five 0A2's, to the screen of the 813 and 90 volts, regulated by a VR90, to the grid. On AM and c.w. 400 volts are taken from the speech-amplifier power supply for application to the screen with an additional 60 volts of bias obtained from a 4000-ohm grid leak.

Adjustment

Preliminary adjustment and neutralization of the amplifier may be made either with a regular antenna or with a dummy load. Set S_1 and S_1 to 80 meters. Close S_2, thus paralleling C_{12} with the 80-meter padder, C_{11}. Close S.. Put C_1 and C_{11} at full capacity. Apply the proper voltages and drive for class C operation. Tune C_3 and adjust the output of the exciter until a grid current of 15 ma. is obtained. Dip the final with C_{12}. Then rock C_{12} back and forth, while watching the grid meter. If the grid current drops as the capacity of C_{12} is increased and rises as the capacity of C_{12} is decreased, the amplifier is insufficiently neutralized. Set C_1 at two-thirds capacity and rock C_{12} again.

Should the amplifier still show signs of inadequate neutralization, increase the length of the wire which is a part of C_1, or move the wire closer to the 813. Keep in mind, though, that the spacing between the tube envelope and the wire must be not less than 1/4" to prevent a corona discharge or arcover. In addition, be sure that the wire is positioned near the edge of the 813 plate, where it is closest to the glass.

Warning: Make certain that power is removed from the rig and all high-voltage capacitors are discharged before reaching into the case to change the length or position of C_1.

When the amplifier is correctly neutralized, the grid current will remain constant, or may fall off slightly, as C_{12} is tuned above and below plate-circuit resonance.

If the capacity of C_1 is set too low or if the length of C_1 is too great, over-neutralization will occur. When this condition exists, the grid current will drop as C_{12} is tuned to the low-capacity side of plate resonance and will rise when C_{12} is on the high-capacity side of resonance. C_1 should be adjusted so that optimum neutralization takes place on 80 meters with C_1 set between two-thirds and three-quarters of full capacity.

As you switch upward in frequency, from one band to another, you will discover that you must reduce the capacity of C_1 a bit in order to maintain neutralization. Once you have found the correct setting for this capacitor on a particular band, you can mark the spot with a decal. Then you will be able to locate the correct position in the future without having to go through the entire neutralizing procedure each time you switch bands.

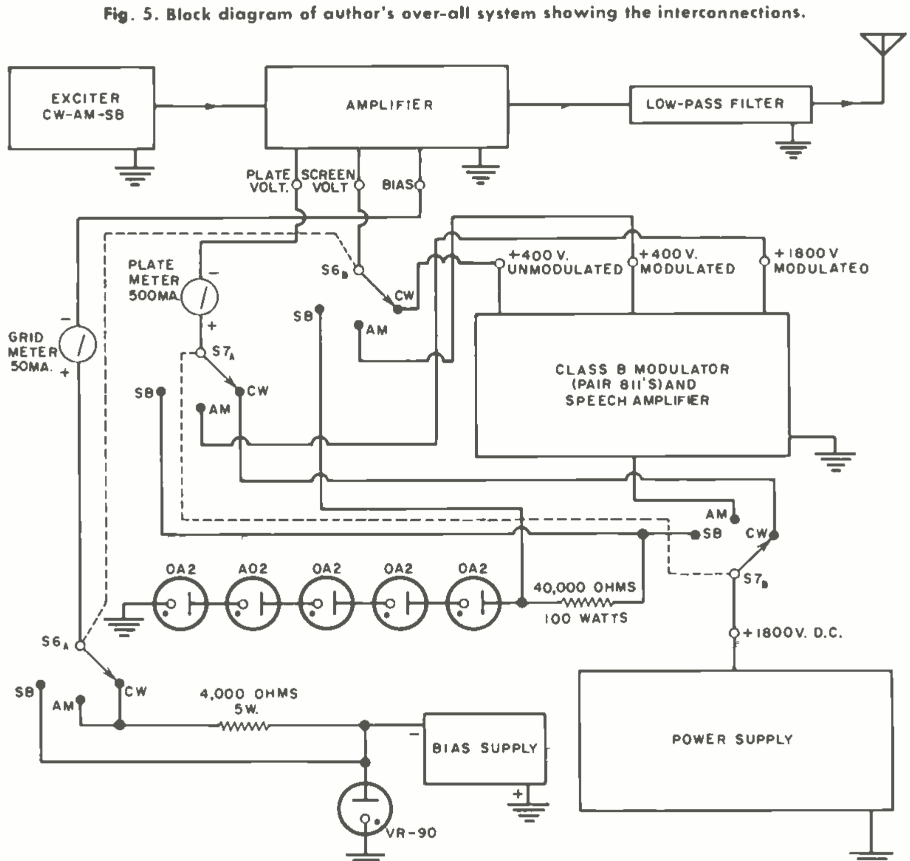
Since C_1 is in series with the ground end of L_1, it will have some effect on the resonant frequency of the L_1-C_3 combination. Consequently, when you neutralize the rig for the first time, you may find it necessary to re-adjust C_3 slightly as C_1 is varied.

S_2 should remain open on 10, 15, 20, and 40 meters in order to remove the 80-meter padding capacitor C_{11} from the circuit. Normally, S.. will be closed on 80 and 40 while it will be open on 20, 15, and 10. The correct setting of this switch, however, will depend on the impedance and s.w.r. of the antenna feed-line.

Grid current for either phone or c.w. should be set to 15 ma. Plate current should not exceed 200 ma. on AM or 225 ma. on c.w. Do not attempt to operate the amplifier as a sideband linear until you have carefully tuned it with the aid of an oscilloscope. Most of the complaints that are heard about broad sideband signals are the result of overdriven and improperly loaded rigs. Information regarding linear adjustment will be found in various sideband handbooks available at most radio distributors. A description of the correct method of tuning an amplifier for SSB operation is beyond the scope of this article.

Performance of the unit has lived up to all of the author's expectations. The amplifier holds its own in pile-ups and has easily provided the extra contacts needed for DXCC phone. Over a period of several months, only one case of TVI has been reported. This resulted from receiver overload, not transmitter harmonic radiation. ▲

Fig. 5. Block diagram of author's over-all system showing the interconnections.



Electronics and Biology

(*Continued from page 30*)

again, another bit of information has been extracted from the object seen to help classify it. The object of research in this area is to find ways of reducing computer time by presenting to the computer more highly organized information in much the same way as our sense organs pre-select information for the brain. If this pre-selected information were added to the other end—the input presentation—nothing would be gained but if the computer can pre-select with the same amount of input information, some of which is normally lost in the process, then time has been gained. Let us look at another somewhat over-simple example.

Punched cards of the type being used for billing by utility companies and other firms, contain holes and printed letters. The holes are for the benefit of the business machines that receive their input this way. The printed letters and numerals (like the address) are included for the post office. Now suppose the machines could also "read" this address and sort the mail before delivery (we now have machines capable of doing this) then time would be saved in the total process. Suppose the machine could also "see" a tear in the card which would cause it to reject that card, thus eliminating inspection before the card goes into the machine and the machine could operate more rapidly. This is a simple yet practical example of "property filters."

Another early bionics model was the "homeostat" constructed by Ashby. He noticed that animal systems always came to equilibrium so he constructed an electronic device which actively sought equilibrium no matter what the value of its four inputs.

There are many biological mechanisms which are being studied by means of electronic models. One of the characteristics of living entities—not shared by their electronic counterparts—is "redundancy of parts." Thus, if part of your brain is damaged, it may not be "repairable" but other sections of the tissue will eventually (after learning) take over the necessary function almost as well as the original part. We have far more nerve fibers than we need to do the job. If one fails, another takes over. This philosophy of redundancy is now creeping into the design of electronic equipment for space exploration where failure simply cannot be tolerated.

This pinpoints the reason for the close cooperation between electronics and biology. Each discipline needs the other if we are to succeed in realizing man's dream of leaving this planet and exploring space. ▲

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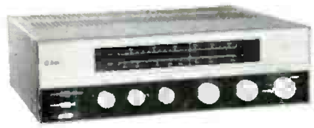

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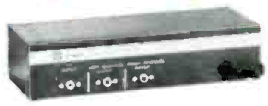

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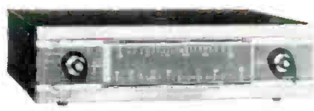

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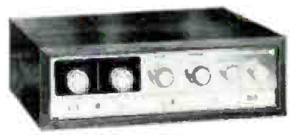

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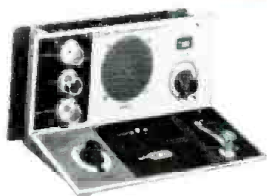

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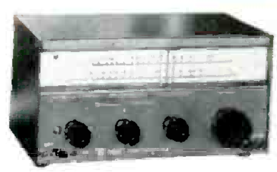

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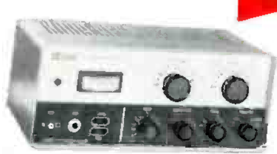

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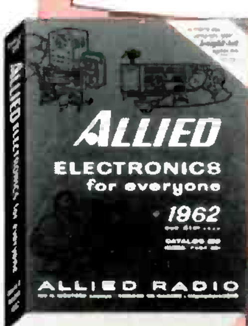

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TRANSISTOR PRECAUTIONS

By NORMAN R. McLAUGHLIN

Some practical suggestions to prevent damage to transistors. Good shop practices based on industrial-plant experience.

STURDY as semiconductors are for jobs they are designed to do, there are many conditions that they just won't tolerate. Some of these conditions may come as a surprise. For example, the static electricity built up in your body while walking on a non-conductive surface would be sufficient to send a damaging pulse through a semiconductor device when you touch it. To be sure you don't ruin those solid-state devices you plan to wire into your next construction project, ground yourself before handling them.

Semiconductors are low-voltage devices and, as such, cannot stand high voltages. There is enough leakage present at the tip of some soldering irons to break down the junction of a semiconductor and permanently destroy its characteristics. Check your soldering iron for leakage voltage. If it is high enough to cause damage, replace it. If this is not practical, remove the semiconductors from the circuit while wiring. If you must wire them into a circuit, ground the side of the semiconductor being wired.

Transients can develop in inductively driven devices which exceed the voltage that can be safely applied to semiconductors. Some types of soldering guns, wire wrappers, and similar inductively actuated tools produce transients that could be dangerous every time the power is turned on or off. When such tools must be used, they should be lifted away from the semiconductor before being turned on or off. For example, start the soldering gun warming before you touch the semiconductor and do not turn it off until after you have lifted the gun from the wiring.

Most of us are aware of the semiconductor's vulnerability to heat—yet how often have we "sneaked" a solder connection without benefit of a heat sink? A heat sink is a simpler device than its name implies. In this instance, it is any device that will divert heat from the semiconductor. A pair of flat-nose pliers makes an excellent heat sink when placed between the semiconductor and the soldered joint. Hold the pliers in position long after you have quit soldering and the joint has cooled down.

Speaking of heat, did you know that in order to obtain valid test data the various semiconductors must be tested at the same ambient temperature? Electrical characteristics of semiconductor devices change rapidly with variations in operating temperature. Thus if you want to make comparative tests, both units must be tested in the same temperature environment. The recommended ambient temperature is 77 degrees F ±5.4 degrees (or 25 degrees C ±3 degrees).

While diagonal cutting pliers are satisfactory for snipping leads of ordinary components, they should never be used to cut leads of semiconductor devices. "Dikes" produce a mechanical shock that travels into the device with sufficient impact to weaken or destroy the delicate internal electrical connections.

To prevent such damage always use a shearing type tool for cutting semiconductor leads. Between the point where the lead is to be cut and the body of the semiconductor, hold the lead with flatnose pliers. The pliers will act as a mechanical shock dampener and further reduce shock which results when the leads are cut. Surgical scissors make satisfactory shearing tools, although sharp tin snips are probably more readily available.

Damage can also be caused by bending leads too close to the body of the device. The better semiconductors are hermetically sealed in glass to improve reliability. Bends too close to the body will crack the glass and break the seal. This hazard can be minimized by keeping bends at least 1/16" away from the body.

Many semiconductors have plated leads that improve conductivity and make soldering simpler. This plating can also be damaged if bends are made too acute. To protect the plating make bends gradual and keep the radius greater than 1/32".

Other forms of mechanical shock should be avoided. Rough handling, dropping, and throwing about can produce jolts and jars that could be fatal. Avoid these, of course, and as an added precaution use a padded work surface when working on these devices.

A common means of "testing" semiconductors is to put them across an ohmmeter. Believe it or not, this can be fatal. Many commonly available ohmmeters deliver considerably more current than the average semiconductor is designed to handle. Before making such a check you should first know the current-carrying capability of the device to be tested. This can be found in the manufacturer's data sheet or by analyzing the circuit in which the device is being used. Then, if you must make a resistance measurement, be sure that the ohmmeter you use is a high-impedance type that delivers only a small current.

A much safer way to make such measurements is to use a voltmeter or an ammeter. With either of these instruments and Ohm's Law, you can arrive at the same conclusions without risking the semiconductor.

These suggestions and recommendations are those which the *Western Electric Company* asks its production people to take. You'll profit too, by adopting them as good shop practices. ▲

Selenium Photocell Light Meter

Design of simple light meter and a calibration technique to allow a wide range of light intensities to be measured.

By A. A. MANGIERI

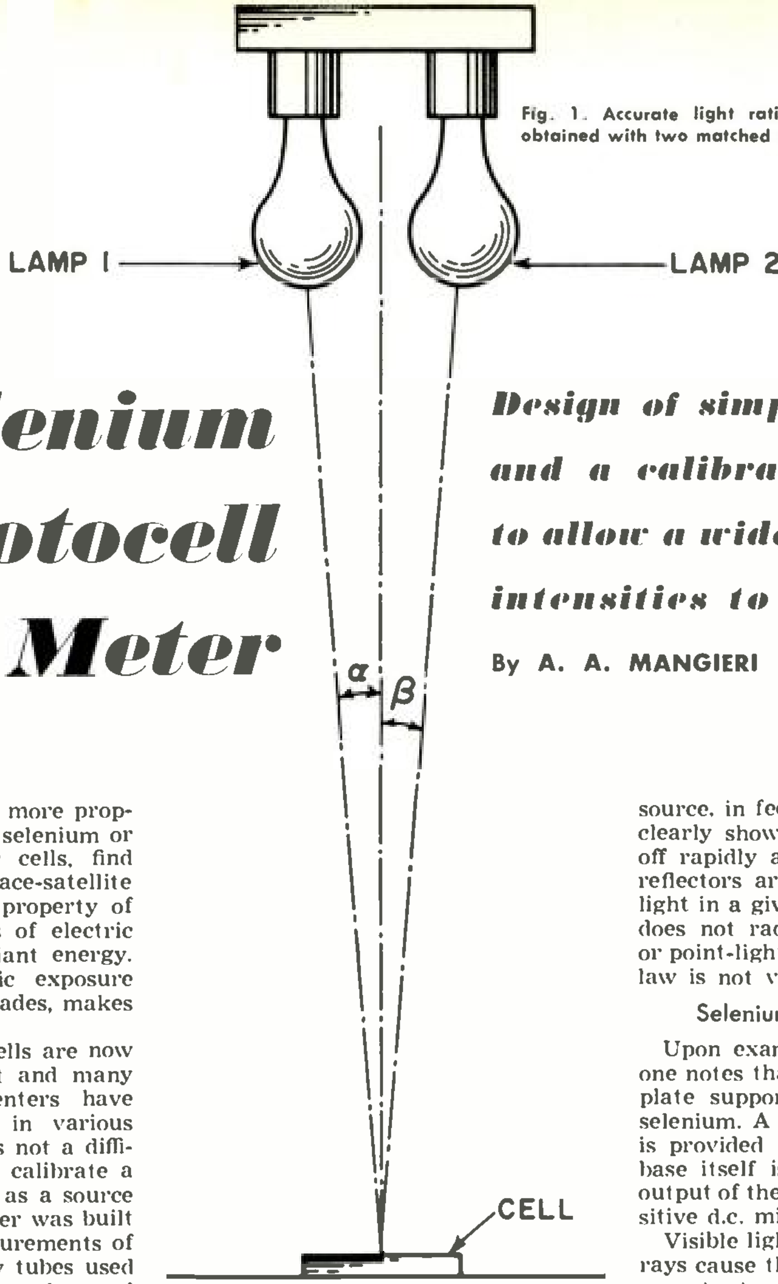


Fig. 1. Accurate light ratios of 1 to 2 are obtained with two matched incandescent lamps.

SUN BATTERIES, or more properly self-generating selenium or silicon photoelectric cells, find wide application in the space-satellite program because of their property of generating useful amounts of electric power from the sun's radiant energy. The ordinary photographic exposure meter, in use for many decades, makes use of this property.

Selenium photoelectric cells are now available at moderate cost and many technicians and experimenters have purchased them for use in various photosensitive devices. It is not a difficult task to construct and calibrate a light meter, using the cell as a source of power. Such a light meter was built to make comparative measurements of light output of cathode-ray tubes used in scopes and TV sets. It was also used to adjust light levels for microfilming.

An understanding of some of the general characteristics of the cell will enable one to construct, calibrate, and successfully operate the light meter. The meaning of a few commonly used photometric terms has been included for the benefit of the reader unfamiliar with this field.

Photometry

Selenium cells are normally supplied with a manufacturer's specification stating that the average cell produces a given current into a given load resistance at a specified number of footcandles of illumination. Thus the footcandle was chosen as the measure of illumination although other suitable classifications can be made.

Light may be regarded as a flow of radiant energy or luminous flux. The term *lumen* is a measure of the quantity of *luminous flux*. A point source of light of one candlepower will radiate a total of 12.56 lumens of flux radially in every direction from the light source. The *candlepower* is a measure of the *luminous intensity* of the light source and is denoted by the letter *P*. A 10-candlepower light source would radiate a total of 125.6 lumens of flux.

Next, consider a one-candlepower light source radiating 12.56 lumens of flux and located in the center of a hollow thin-walled sphere of one-foot radius. This sphere has a surface area of 12.56 square feet. Each square foot of surface area then receives one lumen per square foot. In engineering practice, a surface receiving one lumen per square foot receives an *illumination* of one *footcandle*. One footcandle is numerically equal to one lumen per square foot.

Now, if the sphere is enlarged to a radius of ten feet, the inner surface still receives the original 12.56 lumens of flux radiating from the one-candlepower source. The area of the surface is now 1256 square feet or one-hundred times greater. Each square foot now receives one-hundredth of one lumen per square foot or one-hundredth of one footcandle of illumination.

This illustration demonstrates the inverse square law of illumination and is given by the relationship $I = P/r^2$. The term *I* is in footcandles, *P* in candlepower, and *r* is the distance to the light source, in feet. The inverse square law clearly shows why illumination *I* falls off rapidly as distance is increased. If reflectors are used to concentrate the light in a given direction or if the light does not radiate from a concentrated or point-light source, the inverse square law is not valid in its present form.

Selenium Cell Characteristics

Upon examining an unmounted cell, one notes that one surface of the metal plate supports a thin layer of active selenium. A silvered strip on this layer is provided for electrical contact. The base itself is the other terminal. The output of the cell is fed directly to a sensitive d.c. microammeter.

Visible light rays and also ultraviolet rays cause the selenium cell to produce an output voltage and current. Because ultraviolet rays do not aid vision, they can be excluded from the cell by means of a suitable filter. However, the meter will be calibrated by means of light from tungsten lamps. The ordinary incandescent lamp used in the home is quite lacking in ultraviolet rays, therefore, there is no need for a corrective filter except in cases where the light source is rich in ultraviolet rays.

Manufacturers' data sheets state that the cell output current is linear for illumination ranging from 0 to 1000 footcandles when the load resistance is zero ohms. However, because of the resistance of the meter, the characteristic curve is quite non-linear over such a wide range. The internal resistance of the cell itself is fairly high at low light levels but drops appreciably at high light levels. The ratio of load resistance to internal cell resistance varies widely with light intensity and results in a non-linear characteristic curve.

Each cell is supplied with the manufacturer's rating which states the output current into a 100-ohm load at 100 footcandles. For an *International Rect.* B-5 cell, the output current at these conditions is listed as 220 μa. This point is plotted on a sheet of graph paper and is shown as point "A" in Fig. 2. A straight line is drawn through point "A" and the origin and is labeled "Curve 1" for comparison with actual test data.

Access to a laboratory light meter would solve the problem of calibrating this light meter but, unfortunately, such a meter was not available, which is the situation in most cases. Therefore, the manufacturer's data was accepted as establishing one known point on the curve.

How do we go about calibrating the meter for light levels much above 100 footcandles? How does the resistance of the meter affect the curve? How much resistance should be added in series or parallel with the meter so that full-scale corresponds to a certain number of footcandles? The answer to all these questions can be found by means of the light ratio test to be described.

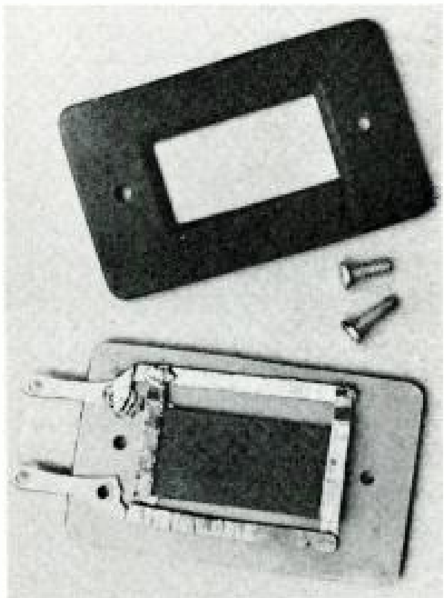
Construction & Calibration

Any suitable arrangement can be used to mount the cell. The photos illustrate a B-5 cell mounted between two thin pieces of insulation. A hole is cut in the upper piece to expose the entire active area of the cell. Strips of thin copper are arranged to bring out the connections to a pair of lugs staked to the lower piece. A two- or three-foot cord completes the connections to the meter. The reader may devise other means to suit his taste. Precautions must be taken to expose the entire active area and to avoid damaging the selenium layer. Contact should be made with the silvered strip on the selenium and not with the selenium itself.

A milliammeter rated at 0-1 ma. is satisfactory for use with the B-5 cell used. Ordinarily, a meter of this rating will have about 55 ohms resistance. This resistance, being less than the 100-ohm load specified by the manufacturer, will cause the output current at 100 footcandles to increase by about one or two per-cent. If the smaller B-2M cell is used, a 200-μa. meter is satisfactory. Ordinarily, a 200-μa. meter has about 350 ohms resistance and will cause about a four per-cent reduction in output current at 100 footcandles.

If available, use an accurate meter with a large scale for more precise readings. Standard v.o.m. testers are satisfactory, but avoid changing the current range selected for the tests because each current range of the tester presents a different load impedance to the cell.

The meter used in these tests had a resistance of 125 ohms on the 0-1.2 ma. current range. If the meter resistance



Cell is mounted between two pieces of insulation as shown. Foil contacts are used.

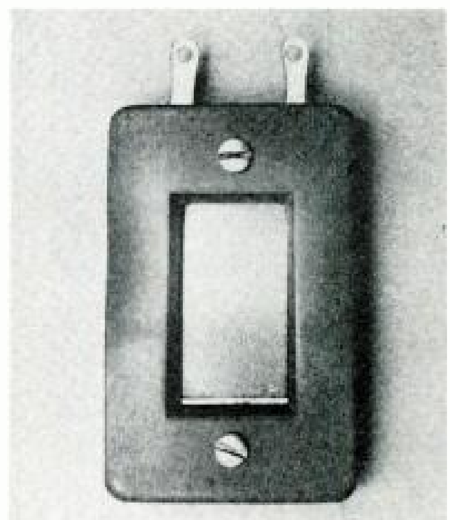
is unknown, do not attempt to measure it with an ohmmeter as the meter may be damaged. Instead, proceed as follows. Connect a 6-volt battery, a 100,000-ohm variable resistance set at maximum resistance, and the meter in series. Reduce resistance until meter reads full scale. Then, shunt a 400-ohm rheostat across the meter terminals and adjust it to obtain a meter reading of one-half scale. Next, disconnect the 400-ohm rheostat and measure the adjusted value of the rheostat on an ohmmeter. This value will be equal to the meter resistance.

Known ratios of illumination are provided by the arrangement shown in Fig. 1. Two incandescent light bulbs of equal wattage are mounted side by side by means of two sockets screwed to a supporting base. The base is adjustably suspended above a work table, supporting the cell under test. A vertical strip of wood nailed to a rafter in the basement was used along with a C-clamp for adjusting the distance between the cell and lamps.

When the lamps are identical in light output and the arrangement is symmetrical so that angle α is equal to angle β, the meter indication upon energizing either lamp alone will be the same. Then, upon energizing both lamps, the cell receives twice the illumination and the meter indication may or may not be doubled depending on light levels and the cell/meter combination.

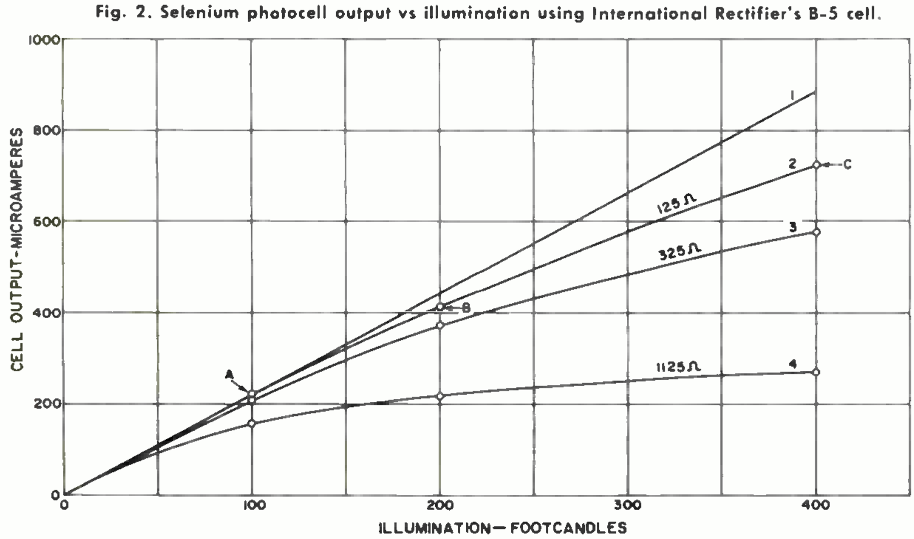
For best results, the test setup should be well removed from light-reflecting surfaces and the lamp supports painted with carbon black. Also, the test should be conducted in a darkened room or at night. Check the lamps to determine if they are matched in light output by energizing each in the same light socket and noting the meter indication. If you happen to have poor voltage regulation or low line voltage in your area, add an adjustable autotransformer and monitor the line voltage at the lamp terminals.

To obtain point "B" on Curve 2 (Fig. 2), proceed as follows. First energize lamp 1 and adjust the lamp distances until the meter indicates the manufacturer's rated output at 100 footcandles. Next, de-energize lamp 1 and energize lamp 2. If the meter indications are not identical, re-position the cell slightly until equal readings at the rated output at 100 footcandles are obtained for each bulb. Then, energize both lamps and the resulting meter indication is the cell output at 200 footcandles. Point "C" at 400 footcandles is obtained similarly except that the distances are changed so that one lamp alone will produce the cell output corresponding to point "B."



The cell in its home-made mount. Actual cell size is about 1-7/16" long by about 5/8" wide with a photosensitive area of just over 3/4 sq. in. For convenience a manufacturer-mounted cell may be used.

Fig. 2. Selenium photocell output vs illumination using International Rectifier's B-5 cell.



After checking to make sure that each lamp, individually, produces an output equal to point "B," both are again energized simultaneously to produce 400 footcandles of illumination at the cell, thereby providing data for point "C." This procedure can be repeated for higher light levels using larger lamps if necessary. Use 60- and 100-watt lamps and avoid coming much closer than 10 or 12 inches from the cell because the heat radiated from the lamps may heat the cell and introduce error in the meter indications. A smooth curve is drawn through the points on the graph paper and is labeled with the resistance of the meter as shown. The curve is used to measure light levels and also to set up light levels at any point on the curve.

To determine the effect of added series resistance on the shape of the curve, set up light levels of known value by using Curve 2 and insert the added resistance and note the drop in meter indication. Curve 3 shows test results upon adding a 200-ohm resistor in series with the meter. Obviously, it is possible to select a resistance so that the meter at full-scale corresponds to a certain light level provided that the cell output current at the desired light level exceeds full-scale in absence of the series resistor. Curve 4 shows the effect of adding 1000 ohms in series with the meter.

Resistance can be connected in parallel with the meter to extend the range of light measurements. This has the effect of lowering the load resistance on the cell. Because the parallel path of the shunt resistance carries some of the cell output current, the graph must be labeled as meter indication *versus* footcandles and not cell output current *versus* footcandles.

Applications

Comparison tests of the relative light output of cathode-ray tubes used in oscilloscopes and TV sets is one useful application of this light meter. In making comparative tests, test conditions must be identical. The raster size and the intensity settings must be the same, as should be the electron beam accelerating voltages.

For TV receivers, set the channel selector to a blank channel. For oscilloscopes, feed the 60-cps test signal into the vertical axis and set the sweep frequency to a high value to obtain a raster. Adjust the gain controls to obtain a raster just larger than the exposed area of the cell. This will give a higher reading on the meter. Be careful to avoid burning the screen of the tube by accidentally producing an excessively bright dot or raster. If necessary, expand the raster or reduce the intensity setting. The cell may be taped to the face of the tube for convenience during tests. For scope tubes, use the positioning controls to shift the small raster behind the photocell and maximize the meter indication that is obtained.

Although a reading in footcandles taken at the face of the tube is not meaningful by itself, it can be compared to a reading taken on another tube operating under similar conditions to determine relative light outputs. Because of the relatively low light levels produced by the cathode-ray tube, it is necessary to use a 50- or 100-μa. meter and a large cell. Cells may be paralleled for higher output at very low light levels, but each particular combination of meter and cells should be calibrated as a unit.

Measurement of light in photography is another application. In microfilming, it is essential to provide uniform illumination to avoid non-uniform negatives. By placing the cell on the copy at each corner and at the center, we can adjust the lamps to obtain uniform illumination. Then, a test strip of film is exposed at various camera settings to determine the proper exposure time. The resulting data is recorded for future use and assures positive results when using high-contrast copying films. Light levels can be measured in any photographic situation and the data recorded for future use.

The inverse square law of light previously described can be used to calculate the candlepower of an incandescent lamp. Use a clear glass lamp if available and measure the distance to the filament of the lamp. From the distance r and illumination I, the candlepower P can be calculated. Place the photocell at least two or three feet from the lamp and do not use any reflectors.

Further applications include the measurement of light losses in clear and colored glasses and light filters, density of negatives, and measurement of illumination in living and working areas. Thus, the selenium photocell light meter is a useful and practical device. ▲

ANSWERS TO QUIZ

(Appearing on page 66)

1. L	6. G	11. F
2. E	7. H	12. C
3. O	8. M	13. N
4. I	9. B	14. D
5. A	10. K	15. J

Answer to Solid-State Crosswords

(Appearing on page 75)

■	S	E	M	I	C	O	N	D	U	C	T	O	R	■
■	I	■	O	■	A	N	I	O	N	■	H	■	E	■
T	■	B	O	X	■	E	■	■	■	I	E	■	A	T
R	A	■	T	Y	■	■	S	A	N	D	W	I	C	H
A	T	T	■	Z	E	N	E	R	■	A	■	A	T	E
N	O	D	E	■	S	O	R	T	S	■	C	■	O	R
S	M	■	■	G	■	■	V	S	■	C	O	■	R	M
I	■	R	E	E	D	■	O	■	C	E	L	L	■	I
S	T	A	R	■	■	■	■	■	■	■	L	■	E	S
T	E	T	R	O	D	E	■	A	P	S	E	■	M	T
O	S	■	■	P	I	N	■	T	A	L	C	■	I	O
R	L	■	S	T	O	W	■	O	■	A	T	■	T	R
S	A	N	K	■	D	R	A	M	■	V	O	L	T	S
■	■	P	I	■	E	A	■	I	■	E	R	I	E	■
N	P	N	P	■	S	P	■	C	U	■	S	P	R	Y

IMPROVED MICROPHONE CIRCUIT

By TOM LAMB, K8ERV

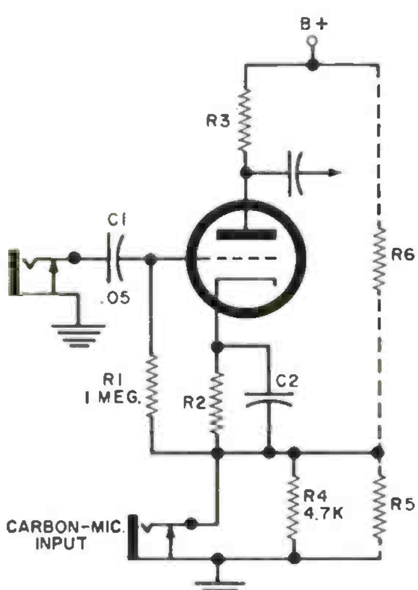
Simple modification takes the carbon microphone out of amplifier bias circuit.

THE popular carbon microphone circuit places the mike directly in the cathode of the speech amplifier tube (or emitter circuit of a transistor). The required mike current is supplied by the tube and the circuit is very simple. Unfortunately, the microphone resistance is part of the bias circuit. Changes in this resistance from different mikes or different mike positions can shift the stage bias enough to cause considerable distortion.

The microphone may be removed from the bias circuit as shown in the schematic. Returning the grid resistor, R_1, to the mike, rather than to ground, does the trick. The mike is now simply in the "B−" lead and does not affect the tube's operating point. As long as the grid is bypassed to ground by C_1, the signal circuit is identical to the more common circuit. R_1 prevents the cathode voltage from sailing up to the "B+" value should the carbon mike circuit be opened. The plate and cathode resistances are taken from the resistance-coupled amplifier tables.

The carbon mike circuit gain may be adjusted to match the Hi-Z input. Shunting the mike (R_5) lowers the gain, while increasing the mike current (R_6) raises the gain. ▲

By employing the circuit shown below for the microphone amplifier, the resistance of the carbon microphone is removed from the bias network of the amplifier tube. A high-impedance microphone may still be connected to the grid circuit by way of the high-Z input mike jack as is shown.



Pulse-Modulation Techniques

(*Continued from page 53*)

successive cycles) is a synchronization or "marker" pulse. As its name implies, it marks the beginning of each cycle and triggers the receiver for synchronous operation with the transmitter.

In practice, in the various pulse-modulation systems to be described, the marker pulse may be identified by its magnitude, its absence (a timed space), or its duration. It should be recognized that "jitter" of the marker with respect to its specifying parameter is critical to the operation of the entire system, since the coincidence of a burst of noise with marker time which distorts that parameter has the effect of shifting the time-axis for that entire cycle.

Fig. 3 illustrates one example of several types of pulse-modulation systems commonly used. In these systems, a periodic sequence of pulses, or pulse-train, constitutes the carrier. Its characteristics are varied, or modulated, by the input signal.

PAM, PDM, and PPM

In Fig. 3 (and Fig. 6), since the train of periodic pulses is modulated by the amplitude of the input signal, this system is called *pulse-amplitude modulation* (PAM) in the communication field, equivalent to the term "sampled-data system" in the controls field. In PAM, the amplitude of the pulse-train increases or decreases according to whether the input signal is positive or negative.

Another significant technique is the use of the input signal to modulate the width of successive pulses, called *pulse-width modulation* (PWM), or more commonly, *pulse-duration modulation* (PDM), since the "width" of pulses is measured on a time scale. In PDM, pulse width increases or decreases as the signal amplitude varies about its zero-reference (*i.e.*, positive or negative). See Fig. 6. In a variation of this method, the position of the leading edges of the pulses is fixed, with all of the variation in the widths of the pulses taking place by varying the trailing edges according to signal variation. The earliest recorded patent for a PDM system was apparently issued to R. A. Heising in 1924.

When pulse width and amplitude are unaltered, but pulse occurrence is delayed or advanced in time in accordance with the input signal, the method is called *pulse-position modulation* (PPM). PPM was patented by R. D. Nell in 1934.

The individual drawings of Fig. 6 summarize graphically the three methods discussed to this point. Each presents an alternate representation for a single input channel.

PAM and PDM are readily represented by Fig. 6, but PPM is more difficult to visualize. Fig. 7 may be helpful due to the "stroboscopic" method of presentation. Assume that the sine wave appears on Channel 2, Channel 1 being idle. Successive traces, termed "frames," show 1 cycle each, that is, the time axis continues from one frame to the next but has been broken off at interval T to make the dynamic development easier.

It is interesting to examine actual practice in the light of the conditions stated previously. The *Federal Telephone* system uses PPM having the following specifications.

a. Twenty-three voice channels are transmitted, each described as passing frequencies between 100 and 3400 cps.

b. The sample rate is 8 kc., which is greater than 2 x 3.4 kc.; the sample interval is thus 1/8 kc. = 125 μsec.

c. Marker pulses are sent at the start of each new time interval, *i.e.*, 23 input pulses per marker.

d. Approximately 5 μsec. are available per channel (125/24), which includes 2.7 μsec. guard time and 2 μsec. for maximum displacement (maximum modulation).

PPM and PDM systems require greater bandwidths than c.w. systems, for they depend on accurate location of pulse edges. However, the increased bandwidth leads to signal-to-noise ratio improvement in PPM. As stated earlier, the modulated pulses of PPM and PDM, being of uniform amplitude, may be reshaped periodically during transmission to avoid excessive distortion.

PCM

Another form of pulse modulation has been developed recently, to improve the validity of transmission, and this is *pulse-code modulation* (PCM). Sample signals are first "quantized," that is, determination is made into which one of a definite number of discrete amplitude levels each sample belongs. Each quantized sample is then assigned a particular code pattern, being uniquely related to the magnitude of the sample. The coded signal is then transmitted. Consisting only of discrete pulses, each code pattern is identified when received, even though it may have been deformed by noise. It is then decoded and caused to produce a voltage proportional to the original sample signal. By making each amplitude-level step sufficiently small, the original wave may be approximated as closely as desired.

PCM has two outstanding properties: It possesses marked freedom from noise and interference and permits relaying signals without significant distortion. At each regenerative repeater, a new correct (and noiseless) code pattern is transmitted to the next repeater.

All the pulse-modulation systems described above are widely used for data transmission. It is important that the industrial technician be familiar with all of these systems and their operating characteristics.

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Kloeffler, R. G. & Horrell, M. W.: "Basic Electronics," John Wiley & Sons, New York 1957

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IDENTIFY YOUR COMPONENTS

By **HOWARD S. PYLE**

Insure component duplication by labeling the major parts in your construction projects.

YOU ARE in the process of building a piece of hi-fi gear, an item of test or measuring equipment, or perhaps a ham transmitter or receiver. You mount transformers, chokes, and other major components in a neat cabinet and come up with a mighty nice looking job which performs as well as it looks. You make a mental note that the next time you are building something requiring similar components you'd like to use the same brands which worked out so well in the present project. Months later you come up with an idea involving such components but you can't remember the manufacturer's name, let alone the part numbers of the items you formerly used and want to duplicate.

There are several ways of avoiding this dilemma: you can make a list of all such items as you install them—but that is almost as bad as "mental notes" for when you look for the list, you've probably mislaid it. Or, if you make a schematic of the rig, you can letter this information right on the drawing, providing you can remember later where you put the drawing! It seems odd but many of the smaller components like resistors and capacitors are pretty well labeled both with their make and their values, while the larger items seldom are.

The author has found that the best way to lick this problem is to remove the label from the wrapping in which the component comes (if you buy it new). Cabinets and chassis are generally packaged in lightweight wrapping paper with a prominent label glued on one or both ends of the package. Carefully tear out the label area from the paper and drop it in a pan of water for from 15 to 30 minutes and it will peel right off. When it is dry, glue it right on the part itself; the back apron of a chassis, one side or the other of a transformer, the bottom of the cabinet, etc. Give the whole label a coat of clear lacquer after the glue dries and you will find that the label will remain intact for a long time.

With used parts lacking a wrapping, print or type such a label with all of the information you have on the component and attach it in the same manner. ▲

Mac's Electronics Service

(*Continued from page* 48)

his course and then concentrate entirely on transistor radio service."

"Hm-m-m-m, what reasons did you give?"

"First, this kind of service will require a very minimum expenditure of physical energy. The heaviest transistor receiver won't weigh more than three or four pounds. Second, he can start a shop in a small, low-rent room. All the receivers he will have in his shop can be stored on two or three shelves. Miniature replacement parts could be stored in a very small space. The new universal-replacement-type transistors coming on the market will enable him to have a small, rapidly moving stock of these instead of the shelves and shelves of tubes we have to keep on hand to service tube-type radios and TV sets. Even his bench need not be more than a fourth the size of ours."

"What instruments do you figure he will need?"

"I suggested he could start with either a v.o.m. or v.t.v.m., a signal generator, a signal tracer, and a transistor tester. That means he won't have to buy a scope, sweep generator, tube tester, isolation transformer, flyback checker, color bar generator, and a whole mess of other instruments and probes we use in our business."

"Yeah, and he can also get by with a lot slimmer service library than we can," Mac said thoughtfully. "Our service data includes diagrams of sets going back to 1946; but he can start with *Regency's* TR-1 that appeared in service literature in July 1955, and come up to the present. That means a big saving in both money invested and room needed to store this service literature. In fact, if he did not want to subscribe to the entire radio and TV service literature output—and most of it would be useless to him—he probably could manage quite well just by buying the Transistor Servicing Manuals put out annually. He would not have quite so up-to-the-minute service data, but I think he could manage quite well until he sort of got on his feet."

"And don't forget he'll not need any pick-up and delivery equipment," Barney pointed out. "All his business can be cash-and-carry. If a customer can't bring his radio in or pick it up, he can have a taxi do it for him."

"Even the hand tools needed will be few and inexpensive," Mac observed. "The soldering iron can be a miniature type. No large screwdrivers or heavy-duty pliers will be needed. A few small wrenches will suffice. He won't need a whole quiver full of alignment tools as we do."

"Then you're not mad at me for encouraging competition?" Barney asked hopefully.

"Of course not! Any time we're in a business where we can't afford to scoot over a bit and make room for a man who needs the work as much as this fellow does, we'd better get out of that business. We're human beings first and businessmen second. I'm proud of you for helping him, and I'll be more than happy to give him a hand, too. The more I think about it, the more convinced I am that transistor radio servicing is a good field for people with limited physical ability. It's something they should be able to do just as well as an able-bodied man."

"Yes, and it is a field that is just starting to roll," Barney added as he swung a heavy TV chassis from the "incoming bench" over to his work area. "I don't think it will be too long until transistors will cut the weight of these back-breakers to a fraction of what they weigh now. When that happens, the fellow who has really learned to work with transistors in radios can make a smooth transition into TV service—providing, of course, he has kept right up on his technical reading in the TV field."

"I'm glad you put in that postscript," Mac remarked as he, too, started to work. "The technician who neglects his technical reading these days is already on his way down, whether he knows it or not." ▲

SHORTENING SCREWS

By GLEN F. STILLWELL

FREQUENTLY there is need to shorten a machine bolt or capscrew to properly fit into a hole. This is ordinarily a tedious and difficult task because the screw cannot be clamped securely in the vise without marring the threads. Even when this is possible, the sawing may leave a jagged end. When this happens, the screw cannot be used until the threads are "chased" or smoothed.

To overcome this trouble, simply thread two nuts on the screw and use them to clamp the screw in the vise. This will prevent marring screw head or the threads. Cut off the screw at the desired point, smooth the end with a file and the removal of the nuts will "chase" the threads for immediate use. ▲

"Yes, I'm familiar with your line—I've heard it from a dozen different salesmen!"

Product Test Report

(Continued from page 20)

indicator lamps for the v.t.v.m. These lamps operate in conjunction with the range switch. Instead of having to study the scales and deciding which one to read when you change ranges, all you need do is to look for the lighted arrow to show you instantly which scale is to be used. Still another feature is the pair of convenience outlets connected right across the meter's line cord so that you can plug in a soldering iron or a TV set. Finally, the compact, easy-to-carry metal case, with some useful servicing data printed inside the cover, makes it extremely convenient to take the combination meter from one job to another.

In order to see just how good the SM112 really is, we checked it against a laboratory a.c. v.t.v.m. and a couple of lab-type v.o.m.'s. We took measurements on all the voltage ranges for both v.t.v.m. and v.o.m. opration. We found that all d.c. v.t.v.m. readings fell between exactly the correct values and 1.3% (of full-scale) high, with most of the readings being high by only a small fraction of 1%. All d.c. v.o.m. readings were between .5% and 2.6% (of full-scale) high, with most of the readings around +1%. All these figures are well within the ±3% accuracy claimed by the manufacturer, with most of the v.t.v.m. readings being especially close.

We next checked the a.c. scales. All a.c. v.t.v.m. readings were between −1% and +3% of full-scale, with most of the readings around +1%. All a.c. v.o.m. readings were between −.6% and +3%, with most of the readings a little over +1% of full scale. These figures too were within the ±5% accuracy claimed. The results obtained on a.c. were all the more remarkable when it is considered that no special a.c. scales are used on the v.t.v.m. What is more, although most of our a.c. measurements were taken around 60 cps, we did take some checks as high as 100 kc. and all readings that we obtained were well within the figures indicated above.

To summarize, the Sencore SM112 is not only a very versatile, convenient, and useful addition to the service bench, but its accuracy of reading puts it well in the forefront of multipurpose service-type meters. The instrument sells for $69.95.
E.W.

If you are ever stuck for a convenient housing for your custom hi-fi amplifier, Glen F. Stillwell suggests using a small size card index drawer. They are available at nominal cost at many variety stores or can often be obtained from office salvage suppliers for less than a dollar. Such a case will accomodate many amplifiers and thus put the unit in an accessible housing which can be mounted in a wide variety of different ways.

LIGHT-BULB VOLUME EXPANDER

By **GIL ARROYO** / Hughes Aircraft Co.

Complete analysis and design of a simple bridge circuit that will increase the dynamic range of a hi-fi system.

EDITOR'S NOTE: *The idea of using the changing resistance of a light bulb in a volume-expander circuit is not new. We have run articles in the past showing various circuit arrangements that can be used. However, the article below is a fairly comprehensive study by our author, and we felt that our readers would be interested in it. Because of the thermal lag of the bulb filaments, there may be objectionably long attack times and "overhang" with this circuit, particularly if it is adjusted to give maximum expansion. Also, the expansion will change at different listening levels. However, the circuit is simple to build, uses a handful of inexpensive parts, and is easy to try.*

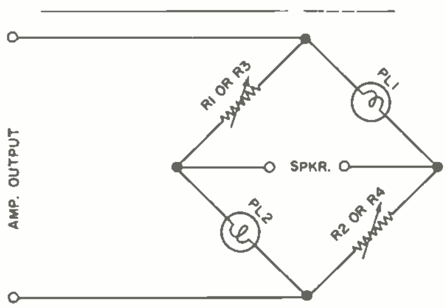
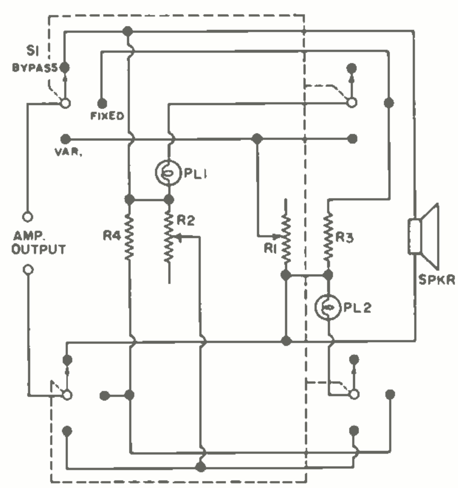


Fig. 1. Basic bridge circuit used.

SOME TIME ago the writer came to the conclusion that record and tape recordings did not seem to have the same dynamic range that is heard in live performances. This is because of the volume compression that is usually employed when a record is made or when a program is broadcast over the air. To compensate for this, a volume expander is required. Investigation of various expansion circuits, some involving considerable complexity, revealed that the use of some of the circuits resulted in an increase of the intermodulation distortion effects.

It was decided to build a simple circuit (Fig. 1) using the changing resistance of two ordinary miniature lamp bulbs in order to bring about expansion.



PL1, PL2 - SELECTED LAMPS
R3, R4 - 0-10 Ω, 5W. (MIN.) ADJ.
SPKR - 8-16 Ω
R1, R2 - 0-10 Ω, 2W. (MIN.)
S1 - 4P3T SWITCH

Fig. 3. Circuit diagram of unit which permits fixed and variable volume expansion.

This circuit is connected between the output of the power amplifier and the loudspeaker as shown. At low-level passages of music, the resistance of the lamps is low, the bridge is almost balanced, and there is very little output to the speaker. During high-level passages, the lamps light, their resistance increases, and the bridge becomes unbalanced. This increases the output to the speaker much more than it would ordinarily. Expansion of dynamic level has occurred. Fig. 5 shows the resistance characteristic of a #44 panel lamp bulb (6-8 volts at .25 amp.) at various values of applied voltage. Note the increasing slope at the lower voltage end. It is this low-voltage characteristic that is responsible for the increasing attenuation of quiet music passages and finally residual noise.

Several circuit configurations were tried, but none of them had the over-all simplicity, flexibility, and low distortion capability of the circuit adopted. See Fig. 3. A four-pole, triple-throw switch (*Allied* 34B357 or equivalent) is used in the circuit in order to bypass the expander or to provide a choice of adjustable tapped resistors for a fixed expansion ratio or a pair of rheostats for varying the expansion for a particular type and level of music at the moment. The rheostats should be adjusted to equal resistance values.

Fig. 2. Amount of expansion for various resistance values.

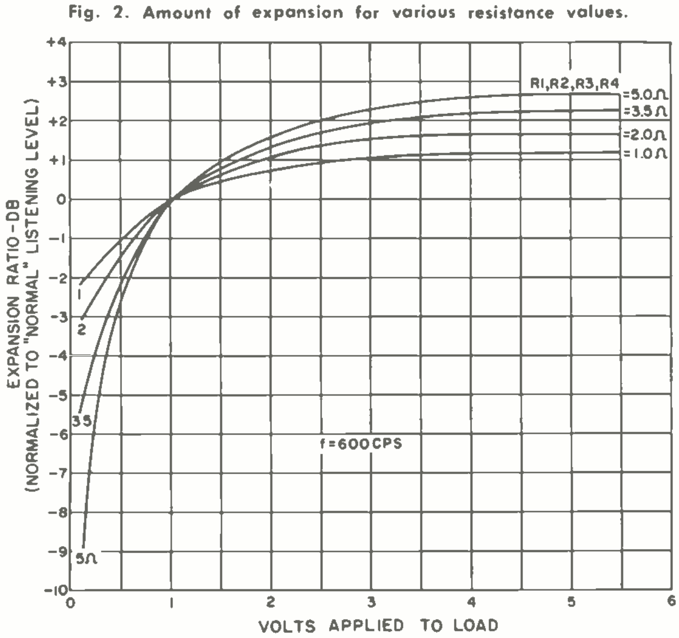
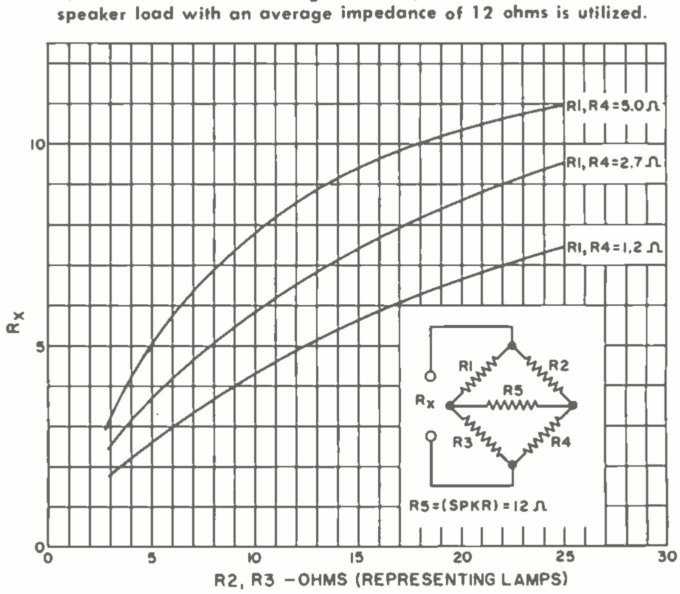


Fig. 4. Range of values of the circuit's input resistance (R_X) for various amounts of bridge and lamp resistance when a loudspeaker load with an average impedance of 12 ohms is utilized.



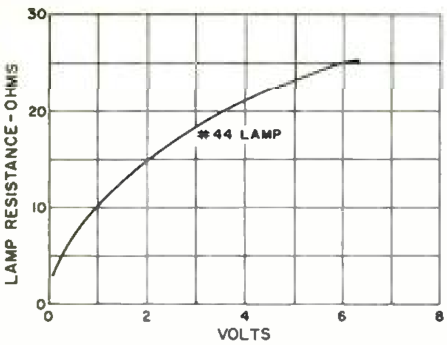


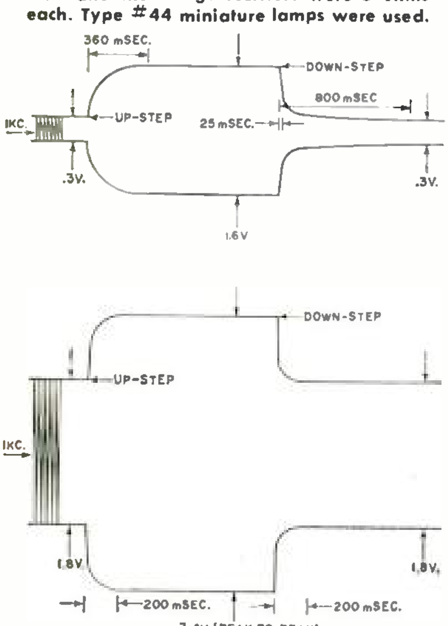
Fig. 5. Resistance at various voltages of the panel lamps used by the author.

Expansion range for any given amplifier is determined by the setting of the adjustable resistors or rheostats in the circuit and the pilot-lamp selection. Lamps that might be tried are: #55, #44, #1891, #50, #40, and #47, in order of decreasing sensitivity.

A *Heathkit* W5M (25-watt amplifier) was used in the initial tests. The #44 pilot lamps were found to be ideal for the operating range of the amplifier at the listening levels desired. In later tests, a *Heathkit* W7A (55-watt amplifier) was used with #1891 lamps and equally satisfying results were obtained.

Expansion ratios obtained are shown in Fig. 2 (as measured in the W5M, #44 lamp set-up). As can be seen, the expansion ratio increases with increasing rheostat resistance. The curves are based on a "nominal" listening level of one volt (r.m.s.) applied to the speaker terminals. It will be noted that the curve of expansion tends to flatten as the power to the speaker increases. The flattening is due to the decreasing resistance to voltage slope of the lamps in the circuit. On the low-voltage end, it will be noted that considerable range of listening expansion is achieved by the bridge circuit. It will be found that at normal listening, expansion will average 6 to 8 db and that an additional 10 db or more attenuation occurs at the residual noise level. (The negative numbers on the db scale refer to levels below the "nominal" level.)

Fig. 6. Rise and decay times at two values of input. An 8-ohm speaker was used as the load and the bridge resistors were 5 ohms each. Type #44 miniature lamps were used.



Distortion levels were checked before and after the expander installation and the distortion increases were small and probably all attributable to the unavoidable impedance mismatch generated by this type of circuit.

Fig. 4 shows the input resistance for various lamp and bridge-arm resistances. With an average speaker impedance of 12 ohms, the input resistance (R_i) is in the 5-10 ohm range. It is suggested that the 4-ohm amplifier tap be used with 8-ohm speakers. The resistance relationships are not critical and individual choice of damping factor, amplifiers, expander lamps, and resistor values will determine the best match. The reader is urged to experiment.

Fig. 6 shows the attack and decay times for two voltage levels in response to step changes (as seen on a scope). It will be noted that the attack and decay times are longer at the lower listening levels. This characteristic tends to produce a more even listening level.

Set-Up Procedure

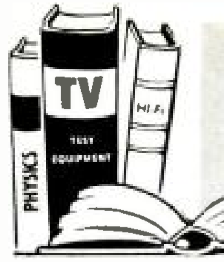
Connect the expander circuit with a pair of #44 lamps installed between the speaker and the amplifier output. Use one-half the usual driving impedance tap (*i.e.*, 8-ohm output tap for 16-ohm speaker). Put the selector switch in the "Bypass" position. Set the variable resistors to mid-range (about 4 to 5 ohms each). Care should be exercised to avoid burning out the lamps while setting up.

Establish a normal listening level using music containing short passages of soft and loud material. It should be emphasized that the device should not be used for background music. It operates best in the normal listening range. When the listening level is established, switch in the rheostats ("Var" position of switch). Then re-establish normal listening level using the amplifier volume control. The soft passages should be quite noticeably quieter and the loud passages louder than before. When the music stops, there should be no audible noise. If the music seems to undulate or if the soft passages are inaudible, try setting the resistance arms to lower values. This will reduce the expansion range. If a lower setting is satisfactory, then the next lower amplifier output tap should be tried for optimum power transfer.

If the full range of the rheostats does not produce the desired effect, try using a pair of #55 lamps for more, and #1891 lamps for less "sensitivity" before using different rheostat values.

Once the average expansion characteristics are established, the tapped adjustable resistors ("Fixed" position of switch) may be set to the rheostat values; the rheostats are then used for the custom setting of particular music levels or types of music.

The device as described is for a single channel. A companion unit should be constructed for use with stereo or dual-channel sound systems. ▲



Technical BOOKS

"ROD, BAR AND WIRE" by Kaiser Technical Publications Dept. Published by *Kaiser Aluminum & Chemical Sales, Inc.*, Oakland, California. 364 pages. Price $7.50

This is a revised product information book designed to meet the increasing need for current data applicable to the rapidly expanding metal-working field where aluminum rod, bar, and wire are used.

In addition to new alloy descriptions and product availabilities, the book presents specific characteristics about standard alloys. It also discusses in detail advanced fabrication techniques developed for a broad range of development work.

Technical information covers metal working methods, welding, mechanical joining and finishing. Engineering tables, designed to simplify and speed reference work, are listed in a classified index for ready accessibility.

* * *

"INTRODUCTION TO FEEDBACK SYSTEMS" by L. Dale Harris. Published by *John Wiley & Sons, Inc.*, New York. 360 pages. Price $10.50.

This volume has been prepared with the undergraduate student of science and engineering in mind and is designed to help correlate the aspects of feedback in electronics and control systems into a common approach.

With this thought in mind, the author has devoted a chapter to laying a common background of feedback ideas. He then takes up mathematics and physical systems, root-locus, response of feedback systems, feedback and pole-zero configuration, feedback in amplifiers, feedback control systems, sinusoidal methods of analysis, oscillating systems, LaPlace transform, roots of higher-order equations by root-locus, transfer functions of physical systems, and real axis departures of root-locus branches.

A facility in handling mathematical procedures is requisite for the user of this text.

* * *

"ABC'S OF ULTRASONICS" by Alan Andrews. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 94 pages. Price $1.95. Soft cover.

The science of ultrasonics has captured the imagination of the layman and engineer alike and questions regarding its application come thick and fast. This volume is designed to introduce the reader to the basic operating principles, the terminology, and applications such as cleaning, degreasing, thickness and distance measurement, testing, machining, welding, and soldering. Medical uses are touched on briefly.

Descriptions and photographs of specific commercial equipment for the various applications have been included which helps to make this a "buyer's guide" as well as an interesting and informative text.

* * *

"AMPLIFIER CIRCUITS" by Thomas M. Adams. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 133 pages. Price $2.95.

This is the second volume in this publisher's "Basic Electronics Series" which features dynamic circuit diagrams in four colors to demonstrate circuit operation.

The text is divided into seven chapters covering basic vacuum-tube actions, *RC*-coupled and transformer-coupled a.f. voltage amplifiers, audio-frequency power amplifiers, audio phase-inversion circuits, and impedance-coupled and transformer-coupled r.f. voltage amplifiers.

The author has presented his material at a basic level with the requisite explanatory data provided as required, making it a self-contained volume on the subject of basic amplifiers.

* * *

"TEACH-R-MATIC" compiled and published by *Harry G. Cisin, Publisher*, Amagansett, N.Y. Price $4.90. Soft cover book plus chart.

This is a basic teaching aide rather than a specific book in that the technique involved is applicable to various subjects and courses. Each workbook accompanying the multiple-choice chart (like a large circular slide-rule) includes special cards to be inserted into either the true or false slots of the chart.

The Study Course No. TV1 covers the diagnoses of TV and radio faults. The system can be used either for mastering original material or reviewing previously learned material before examinations.

* * *

"UNDERSTANDING DIGITAL COMPUTERS" by Paul Siegel. Published by *John Wiley & Sons, Inc.*, New York. 393 pages. Price $8.50.

This is a basic text covering the fundamentals of operating digital computers and data processors, with special emphasis on the practical aspects of the subject. From the introductory chapter in which the author explores the question as to what is a digital computer to the final chapter when he carefully details the operation of a specimen computer, he has stressed usability in his material. The text is clearly written, well illustrated, and each chapter carries with it a special summary.

Even those studying on their own should be able to derive much valuable practical material from this exposition.

* * *

"AUTO RADIO MANUAL" by Sams Staff. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 160 pages. Price $2.95. Soft cover.

This is Volume 13 in the auto-radio service data series and covers 50 models used in late model cars including sets by *Automatic, Blaupunkt, Buick, Chevrolet, GMC, Karmann-Ghia, Mercury, Mopar, Motorola, Oldsmobile, Pontiac, Riverside, Studebaker*, and *Volkswagen*.

Like previous manuals in the series, the volume includes standard notation schematics, resistance charts, chassis photos, parts lists and replacement data, alignment information, push-button adjustments, plus time-saving service hints.

* * *

"TRANSIENT CIRCUIT ANALYSIS" by Y. H. Ku. Published by *D. Van Nostrand Company, Inc.*, Princeton, N. J. 432 pages. Price $13.00.

This text has been prepared for graduate engineering students and covers the subject from the combined Fourier-transform and Laplace-transform approach. The material is presented progressively and is based on the author's course at the University of Pennsylvania's Moore School of Electrical Engineering.

There are eleven chapters and four appendices, including a table of Laplace and Fourier transforms. Since the treatment is exclusively mathematical, those without a thorough grounding in complex variables, Fourier series, integral, transform, functions of complex variables, etc. are put on notice that this volume is not for them.

* * *

"SYSTEMS: RESEARCH AND DESIGN" edited by Donald P. Eckman. Published by *John Wiley & Sons, Inc.*, New York. 308 pages. Price $8.50.

This volume comprises the proceedings of the first Systems Symposium held at Case Institute of Technology in Cleveland under the sponsorship of the Systems Research Center of the Institute.

Fourteen papers have been assembled and edited by Dr. Eckman, director of the Systems Research Center. This volume covers a wide range of problems and approaches to their solution by means of "systems engineering."

Those involved in this burgeoning technology will find this compilation a gold mine of basic thought on the subject.

* * *

"SERVICING TV REMOTE CONTROLS" by Samuel L. Marshall. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 151 pages. Price $2.95. Soft cover.

Since the "age of the push-button" has hit TV set makers, service technicians are called upon to handle a wide variety of remote-control devices—most of which are relatively unfamiliar, if not a complete mystery.

This volume covers the principles of operation and servicing techniques for all types of transmitters, receivers, and relay- and motor-control systems. Whole chapters are devoted to *Sylvania, Zenith, Packard-Bell*, and *General Electric* systems.

* * *

"GENERAL CLASS AMATEUR LICENSE HANDBOOK" by Howard S. Pyle, W7OE. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 126 pages. Price $2.50. Soft cover.

This handy manual by a real "Old Timer" provides not only basic theory, but complete information and typical questions and answers needed by the Novice or those studying for the Technician, Conditional, or General class amateur tickets.

The text is divided into ten chapters which present the material progressively for self-instruction and home study.

* * *

"MOST-OFTEN-NEEDED 1940 RADIO DIAGRAMS AND SERVICING INFORMATION." Compiled by M. N. Beitman. Published by *Supreme Publications*, Highland Park, Ill. 208 pages. Price $2.50. Soft cover.

It seems incredible in this day of "conspicuous consumption" that there are still 1940 radios around to be serviced but evidently there are enough of them to justify this publication. The sets of almost 50 makers are included, along with schematics, parts lists and service notes. ▲

ACCURATE V.O.M. RESISTANCE MEASUREMENT

By TOM JASKI

Although ohms scales on commercial v.o.m.'s are not always reliable, voltage and current functions can be used for precise measurement.

MUCH HAS been said about the inaccuracy of the ohms scales on most voltohmmeters (see "Is Your Multimeter Accurate?" page 32, February 1961), and justifiably so. Not only is initial precision open to much question, but long-term reliability is also suspect. As the internal battery used for resistance measurement ages, voltage distribution through the divider of which the external resistor becomes an effective part changes. Thus a calibration made at any given time may not be valid at some later date, when battery condition or the battery itself is different.

The technician may often have good reason for wanting to take a dependable and accurate resistance reading, although he does not have access to a bridge or other precise instruments. Can he do it with a v.o.m.? Yes, he can. The most obvious way is to apply power across the resistor to be measured, take a reading of the voltage across it, take another reading of the current through it, and then use Ohm's Law ($R=E/I$). If he knows the accuracy of his d.c. voltage and current scales, which are relatively easy to check (see "Calibration Standards for the V.O.M.," page 51, October 1961), he should certainly be able to get a reading that is more accurate and dependable than the one the ohmmeter function will give him.

Sometimes, however, he wants true precision. For various reasons, the simple technique just noted cannot provide it. Suppose that the current through the unknown resistor is just a few microamperes. To take a reading, the user will have to place the v.o.m., set on its lowest current scale, in series with the unknown. But the meter's internal resistance on this scale can be a few thousand ohms. This may throw off the current reading quite a bit. Then he connects his v.o.m. across the unknown to take a voltage reading. But the shunt resistance of the meter draws increased current from the source. Unless a well regulated supply is used, the additional loading will cause voltage to shift from what it was in the first measurement. Even with excellent regulation, actual voltage across the unknown resistor will not be the same in both steps, because of the drop across the meter's resistance during the first step (current measurement). Thus the variations in both I and E will combine to throw the calculation off.

We have assumed the absence of auxiliary, precision equipment. Can a more accurate reading be obtained? Again the answer is yes. All that is needed in addition to the meter itself is a voltage source and a few resistors. None of these has to be precise, for reasons we will touch on later. Aside from equipment, some information—about the v.o.m. itself—is needed. First, the circuit resistance of the instrument on any d.c. voltage scale must be known. This is easily derived from the ohms-per-volt rating. Thus a 10,000-ohms-per-volt meter would have an internal resistance of 25,000 ohms on its 2.5-volt scale.

Second, internal resistance on any current scale must be known. The manufacturer usually also provides this data, although indirectly. For instance, he might say that the unit is rated at 100 mv. on the 100 ma. range. From Ohm's Law, then, internal resistance on this range would be 1 ohm.

If these resistance values are not readily available, you can determine them approximately (which is all you need) with little difficulty. First apply voltage to the meter on the scale in question through a high-resistance pot set for maximum resistance. Then adjust the pot to produce full-scale deflection. This is shown in Fig. 1A, with voltage and resistance values that would be safe for current scales as low as 50 microamperes.

Now shunt the meter with a resistor of known value (Fig. 1B) and note the new reading. Suppose this is 30 μa., whereas the full-scale reading was 50 μa. This means the added shunt is drawing 20 μa. approximately (since total current drawn has changed very slightly from 50 μa., which is not important). Since the ohmic value of two parallel resistors is inversely proportional to the currents through each, we now know that meter resistance is ⅔ the value of the known resistor.

We are now ready for "the method." which can be performed in either of two ways, depending on the approximate value (ordinary ohmmeter check) of the resistor we want to know precisely. For low values, we use the first variation.

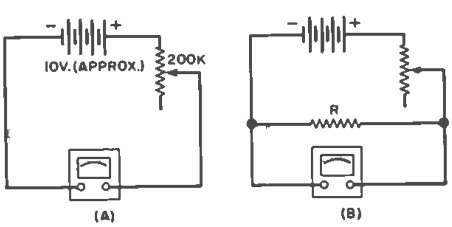


Fig. 1. Approximate internal resistance can be determined in two, quick steps.

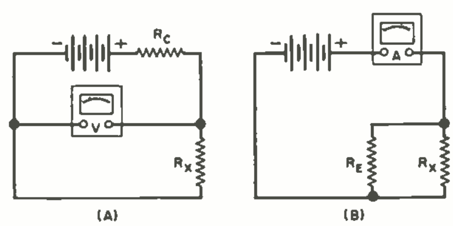


Fig. 2. Arrangement for the two readings needed to calculate low-value resistance.

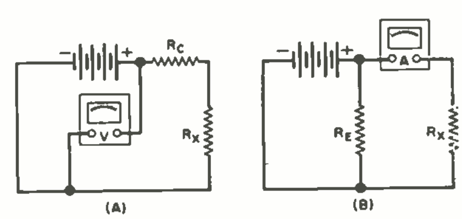


Fig. 3. Arrangement for the two readings needed to calculate high-value resistance.

This covers anything from 1 per-cent of internal resistance on the voltage scale to be used on down. For example, assume that a 20,000-ohms-per-volt device will be used on the 2.5-volt scale. Internal resistance being 50,000 ohms, we can measure from 500 ohms down accurately.

(Where resistor values are 100 times that of the current scale to be used, or higher, the second variation would be more precise. Suppose internal resistance on the 100-ma. scale is 2.5 ohms. This would cover values from 250 ohms on up. With a reasonable voltage source, we have full-range coverage of unknown values.)

Low-Resistance Method

The first variation of the method is shown in Fig. 2. Essentially this is an elaboration of the first technique proposed, involving two steps, in which first voltage and then current readings are taken across the unknown, R_x. However, another resistor has been added in each step to compensate for the shifts in current and voltage that would otherwise take place. In the first step, we take a voltage reading across the unknown, but we do so with another resistor, R_c, placed in series with the voltage source. R_C is simply a standard-value, standard-tolerance component (5 or 10 per-cent, with the former preferred), chosen to be as close as we can possibly get to the resistance of the v.o.m. on the *current* scale we are going to use.

In the second step (Fig. 2B), we take our current reading through unknown resistor R_X—but this time we have shunted the latter with R_E. R_E is another ordinary resistor whose value is chosen to equal internal meter resistance on the *voltage* scale used in the first step. The same source voltage is used, of course, in both steps.

What have we accomplished by adding extra resistors? We have made the circuits in parts *A* and *B* of Fig. 2 identical. In the first case, we have resistor R_C in series with the supply and also in series with a parallel combination of R_X and R_E (in this case, represented by the v.o.m. itself). In the second step, we again have R_C (represented by the v.o.m.) itself in series with the supply and also in series with a parallel combination of R_X and R_E. Current and voltage distribution will be the same in both steps, with no shifts due to differences in loading. However, instead of using the simple version of Ohm's Law ($R = E/I$) to calculate resistance from our two readings, we must make allowance for our added resistors. The formula becomes $R_X = ER_E/(IR_E - E)$. R_X is the unknown resistance, E and I the voltage and current readings taken, and R_E is the internal resistance of the v.o.m. on the voltage scale used (or the resistor substitute).

We have dealt lightly with the need for an accurate supply or precision resistors. As to the supply, only the voltage across the unknown is important, and this will not change with the technique described. As to the resistors, assume, for example, that the R_E substitute resistor is 20 per-cent off the actual meter resistance. However, the resistance being measured is only 1 per-cent of either value (or less). Total error would then be no more than 20 per-cent of 1 per-cent, or .2 per-cent!

High-Resistance Method

When measuring higher resistances, we would change the set-up in the two steps slightly, as shown in Fig. 3, although the principle of keeping circuit conditions identical to stabilize readings remains unchanged. Where resistance to be measured is higher, current is likely to be smaller, and therefore a lower current scale is used. The lower the current scale, the higher will be the internal resistance on that scale. Suppose that, in this set-up, the current-range substitute resistor, R_C, is 20 per-cent off the actual value of the v.o.m. At worst, this value is 1 per-cent that of series resistor R_X. Accuracy would then be the same as that obtained in the method of Fig. 2. In the set-up of Fig. 3, the formula for obtaining resistance is $R_X = E/I - R_C$. In each variation of the basic method, the set-up is such that substantial inaccuracy in the values of the meter-substitute resistors will have negligible effect on the answers. ▲

Advanced Training

(Continued from page 44)

aged by what they consider the high cost and long period of study. Both the cost of advanced courses and the length of time required become insignificant when compared to their potential importance. The few hundred dollars for correspondence study enabling a student to advance to a job with higher pay and a better future are often repaid during the first six months of the new career in the form of salary increases. It is difficult to put down hard and fast prices, since these will depend on the length and type of course and, to some extent, on the method of payment. In general, a course consisting of 25 lessons will cost somewhere around $350. When time payments or pay-as-you-learn plans (per lesson) are involved, the cost usually increases by about 10 per-cent.

As far as the time required to learn a particular subject is involved, this depends almost entirely on the student. The *Cleveland Institute of Electronics* has found that the average student can devote between 7 and 10 hours per week to his studies, which should be sufficient to digest an average of one lesson each week. Actually many students with past experience in electronics, already familiar with some of the material they must work with, are therefore able to absorb it faster. Regular study habits and a sincere desire to learn are most valuable assets. Sometimes it is possible to apply some of the new material directly and actually move into a better-paying job before completion of the course.

To sum up, the matter of cost and length of study should not deter a potential student. It will turn out that the things one learns are well worth the investment in time and money.

Who Qualifies?

As explained earlier, a certain technical background in electronics is required for many of the courses mentioned here. This background must include an understanding of the fundamentals of a.c. and d.c. networks, the principles of radio transmission and reception, and at least some familiarity with electronic equipment. The student should be able to read circuit diagrams, perform simple repair jobs, know the basic meters, and possibly understand the oscilloscope. This background is often gained by attending a trade school or by taking correspondence courses, followed by practical work as a radio and TV service technician. Those who are high-school graduates but do not have an adequate electronics background could qualify for these advanced courses by taking the fundamental radio and TV courses first or else they can enroll at a technical institute whose curriculum includes both fundamental and advanced technical training.

Where Does it Lead?

Anyone following the classified advertisements in the daily newspapers and the "Help Wanted" ads in the journals of the electronics industry will find the answer to this question right there. At the present time, the demand for non-degree personnel is greatest in the fields of commercial computers, automation, control electronics, and military field service. It is sometimes confusing that many different titles are applied by different companies to the same job. For example, the man who works for a civilian contractor and installs radar equipment in the arctic may be called a technical representative, a field service engineer, a customer service engineer, or simply a field engineer.

In deciding just where a person will fit in best, personal preferences, individual abilities, and personalities must be considered. For example, it probably would be a mistake for the head of a large family to seek a position as field service engineer in the arctic but the same position, with its high earnings, might be ideal for a bachelor out to earn a stake for his future.

Positions involving contact with commercial customers will naturally involve an outgoing personality with some potential for salesmanship an important asset. Inside positions, primarily concerned with technical details, call for the ability to concentrate on intricate technical problems. Jobs in quality control and reliability engineering are best performed by persons with patience and a liking for statistics. While most companies consider these factors very carefully when interviewing prospective employees, it is to the individual's own benefit to analyze himself along these lines before deciding where to apply.

Conclusion

As the electronics industry grows, it becomes more specialized. Many new jobs are opening up as a result of this specialization. These jobs require men with advanced technical knowledge. The technician already engaged in the industry is in the best position to fill these jobs, but he needs additional training for many of them. Such training is available from technical institutes and schools, both in residence and home-study programs. We have described what some of these programs offer and what is required to complete them successfully. Better jobs are available to those who have the technical "know-how" and ability. ▲

New Products and Literature for Electronics Technicians

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 120.

TRANSISTORIZED POWER SUPPLY

1 **Delco Radio Division** is now offering an all-transistor, electronically filtered power supply to convert 117-volt a.c. to 0-16 volts d.c. The unit is designed to be used as a bench power supply for automotive radio repair work.

Designated the Model P-612, the unit will operate any auto radio including "Wonder Bar" and all-transistor types. Its rated output is 8 amps continuous at 6 volts and 5 amps continuous at 12 volts with only .01% ripple at the rated load. Other features include smooth rheostat voltage control from 0 to 16 volts, electronic filtering, 20 amps instantaneous output, and lightweight, compact, portable design.

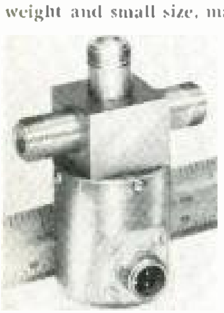
SIGNAL INJECTOR

2 **Don Bosco Electronics Inc.** is now marketing a small-size, low-cost transistorized signal injector known as the "Mosquito."

Designed for service technicians, engineers, and maintenance personnel, the probe can be coupled to magnetic pickups and circuits without leads. The unit covers a wide frequency range from basic mid-audio frequencies (approximately 1.5 kc.) to high r.f. with harmonics.

COAXIAL SWITCH

3 **Bay Roy Electronics, Inc.** is now offering a low-cost coaxial switch which features light weight and small size, making it suitable for limited-space applications.



The standard model employs type N connectors and a rapidly operating 117-volt a.c. actuator. The unit can also be supplied with other varieties of r.f. connectors such as BNC, TNC, UHF, etc., as well as with other actuating voltages.

The switch is suitable for receiver as well as low- and medium-power transmitter applications in the frequency range from 0 to 1200 mc.

STATIC RELAY

4 **Kidde Electronics Laboratories** has developed a compact new static relay which is said to eliminate problems of arcing in the switching of heavy inductive loads.

The Model WK-BYN-6 solenoid-actuating relay contact is a bi-stable semiconductor. Its sole stable states are a low-impedance or "on" state and a high-impedance or "off" state. Signals causing a change in state have the same effect as opening or closing a mechanical contact.

The relay measures 2" x 2" x 2" and operates in a range of line voltages from 105 to 127 volts at 60 cps. over an ambient temperature range of 0 to 50 degrees C.

TRANSISTOR & CIRCUIT TESTER

5 **Electronic Instrument Co., Inc.** is now offering a new transistor and circuit tester which provides significant measurement of actual transistor parameters, plus all the v.o.m. ranges needed to service transistor equipment.

The Model 680 employs a 50 μa., 3½-inch meter movement. The d.c. current ranges are 50 μa., 500 μa., 5 ma., 50 ma., 500 ma. while the d.c. voltage ranges are 5 and 50 volts. Resistance ranges include coverage from 0 to 20 megohms in three scales.

The instrument is housed in a Bakelite case measuring 6¾" x 5¼" x 3". It is offered in both kit and wired versions.

ULTRASONIC TOOL

6 **Electromation Component Corp.** is now marketing its "Ultrasonic Toolshop," an ultrasonic unit which utilizes a small, hand-held, air-cooled ultrasonic magnetostrictive transducer.

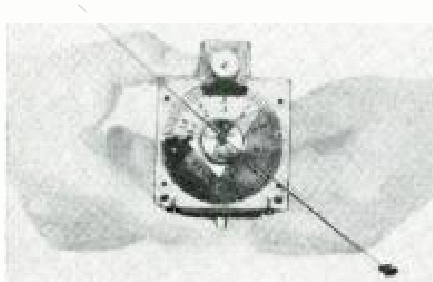
Using reciprocating motion, the instrument delivers accelerations up to 30,000 g's, with a mechanical amplitude of .0016" at the tool tip. The device can be used to make solder joints without flux; solder hard-to-join metals; seal plastics without heat; and cut, scribe, engrave, burnish, and grind metals with minimum effort.

The instrument operates from standard 117-volt a.c. lines and comes in a wide variety of standard tool tips. Custom-engineered tools are also available on special order.

TORQUE METER

Power Instruments, Inc. of Skokie, Illinois has recently introduced a new low-range, direct-reading "Torqmeter" for comparing the relative torque value of ball bearings. Full-scale ranges are 1, 2, and 5 grams/cm. providing 3% accurate readings from .1 to 5 grams/cm. at speeds up to 10,000 rpm.

The meter is of clear, molded plastic throughout making possible readings from either side as well as torques in either direction. The scale used is 5½ inches long. Degree graduation on the housing permits torque and degrees of deflection to be read simultaneously.



MAGNETIC-FIELD DETECTOR

7 **Instrument Systems Corporation** has just introduced a portable magnetic-field detector which detects and measures d.c. magnetic fields existing around many types of electronic and power equipment.

The unit is sensitive enough to give indications at levels as low as the earth's magnetism. The instrument employs a Hall-effect generator operating on semiconductor principles and having no moving parts. It incorporates a zero-center meter, allowing comparisons for polarity. The use of a "magnetic concentrator" permits operation without amplifiers from a single mercury battery, which supplies exciter current for the generator.

EPITAXIAL SWITCHES

8 **Texas Instruments Incorporated** has announced six new germanium epitaxial transistors for all ultra-high-speed switching applications from 3 ma. through 100 ma.

Transistor types 2N960 through 2N962 and 2N964 through 2N966 combine high dissipation, low I_{CBO} and rugged mesa construction with the epitaxial benefits of low storage time and low V_{CE}.

Packaged in a JEDEC-standard TO-18 case, they are available through the firm's sales offices and authorized distributors.

COMPUTER-CONVERTER TEST SET

9 **United Aircraft Corporation's Norden Div.** is now in production on a new test set for analogue-digital converters.

The unit presents a visual display on a series

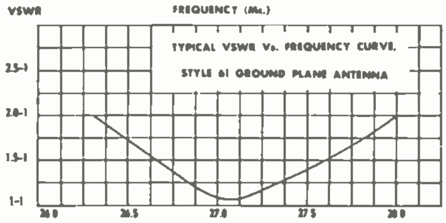
of light banks of either a binary (self-selecting model) or a binary-coded decimal encoder. The light banks present both the digit and the complement.

The set has a capacity for checking 22 bits for pure binary code and can test up to five decimal digits for a binary-coded decimal unit. Drive circuits are transistorized and several codes are applicable to the set. It can be operated by regular 117-volt, 60-cycle a.c. power input.

SUBMINIATURE POT

10 **Daystrom, Inc.'s Potentiometer Division** has announced the availability of a subminiature rotary potentiometer which is capable of delivering maximum performance in minimum space.

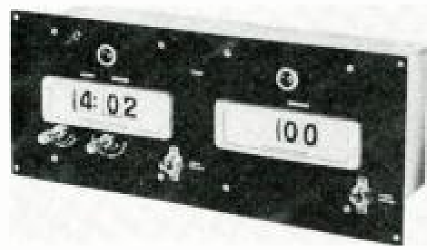
Weighing only 7 grams with a total over-all case length of only ⅜", the Model 304 is a single-turn unit which emphasizes high linearity.



Its standard is .3 to 3%, with linearities as fine as .18% available on special order. The units will carry 2 watts at 50 degrees C in still air and operate from —55 to 125 degrees C. Resistance values range from 10 ohms to 50,000 ohms.

DIGITAL CLOCK

11 **Pennwood Numechron Co.** is now marketing a "Gradinetic" second-by-second 5-digit readout digital clock which provides split second-by-second precision timing. Time is registered on 5 polygonal drums: a one-hour, a 10-minute, a 1-minute, and two "seconds" drums.



The entire unit is housed in a 4½" x 12" x 4½" dustproof case that weighs just 6 pounds. It can be panel mounted or used on a desk or bench.

Models to register 120 volts a.c., 50-60 cps; 240 volts a.c., 50-60 cps; and 115 volts a.c., 400 cps are available.

PRE- & POST-AMPLIFIERS

12 **Airborne Instruments Laboratory Division** is now offering a complete line of i.f. preamplifiers and postamplifiers. Standard models are at 30 and 60 mc. with both narrow-band and wide-band versions available.

The low-noise preamplifiers include single-ended, double-ended, balanced, and unbalanced input configurations. This new equipment can provide a variety of technical information including such characteristics as both typical and maximum noise figure, skirt selectivity, bandpass ripple, center frequency shift, and bandwidth change with gain.

POSITION TRANSDUCERS

13 **Lockheed Electronics Company** has announced the availability of a complete line of precision-built transducers designed to translate large mechanical deflections into accurate linear voltage changes.

Built around an infinite-resolution potentiometer which provides measurement accuracies within ± 0.1%, these precision transducers are available in various sizes for up to 120 feet displacement on request. The standard line is an off-the-shelf item. Case sizes vary from 2½" x 4" x 1⅞" to 4⅞" x 6½" x 6".

BINARY CODED SWITCH

14 **Ultronic Systems Corporation** is now offering a new series of ultra-switches which have been designated as 2000 binary coded switches. These fully mechanical push-button switches are designed for the manual conversion of decimal to various binary code systems. Standard models will convert to the 1-2-4-8 standard binary code but are easily adapted to other codes if required.

Two standard 10-key models are available; vertical mounting in a single row and horizontal mounting in two rows of five buttons each. Clear bars and an interlock, to permit one key to be depressed at a time, are available.

REGULATED D.C. SUPPLIES

15 **Fisher Research Laboratory, Inc.** is now offering a family of regulated d.c. power supplies of large current capacities. Supplies are high-efficiency solid-state using full-wave bridge rectification.

The PS-12-8 unit operates from inputs of 105 to 125 volts, a.c. and provides regulated 12 volt d.c. output ± 0.25 volt from zero to full load. Output current is 0 to 8 amps. The PS-32-15 operates from 105-125 or 205-240 volts, 50/60 cycles and provides regulated 32 volts d.c. at 0-15 amps. The duty cycle is 100% to 35 degrees C.

PRINTED-CIRCUIT RECEPTACLES

16 **Methode Electronics, Inc.** has recently introduced a new series of printed-circuit receptacles with 7, 11, 15, 19, or 23 contacts.

Not only do the new connectors meet all the requirements of NAS-713 specifications, but feature additional improvements such as closed entry, removable socket contact for solder or crimp termination in the NAS-714 type and removable contacts with the NAS-715 circuit board plugs.

AUDIO/VIDEO TRANSMITTER

17 **Marsan Industries, Inc.** is now offering a low-cost audio/video transmitter which is designed to feed audio and/or video programming into any closed-circuit TV or master TV system.

The Model T-F-I feeds audio and/or video into the system on an unused v.h.f. channel. Composite output capacity is 0.1 volt. Three audio inputs are provided to accept signals from microphone, tape recorder, or 70-volt audio line. Receptacles are RCA-type audio jacks. The video output is a coax receptacle of the SO-239 type.

The unit weighs six pounds and uses four tubes. Circuit features include transformer isolation and d.c. restoration.

INDICATOR TUBE

18 **Amperex Electronic Corp.** has developed an indicator tube designed specifically for use with transistors. The Type Z550M is a cold-cathode, gas-filled tube which requires less than 5 volts at less than 50 μa. to produce a discharge. The indication is a bright red neon glow which is viewed through the clear dome of the tube envelope.

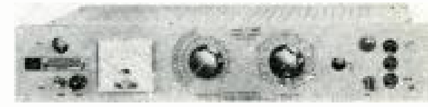
Its special characteristics make it possible to operate the tube directly off commonly used low-voltage transistors without intervening circuitry or high-voltage transistors. The tube is designed to operate for over 30,000 hours.

CONSTANT-CURRENT SUPPLIES

19 **Electronic Measurements Company, Inc.** has added a new series of fourteen "Regatron" programmable constant-current power supplies to its line. The new units cover from 1 μa. through 3 amps.

The new units are designed to be used in a variety of constant-current applications including semiconductor diode testing, transistor production testing, ampere-turn control of magnetic devices, capacitor forming, and gyro compensation, among others.

These devices are remotely programmable.



A multi-step range selector and continuous vernier control permit adjustment from zero current to the range selector maximum.

HIGH-FILTER POWER SUPPLY

20 Dynatech Corporation has developed a high-filter power supply which features a ripple percentage of less than one-tenth of 1%.

Designed for transistor and solid-state circuits, the Model DT-30 is rated at 300 ma. and features

variable power from 3 to 25 volts. A pair of transistors and zener diodes act as a regulator for the supply.

The supply is housed in a streamlined lucite case. A 0-50 volt meter is standard equipment.

INFINITE-RESOLUTION POT

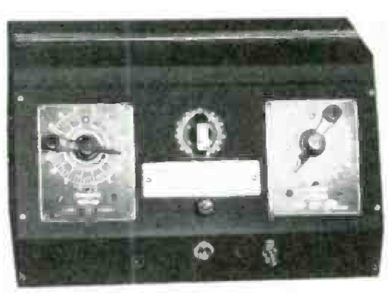
21 Computer Instruments Corporation is now in production on a multi-turn, precision carbon-film potentiometer which offers infinite resolution and exceptional linearity.

The Model 210 incorporates a helical carbon film element in its 2" diameter units which can be specified with as many as 20 turns. Taps can be located on any angular position within .025% (on a voltage basis) and continuous compensation for loads down to 20-to-1 loading ratios can be provided. The pot is available with resistances between 5000 and 150,000 ohms.

OHMIC CONTACT SEALER

22 Research Instrument Company, Inc. is now offering a single-head sealing unit and control which is designed for laboratory and pilot-production of glass diodes.

In use, the operator loads the whisker assembly



into a magnetic holding device and the sleeve is inserted into the open chuck. The operator merely presses the starting button and the machine runs through its cycle.

Control equipment includes heat timer, cool-off timer, and heater control. Production from the one head is approximately 100 units per hour.

VARIABLE TRANSFORMER

23 The Superior Electric Company is now offering its "Powerstat" variable transformer in a 40-volt series to meet the high current requirements of low-voltage power supplies and a wide range of transistor circuit applications.

Input rating is 40 volts, 60 cycles and output is 0-40 volts. Three types are available in a variety of ratings. Features of all three models include a gold-alloy plated commutator, zero waveform distortion, high efficiency, good regulation, linear output voltage, and rugged mechanical construction.

HI-FI—AUDIO PRODUCTS

STEREO/MONO MIXER

24 Switchcraft, Inc. is marketing a four-channel, high-impedance mixer for feeding up to four signals into a single output to a recorder or amplifier. Individual control is provided for gain adjustment in each of the four channels. The unit will accept signals up to 1.5 volts.

The mixer is equipped with a built-in tran-

sistor amplifier powered by a 9-volt battery and provides 6-db gain. Response is 20 to 20,000 cps. Input and output jacks accept standard two-conductor phone plugs. The jacks are located on the back of the unit so as not to interfere with the volume controls.

The unit is housed in a modern style cabinet in tan finish with brown knobs. Rubber feet prevent marring of furniture surfaces.

SOUND COLUMNS

25 University Loudspeakers, Inc. has introduced two new "Uniline" sound columns which have been specifically designed for the commercial sound field. According to the company, these new units offer high power handling capacity and effective control of dispersion for the elimination of feedback and reverberation.

The Model UCS-6 is a 60" column carrying six extended-range 8" speakers. Frequency response is 35-17,000 cps and it will handle 150 watts. Impedance is 16 ohms. The Model CS-4 is a 40" unit with four extended-range 8" speakers. It covers the range from 45 to 17,000 cps and will handle 80 watts. Impedance is 8 ohms. Other units at lower power ratings will be offered in the near future.

HEADPHONE SET

26 Clevite Electronic Components is now offering a new headphone set designed for maximum comfort and featuring a frequency response of 50 to 10,000 cps.

The Model ED-300 features a moisture-proof piezoelectric bimorph motor. Impedance is 50,000 ohms at 1000 cps and sensitivity is 8 dynes/cm.²/volt at 1000 cps.

The headphones can be worn comfortably over glasses and the set's single cord allows easy "on-off" movements. Two types of removable ear cushions are available. The "blanket" cushion prevents direct contact between ear and phone. A "donut" cushion is recommended for especially long listening periods or where elimination of external noises is desirable. Both cushions may be detached or attached in seconds by means of a special nylon zipper. Both are made of comfortable, easy-to-clean polyurethane foam.

WIRELESS INTERCOM KIT

27 Heath Company has recently introduced a low-cost wireless intercom in kit form as its GD-51.

The all-master system permits any station to call all other stations. Each unit features an all-transistor circuit for high operating economy and a self-contained 117-volt a.c. power supply. There

is a squelch circuit for full quieting on standby, overload diode to prevent distortion on high-level signals, and two indicator lights. The press-to-talk bar switch has a spring-return "listen" position and a transmit "hold" position for dictating and baby sitting.

The unit is housed in a two-tone beige plastic cabinet. Complete easy-to-assemble instructions are included in the kit.

FM-STEREO TUNER TUBE

28 Sylvania Electric Products Inc. is now marketing a new receiving tube which has been designed to upgrade the front end of FM multiplex tuners. Released as the type 6JK8, the new unit is described as a miniature dual triode with dissimilar sections that serve as a neutralized r.f. amplifier and autodyne mixer.

The tube is a 6.3-volt, 400-ma. type. Other heater versions are the 8JK8 (8.4 volts, 300 ma.), and 17JK8 (16.8 volts, 150 ma.).

FM WIRELESS MIKE

29 Federal Manufacturing & Engineering Corp. is now offering a wireless microphone system which is based on the patented "Victoreen" method of operating crystal-controlled oscillators at high frequencies and directly frequency-modulating them.

The transmitter is little larger than a pack of cigarettes and weighs only 10 ounces including mercury batteries. An omni-directional high-quality dynamic button mike leaves the user's hands completely free.

The Model 121 has FCC-type acceptance for licensed use in specific commercial applications and can also be used under Part 15 of FCC rules for operation without a license.

P.A. MATCHING TRANSFORMERS

30 Stancor Electronics, Inc. is now offering two new line-matching p.a. transformers as the A-8099 and A-8109.

The A-8099 is for 25-volt line applications and has taps for primary impedances of 312.5, 625, and 1250 ohms. The A-8109 is for 70.7-volt line use and has taps for primary impedances of 2500, 5000, and 10,000 ohms. Both units have outputs of 4 and 8 ohms and provide power steps of 0.5, 1, or 2 watts.

The transformers are 1¼" high with a base area of 2⅛" x 1⅜" with 1¾" mounting centers.

NEW PICKUP SYSTEM

31 Audio Dynamics Corporation has introduced a new pickup system that tracks at ¾ gram, eliminating distortion, record wear, and preserving the linearity of the stylus tip suspension.

The system combines the ADC-1 stereo cartridge with a balanced tonearm. The combination eliminates the problem of matching a highly compliant cartridge to a properly designed tonearm.

Arm length is 10⅝" over-all, pivot to stylus tip length is 9" with a rear overhang of 1⅝" maximum. Fundamental resonance is 6 cps. The tonearm is made of walnut wood and will accommodate other pickups if desired.

CB-HAM-COMMUNICATIONS

TUBES FOR MOBILE USE

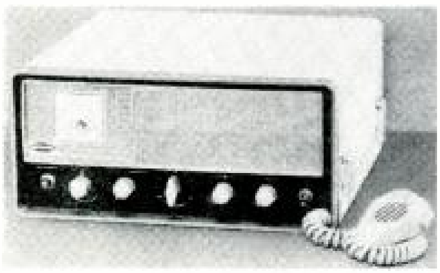
32 RCA's Electron Tube Division has announced the development of three new, economical beam-power tubes especially designed for radio-frequency generation in mobile equipment.

The new r.f. power amplifiers not only satisfy mobile power requirements up to 500 mc. but also provide three choices of cooling. Designated RCA-8072, RCA-8121, and RCA-8122, the tubes are rated for continuous wave and linear service.

All three tubes feature sturdy ceramic-metal construction; precision-alignment of grids; high power sensitivity and high efficiency; high temperature operation; and dependable performance with battery operation.

MARINE RADIOTELEPHONES

33 Raytheon Marine Products has added four "flat-pack" marine radiotelephones to its line of ship-to-shore communications equipment.



The new units are the RAY-1024 (24 watts); RAY-1065 (65 watts); RAY-1095 (100 watts); and RAY-1130 (135 watts and shown in photo). The RAY-1024 has five crystal-controlled channels as well as a tunable broadcast band. It operates from 12-volt power sources.

Each of the larger units provides 8 channels plus broadcast-band and can be operated with 12, 32, or 110 volts d.c. or 117 volts a.c. All of the units are packaged in flat-pack, space-miser cases to permit easy mounting either horizontally or vertically. The units are fully protected against moisture and corrosion.

6-METER TRANSCEIVER

34 Lafayette Radio Electronics Corporation has added a deluxe 6-meter transceiver to its amateur radio equipment line as the Model HE-45.

Designed for either fixed station or mobile use, the Model HE-45 features a superheterodyne receiver section that employs an r.f. stage with front-panel peaking control and two i.f. stages for 1 mv. sensitivity with 35 db image rejection.

The transmitter section utilizes a 6U8 oscillator and buffer/multiplier, driving a 2EX6 final with a plate input of approximately 12 watts on AM.

The transceiver is housed in a metal cabinet measuring 12" x 5" x 8½" and comes complete with push-to-talk ceramic microphone, crystal for 50.12 mc., detachable mounting bracket, and all power cables.

SSB CONVERTER KIT

35 Manson Laboratories, Incorporated has announced the availability of a new single-sideband modification kit which quickly converts conventional r.f. receivers for SSB reception.

The modification kit upgrades a variety of high-frequency receivers, making them SSB systems that can be tuned to any desired operating frequency, well within voice tolerance, without fine tuning or pilot carrier lock-in.

At present, modification kits are available for the Hammarlund SP-600, Hallicrafters Model SX-116, and Government Model R-390A receivers. Kits for other receivers will be marketed in the near future, according to word received from the company.

MANUFACTURERS' LITERATURE

SILICON RECTIFIER DATA

36 Fansteel Metallurgical Corp.'s Rectifier-Capacitor Division is offering a 44-page, two-color catalogue describing its standard line of silicon power rectifiers and rectifier stacks.

(*Continued on page 118*)

LORAN APN-4
FINE QUALITY NAVIGATIONAL EQUIPMENT

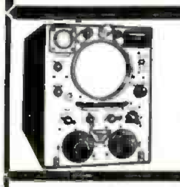
Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.

INDICATOR ID-6B/APN-4, and RECEIVER R-9B/APN-4. complete with tubes. Exc. used **$49.50**

Receiver-Indicator as above. BRAND NEW **$88.50**

INVERTER POWER SUPPLY for Loran. Made by Eclipse—Pioneer Div. INPUT: 24 V DC @ 75 A. OUTPUT: 115 V AC @ 10.5 Amps. 800 cycles. Complete with two connecting plugs BRAND NEW..........$49.50

12-Volt Inverter Power Supply, Like New. P.U.R.
Shock Mount for above....................$2.95
We carry a complete line of spare parts for above.



LORAN APN/4 OSCILLOSCOPE

Easily converted for use on radio-TV service bench.

LIKE NEW! Supplied with 5" Scope. type 5CPI only **$14.50**

LORAN R-65/APN-9 RECEIVER & INDICATOR

Used in ships and aircraft. Determines position by radio signals from known xmitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. used.
Value $1200.00. Our Price **$79.50**
Used. less tubes, crystal and visor, but with 3BP1 C.R. tube **$29.50**

INVERTER POWER SUPPLY, INPUT: 24 V DC. OUTPUT: 115 V AC. BRAND NEW $49.50

12-Volt Inverter Power Supply, Like New ...P.U.R.
Shock Mount for above....................$2.95
Circuit diagram and connecting plugs available.
We carry a complete line of spare parts for above.

BC-433 RADIO COMPASS RECEIVER

200 to 1750 Kc in 3 bands. 28 V DC power supply required. Complete with 15 tubes. BRAND NEW **$21.50**

ASB-5 'SCOPE INDICATOR

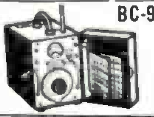
BRAND NEW, Including all tubes, **together with 5BP1 'Scope Tube.** Originally used in Navy Aircraft RADAR equipment. Easily converted for AC operation.
VALUE $250.00!
OUR LOW PRICE **$15.95**

APN-1 FM TRANSMITTER-RECEIVER

420 to 460 Mc Aircraft Radio altimeter equipment. Tubes: 4-955. 3-12SJ7. 4-12SH7. 2-12H6. 1-VR150; Complete with tubes, brand new **$9.95**
APN-1 exc. Used $6.95

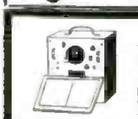
ARN-5-C AIRBORNE Equipment, to give vertical guidance during landings. 11 tube superhet circuit. Tubes: 2807, 12SR7, 2-12SN7, 7-6AJ5. Crystal Controlled on 6 channels. Like new..........$12.95

BC-906 FREQ. METER—SPECIAL



Cavity type. 145 to 235 Mc. BRAND NEW. complete with antenna. Manual and original calibration charts included.
OUR LOW PRICE.......... **$10.88**

BC-221 FREQUENCY METER



SPECIAL BUY! This excellent frequency standard is equipped with original calibration charts, and has ranges from 125 KC to 20,000 KC with crystal check points in all ranges. Excel. Used with original Calibration Book, Crystal, and all tables—LIKE NEW!
Unmodulated ... **$72.50** Modulated **$99.50**
RA-133 original A.C. power supply made for Govt. For use with BC-221. Wired and tested **$18.95**

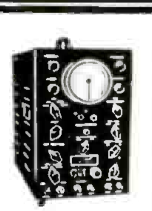
BC-638A FREQUENCY METER 100-156 Mc. Xtal controlled. Rack mounting. For 110V AC operation. Less crystals. BRAND NEW $29.50

TS-16/APN TEST SET

For aligning and calibration of radio altimeters. May be used to check calibration of count or circuits and modulator sweep freq. and bandwidth of transmitter. Audio-oscillator range: 340 to 7250 cycles. 13/14 V.DC input.
Complete with tubes, connecting cables, instruction summary. **BRAND NEW**...... **$11.95**

AN/ARN-6 RADIO COMPASS EQUIPMENT

Highly efficient airborne direction finding system. Frequency: 100 to 1750 Kc in 4 bands. 26.5 DC V Power input. LIKE NEW.. **$79.50**



TS-100AP 'SCOPE

(WORTH $750)
OUR LOW PRICE **$29.50**

Can be used with linear sweep or general purpose test scope. Cables included. Also used with circular sweep as precision range calibrator. Self-contained in metal case 8" x 12½" x 16" deep. For 110 V 50 to 1200 cycles AC. Excellent used, like new, with all tubes including crystals and C.R. Tube.
BRAND NEW **$69.50**

SCR-625 MINE DETECTOR

Complete portable outfit in original packing, with all accessories. Brand New **$27.50**

BC-603 FM RECEIVER

20 TO 27.9 MC.
Like new **$18.95**
BRAND NEW **$22.50**
10-channel. pushbutton or continuous tuning. Complete with speaker, squelch, and ten tubes: 3-6AC7, 1-6J5, 2-12SG7, 1-6H6, 1-6V6, 2-6SL7.

EXTRA SET OF 10 TUBES FOR ABOVE brand new in original boxes..........$3.95

FT-237 MOUNTING BASE for BC-603 Revr and BC-604 Xmitter. Brand New **$5.95**

12 or 24V Dynamotor for Above.
Exc. Used $4.25..........Brand New **$5.50**

BC-683 FM Receiver, 27 to 38.9 Mc. Complete with all tubes. Like New.......... **$33.33**

4-Section Antenna for BC-603, 683 Receivers. Complete with mounting base. BRAND NEW......$4.95

BC-604 TRANSMITTER—Companion unit for BC-603 Revr above. With all tubes. BRAND NEW......$6.95

4-Section Antenna for BC-604, 684 Transmitters. Complete with mounting base. BRAND NEW..$4.95
We carry a complete line of spare parts for above.

SPECIAL! BC-603 FM RCVR CONVERTED FOR ANY FREQ.—30 TO 50 MC.

BRAND NEW! Checked out, perfect working condition, ready for operation. Specify Frequency desired (between 30-50 Mc) when ordering. **$32.50**

AC POWER SUPPLY FOR BC603, 683
Interchangeable, replaces dynamotor. Has On-Off Switch. NO RECVR. CHANGE NEEDED. Provides 220 VDC @ 80 Ma. 24VAC @ 2 Amps $10.25

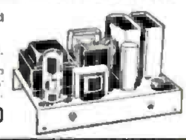
Complete **240-page Technical Manual for BC-603, 604** $3.15

BC-605 INTERPHONE AMPLIFIER for above.
BRAND NEW ....Each $4.95

SCR-522 2-METER RIG!

Terrific buy! VHF Transmitter-receiver. 100-156 Mc. 4 channels. Xtal-controlled. Amplitude modulated voice. They're going fast! Excellent condition.
SCR-522 Transmitter-Receiver, complete with all 18 tubes, top rack and metal case.
COMBINATION. Like new **$29.50**

UNIVERSAL POWER SUPPLY KIT



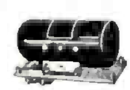
For All Command Xmitters and others requiring:
INPUT: 117V 60 cycles AC.
OUTPUT: 450V DC @ 150 Ma. 24V DC @ 2 Amps.
Carefully designed, using top quality components. A really substantial, good-looking unit.
BARGAIN PRICED AT **$29.50**

ATTENTION: IMPORTERS-EXPORTERS of ELECTRONIC EQUIPMENT

We specialize in the export of electronic equipment, Parts, and Electronic Tubes at LOWEST prevailing prices. All packing and shipping is made directly from our own warehouses in NYC, to give you substantial savings in handling costs! Your inquiries invited.

MOBILE-MARINE DYNAMOTOR

Model DM35



Input 12V DC. Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation. Shpg. wt. 14 lbs.
OUR LOW PRICE, BRAND NEW.......... **$9.95**

OTHER DYNAMOTOR VALUES:

Type	Input	Output	Excellent Used	BRAND NEW
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A 28V 7A	575V .16A 540V .25A	1.95	3.75
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-53A	28V 1.4A	220V .080A	3.75	5.45
DM-64A	12V 5.1A	275V .150A		7.95
PE-73C	28V 20A	1000V .350A	8.95	14.95
PE-86	28V 1.25A	250V .050A	2.75	3.85

MICROPHONES

Model	Description	EXC. USED	BRAND NEW
T-17	Carbon Hand Mike	$4.45	$6.95
RS-38	Navy Type Carbon Hand Mike		4.75

HEADPHONES

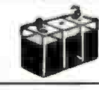
Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.19	$4.49
HS-33	Low Impedance	2.69	4.59
HS-30	Low Imp. (featherwt.)	.90	1.65
H-16/U	High Imp. (2 units)	3.75	7.95

TELEPHONICS—600 ohm Low Impedance HEADSETS. BRAND NEW. PER PAIR $3.25
CD-307A Cords, with PL55 plug and JK26 Jack .99
Earphone Cushions for above—pair .50

2 VOLT BATTERY "PACKAGE"

1—2V. 20 Amp. Hr. Willard Storage Battery. Model ≠20-2. 3" x 4" x 5½" high..........$2.79
1—2V. 7 Prong Synchronous Plug-in Vibrator..........1.49
1—Quart Bottle Electrolyte (for 2 cells)..........1.45
ALL BRAND NEW!
Combination Price **$5.45**

WILLARD 6-VOLT MIDGET STORAGE BATTERY



3 Amp. Hour. **BRAND NEW.** 3⅝" x 1-13/16" x 2⅜". Uses Standard Electrolyte ....Only $2.95

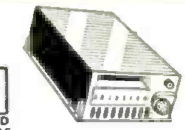
Please include 25% Deposit with order—Balance C.O.D., or Remittance in Full. 50c Handling Charges on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C. All Merchandise subject to Prior Sale and Price Change.

G & G RADIO SUPPLY CO.

Telephone: CO 7-4605

Mail Order	Retail Sales
51 Vesey St.	75-77 Leonard St.
New York 7, N. Y.	New York 13, N. Y.

ARC-3 RECEIVER!



Complete with All Tubes Exc. Used **$16.95**
Like NEW $21.50
Used $14.95
Crystal-controlled 17-tube superhet, tunes from 100 to 156 MC., AM., on any 8 pre-selected channels. 28-volt DC power input. Tubes: 1-9002, 6-6AK5, 1-12SH7, 3-12SG7, 1-9001, 1-12H6, 2-12SN7, 1-12SL7, 1-12A6.

ARC-3 TRANSMITTER

Companion unit for above, tunes 100 to 156 MC on any 8 pre-selected channels. 9 tubes, crystal controlled, provides tone and voice modulation. 28V DC Power input. Complete with all Tubes: 3-6V6, 2-832A, 1-12SH7, 1-6J5, 2-6L6. Exc. Used ....Only **$16.95**
Like new condition..........$22.50
ARC-3 PUSHBUTTON CONTROL BOX..........$5.95

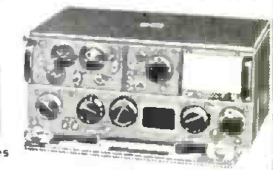
R77/ARC-3 RECEIVER POWER SUPPLY

INPUT: 110V 60 Cycles, a.c. OUTPUT: 210V. d.c. 125Ma & 24V ac at 2 amps. Includes transformer, choke, capacitor, 5Y3GT tube, punched chassis, all parts, wiring diagram. Size 8½x9½x1½". Shpg. wt. 12 lbs.
Complete kit **$15.00**
Wired $19.95

AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc

$69.50 exc. used



Complete with Tubes

Famous Collins Autotune Aircraft Transmitter, AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP811s modulate 813 in final up to 90%, class "B." A Real "HOT" Ham buy at our low price! Orig. cost $1800.
AN/ART-13 XMTR as above. Like New .. **$69.50**
0-16 Low Freq. Osc. Coil for ART-13.......... 7.95
24V Dynamotor for ART-13.......... 11.95
Same as above less meter.......... 39.50
We carry a complete line of spare parts for above.

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 Mc	10.45	12.45
BC-455	Receiver 6-9 Mc	11.50	13.95
Marine	Receiver 1500-3000 KC Brand New		$16.95

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions **$7.95**
Factory wired, tested, ready to operate...$11.50

SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. **Only** **49c**

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal. BRAND NEW.. **$9.75**
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal.
BRAND NEW **$9.75**
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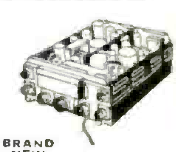

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GOVERNMENT Surplus Receivers, Transmitters, Snooperscopes. Parabolic Reflectors, Picture Catalog 10¢. Meshna, Malden 48, Mass.

GOVERNMENT Sells Surplus: — Electronics; Oscilloscopes; Transceivers; Test Equipment; Radar; Sonar; Walkie-Talkie; Boats; Jeeps; Aircrafts; Misc.—Send for "U.S. Depot Directory & Procedures"—$1.00—Brody, Box 425(RT), Nanuet, New York.

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BEFORE You Buy Receiving Tubes or Hi-Fi Components send now for your giant Free Zalytron current catalog-featuring nationally known Zalytron First Quality TV-Radio Tubes, Hi-Fi Stereo Systems, Kits, Parts, etc. All priced to Save You Plenty—Why Pay More? Zalytron Tube Corp., 220 W. 42nd St., NYC.

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PRINTED CIRCUITS, free catalog lists hundreds of circuits. Cloud "9" Engineering, Brookdale, California.

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SELF-Hypnosis. New concept teaches you quickly by tape or LP-record. Free literature. McKinley Publishers, Dept. T6, Box 3038, San Bernardino, California.

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OVER 245,000 buyers and sellers will read your ad when placed in this space. It costs only 60¢ per word; minimum of 10 words including your name and address.

The catalogue is a composite of 12 individual data bulletins describing eight basic silicon power rectifiers and their corresponding rectifier stack assemblies. Complete electrical data, characteristic curves, and dimensional diagrams are included.

SHORT-FORM CATALOGUE

37 **Borg Equipment Division** has available a short-form catalogue which provides pertinent information on its line of "Micropot" precision and trimming pots, "Microdial" precision potentiometer controls, and sub-fractional horsepower motors. Each unit is pictured and the specs are presented in tabular form for fast and accurate use.

INDUSTRIAL ELECTRONICS COMPONENTS

38 **Amphenol Distributor Division** is now offering copies of a 22-page catalogue covering its line of electronic components for industrial applications.

Included in this new publication are details on connectors, miniature AN-type connectors, "Minni-E" connectors, MS/AN units, r.f. connectors, ribbon connectors, as well as rack and panel units, coaxial cable, and miscellaneous electronic components. The publication has been designated IEC-4.

ENERGY DISCHARGE CAPACITORS

39 **Sangamo Electric Company** has issued a 12-page bulletin which discusses the electrical and mechanical design criteria on energy discharge capacitors, which it is offering as a service to the industry.

Typical applications of these capacitors include impulse generators, hypersonic wind tunnels, laser experiments, and in propulsion and plasma research. The bulletin is designated TSC-208.

COMPONENT END-SEALING

40 **Epoxy Products Division, Joseph Waldman and Sons** is now offering an informative bulletin telling how to end-seal electronic components for environmental protection.

A step-by-step description of end-sealing is given, including pellet composition, selection of a sleeve material, and important design considerations.

WELDING CHECK CHART

41 **Raytheon's Commercial Apparatus & Systems Division** has issued a handy chart covering the "do's and don't's" for precision welding.

Printed on heavy card stock for posting at work stations, the two-color chart describes and illustrates 14 major tips for better welding, especially where precise, highly reliable welds are required. On the reverse side is a check list for correcting unsatisfactory welds, instructions for solving specific welding problems, and a description of the firm's complete line of resistance welding equipment.

"COMPACTRON" DEVICES

42 **General Electric Company** has published a new bulletin (ETD-2731) which carries information on 35 types of "Compactron" devices which are now available as engineering samples for designers of radio, television, and other equipment, in lieu of conventional tubes or transistors.

Manufacturing savings, reliability, life expectancy, power, sensitivity, and typical circuitry employing these 12-pin multi-function devices are discussed.

PROCUREMENT GUIDE

43 **Lafayette Industrial Electronics Division** has issued a 32-page electronic procurement guide and directory which is designed to assist purchasing agents in the government, research, industrial, military, educational, and broadcasting categories.

In addition to providing an alphabetized listing of off-the-shelf items, the publication carries selected listings for commercial and military applications, an interpretation of MIL-spec numbers, and a section on tables, charts, formulas, and terminology most often needed by procurement men.

METER RELAYS

44 **Weston Instruments Division** has published a 4-page bulletin (No. 02-106) covering its "MagTrak" meter relay Model 1073.

Installation data, dimensions, and details of components are provided. Applications listed include use in switching for automatic control equipment, independent "on-off" controllers, and alarms for any preselected value.

CONCISE BATTERY CATALOGUE

45 **P. R. Mallory & Co. Inc.** has issued a four-page folder which offers in concise form complete details on its entire line of batteries. Presented in tabular form, the publication includes mercury cells, manganese alkaline batteries, zinc-carbon units, as well as a handy battery replacement cross reference chart. Outline drawings of the various battery types are included to further aid identification.

RADIO-INTERFERENCE FILTERS

46 **Genistron, Incorporated** has prepared an elaborate 52-page publication describing in detail its complete line of standard radio-interference filters.

All of the more than 300 filters in the line are listed with important technical data, useful applications information, and an outline of the company's facilities for providing custom application engineering and systems engineering services.

TAPE-MACHINE BUYING GUIDE

47 **North American Philips Co., Inc.** has issued a four-color, 8-page catalogue which contains photographs and detailed specs on four "Norelco" tape recorders. Also included is a unique buyer's guide and condensed applications chart for all four of the recorders. The catalogue also shows and describes in detail the full line of high-fidelity loudspeakers offered by the manufacturer.

RELAY CATALOGUE

48 **Potter & Brumfield Division** has just issued an 8-page catalogue which describes a new series of mercury-wetted contact relays, designated the JM series.

Design details, electrical and physical performance characteristics are featured in the catalogue along with formulas from which to calculate contact operating characteristics.

SHIELDED-ROOM DESIGN

49 **Ace Engineering and Machine Co.** is offering copies of a four-page reprint of an article, "Shielded Rooms for Electronic Equipment" which describes the techniques and materials used to protect sensitive electronic equipment from radio-frequency interference.

MICROWAVE COMPONENTS

50 **Airtron Division of Litton Industries** has published a 16-page condensed catalogue of microwave components and a description of development and production facilities available at the firm.

Included are photos and specifications of representative ferrite devices, rigid waveguide components, rigid and flexible waveguides, and solid-state materials and devices.

CORE WINDER SPECS

51 **Telex/Lumen** has issued a four-page brochure providing complete details on its Model 1402 core winder for manufacturing microminiature and subminiature toroids.

The brochure is illustrated and a chart provides information on core dimensions and wire gauge sizes that can be handled by the machine.

WHITE-NOISE DIODES

52 **Solitron Devices, Inc.** has issued a 16-page manual which contains specifications, operating characteristics, and performance curves of the "Sounvister" white-noise diode.

Included is a discussion of the theory and effects of white noise, graph traces characteristics of the four basic noise diode types, and two classifying circuits. Specifications for nine different types are also given.

POWER SUPPLIES

53 **Gates Electronic Co.** is offering copies of a new catalogue which covers the firm's basic line of over 22 power supplies plus a line of selenium and silicon rectifiers, rectifier transformers, chokes, and duralytic capacitors.

Full specifications and prices are shown for each item.

VOLTMETER DATA

54 **Trio Laboratories, Inc.** announces publication of a six-page, two-color illustrated bulletin introducing three new voltmeters in its line.

Information presented covers the design, performance specifications, and applications of each device. Photographs of each instrument and circuit diagrams of typical applications are included. The units are especially designed for instrumentation-systems applications.

V.H.F. PREAMPS

55 **Community Engineering Corporation** has just issued a four-page, two-color bulletin which describes its line of v.h.f. ultra-low-noise preamplifiers. The units are available for any v.h.f. channel from 2 through 13. The bulletin gives general technical specifications and descriptions of three models, along with feed-box specifications, etc.

ELECTRICAL TAPES

56 **Johns-Manville** has assembled a unique electrical insulation selection chart which it is offering to the industry. The chart, DB-70A, contains actual samples of 15 different "Dutch Brand" insulating tapes, including paper, polyester film, glass cloth, acetate cloth, acetate film, and vinyl film insulations, backed with thermosetting, thermoplastic, and pressure-sensitive adhesives.

RECORD/TAPE CATALOGUE

57 **Allied Radio Corporation** is now offering copies of its new 144-page "Discount Stereo Record and Tape Catalogue" to audiophiles.

The catalogue lists more than 1600 of the latest stereo record releases, 300 mono recordings, and some 800 four-track stereo tapes. The publication is subdivided into musical categories and lists classical records and tapes alphabetically by composers. ▲

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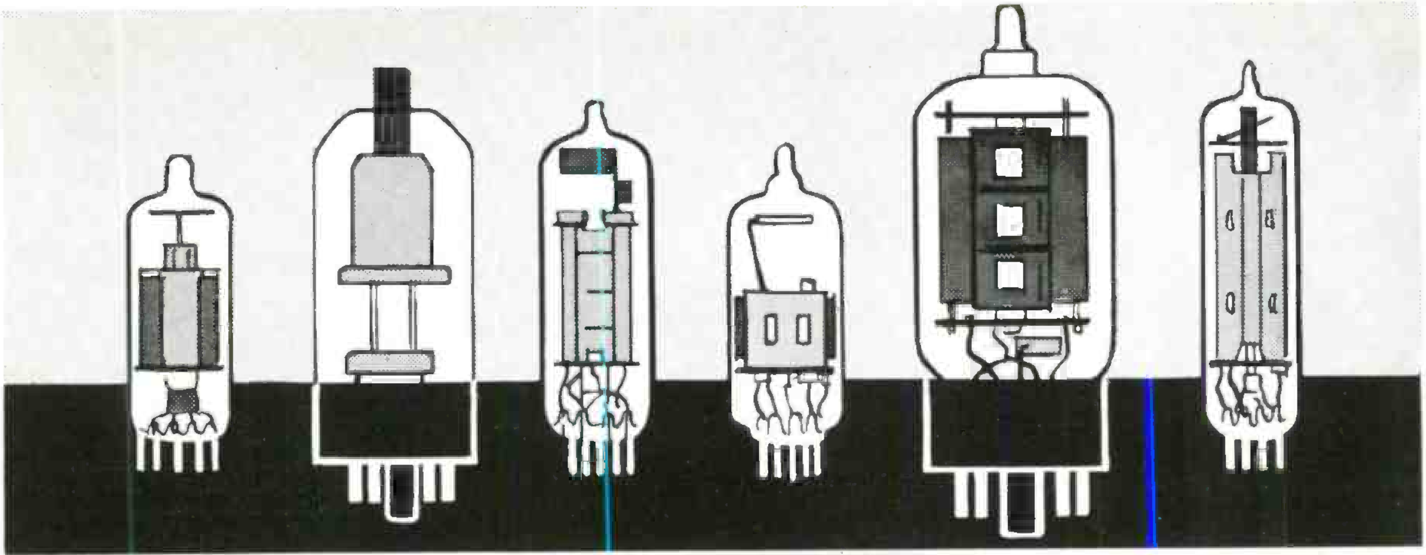

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1J3*	.79	5T8	.81	6BX7	1.02
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1R5	.62	5U8	.81	6BY6	.54
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3S4	.61	6AW8	.90	6DB5	.69
3V4	.58	6AX4	.66	6DB6	.51
4BQ7	1.01	6AX5	.74	6DE6	.58
4BZ7	.96	6AX7	.64	6DG6	.59
4BZ8	1.10	6AX8*	.92	6DK6	.59
4CS6	.61	6BA6	.50	6DN6	1.55
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5BK7	.82	6BH6	.65	6EW6	.57
5BQ7	.97	6BH8	.87	6EY6*	.75
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ECC-83	12AX7	.96
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6H6	.58	12AQ5	.60	12J8	.84
6J5GT	.51	12AT6	.43	12K5	.65
6J6	.67	12AT7	.76	12L6	.58
6K6	.63	12AU6	.51	12SA7	.92
6L6	1.06	12AU7	.60	12SF7	.69
6N7	.98	12AV6	.41	12SH7	.49
6S4	.51	12AV7	.75	12SJ7	.67
6SA7GT	.76	12AX4	.67	12SK7	.74
6SG7GT	.41	12AX7	.63	12SL7	.80
6SH7GT	.49	12AY7	1.44	12SN7	.67
6SJ7	.88	12AZ7	.86	12SQ7	.78
6SK7GT	.74	12B4	.63	12U7	.62
6SL7GT	.80	12BA7	.84	12V6	.53
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6SQ7	.73	12BE6	.53	12X4	.38
6T4	.99	12BF6	.44	17AX4	.67

EACH TUBE INDIVIDUALLY & ATTRACTIVELY BOXED & BRANDED RAD TEL

6T8	.85	12BH7	.77	17BQ6	1.09
6U8	.83	12BK5	1.00	17DQ6	1.06
6V6GT	.54	12BL6	.56	17W6	.70
6W4	.60	12BQ6	1.06	18FW6*	.49
6W6	.71	12BR7	.74	18FX6*	.53
6X4	.39	12BV7	.78	18FY6*	.50
6X5GT	.53	12BY7	.77	19AU4	.83
6X8	.80	12BZ7	.75	19BG6	1.39
7A8	.68	12C5	.56	19C8	1.14
7AU7	.61	12CN5	.56	19T8	.80
7B6	.69	12CR6	.54	21EX6	1.49
7EY8*	.73	12CU5	.58	25AV5	.83
7F8	.90	12CU6	1.06	25AX4	.70
7N7	.90	12CX6	.54	25BK5	.91
7S7	1.01	12D4*	.69	25BQ6	1.11
7Y4	.69	12DB5	.69	25C5	.53
8AU8	.83	12DE8	.75	25CA5	.59
8AW8	.93	12DL8	.85	25CD6	1.44
8BQ5	.60	12DQ6	1.04	25CU6	1.11
8CG7	.62	12DS7	.79	25DN6	1.42
8CM7	.68	12DT5*	.76	25EH5	.55
8CN7	.97	12DT7*	.79	25L6	.57
8CS7	.74	12DT8*	.79	25W4	.68
8CX8	.93	12DU7	1.01	32ET5	.55
8EB8	.94	12DW8*	.89	32L7	.90
8SN7	.66	12DZ6	.56	35B5	.60
9CL8	.79	12ED5	.69	35C5	.51
11CY7	.75	12EG6	.54	35L6	.57
12A4	.60	12EK6	.56	35W4	.42
12AB5	.55	12EL6	.50	35Z5	.60
12AC6	.49	12EM6	.79	36AM3*	.36
12AD6	.57	12EN6	.78	50B5	.60
12AE6	.43	12EZ6	.53	50C5	.53
12AE7	.94	12F8	.66	50EH5	.55
12AF3	.73	12FA6	.79	50L6	.61
12AF6	.49	12FM6	.43	70L7	.97
12AJ6	.46	12FR8	.91	7025	.69
12AL5	.45	12FX8	.85	807	.70
12AL8	.95	12GC6	1.06	117Z3	.61

Popular New Tube Types Offered by Rad-Tel*

RAD-TEL TUBE CO.

Dept. EW 55 CHAMBERS ST., NEWARK 5, NEW JERSEY

TERMS: 25% deposit must accompany all orders, balance COD. Orders under $5: add $1 handling charge plus postage. Orders over $5: plus postage. Approx. 8 tubes per 1 lb. Subject to prior sale. No COD's outside continental USA.

ADVERTISERS' INDEX FEBRUARY, 1962

Advertisers listed below with code numbers have additional information available on their products in the form of catalogues and bulletins. To obtain more detailed data, simply circle the proper code number in the coupon below and mail it to the address indicated. We will direct your inquiry to the manufacturer for processing.

The coupon below can also be used to obtain additional information on the new product items shown on pages 111 through 118 as well as on the ads as listed above.

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ADVERTISED PRODUCTS (SEE INDEX ABOVE)

100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
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NEW PRODUCTS & LITERATURE

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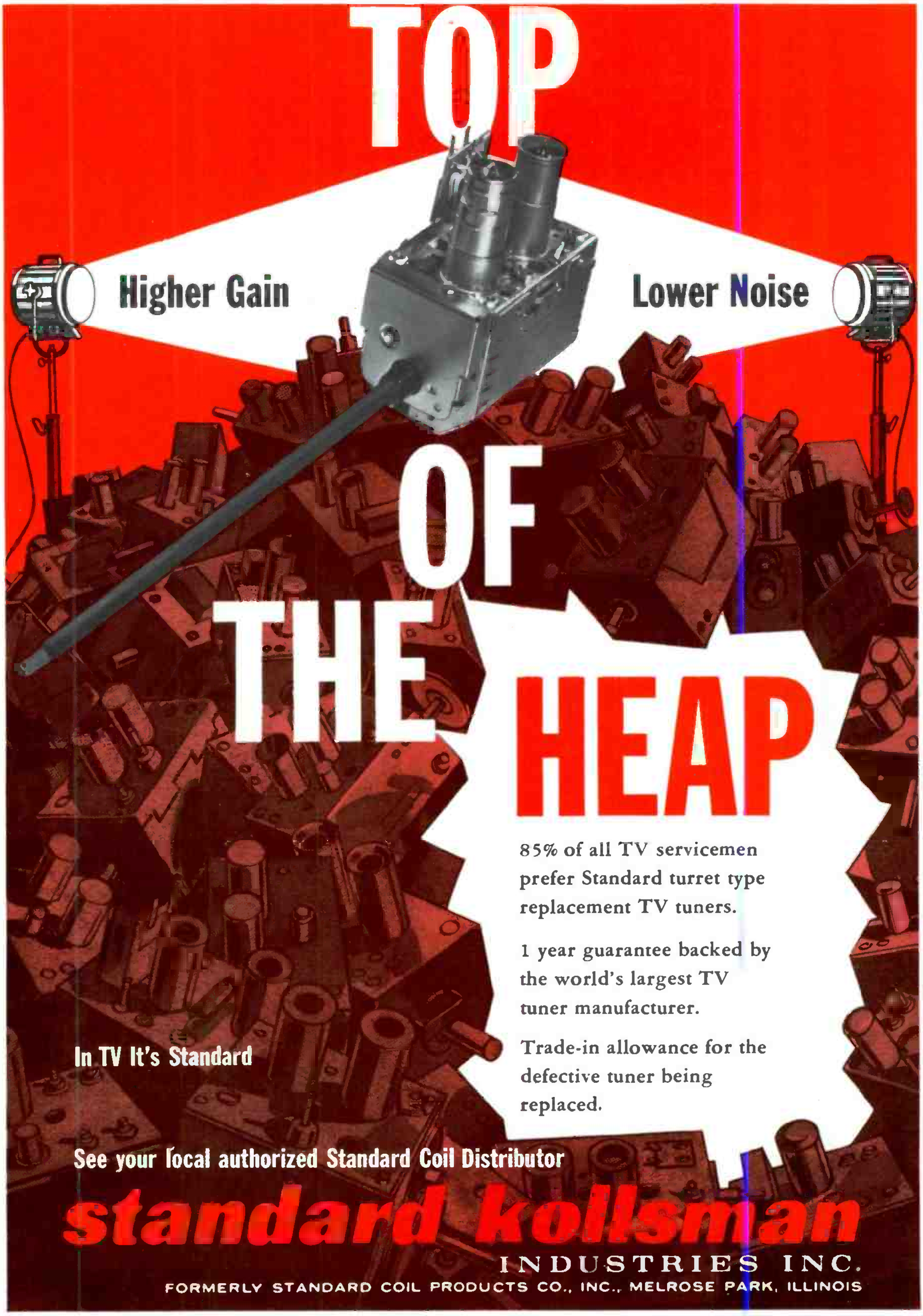
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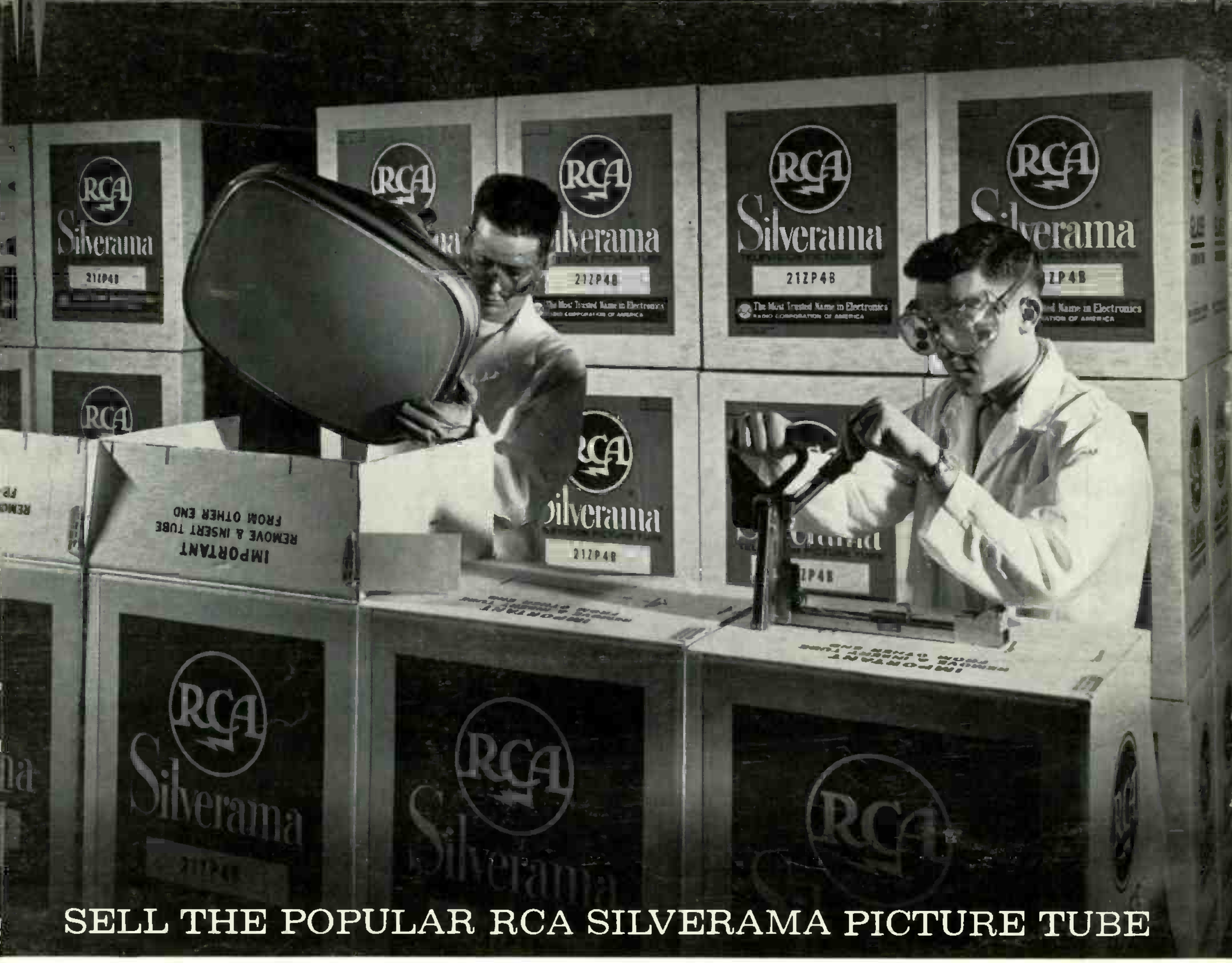

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