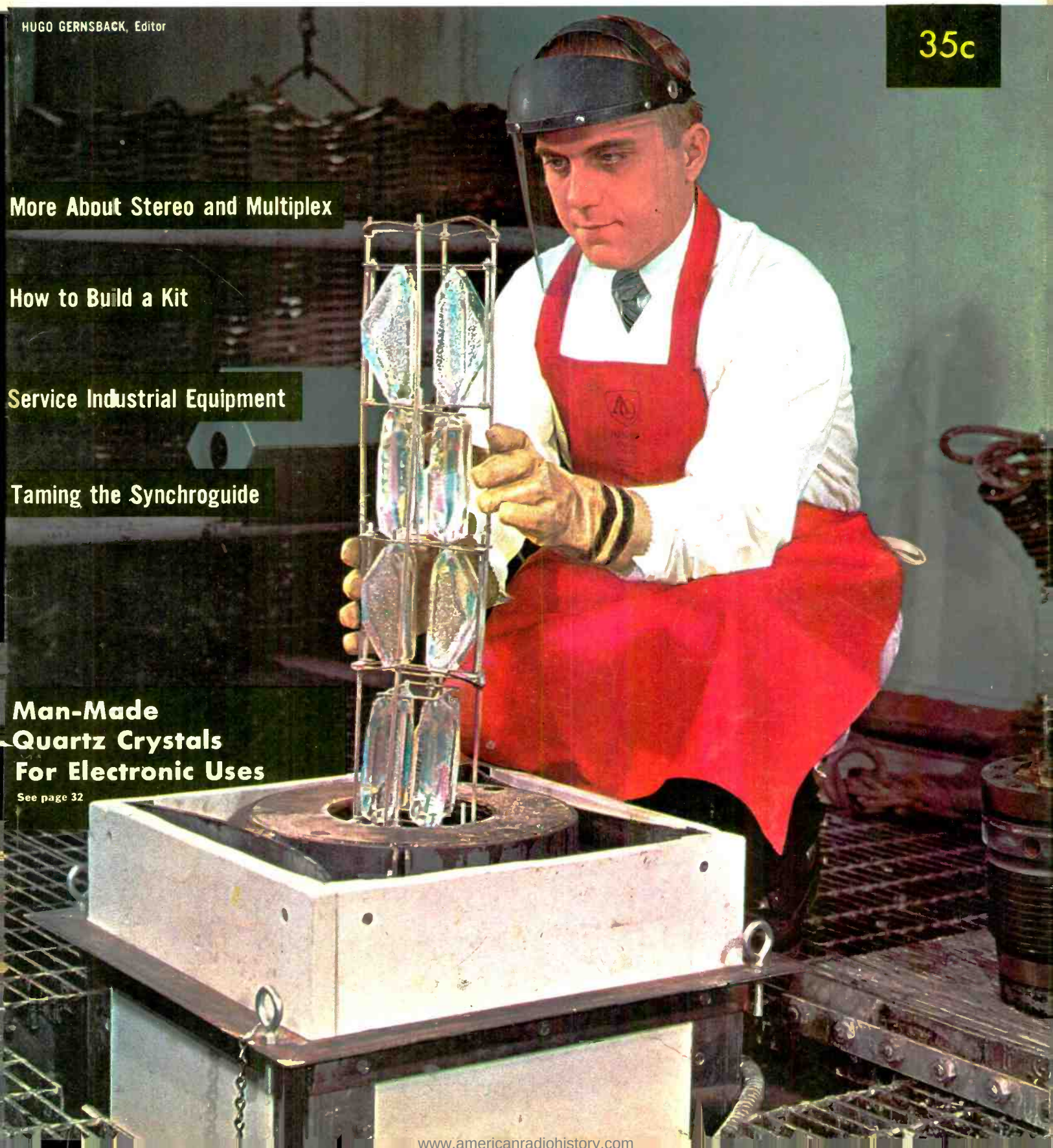
Transistors—Fact and Fiction

July 1959
IND.

Radio-Electronics

HUGO GERNSBACK, Editor

35c



More About Stereo and Multiplex

How to Build a Kit

Service Industrial Equipment

Taming the Synchroguide

Man-Made Quartz Crystals For Electronic Uses

See page 32

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More than 74, in fact, because many of these units come in three versions — 4, 8 and 45 ohms. In addition, we make a large number of special speakers for special applications, as well as a complete line of accessories.

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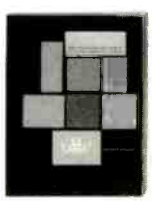
Only book of its kind . . . packed with the solid factual data you need to save time and money. Covers in detail: how to select the proper driver for the specific job. directional vs. wide-angle horns, best use of radial trumpets, high fidelity in P.A., coping with reverberation, methods of overload protection, etc. Includes specs, charts, diagrams, and the *exclusive* SOUND SYSTEM DESIGN CHART—effective guide for planning typical installations. Send $1.00 to Desk J-3, University Loudspeakers, Inc., 80 So. Kensico Ave., White Plains, New York.



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Contains information and specifications on all University public address speakers...directional, radial, wide-angle, paging and talk-back, submergence-proof, high fidelity weatherproof, super-power, explosion-proof, portable soundcasting, etc. Also, high fidelity cone speakers, enclosures and speaker systems suited for commercial installations.

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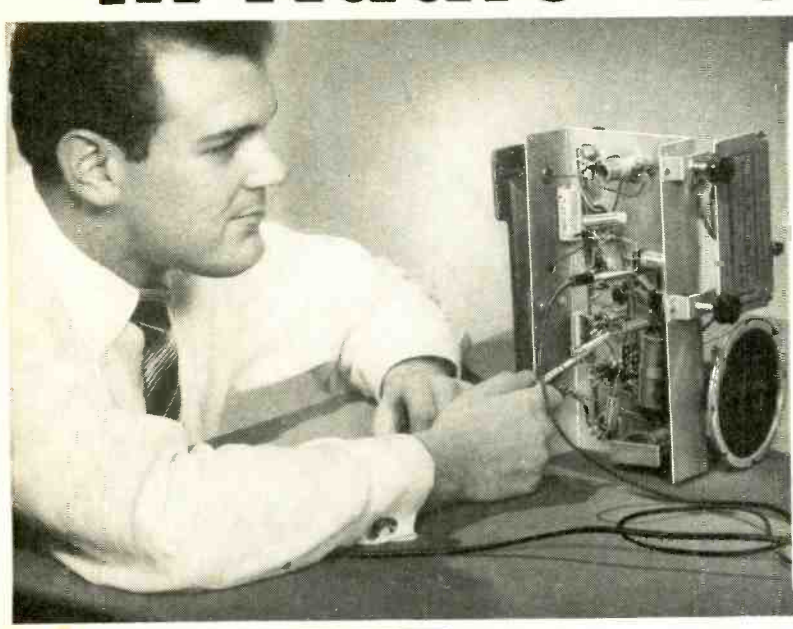

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JULY, 1959

Radio-Electronics

Formerly RADIO-CRAFT ■ Incorporating SHORT WAVE CRAFT ■ TELEVISION NEWS ■ RADIO & TELEVISION

ON THE COVER

(story on page 32)

Albert LeBel, technical assistant at Western Electric's Merrimack Valley (Mass.) Works, removes a frame of quartz crystals from the autoclave in which they were grown.

Color original by Western Electric

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NEWS BRIEFS

NEW COLOR THEORY may upset current thinking based on the classic tri-stimulus theory, and can possibly have important effects on color television and color photography.

According to present thinking, color is the sensation produced by light of a given wavelength, but a combination of three wavelengths (red, cyan, blue) can be combined to produce all the colors. Dr. Land, inventor of the Polaroid camera, has discovered that the various waves appear to be, not the direct bearers of color information, but part of a coding system which enables the brain to assign colors to various parts of the object seen. Color information can be transmitted as a ratio of the quantity of light of two frequencies (wavelengths). Red–green color systems have been used in the past, but they have always been considered an imperfect type of tri-stimulus transmission. Dr. Land has used two light sources of different frequencies, selected from different parts of the spectrum, and has succeeded in projecting many colors, including some outside the frequencies chosen. For instance, with a long-wave source of orange yellow light and a short-wave source in the green, an image has been projected that contains reds and blues, something that the tri-stimulus theory would declare impossible. Dr. Land is at present using red light for the long wave, and ordinary white light for the short-wave source in many experiments.

WIRELESS POWER TRANSMISSION seems about to become a reality after many years of dreams, science fantasy and experiments by, among others, famed Nikola Tesla. Raytheon has announced a new microwave tube, the Amplitron, which can convert raw ac into microwaves with extremely high efficiency—on the order of 80%. In addition, the company said it has learned how to cool the Amplitron so well that up to about 10 times as much heat can be dissipated as previously. The combination of high efficiency and greatly improved cooling seems to point the way to relatively efficient microwave power transmission.

One dramatic proposal which the Amplitron makes possible may be the amateurs' long-dreamed-of "sky-hook." This unmanned, permanently anchored-in-the-sky platform would be a radio-controlled helicopter receiving the power to keep it up with a big parabolic antenna, say 100 feet in diameter. Amplitron-produced microwave energy would be beamed at the parabola in the sky from a battery of many similar parabolas on the ground. This would be used to heat compressed air to drive the rotor blades keeping the platform aloft. Efficiency of such a system is estimated to be such that about 35% of the power beamed would actually be delivered to the heat turbines. In other words, 1,000 watts ac on the ground might become 800 watts of microwave energy, delivering perhaps 280 watts to the heat turbines.

Immediate use for sky-stations would be as communications centers using microwaves to cover hundreds of thousands of miles.

10-KW SSB PORTABLE transmitter and associated gear for handling up to 16 teletype and 2 voice circuits simultaneously is contained in two big motor vans. The vans can be loaded in 4 hours into Globemaster transport planes for emergency installation anywhere in the world on a day's notice. Shown jointly by the Army and Adler Electronics, this setup provides reliable communications in the range of 4 to 28 mc over 1,000 to 3,000 miles.

Previously, land-based stations handling similar radio traffic took about 6 to 8 weeks to get into operation, as in the Lebanese crisis. With this new compact equipment, the Army can get messages into its global communications net within 6–8 hours after the planes land. This assumes use of makeshift antennas. Full range and reliability are attained in 2–3 days, as soon as the big antennas for regular operation are erected.

One van holds receivers, teletype machines and transistor input equipment along with a uhf link to the transmitter van may be 2–10 miles away. The transmitter excites one rhombic antenna 600 feet on each side. Reception is over two spaced rhombics using double diversity reception, a method whereby the receiver continuously selects the better of the two incoming signals.

Each complete installation costs $500,000 and weighs 70,000 pounds, including gasoline 30-kw ac generators. Nine operators are required to work all the gear. Full personnel for 24-hour operation and maintenance (3 shifts) is 48 men.

MARS RADIO NET FORUMS go off the air for the summer, to start again in early September. In 1958–59, talks by 53 leading electronic scientists and engineers were given over the MARS SSB technical network regularly on Wednesday nights. The director of the net, S. E. Piller, proposed the term "communicasting" to describe the technical information exchange which has been taking place over the MARS net. In this activity, a leading authority delivers a lecture and then others join in via shortwave radio in a discussion. Interested parties listen in just as though they were present at a seminar in a lecture hall.

TAPE SITUATION is still unsettled, but recently in Chicago 7½-inch-per-second four-track stereo tape (page 6, May, RADIO-ELECTRONICS) for reel-to-reel, non-cartridge use got the go-ahead from the Magnetic Recording Industries Association It is predicted that two-track 7½-inch tape will be supplanted by this new standard for high-quality stereo tapes.

Several recorded tape makers including Mercury and Westminster have already announced early releases conforming to the new standard.

A new cartridge for ⅛-inch tape instead of standard ¼-inch is now under development, according to officials of Columbia Labs and Minnesota Mining & Manufacturing (3M). It runs at 1⅞ inches per second. Two tracks would be handled on this tape, making each track about the width of those now on a four-track ¼-inch tape. Officials emphasized that it would take at least 2 years to get such a cartridge into consumers' hands, if it gets off the ground.

FAMED RADIO ROW, the Cortlandt St. area of New York City, is about to stage a comeback, if the plans of some 50 electronic merchants, banded together in the Cortlandt–Greenwich Sts. Merchants Association, bear fruit. Once known to visiting radio men as the fabulous street where unobtainable items were piled on counters at fantastically low prices, it has now been invaded by foreign types of business and at least part of the glory has departed. The effect has been to weaken Cortlandt St. trade in favor of suburban stores, discount houses and TV–appliance chains.

A fund of $10,000 has been pledged for a cooperative advertising campaign and to arrange for ample free parking space for shoppers. The merchants are considering cooperative buying if the cooperative advertising plan shows success.

(*Continued on page* 10)

SENCORE Electronic Time Savers

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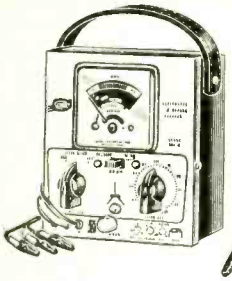
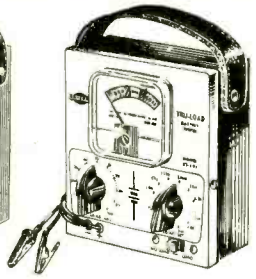
A QUALITY line of test instruments designed with the serviceman in mind. Manufactured by the Service Instruments Corporation, leaders in low cost time saving equipment. Each instrument is carefully engineered of quality components to give long life and perfect performance, providing the serviceman with versatile instruments at a low cost.

SENCORE Time Savers for TRANSISTOR WORK



TRC4 TRANSISTOR CHECKER—Tests transistors for opens, shorts, leakage and current gain. Includes gain test on power transistors. Checks all crystal diodes for forward to reverse current ratio. Checks seleniums for forward and reverse currents. Controls are accurately set for each transistor by referring to set up chart on rear of unit. Test leads or socket for fast hook-up. Cannot become obsolete.

Net Each.....$17.95



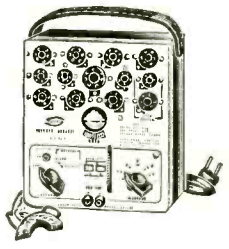
BT-101 TRU-LOAD BATTERY TESTER—Tests all batteries under manufacturers recommended loads—even small mercury cells, without damage. Ideal for transistor work. Load setting is determined from current capability instead of battery voltage. So simple to operate that a counter girl can learn to use it in a few minutes, yet accurate enough for labs.

Net Each.....$15.95

PS-103 TRANSI-PAC TRANSISTOR POWER SUPPLY—A low cost DC power supply for all portable transistor radios. 0-24 volts adjustable with a 1½ volt tap for Philco and Sylvania radios. Meter on unit reads voltage applied. Flick of switch and meter shows current drain. Current scale reads to 100 Mills. Operates push-pull radios with tap above 1.5 volts by using center lead as phantom ground.

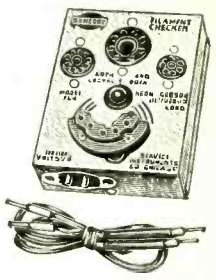
Net Each.....$17.95

SENCORE Tube Checkers make quick-accurate checks



LC3 LEAKAGE CHECKER—Tests nearly 200 different tube types including UHF and latest types; Checks CRT without removing tube from chassis. Roll-Chart design for quick checking; prevents obsolescence. Two spare pre-heating sockets cut down test time. Dynamic filament checks include heater to cathode leakage and shorts. Leakage sensitivity is 100 megs and 50,000 ohms; can be increased by changing the value of one resistor only. Capacitors can be easily tested for leakage to 100 megs, opens, shorts and charge with voltage applied. Compact unit 7"x6"x3½" comes in black hammertone case with aluminum panel. Weight 3 lbs.

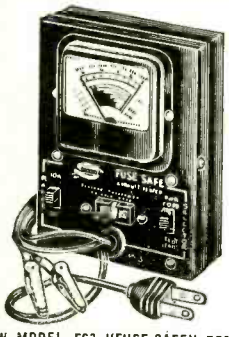
Net Each.....$28.95



FC4 FILAMENT CHECKER—Here is a new filament checker that automatically tests ALL tubes, including loctals and picture tubes; and also acts as a continuity and voltage tester. Continuity and voltage checks are made by simply plugging test leads into pins 1 and 12 of the picture tube socket—no switches. A neon indicator acts as a voltage indicator as well as GOOD-BAD tube tester.

Net Each.....$2.75
With Leads.....$2.95

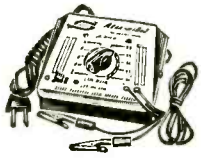
Eliminates Costly Call-Backs



NEW MODEL FS3 "FUSE-SAFE" TESTER—Prevents expensive call-backs on fuses and fuse resistors. Tests fuse, fuse resistor or circuit breaker circuits. Has individual scale for each value fuse resistor; reads red or green. Measures wattages up to 1100 watts at 115 volts. Two current ranges, 0-2 amps. and 0-10 amps. Test leads clip in place of fuse or fuse resistor. Tests both AC and DC. Safety 5-ohm, 10-watt resistor prevents circuit damage; simulates operating conditions.

Sencore Model FS3 Circuit Tester
Net Each.....$8.95

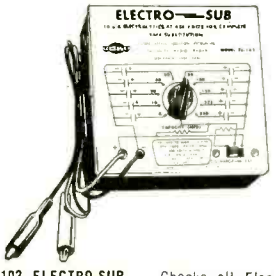
For AGC and Alignment Work



MODEL BE3 ALIGN-O-PAK — Fully isolated DC supply for TV alignment—AGC troubleshooting and other DC checking requirements. Provides all DC voltages recommended by TV manufacturers. Provides 0 to 18 volts, positive or negative, with less than 0.1% ripple. For alignment, merely plug in 115-volt AC and set knob at required voltage; for AGC trouble shooting, connect to AGC buss and vary voltage from 0 to 18 volts neg. If picture stabilizes, AGC is defective. Black hammertone case with aluminum panel. Complete with test leads. Shipping Weight, 2 lbs.

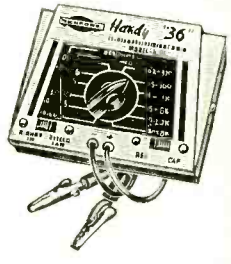
Sencore Model BE3 Align-O-Pak
Net Each.....$7.85

Capacitors and Resistors at your fingertips for *Easy-Safe-Substitution*



ES102 ELECTRO-SUB — Checks all Electrolytic Capacitators in seconds, merely select the electrolytic and substitute it. 10 big electrolytics from 4 to 350 mfd to safely substitute in any circuit from 2 to 450 volts. Automatic capacitor discharge within seconds. Unique surge protector circuit prevents accidental healing of capacitor being "bridged," completely safe. Compact unit can be carried anywhere, measures 4¾" h. x 4¾" w. x 2¼" d.

Net Each.....$15.95



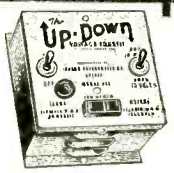
NEW MODEL H36 R-C SUBSTITUTOR—Provides 36 of the most often needed components for direct substitution: 12 one-watt 10% resistors from 10 to 5600 ohms; 12 half-watt 10% resistors from 10K ohms to 5.6 megs.; 10 capacitors from 100 uuf to 0.5 uf, 600 volts; one 10 uf and one 40 uf 450 volt electrolytic. Three-pole, 12-position switch selects each component individually.

Sencore Model H36 R-C Substitution Unit
Net Each.....$12.75
Leatherette Carrying Case for H36—Net Ea. $2.95

Quick check for Vibrators

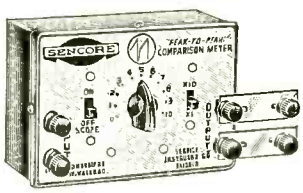
MODEL VB2 "VIBRA-DAPTOR"—Permits checking vibrators in any tube checker; provisions for 3- or 4-prong vibrators. Plugs into tube tester; set for 6AX4 (or 6SN7) for 6-volt, 12AX4 (or 12SN7) for 12-volt vibrators. Two lamps in top of adaptor indicate good or bad. Rugged steel construction. Unbreakable #51 lamps are used. Complete instructions screened on front.

Sencore Model VB2 "Vibra-Daptor"
Net Each.....$2.75



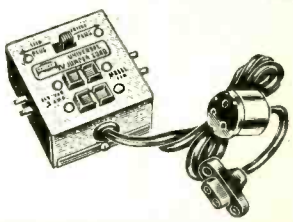
MODEL LB2 UP-DOWN VOLTAGE BOOSTER—For TV set or appliance up to 300 watts. No need to contend with inadequate picture width, insufficient height, low picture brightness, poor sync and oscillator drift, low sensitivity in fringe areas and/or excessive tube failure, due to lower than normal or higher than normal line voltages. Increase or decrease line voltage 10 volts with the flick of a switch.

Sencore Model LB2 Up-Down Voltage Booster
Net Each.....$5.97
Sencore Model LB2N Up-Down Voltage Booster—Same as above except with neon warning light that glows at 126 volts.
Net $7.17



MODEL PP2 PEAK-TO-PEAK METER—Completely assembled peak-to-peak meter for quickly servicing gated AGC and sync separator circuits. Occupies minimum space on the bench—only 4" x 6" x 3". Installed in seconds. A real time saver when servicing any TV set or electronic circuit. Essential for color with up to six gated circuits. Permanently connected to scope—straight through when turned off. Uses wire-wound potentiometer for accuracy. Calibrated against Dumont Calibrator and Textronix scope.

Sencore Model PP2 Peak-to-Peak Meter
Net Each.....$8.75



MODEL JC2 UNIVERSAL TV JUMPER CORD—Universal jumper cord that can be utilized with any TV set. Extends power from back of TV set—no moving furniture to get to the wall plug. Two handy power outlets for soldering iron and test equipment. Will fit many speakers, focus coils, etc. Two plugs accommodate all TV rearboard sockets and two sockets to fit the interior connections. Requires 115 v. AC, 3 amps.

Sencore Model JC2 Jumper Cord
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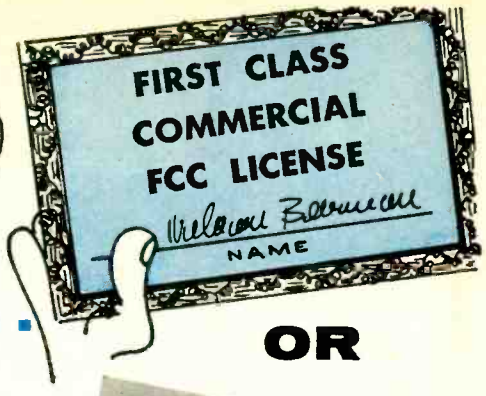

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Employers Make Offers Like These

to Our Graduates Every Month

Broadcast Station in Illinois: "We are in need of an engineer with a first class phone license, preferably a student of Cleveland Institute of Radio Electronics; 40 hour week plus 8 hours overtime."

West Coast Manufacturer: "We are currently in need of men with electronics training or experience in radar maintenance. We would appreciate your referral of interested persons to us."

Our Trainees Get Jobs Like These Every Month

CHIEF ENGINEER
"Since enrolling with Cleveland Institute I have received my 1st class license, served as a transmitter engineer and am now Chief Engineer of Station WAIN. I also have a Motorola 2-Way Service Station. Thanks to the Institute for making this possible."
Lewis M. Owen, Columbia, Ky.

TEST ENGINEER
"I am pleased to inform you that I recently secured a position as Test Engineer with Melpar, Inc. (Subsidiary of Westinghouse). A substantial salary increase was involved. My Cleveland Institute training played a major role in qualifying me for this position."
Boyd Daugherty, Falls Church, Va.

Names of Trainees in Your Area Provided on Request

Carl E. Smith, E.E., President

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- ☐ Home Experimenting
- ☐ Telephone Company
- ☐ Other

In what kind of work are you now engaged? .....

In what branch of Electronics are you interested? .....

Name ..... Age.....

Address .....

City ..... Zone..... State.....

RE-31

NEWS BRIEFS *(Continued from page 6)*

AIR FORCE HONORS HAMS from 50 countries for making vhf contacts for 2 years and reporting on them to the AF in connection with the International Geophysical Year. Up to 30,000 reports a month were processed through amateur headquarters to the Air Force. Dr. W. Phfister, head of AF Cambridge Research Center which made use of the hundreds of thousands of reports, said that the 550 ham operators honored had contributed a great deal toward better understanding of transmission modes in the 50-, 144- and 220-mc bands and transequatorial scatter, the sporadic E-layer and auroral reflection communications.

TWO TV ELECTROCUTIONS occurred recently when youngsters completed 110-volt circuits with their bodies. In one tragedy, a 2-year-old, boy, Dale McLaughlin of Capreol, Ontario, touched a TV receiver while lying on a hot-air register. In another accident a Chicago girl, Pamela Dobbertin, 17, apparently touched a metal-cased set while her foot was in contact with a metal lamp. In this case, both the lamp and the set must have been shorted to opposite sides of the house ac line.

TWO NEW TV STATIONS can be added to our growing list:

WCHU, Champaign, Ill.....33
WTOM-TV, Cheboygan, Mich... 4

WCHU is a satellite of WICS, Springfield, Ill., channel 20.

WFAM-TV, Lafayette Ind., channel 59, is off the air temporarily, pending certain business negotiations. Its return will probably be to another channel.

The following new call letters have been adopted:

KHOU-TV, Houston, Tex.....11
(formerly KGUL-TV)
KXTV, Sacramento, Calif.....10
(formerly KBET-TV)

These developments bring our total up to 557, which figure includes 469 vhf and 88 uhf. Our new noncommercial figure is 43.

Calendar of Events

National Convention on Military Electronics, June 29–July 1, Sheraton-Park Hotel, Washington, D.C.

International Electrotechnical Commission, June 30–July 10, Madrid, Spain.

British IRE TV Convention, July 1–7, University of Cambridge, England.

Hoosier Electronic Conference, Aug. 9–12, French Lick Sheraton Resort Hotel, French Lick, Ind.

National Ultrasonics Symposium, Aug. 17, San Francisco, Calif.

Western Electronic Show and Convention, (WESCON), Aug. 18–21, Cow Palace, San Francisco, Calif.

German Radio TV & Phono Exposition, Aug. 14–23, Frankfurt om Main, Germany.

National Alliance of Television & Electronic Service Assocs. (NATESA) Convention, Aug. 20-23, Congress Hotel, Chicago.

British Radio Show, Aug. 26–Sept. 5, Earls Court, London, England.

THE COLUMBIA (Lp) RECORD CLUB

now enables you to acquire a **STEREO RECORD LIBRARY** at a saving of 40%

ANY SIX STEREO RECORDS

FOR ONLY **$5.98**

RETAIL VALUE UP TO $35.88

if you join the Club now — and agree to purchase as few as 5 selections from the more than 100 to be made available during the coming 12 months

1. Night and Day, plus 11 more hits

2. A beloved American classic

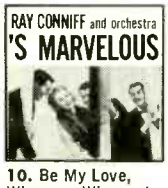
15. Broadway's newest smash hit

19. No Other Love, Our Love, 10 more

49. That's All Over, One More Ride, etc.

40. "Hallelujah", "Finlandia", etc.

37. Lovely "musical portrait of nature"

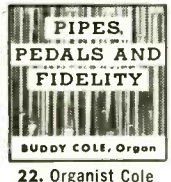


10. Be My Love, Where or When, etc.

24. 16 classical and pop selections

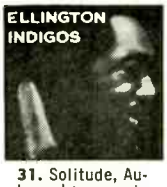
9. Always, Please, Speak Low, 9 more

11. Berlioz' most popular work



22. Organist Cole plays 11 hit tunes

28. Brahms' most beloved symphony

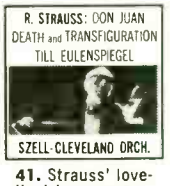


31. Solitude, Autumn Leaves, etc.

18. Two electrifying tone poems

42. Body and Soul, I Got It Bad, 10 more

33. 11 beautiful, immortal melodies



41. Strauss' loveliest tone poems

45. Tico-Tico, Brazil, 10 others

16. Two colorful, exciting scores

21. Four dashing, fiery rhapsodies

36. The ballet that "rocked the world"

COLUMBIA (Lp) RECORD CLUB
Terre Haute, Ind.

If you now own a stereophonic phonograph, or plan to purchase one in the near future — here is a unique opportunity to obtain SIX brand-new stereo records . . . up to a $35.88 retail value — ALL SIX for only $5.98!

We make this unusual offer to demonstrate the money-saving advantages you will regularly enjoy as a member of the Columbia (Lp) Record Club.

Read below how the Club operates . . . then mail the coupon, without money, to receive the six stereo records of your choice — all six for only $5.98.

NOTE: Stereo records must be played only on a stereo phonograph

8. What'll I Do, Warm, 10 more

7. Three brilliant hi-fi showpieces

50. Where or When, Manhattan, 10 more

6. Newly recorded for stereo sound

12. Let's Dance, Jubilee, 7 more

5. 16 favorites — Sweet Violets, etc.

25. Two very popular piano works

27. Granada, La Paloma, 11 more

30. A "must" for any record library

3. Didn't It Rain, God Is Real, etc.

29. High-spirited, gay symphonies

20. Come to Me, Long Ago, 10 more

HOW THE CLUB OPERATES:

- ★ You enroll in either one of the Club's two stereo Divisions: Classical or Popular — whichever one best suits your musical taste
- ★ Each month the Club's staff of music experts selects outstanding recordings that deserve a place in your new stereo record library. These selections are described in the Club's entertaining Music Magazine, which you receive free each month
- ★ You may accept the selection for your Division . . . take any of the other records offered in both Divisions . . . or take NO record in any particular month
- ★ Your only obligation as a member is to purchase five selections from the more than 100 Columbia and Epic records to be offered in the coming 12 months . . . and you may discontinue membership any time thereafter
- ★ After purchasing only five records you receive a Columbia or Epic stereo Bonus record of your choice free for every two additional selections you buy
- ★ The records you want are mailed and billed at the regular list price of $4.98 (Classical Selections, $5.98), plus a small mailing charge
- ★ Here, indeed, is the most convenient method ever devised to build a superb stereo library, at great savings — so mail the coupon today!

SEND NO MONEY — Mail coupon to receive 6 records for $5.98

COLUMBIA (Lp) RECORD CLUB, Dept. 245-1
Stereophonic Section
Terre Haute, Indiana

I accept your offer and have circled at the right the numbers of the six records I wish to receive for $5.98, plus small mailing charge. Enroll me in the following Division of the Club:

(check one box only)

☐ Stereo Classical ☐ Stereo Popular

I agree to purchase five selections from the more than 100 to be offered during the coming 12 months, at regular list price plus small mailing charge. For every two *additional* selections I accept, I am to receive a 12" Columbia or Epic stereo Bonus record of my choice FREE.

Name.....
(Please Print)

Address.....

City.....ZONE....State.....

ALASKA and HAWAII: write for special membership plan
CANADA: address 11-13 Soho Street, Toronto 2B

If you wish to have this membership credited to an established Columbia or Epic record dealer, authorized to accept subscriptions, fill in below:

Dealer's Name.....

Dealer's Address.....288

CIRCLE 6 NUMBERS:	
1	22
2	24
3	25
5	27
6	28
7	29
8	30
9	31
10	33
11	36
12	37
15	40
16	41
18	42
19	45
20	49
21	50

F-85

BANDWIDTH REDUCTION FOR TV transmission over long distances is being researched successfully by several laboratory teams. The problem is that TV's 4-mc bandwidth occupies too much valuable spectrum space for the long-distance TV relays which will become commoner in the future.

Present methods have reduced the necessary bandwidth to only 2 mc, though 1-mc results are looked for in the near future. Unfortunately, this work will have little direct effect on home receivers because the equipment for bandwidth reduction is complex and expensive. It works on the principle that most TV pictures actually use much less detail over most of their area than 4 mc permits, so the pictures are taken apart and reshuffled, and only the bandwidth required is used. Then they're put back together again at the receiving end.

Present leaders in the research include Bell Labs, Technicolor Inc. and Florida Communications, Inc.

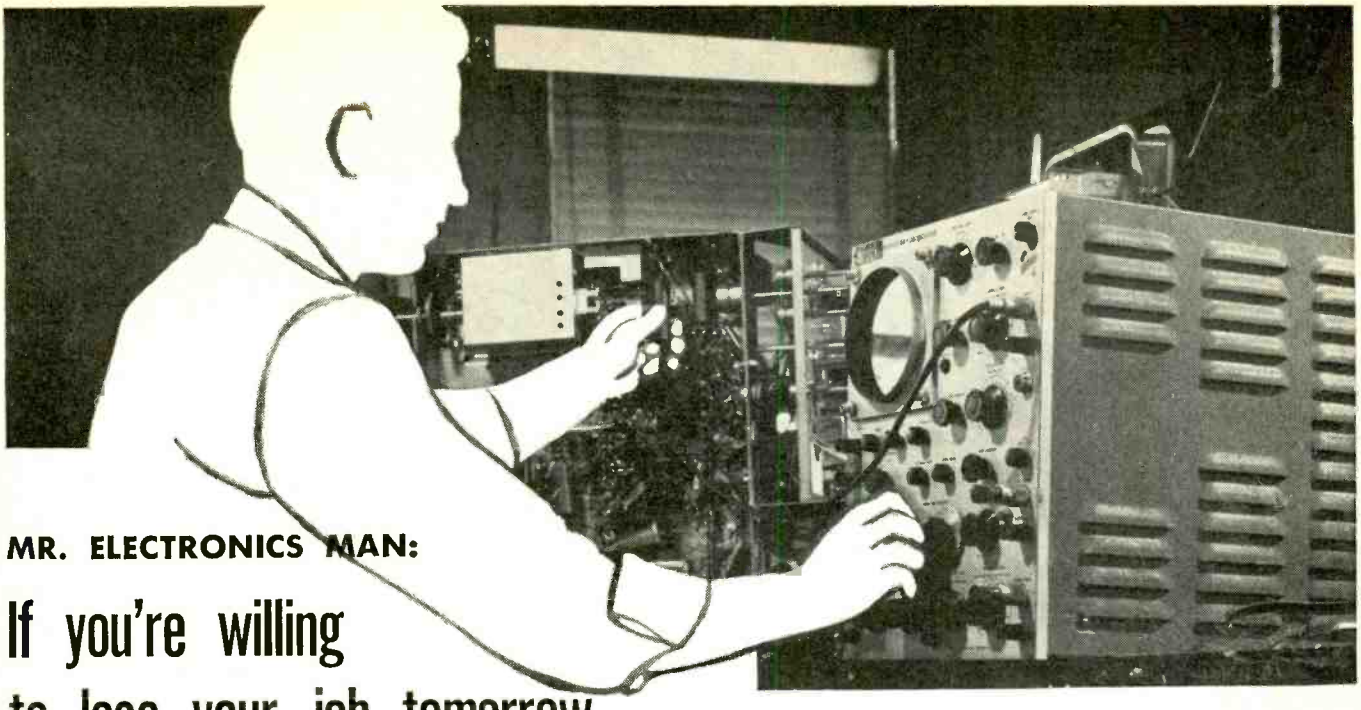
ELECTRICAL ENGINEERS SOCIETY, the AIEE, is 75 years old. Founded in May, 1884, the year after Edison discovered the vacuum diode effect, the organization started with 71 members, including Alexander Graham Bell and Edison. It has 52,000 members today.

CHIEF SIGNAL OFFICER of the US Army just appointed is Maj. Gen. Ralph Nelson. General Nelson has held numerous important posts in the Army during his 31 years of service. The Army also announced appointment of Albert L. McIntosh to the new position of Army Frequency Manager.

TROUBLE-FREE TV SETS within 5 years are predicted by Motorola president Robert W. Galvin. Improved reliability of parts, especially by using transistors, will account for the development. Galvin also said the industry will be marketing transistor TV receivers, see page 56, within 1 to 2 years, along with FM sets for automobiles.

Some people want to know what will happen to the poor TV service technician, if the day of trouble-free TV sets ever comes. This will be no problem, for as fast as TV sets cease to need fixing, there'll be a multitude of new electronic gadgets, especially in the field we now think of as industrial electronics. Many of these will be in the home by the time service on TV sets begins to slacken appreciably.

TV IN JAPAN is booming much as it did in this country a few years ago. Starting in early 1953, Japan had about 8,000 receivers and two transmitters in operation by 1954. During 1955, the number of sets grew to 130,000, transmitters to 5. In 1956, sets more than doubled, as did stations, and by May 1958 the million mark was passed, with TV stations by the beginning of 1959 numbering over 45. There are now about 2,000,000 TV receivers in operation in Japan, with the total expected to reach 4,000,000 in 1960. There will be a total of over 70 TV stations. END



MR. ELECTRONICS MAN:

If you're willing to lose your job tomorrow to a technically-trained man, *turn the page, mister*

There always <u>has</u> been . . . there always <u>will</u> be PERMANENT, PROFITABLE EMPLOYMENT IN ELECTRONICS . . . For <u>everybody</u>? No . . . only for well-trained electronic engineering personnel

See what "Electronics"* says:

**Published by McGraw-Hill Publishing Co.*

In Los Angeles, May and June saw classified advertising for engineers almost quadruple. Airframe manufacturers and missilemakers are drawing heavily on electronics manpower reserves in the West. In Chicago, demand for electronics engineers has trebled in the last 90 days and is still rising.

Chief engineers and personnel officers in industry agree on several major points:

• Many of the men currently on the street are there for a reason. "As many as 8 out of 10 are dead wood," estimates the chief engineer of a medium-sized Philadelphia firm; the problem is to find the live ones.

Now is the time to survey your technical ability. Are you in danger of becoming "dead wood?" Does your technical knowledge seem to suffer from hardening of the arteries? You can do something about that. The first step is to fill out and mail the coupon below. It will bring you your copy of "Insurance For Your Future in the New World of Electronics," which has proved so valuable to thousands of men. This booklet gives you a picture of the astonishing future waiting for men who acquire advanced technical knowledge . . . then goes on to tell you how CREI accredited curricula gives you that advanced technical knowledge—at home, in your spare hours, at your own pace. Act now—and take that first step toward giving yourself the advanced knowledge that will help protect what you have—and will help you go even higher in the multi-billion dollar electronics industry. Write: Capitol Radio Engineering Institute, Dept. 147F, 3224 16th St., N.W., Washington 10, D.C. You can qualify for CREI home study education if you have had electronic training, or experience in electronics—and realize the need of high level technical knowledge to make good in the better electronic jobs. (Electronics experience is not required for admission to CREI Residence School.)

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Correspondence

BAT'S EARS MAN SPEAKS

Dear Editor:

Mr. Cooper makes some practical points in his article "Golden Ears or Bat's Ears?" (May, 1959, page 51.) Such arguments are familiar in all technical fields: "Man will surely be killed by car speeds over a mile a minute . . . planes will never be able to fly faster than sound . . ."

The graying writer of this letter harks back to the horse-and-buggy days of radio, including some rather hammy audio and radio epics dated around 1937–39. He vaguely recalls advertising of those times claiming for the 7-kc bandwidth we had then "thrilling crystal-clear, lifelike reproduction right in your own living room," and learned discussions stating that only crackpots would consider 10-kc bandwidths when phono discs cut off at 8 kc and most speakers folded up at 5 kc.

Recently I listened to discs of "live" sounds at a hi-fi show in hypnotized fascination. A mental picture came to me of the 1920-type nose-cone magnetic speaker squeaking out its tomato-can voice-bandwidth noise; it contrasted glaringly with the startling railway-yard sounds which boomed all *around* my ears. I thought, "Man, this business has come a long way since pilots traded their goggles for space helmets."

While the hi-fi hound may not expect to hear a bat's ultrasonic sonar love call, he has sound technical reasons (and costly ones!) for wanting 100–200-kc bandwidths. For instance, if one slams a door there are not only very-low-frequency components due to building-wall oscillations but a dc component due to the air pressure wave produced by door motion, which one can feel. Hence one can argue that to reproduce the sound properly we must go below a few cycles *down to dc.* A supersonic bullet shattering a pane of glass produces impulse rise-time frequency components that might make a bat's whiskers curl.

A real hi-fi addict is not interested in bandwidths flat within 1 db but within *zero db,* which is the actual distortionless bandwidth. To get good transient response to impulse sounds, one needs a wide *phase* bandwidth. To get stable, clean feedback (traces of dirty ringing are almost impossible to eliminate in pentode feedback loops), one needs not only linear phase but flat amplitude response far beyond the passband.

It might interest Mr. Cooper to know

(*Continued on page* 22)

build this great new knight®-kit A PRODUCT OF ALLIED RADIO

stereo hi-fi amplifier...save up to 50%

COMPARABLE IN EVERY WAY TO WIRED AMPLIFIERS COSTING TWICE AS MUCH

tremendous value at only

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EXCLUSIVE **knight-kit**

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Every KNIGHT-KIT meets or exceeds published specifications, or we refund your money. Buy any KNIGHT-KIT! Build it! It must perform exactly as claimed—or your money is refunded.

ONLY ***knight-kits*** ARE

CONVENIENCE-ENGINEERED

for easiest building—no previous electronic experience needed. "Convenience engineering" means special attention to every detail: resistors are carded and numbered for easy selection; parts and hardware are packaged in clear plastic bags for quick identification; wire is pre-cut, stripped and color-coded; finally KNIGHT-KIT step-by-step instructions and wall-sized diagrams make assembly a marvel of simplicity.

knight-kit 20-watt stereo hi-fi amplifier

Newest complete Stereo high-fidelity amplifier at an amazing low $44.50. Incomparable value: Includes two built-in preamps for magnetic cartridges. Single switch selects stereo phono, tuner or auxiliary inputs, plus stereo reverse on each; also switches monophonic inputs to both amplifier channels. Bass and treble controls boost and attenuate. Special clutch-type concentric volume control permits individual channel balancing, plus overall volume control. Total output is 20 watts (10 watts per channel at less than 1½% distortion). Response, 20-20,000 cps, ± 1.5 db. Hum and noise better than 85 db below full output. Has four pairs of stereo inputs: magnetic cartridge, ceramic cartridge, tuner, auxiliary. RIAA equalized for stereo discs. Expertly designed push-pull output circuitry. Beautiful custom-styled case, 4¼ x 13¼ x 9". With case, tubes, all parts, wire, solder and instructions. Shpg. wt., 27 lbs.

Model Y-773. Knight-Kit Stereo Amplifier, F.O.B. Chicago..... **$44.50**

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Stereo Amplifiers	Short-Wave Radios	VTVM	Cap. Checker
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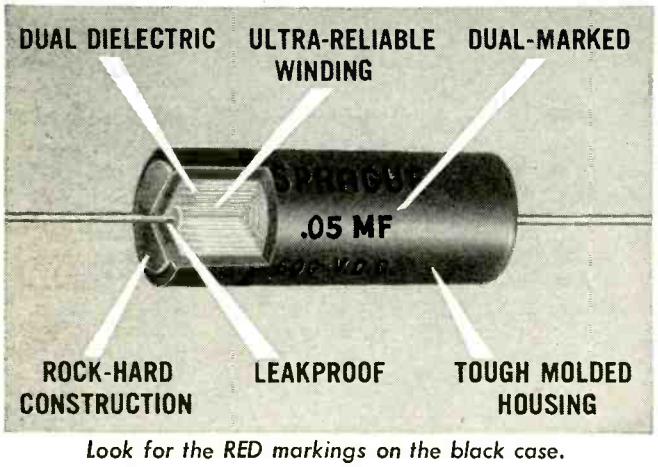
NEW DIFILM® BLACK BEAUTY®
MOLDED CAPACITORS

BEAT THE HEAT AND HUMIDITY!

Now Sprague's new DIFILM BLACK BEAUTY MOLDED CAPACITORS have taken the steam out of heat and humidity problems. These capacitors are so good you can *boil 'em* for 24 hours without affecting their performance.

Unlike straight polyester film tubulars, these capacitors operate in a 105°C environment *without derating.*



Look for the RED markings on the black case.

And the heart of these new DIFILM capacitors can't be beat. It's a dual dielectric which *combines the best advantages of both Mylar* polyester film and the highest grade of paper dielectric.* A rock-hard solid impregnant fills voids and pinholes in the film.

Talk about *reliability!* . . . these capacitors have it. DIFILM capacitors are actually low cost versions of the Sprague capacitors now being used in every modern military missile. The basic reliability and outstanding performance of missile-type Sprague capacitors are all yours in this outstanding new development. Why take chances when you can get the best—DIFILM BLACK BEAUTY MOLDED TUBULARS . . . at regular prices.

For the complete DIFILM BLACK BEAUTY story, write for Bulletin M-759 to Sprague Products Company, 81 Marshall St., North Adams, Mass.

*DuPont trademark

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The Grantham Communications Electronics Course prepares you for a *FIRST CLASS* F.C.C. license, and it does this by TEACHING you electronics. Each point is covered simply and in detail, with emphasis on making the subject easy to understand. The organization of the subject matter is such that you progress, step-by-step, to your specific objective — a first class F.C.C. license.

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

	License	Weeks
Ron Taylor, 29 S. Franklin St., Chambersburg, Pa.	1st	12
Beri Moore, P.O. Box 169, Opp, Alabama	1st	15
Donald R. Titus, 270 Park Terrace, Hartford 6, Conn.	1st	12
Robin O. Okimishi, P.O. Box 375, Hanapepe, Kauai, Hawaii	1st	12
Billy R. Kirby, Route #3, Smithfield, N. C.	1st	9
J. H. Reeves, 10621 Ruthelen, Los Angeles 47, Calif.	1st	12
Donald H. Ford, Hyannis Rd. (Cape Cod), Barnstable, Mass.	1st	12
James D. Hough, 400 S. Church St., East Troy, Wisc.	1st	12

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Please send me your free booklet telling how I can get my commercial F.C.C. license quickly. I understand there is no obligation and no salesman will call.

Name _____ Age _____

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City _____ State _____

I am interested in: ☐ Home Study, ☐ Resident Classes

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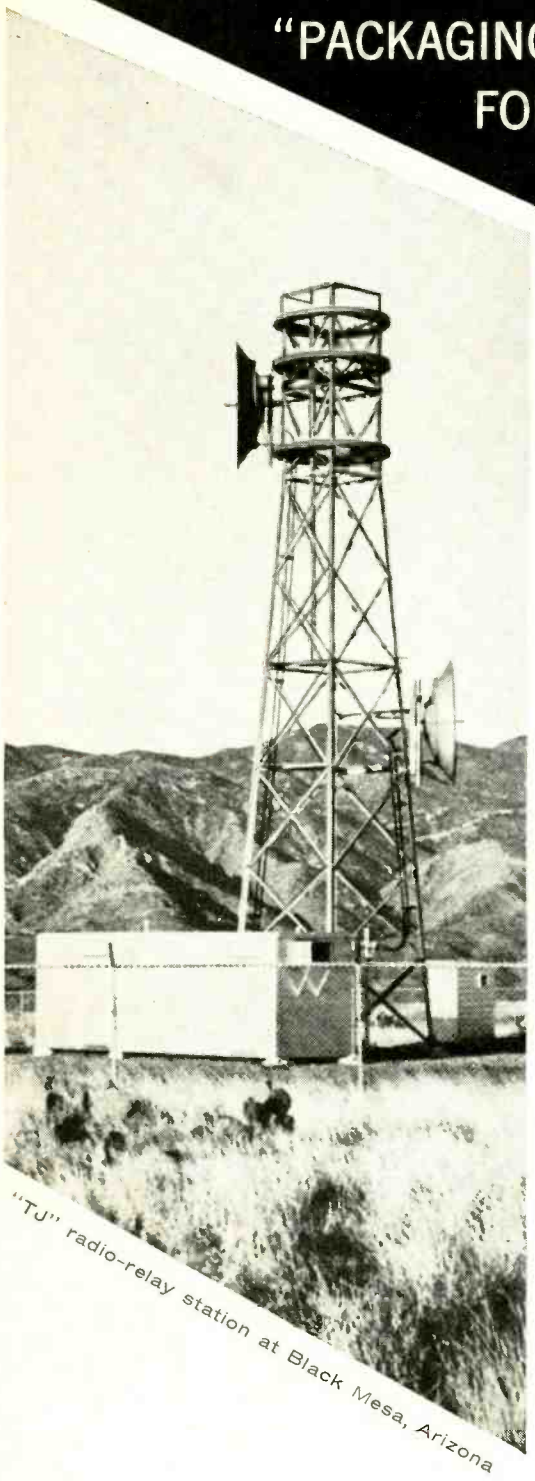
"PACKAGING" MICROWAVES FOR MOUNTAIN TOPS



"TJ" radio-relay station at Black Mesa, Arizona

In Arizona, the telephone company faced a problem. How could it supply more telephone service between Phoenix and Flagstaff—through 135 miles of difficult mountain territory?

Radio offered the economical answer: a new microwave radio-relay system recently created at Bell Telephone Laboratories. Operating at 11,000 megacycles, it was just right for the distance, and the number of conversations that had to be carried.

But first other problems had to be solved: how to house the complex electronic equipment; how to assemble and test it at hard-to-reach relay stations way up in the mountains; and how to do it economically.

On-the-spot telephone company engineers had some ideas. They worked them out with engineers at the American Telephone and Telegraph Company and at Bell Telephone Laboratories. The result: a packaged unit.

The electronic equipment was assembled in trailer-like containers at convenient locations and thoroughly checked out. The complete units were then trucked up the mountains and lifted into position.

The system, now operating, keeps a watch on itself. When equipment falters, a relay station switches in standby equipment, then calls for help over its own beam.

The new Phoenix-Flagstaff link illustrates again how Bell System engineers work together to improve telephone service. Back of their efforts is the constant development of new communications systems at Bell Telephone Laboratories.

BELL TELEPHONE LABORATORIES *World center of communications research and development*

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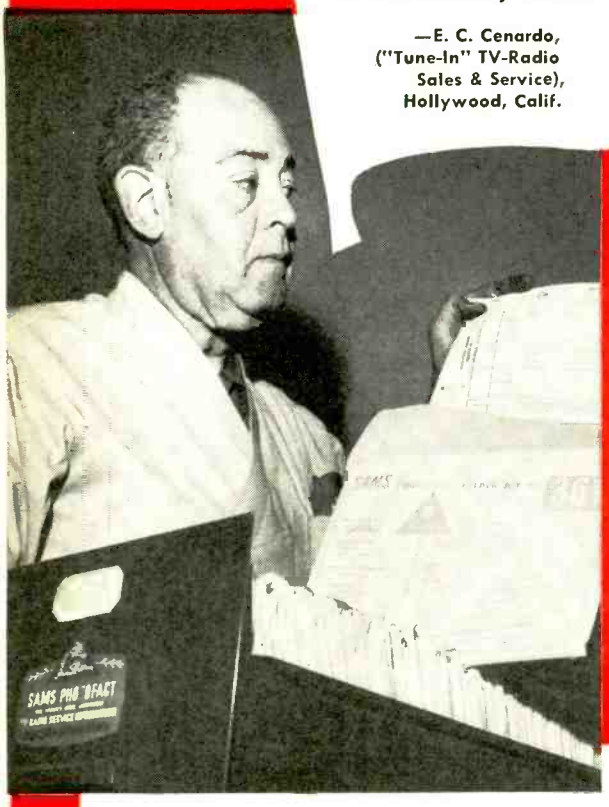
"PHOTOFACTS are a tremendous aid to a service technician in that they save hours of unnecessary work."

—E. C. Cenardo,
("Tune-In" TV-Radio Sales & Service),
Hollywood, Calif.



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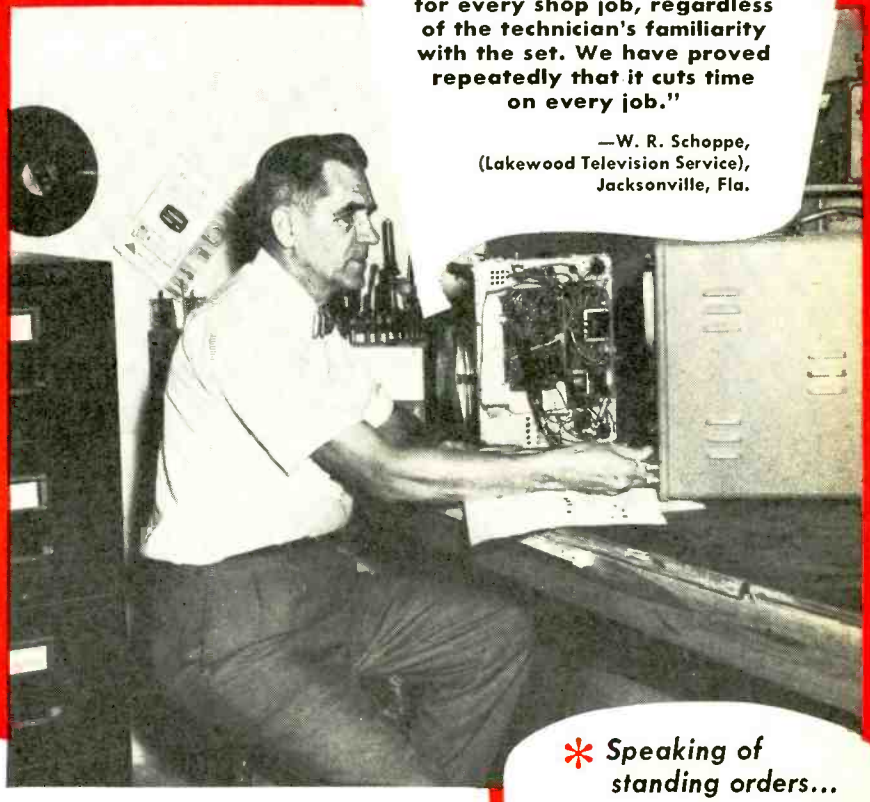
—W. R. Schoppe,
(Lakewood Television Service),
Jacksonville, Fla.



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"PHOTOFACTS mean so much to my business that I would not think of operating for any length of time without them."
—James G. Haynes
Leitchfield, Ky.

"The PHOTOFACTS that I have purchased on the Easy-Buy plan have been paying for themselves each month."
—Donald Johnson
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—Frank J. Schumacher
Hillsboro, Ore.

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—Joseph S. Musil
Stamford, Texas

"PHOTOFACT means quicker and more efficient service to the customer."
—Wesley F. Scott
Logansport, Ind.

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1K3	5BK7-A	6AQ5-A	6BZ7	6DT6	12AT7
1X2-B	5CG8	6AU4-GTA	6CB6-A	6EA8	12AU7-A
2AF4-B	5EU8	6AU6-A	6CD6-GA	6EU8	12AX4-GTB
3BN6	5U4-GB	6AX4-GTA	6CG7	6J6	12BY7-A
3BU6	5U8	6BK7-B	6CG8-A	6SN7-GTB	12DQ6-A
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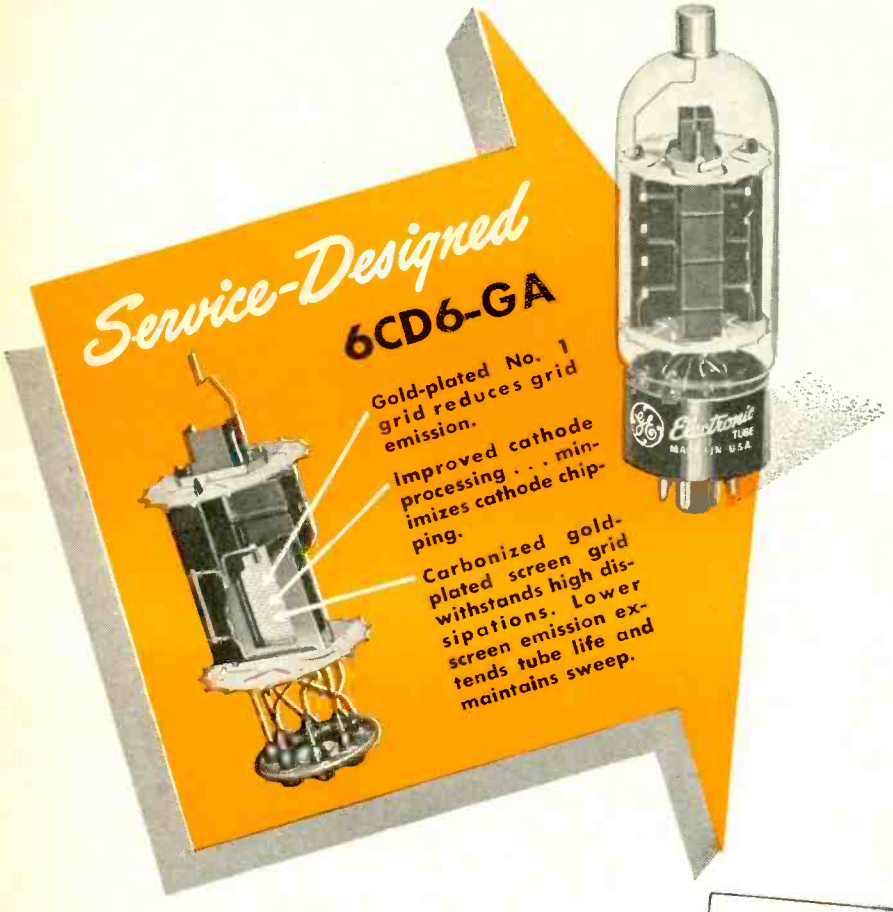

Check the improvements in three popular Service-Designed Tubes at left! These typify quality features that mark the entire line. Over 1,000 advancements give General Electric Service-Designed Tubes top performance, extra reliability!

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that *some* adults can hear 20- to 25-kc sine-wave signals and that some youngsters can actually hear to 40 kc, which is well up into batland! Mr. Cooper may live to see the day when men will not only make startling geological finds on Venus, but listen to all push-pull, all-dc amplifiers working directly into trick pneumatic–hydraulic–ionic transducers with 0–100-kc bandwidths. And his great-grandson may listen to one of our 1959 super-bloopers with a wry grimace and mutter, "Excavate this cubic hardware complex, meteoroids! You can't even zero in on the ultrasonic beats between the digital plucks on the Presley chords and the 100 kc erase oscillator! What tesseract could possibly have endured this ancient stuff?"

TED POWELL

Glen Oaks, N. Y.

GOLDEN EARS?

Dear Editor:

An article in the May issue of RADIO-ELECTRONICS contends that the wide response of modern amplifiers is useless ("Golden Ears or Bat's Ears," page 51) and tries to support this contention with pages of humor, reminiscence and technical data, much of which sidesteps one important question: Just what is the program material to be reproduced?

Let us pause for a moment in the concert hall, forget about watts and feedback, and listen to the music. A symphony orchestra is playing. What sort of sounds do we hear? The bulk of the music falls within very narrow limits. But more than occasionally, the tuba, bass and tympani will thrill us with a genuine 40 cycles. A piano will go still lower, and an organ can really shake the hall. [Mr. Cooper's lower limit was 30 cycles, was it not?—*Editor.*] Possibly more important, almost all the instruments produce overtones and some fundamentals 'way up there where the bats can listen in.

From an engineering point of view, the power-frequency distribution of these sounds may not be concentrated at the extremes; perhaps only a per cent or so. But to a listener they're like salt and pepper; one mustn't use too much, but the meat tastes dull without them. These sounds are important to another group, too—the composers. I'm assuming that they listen to their music live, and not on $29.95 drugstore "hi-fi."

In the concert hall, we hear a complex field of sound, the sum of every fundamental and overtone played. If listening "live" is realistic, then each subtraction from this complex field makes our reproduction less realistic. Subtraction thus is distortion. With current miking technique, pickup and standing-wave dips, we have enough of this kind of distortion without trying to increase it.

I would like to make a suggestion to Mr. Cooper. Drop around to a symphony concert, forget about decibels and efficiency and try to appreciate what goes on at the concert. Then go back to the

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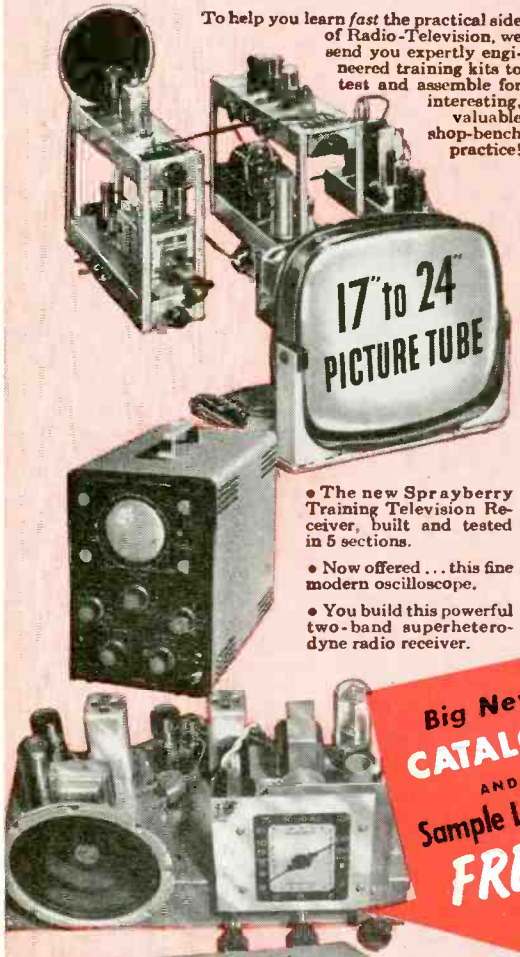

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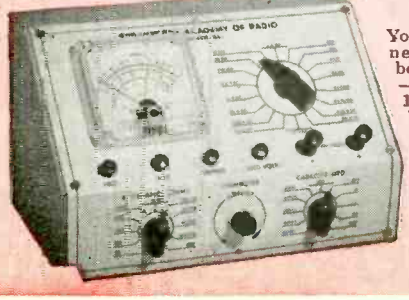

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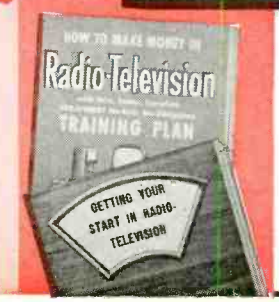

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lab and try to reproduce what you heard in the hall. Mr. Cooper, you've been around "hi-fi" a long time. You might like High Fidelity, too.

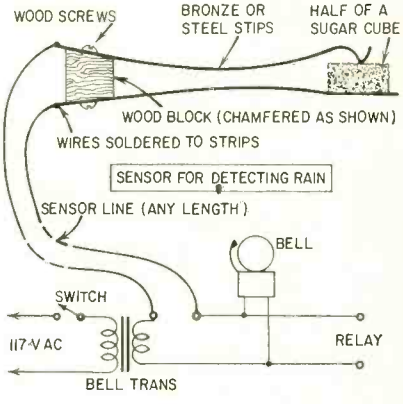
JAMES R. ZIMMERMAN
Lexington, Ky.

TRANSISTORS VS SUGAR

Dear Editor:

I have been a reader of RADIO-ELECTRONICS for many years and you published some of my articles in SHORT WAVE CRAFT. As an electronic-minded physicist, I really like your magazine. I read your article "Water Is the Trigger" in the May issue and decided to build the unit.

I am a married man, and my wife is always "forcing" me to invent or make gadgets and devices to make her home work less hard. So she was happy when I told her I was going to make a transistor rain alarm. I bought the bell and the transformer; I had a small ac



relay. But when I tried to go and buy the transistors, diodes and sensing elements, she stopped me and saved some dollars.

Here is her idea, as dressed up by an electronic man. The sensing element is made as shown in the drawing. The two bronze or steel strips are arranged to touch one another with hard pressure.

You then insert half a sugar cube between the two and expose the unit to the rain, the first drops of which will dissolve the cube and close the electrical circuit, sounding the alarm bell or operating a relay which closes a window with the aid of a small motor. (A second relay can be used to disconnect the power once the window is completely closed.)

Our alarm operates quite well. No transistors, no diodes, no nothing. Any girl can set and reset it without any trouble and you save some money if you are smart enough. I did not save any, because Olga took what I saved to buy a new hat. She said it was the prize for a very bright (and sweet) idea.

J. MERINO Y CORONADO
Professor of physics
Universidad Nacional de Mexico
Villa Obregon, D. F., Mexico

(Ha! And congratulations, professor! —*Editor.*) END

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HF86: Stereo Dual Power Amplifier for use with HF85 above or any good self-powered stereo preamp. Identical Williamson-type push-pull EL84 power amplifiers, conservatively rated at 14W, may be operated in parallel to deliver 28W for non-stereo use. Either input can be made common for both amplifiers by Service Selector switch. Voltage amplifier & split-load phase inverter circuitry feature EICO-developed 12DW7 audio tube for significantly better performance. Kit **$43.95**. Wired **$74.95**.

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Radio-Electronics
Hugo Gernsback, Editor

RADIO ON THE MOON

. . . Radio Signaling on the Moon Differs Vastly From That on Earth . . .

"AFTER the first rocket from the earth has landed on the moon, supplies are unloaded feverishly and our exploration parties are organized. We arrived at the beginning of the two weeks' (earthtime) daylight that makes the lunar day. Six men stayed near the rocket base, the other four in their tank-mooncar were to explore a radius of about 250 miles of lunar terrain. The little tank-car was radio-equipped, while the four explorers all had walkie-talkies. *Thus the tank and men could always be in constant touch with the moon-base headquarters, via radio.*"

Rubbish and nonsense—as far as the last sentence goes! Recently we have all read accounts similar to the above written by amateur scientists, who should know better. The facts are that *one cannot* signal by radio on the moon as one does on earth.*

The moon has no true atmosphere, hence no Heaviside-layer reflecting surface.† That means that if one tried to communicate, let us say, at broadcast frequencies, signals could not be transmitted to points much beyond the visible horizon.

It is true that on the moon we have many mountains, some up to 30,000 feet high. Couldn't the mountains be used to reflect the signals? Yes and no. If you draw a circle of the moon to scale, you will see that a signal bounced against a mountainside will be reflected out into space. The signals will be received only in the *vicinity* of the transmitter, as long as the receiver and transmitter can see each other, but not beyond the horizon. And that goes for all frequencies.

What about the so-called *obstacle gain*, or *knife-edge effect*, whereby a sharp object like a mountain peak will scatter the radio waves on the other side of the mountain, diffracting the wave, i.e., bending it? In this way, TV signals today can leap over an interfering mountain, yet be received well in a valley on the other side, if the transmitting angle in reference to the mountain peak is suitable.

The obstacle effect, as far as has been ascertained, is a *tropospheric* condition. As there is no troposphere on the moon, we cannot depend on such an effect.

Unfortunately, too, the moon (2,160 miles in diameter), a much smaller body than the earth (7,926 miles in diameter), has an exceedingly short horizon. On earth, the average person's eyes are, let us say, 5 feet above the sea or lake level when standing up. The horizon for him is 2½ miles away; actually, due to the refraction of the air, the line of sight is curved, hence he sees the horizon further away, or 3¼ miles.

On the moon, however, conditions are vastly different. There being no atmosphere, the same man sees the horizon much closer—only 1.4 miles away. Even with his walkie-talkie antenna extended to 10 feet, the horizon still is only 2 miles away. True, the explorer could climb up a mountain to extend his range, but mountain climbing on the moon for the first lunar explorers is much too time-consuming, hence not very practical.

Thus, under normal conditions, an exploring party could, under no circumstances, travel 250 miles from its lunar base and hope to be in *direct* radio contact with it in case of emergency, or even to give hourly reports.

One solution would be to station personnel on a number of high mountain tops. These then could relay messages over fairly long distances. This, again, is impractical because of the restricted horizon. Far too many people would be needed just for relaying purposes—and no expedition in the initial stages of moon exploration could even think of transporting scores of people.

Later on, automatic relays could of course be built, and probably will, although the cost of installing such a relay network, running in all directions on an extremely hostile world, will be astronomical. There is also the difficulty of reaching isolated plains, with which the moon abounds. Many of these plains are far from mountains, hence would always be isolated unless, of course, one were to build relay towers to stretch across these flat lunar surfaces.

But we need not despair. There is a very simple, safe and practical radio communication means for the moon's first explorers. It will enable the first men on the moon to roam from pole to pole over thousands of miles and be *constantly* in touch with their lunar base, as long as they are on the side of the moon facing the earth.

The signaling simply will be by relay to the earth.§

For best operation, the explorers' walkie-talkies, as well as their tank-car, will be equipped with directional dishpan radar type antennas. No extra power is necessary. The antennas will be directed toward the home land, if it is in sight. If, because of the earth's rotation, it is not, there will be listeners in other lands waiting to relay the message back to the moon. The total time of such relay transmittals —coming and going—is about 2½ second.

Before the expedition to the moon, certain radio relay stations are selected on earth to handle the lunar traffic on frequencies specifically assigned for just such a purpose. This is obviously necessary as there cannot be too many earth–moon transmitters on the same frequencies, lest jamming and confusion occur. Most transmissions will probably be by code, many by phone.

Such signaling is also quite feasible from *within* the moon's thousands of craters. The latter measure from ½ to 150 miles in diameter. Usually they are surrounded by a chain of high mountains, which often makes it impossible to signal by radio directly *through* the mountains, even over short distances. It is not even possible to radio *within* one crater over 10 miles in diameter, because of the sharp curvature of the moon and its short horizon. Hence, relay to earth is the best and surest means.

There is one signaling means that we cannot test until explorers have actually tried it out on the moon.

It was Nikola Tesla who theorized that it should be possible to *signal with alternating ground currents only.* No antenna was to be used. It was he, too, who, in his famed Colorado experiments, lighted electric light bulbs several miles from the transmitter. There were no conducting wires—ground connections only—at the receiver.

Time will tell if long-distance signaling solely via the ground will prove practical on the moon. —*H.G.*

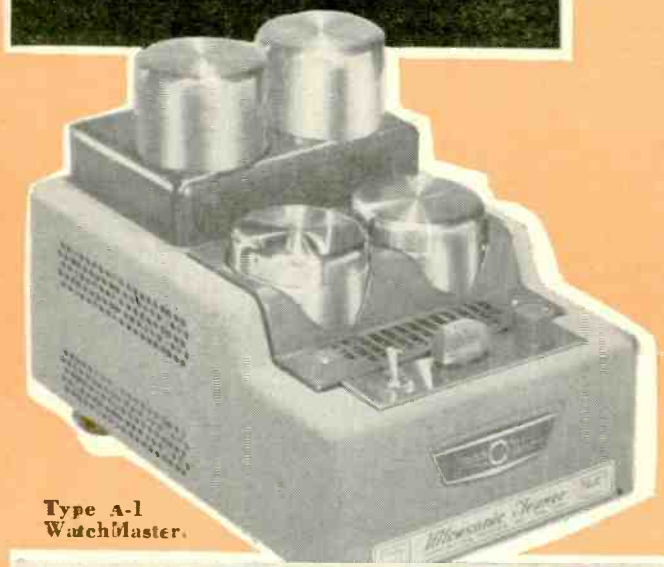
*Excerpts of this editorial were given in a lecture by the author before the Radio Club of America in New York, April 28, 1959.

†The moon *may* have some vestigial gas pockets originating from lunar volcanos, but these, because of the extremely low gravity, are dissipated quickly into space.

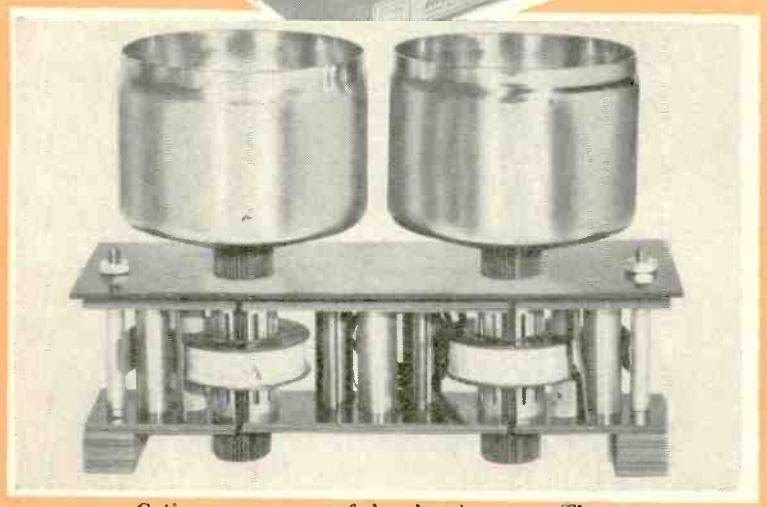
§The author was the first to point out earth–moon signaling in his article "Can We Radio the Planets?" in *Radio News* for February, 1927. Nineteen years later, the US Signal Corps made its first moon contact on 111.6 megacycles. The author's predicted time in 1927 was 2.5 seconds; the actual time 2.4 seconds.

SOUND does the cleaning

You can't hear it—it's above 20 kc—but when it comes to cleaning things, such as watches—ultrasonic sound is hard to beat



Type A-1 WatchMaster.



Coil cores are part of the cleaning cups. They must be in place for the equipment to work.

Under the hood, layout is simple. Note TV type horizontal output tubes which act as power amplifiers.

By ROBERT F. SCOTT
TECHNICAL EDITOR

THE uses of ultrasonics have been growing by leaps and bounds. Among its applications in the medical field are the detection of cancer, destruction of harmful growths in inaccessible places and purification and emulsification of drugs. In industry, its uses range from tire testing and inspection, drilling and machining of hard materials, and flaw detection to precise cleaning of precision parts and assemblies. If you've had a watch or piece of jewelry cleaned recently, the chances are good that the jeweler or watchmaker used an ultrasonic cleaner.

How ultrasonic cleaners work

Ultrasonic energy is simply mechanical vibrations whose frequency may vary from just above the upper limit of human hearing—around 20 kc—to well up into the megacycle range. It is generally developed by feeding the output of an audio or rf generator into a transducer which converts the electrical energy into mechanical vibrations.

The most common types of ultrasonic transducers are piezoelectric crystal and magnetostrictive. The piezoelectric crystal may be quartz as commonly used in oscillator control and wave filters, or Rochelle salt, barium titanate or similar materials used in phonograph and microphone cartridges. When a high-frequency signal is applied, the crystal vibrates at the exciting frequency. The amplitude of the ultrasonic vibrations is greatest at the crystal's resonant frequency.

Nickel, iron, chromium, cobalt and their alloys and most ferromagnetic materials undergo a change in dimensions when placed in a magnetic field. This effect—called magnetostriction—varies with the material and the strength of the magnetic field. The most commonly used magnetostrictive effect is the change in length along the axis of the magnetic field.

When the magnetostrictive material is in a constant field, its change in length is minute. However, an oscillating field causes the material to contract and expand at a regular rate and set up ultrasonic vibrations. The amplitude of such vibrations is greatest when the length of the material is adjusted so it

is resonant at the exciting frequency. At resonance, the change in length may be as great as $L \times 10^{-4}$, or 1 part in 10,000, where L is the length of the material. Off resonance, the change in length is generally limited to about 25 parts in 1,000,000. The magnetostrictive effect decreases as the temperature increases, and disappears at the Curie point. (At the Curie point, magnetic properties cease to exist.)

Magnetostrictive elements in transducers are generally made of thin rods, tubes or laminations fastened together to make a core for the driving coil. This construction minimizes hysteresis and eddy-current power losses.

The selection of the type of ultrasonic transducer depends on the application and operating frequency, because the power in each wave varies inversely as the frequency. Crystals are much more efficient than magnetostrictive transducers, but are relatively fragile and cannot handle great amounts of power. They are used when the frequency is comparatively high and the power input is low. Magnetostrictive devices are sturdy, they operate at lower frequencies and can be designed to handle almost any amount of power. But they are temperature-sensitive and may not be suitable where temperature approaches the Curie point.

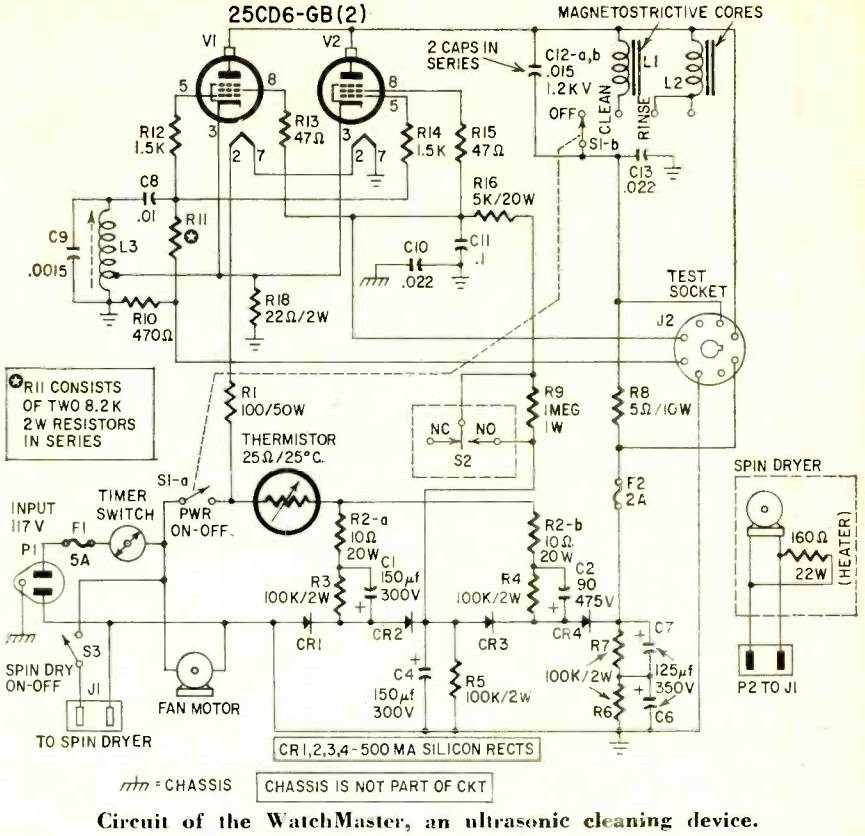
Most cleaning operations consist of immersing the material to be cleaned in a solvent or detergent and scrubbing, either manually or by machine. In ultrasonic cleaning, the scrubbing action is obtained by setting up ultrasonic vibrations in the cleansing solution.

Cavitation

When a high-intensity ultrasonic beam is passed through a liquid, bubbles ranging from microscopic to very large are generated. These bubbles or cavities may be empty or filled with gas or vapor expelled from the liquid. This bubbling effect is called *cavitation*. The size of the bubbles and their makeup depend on the liquid and the ultrasonic frequency.

A considerable amount of power is stored in each of the millions of bubbles produced. As each bursts, it has an erosive action on solids immersed in the liquid. It is this erosive or scrubbing action that is used in ultrasonic cleaning. One author compares the effect to the bursting of a bomb on the ground. Another feels that it is caused by variations in hydrostatic pressure. On half of the excitation cycle, the pressure increases and forces liquid into the pores of the material. On the following half-cycle, pressure is released and the liquid erupts violently from the solid, carrying with it bits of surface material. No matter which explanation you accept, it is easy to see how cavitation is used for rapid removal of surface grime, dirt and film.

The size of the bubbles and the power in them decrease with frequency. At low ultrasonic frequencies, the bubbles are comparatively large and have enough power to do a good cleaning job on open surfaces but may be too large to penetrate deep recesses in closely fitted watches and similar assemblies. For cleaning watches, the optimum operating frequency is around 30 kc. In this range, the bubbles can penetrate the smallest recesses and have enough power for efficient cleaning.



Circuit of the WatchMaster, an ultrasonic cleaning device.

WatchMaster*

This instrument, shown in the photos and diagram, is designed for rapid cleaning of watches, jewelry and small parts. The cleaning process consists of four phases: an ultrasonic wash, a dip rinse, an ultrasonic rinse and a spin-dry that whirls the watch or part in a stream of warm air to remove the rinse solution. The ultrasonic wash, rinse and spin-dry are controlled by an adjustable built-in timer. S1 controls the ultrasonic wash and rinse, and S3 controls the spin-dry motor and heater when the timer is on.

The ultrasonic generator operates at 35 kc. Magnetostrictive transducers are used because of their high stability, power-handling ability and relative immunity to temperature rise during normal operation of the equipment. The transducers exert a magnetic pull when energized. This effect is used to an advantage in the WatchMaster. The watch to be cleaned is demagnetized before being placed in the cleaner. Demagnetizing releases all magnetic dirt particles clinging to steel watch parts and permits them to be removed easily by the cleansing operation. The transducer pulls these dirt particles to the bottom of the cup where they are held during the cleaning process.

The transducers are driven by an electron-coupled oscillator using paralleled 25CD6-GB's delivering more than 75 watts at 35 kc. The transducers are fastened to the bottoms of the wash and rinse cups. The magnetostrictive elements are composed of approximately 40 nickel laminations radiating from a hollow brass tube. These elements are roughly ¾ inch in diameter and 2¾ inches long. They form the removable cores of driving coils L1 and L2. The coil selected by function switch S1-b is parallel-tuned to the operating frequency by the .015-μf capacitor.

The oscillator plate circuit is resonant at 35 kc only when the cores are in the coils, and the 25CD6's would be damaged if operated off resonance. S2 is a safety interlock switch that closes when both cores are in their coils. Removing either the ultrasonic wash or rinse cup opens S2 and inserts a 1-megohm resistor in the screen lead. This reduces screen voltage and cuts off the oscillator.

The violent molecular agitation of the ultrasonic wash and rinse produces heat in the liquid. A cooling fan blows a steady stream of air around the rinse and wash cups to hold the temperature down and to disperse vapor.

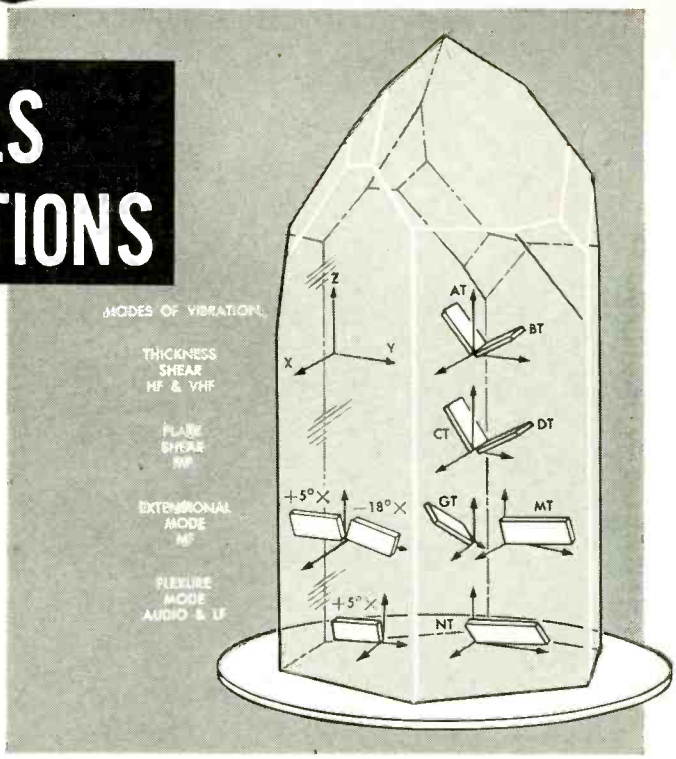
The oscillator power supply is a transformerless voltage quadrupler using four 500-ma silicon rectifiers. The chassis is insulated from the power line. The line cord has a grounding type plug. The grounding terminal connects to the chassis and cabinet and protects the operator against a shock hazard in case of a short circuit. END

*WatchMaster is manufactured by American Time Products Inc., New York City.

COVER FEATURE

MAN-MADE CRYSTALS TO AID COMMUNICATIONS

Synthetic quartz will supplement failing natural supply of crystals for frequency-controlled oscillators, filters and transducers



By FRED SHUNAMAN
MANAGING EDITOR

QUARTZ has long been used as a well-nigh perfect insulator for very low-loss circuits. It has another property that makes it a key material in the electronics field. It generates electricity when twisted, bent or squeezed. And if a voltage is applied across the faces of a properly cut piece of quartz crystal, it bends, shears or otherwise distorts its shape, depending on how the crystal is cut and where the voltage is applied.

When an alternating voltage is applied across the faces of a piece of quartz crystal, it vibrates at the frequency of the applied voltage. And since any solid object has a *natural frequency* at which it vibrates most easily, a crystal can be used to control the frequency of an electronic circuit. If the crystal is placed in the grid circuit of a tube whose plate circuit is tuned near the resonant frequency of the quartz, it starts to vibrate. The pulse of voltage fed back through the internal capacitance of the tube distorts the crystal, and the voltage change in the grid circuit as the crystal regains its original shape produces another pulse in the plate circuit. The quartz vibrates at its natural frequency, acting like an inductance–capacitance circuit of very high Q. This makes an excellent circuit (Fig. 1) for producing oscillations at an exact frequency, and crystal-controlled oscillators are used where frequency is important, for example in broadcast transmitters and even for the exact measurement of time.

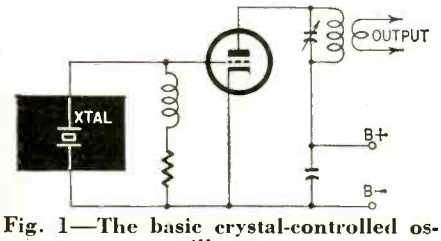


Fig. 1—The basic crystal-controlled oscillator.

Quartz has other uses. As a transducer—a changer of energy from one form to another—it is used in the output stages of ultrasonic generators. With large amounts of power applied to it, a quartz crystal produces very strong mechanical vibrations at its resonant frequency. Where output over a wide range of frequencies is required, as in a crystal headphone, or where a wide-frequency mechanical-to-electrical transducer is needed, as in a phonograph pickup cartridge, other types of crystals with a much lower Q are normally used.

The most selective circuit

Quartz has one other very important use in communications—a use in which it acts as a double transducer with an electrical input and output. Such a *crystal filter* (Fig. 2) inserted in the intermediate-frequency stage of a radio receiver in which the bandwidth was measured in kilocycles can bring it down to a selectivity of a few cycles. In crowded communications bands where interference is a problem, and in separating the various carriers of a multiple-carrier wired or microwave commercial system, such crystal filters are practically a necessity.

The crystal is placed in a bridge circuit, formed by the secondary of the intermediate-frequency transformer (IFT in Fig. 2), the crystal and C2 which balances out the effect of the crystal-holder capacitance. Selectivity is controlled by C1. It may be adjusted so the crystal appears as a series-resonant circuit in series with the signal path to sharpen the response at the carrier frequency. C2 is used in conjunction with the crystal and its holder capacitance to form a parallel-resonant circuit in the signal path. C2 may be adjusted so it puts a sharp notch in the response curve at the carrier frequency of an interfering signal.

Though quartz is silicon dioxide, one of the world's commonest minerals, quartz crystals big enough and pure enough to be cut up for communications use are expensive and hard to get. Practically all of the United States supply comes from Brazil. That source couldn't supply all the crystals needed during World War II, and the quality of crystals procured has been slowly deteriorating since, as if the best and easiest to procure had already been exhausted. Large crystal users became

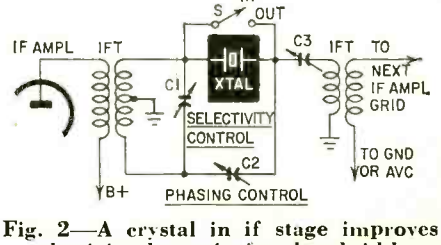


Fig. 2—A crystal in if stage improves selectivity by reducing bandwidth.

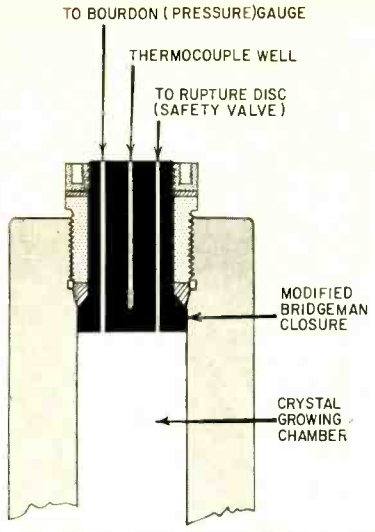


Fig. 3—Seal used on quartz growing chamber withstands 425 tons of pressure.

convinced that another source of crystals would have to be found or another type of frequency control and filter circuit adopted.

Do-it-yourself crystals

Experiments in growing quartz crystals were begun by Bell Laboratories shortly after the end of the war. Natural crystals are believed to have been formed from an aqueous solution under great pressure and at high temperatures. By imitating the forces of nature, it might be possible to make similar or even better crystals than the natural ones.

Steel tubes 1 foot long and 1 inch in internal diameter were constructed for the first experiments. These were filled with a weakly alkaline water solution, a few cheap small quartz crystals dropped in the bottom of each tube and a small perfect "seed" quartz crystal hung at the top. Each tube was placed on a hot plate and insulation wrapped around its lower portion. The temperature was raised to the point where a small part of the quartz crystals at the bottom of the tube dissolved into the solution. The temperature at the top was lowered, so the liquid could not hold as much quartz in solution and it was deposited on the seed crystal. This simple equipment did grow crystals suitable for many commercial applications.

Since the Laboratories had shown the technique to be feasible, the project was turned over to Western Electric, the manufacturing branch of the Bell System, to work out a commercial manufacturing technique.

Tooling up for big production

The main problem was to devise a container. The 1-inch tubes used in the laboratory experiments were too small for the larger sizes of commercial crystals and quite inadequate for the job of producing the large amounts of crystals Western Electric would need annually. But as the size of the vessels increased, their strength had to reach almost impossible levels. Even when tubes that the engineers were sure would stand the gaff had been developed, the question of sealing the vessels became critical. Several known types of seals were tried. The only difficulty: none of them were constructed to stand high pressure, high temperature and a corrosive solution at the same time. One of the most promising designs for high pressures, the modified Bridgeman seal, was omitted initially from serious consideration because the clearance between the closure and the vessel below the seal area was believed likely to provide an opportunity for spurious crystal growth that would cement the vessel solidly together.

With the best practical seals, the liquid, under pressures approaching 25,000 pounds to the square inch, oozed out, giving up its quartz as it cooled and cementing the joints into a flinty mass. Taking a chance, the engineers hauled out one of the tubes and installed a modified Bridgeman seal. The pressure helps hold this type of seal together (Fig. 3) instead of forcing it apart as in most of the others. It stood the 425 tons of pressure applied to the cap without leaking.

A successful setup

The vessels finally adopted are made of a special chromium-molybdenum steel, are 6 inches in internal diameter and 9 feet long, with walls 3¾ inches thick. They weigh 4,000 pounds and are placed in a pit so their tops are only a foot above the floor. A number of 1-kw ring-shaped heating elements (band heaters) encircle the tubes, distributing the heat as it is needed. Thermocouples in holes drilled nearly to the inner surface of the tube and in the bottom indicate the temperature in the head in each of the two zones. The temperature in the lower portion is controlled automatically, but manual controls are still being used to adjust the heat in the growth zone of the tubes. The nutrient (pieces of fused quartz or small quartz crystals) that supplies the quartz for the process is suspended in baskets in the bottoms of the tubes, and the seed crystals placed in frames like that shown on our cover.

Once the problem of a container was licked, various minor puzzles and difficulties turned up. Most serious was an epidemic of cracked crystals. Using universal troubleshooting procedures, engineers isolated the trouble to a particular part of the process by opening tubes at various stages of the process. Once the cracking trouble was pinpointed to the warmup period—the first 16 hours while getting up to operating temperatures—the troubleshooters soon found that too great a difference of temperature between top and bottom of the tube was the cause of cracking.

With a carefully controlled warmup process, rapid growth rates are possible and economic commercial production of

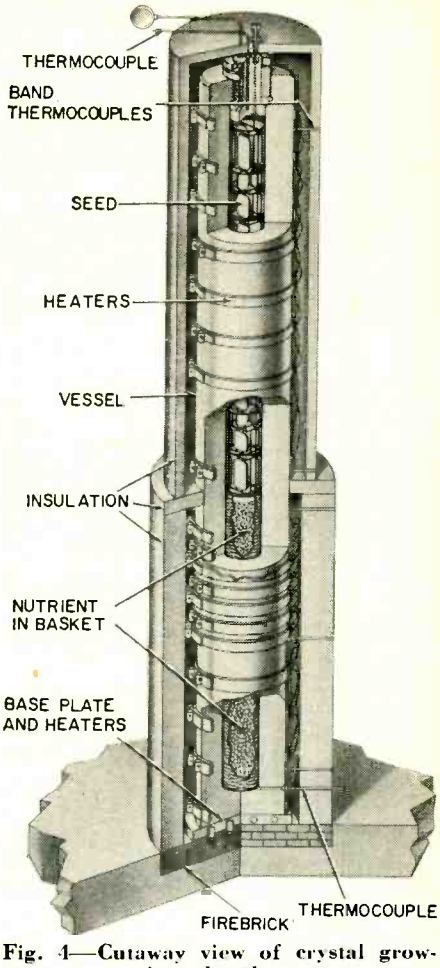


Fig. 4—Cutaway view of crystal growing chamber.

synthetic quartz crystals seems established. The grown crystals have several advantages over natural ones. Their quality is uniformly high, and the seed crystals can be cut so the quartz grows in a way that produces crystals that can be cut with minimum wastage. Further reduction in the cost of quartz crystals may result in their introduction in circuits where they are not now used.

Thanks are due to Lynn Perkins and Richard A. Sullivan, both of Western Electric Co. Mr. Perkins assisted in obtaining both the cover photograph and material for the story, Mr. Sullivan furnished most of the information on which this article is based. END

RADIO FATAL TO MONKEYS

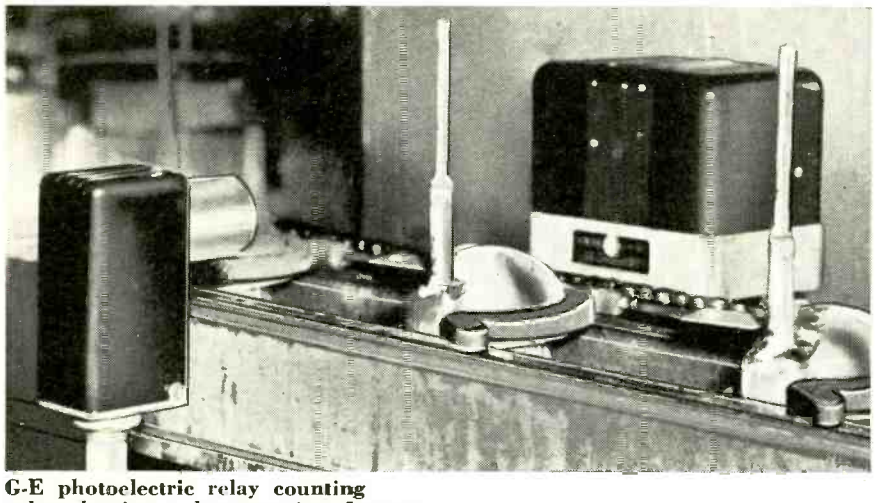
Under controlled conditions, radio waves can kill monkeys, said Dr. Pearce Bailey of the National Institute of Neurological Diseases, in closed-door testimony before a Congressional committee. "Although we feel certain that radio and radar are not dangerous," he said, "it appears that certain frequencies . . . placed in a particular position relative to the head can make it happen."

He described work with 20 monkeys, half of which were killed, half saved by turning off the rf power in less than the 5 minutes required to produce fatalities under this setup.

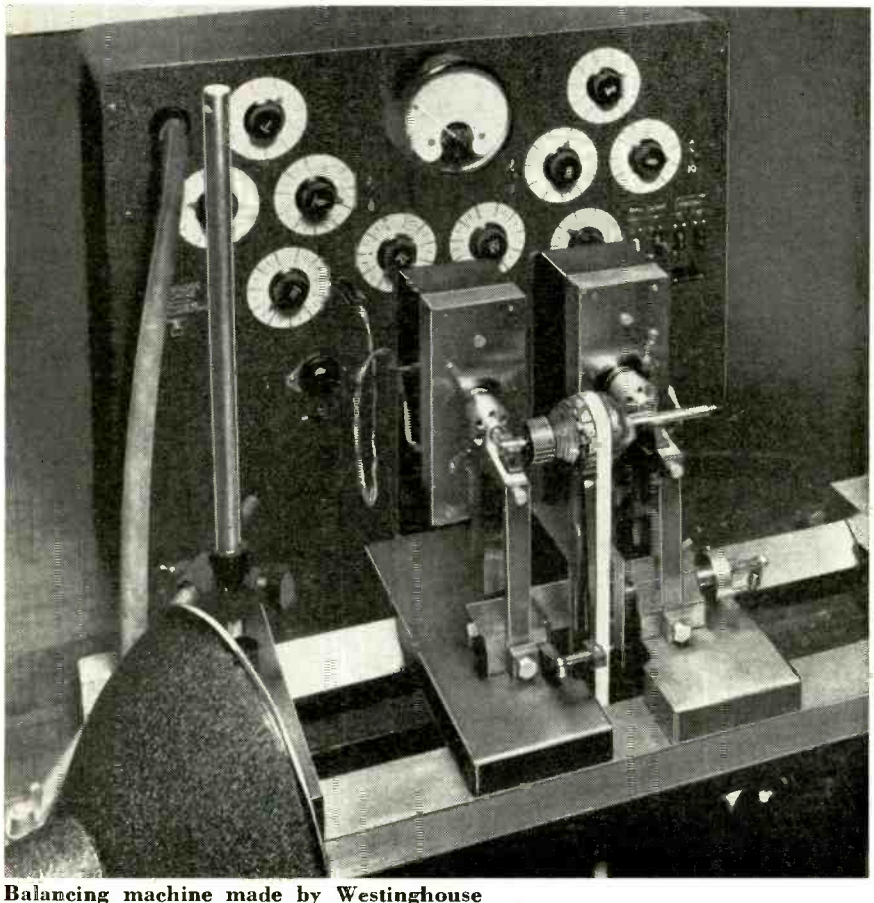
ELECTRONICS

Industrial electronics is a growing field, and someone has to keep the machinery rolling. The local electronic technician, who is right there on the spot, can make himself the man of the hour

ELECTRONIC SERVICING in INDUSTRY



G-E photoelectric relay counting valves leaving a heat-treating furnace.



Balancing machine made by Westinghouse is used to balance motor rotors.

By AARON NADELL

INDUSTRY'S increasing use of electronic equipment automatically creates a growing need and opportunity for technicians capable of keeping such equipment in good operating condition.

Four general arrangements exist, and each will unquestionably expand:

● **The manufacturer of the equipment maintains his own servicing organization.** Many manufacturers prefer this arrangement because it leaves them in complete control and gives them an additional item to sell—service. This method has a grave and sometimes insuperable drawback. If clients are scattered or remotely located, the cost of a service call becomes prohibitive. When this happens, both the manufacturer and client may look for competent local technicians to do the work.

● **Local representation.** Any competent local technician—radio–TV service technician, or others—may be appointed the manufacturer's service representative in a given area on some form of contract arrangement. The commonest setup is a dealership or distributorship. In addition to selling the goods to dealers, the distributor may take upon himself the responsibility for its maintenance. Alternatively, maintenance may be the dealer's responsibility. Either way, the actual maintenance may be carried out not by the dealer or the distributor, but by technicians whom the dealer or distributor hires, just as larger television shops hire TV technicians.

● **The purchaser and user of the equipment may make his own servicing arrangements.** A bank that uses a computer may contract with a local electronics shop to visit, inspect and repair the computer at reasonable intervals, or as necessary. Similarly, the local movie theatre, whether indoor or drive-in, may want such a contract to cover its sound equipment. Many manufacturers use a variety of electronic machines in all types of manufacturing processes. If a manufacturer has six entirely different electronic gadgets, each the product of a different manufacturer, it wouldn't pay to have six maintenance technicians, representing six makers or dealers or distributors, visit-

ing that one factory. It is far more economical for the manufacturer to contract with one organization to send one man who will take care of all six machines.

● **A local technician employed by a local organization,** who may (especially in the larger cities) represent some large, widespread service organization —RCA Service Co., Inc. or Altec Service Co., for example. The latter's vice president, Mr. C. S. Perkins, says that Altec's field force currently services closed-circuit TV systems, ultrasonic production devices, induction heating, electronic sorting, facsimile systems, garage and parking lot systems, and various other installations.

Altec has offices in eight cities from New York to San Francisco, yet an outdoor movie proprietor or small manufacturer located far from any of them might get more favorable maintenance terms from his local TV technician who can visit the premises without making an expensive long-distance service call. However, few business products or services sell themselves. If the local electronic technician wants to sell his maintenance service to local business firms, he must go out and do an effective selling job.

There are five areas of opportunities for the local electronics technician who wants to capitalize on industry's need for electronic maintenance. Two of these are business opportunities; three others in employment.

First, he can solicit or buy a dealership or distributorship in any industrially used electronics product, and service the equipment as well as sell it.

Second, he can expand an existing business for servicing domestic electronic devices such as television sets to include repairing industrial electronic devices or, alternatively, set up a new servicing business for maintaining industrial electronic equipment. Either way, he will solicit business from users of the equipment who are dissatisfied with the quality, cost or degree of promptness of the service they have been getting; from dealers or distributors who would prefer to farm out their servicing obligations; from manufacturers who maintain their own servicing organizations but prefer not to spread them to remote areas involving long service trips, and from service companies that prefer to farm out their business in places too expensive to reach.

Third, fourth and fifth are the employment opportunities: The competent electronics technician can get work (either on a full-time, part-time or emergency basis) from users of electronics industrial equipment, from manufacturers or dealers or distributors of it, or from distantly located servicing companies. I find it best to contract for fixed salaried employment involving periodic inspections and answering of service calls when and if made.

One particularly profitable service contract was with the Roxy Theatre, Seventh Ave. and 50th St., New York. It was quite a while back, in the middle '30's. The theater, which has roughly 5,000 seats, had had the benefit of servicing by one of the largest service organizations in the country. They decided—with no sales effort on my part—to substitute one-man service by hiring me, instead of organizational service by a large service company. It worked out very well until the theater was sold. The new owners had a contract arrangement with another national service organization (not the same one the theater had used originally). Because of that, and not because of any dissatisfaction with my services, they terminated the deal with me.

Getting service data

The primary source of servicing information is the manufacturer of the equipment. He has the schematics, wiring diagrams, assembly drawings, troubleshooting data, and inspection and adjustment data. To duplicate all this information independently would be a formidable and impracticable task—though it has been done. The most practical and economical procedure, by far, is to get the information from the manufacturer. However, the manufacturer's willingness to supply such data varies widely, not only according to his own policies but also according to who is requesting it.

Many manufacturers follow a policy of supplying all possible service data to anyone who asks for it. One fundamental business reason for such a policy is that the firm concerned wants its equipment to work well and give the purchaser the utmost satisfaction, and such firms give as much help as they can to anyone who services their product.

Others follow a somewhat more restricted policy and cooperate with service personnel and organizations only if they are convinced that such persons and organizations are qualified. Still others cooperate with their dealers and distributors by restricting service data to them and their representatives and employees. Manufacturers affiliated with a service organization sometimes restrict service information to that organization. And there are infinite gradations and degrees.

Mr. R. J. Chich, supervisor of field service for Cutler-Hammer Inc., writes: "We will always tend to help our customers help themselves with service manuals, instruction books, drawings, parts lists and whatever else they require to help maintain their equipment. We also anticipate that we will at some later date be in a position to help train men to handle our customers' service problems if their organization wants such a program." This is among the more liberal attitudes in the matter of supplying service information, but it is not uncommon.

Whenever data are hard to get, an

NEXT MONTH

Internal TV Ghosts

Not all the bogus images on the screen are caused by multipath reflections. Read how to save time by looking inside the set for some ghosts.

Finish Your Hi-Fi Cabinet

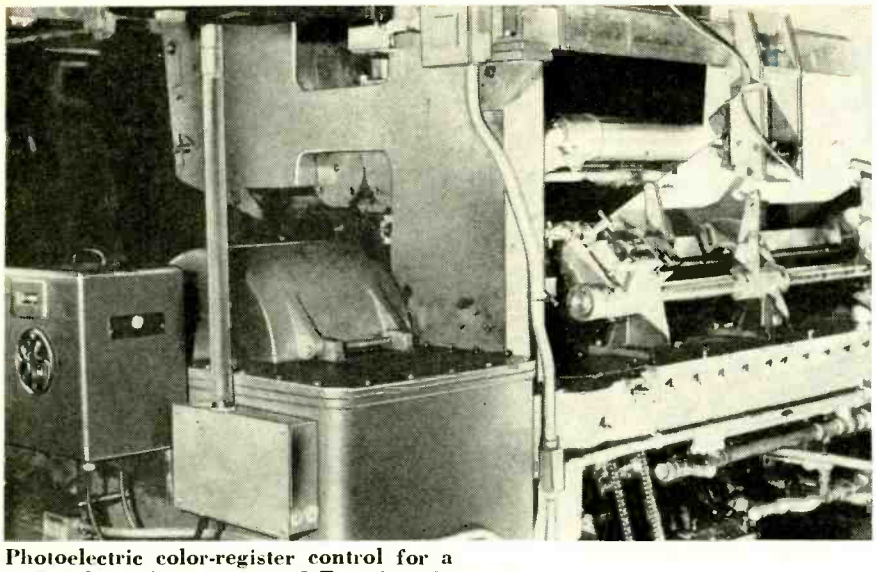
Ever decide what to do with that speaker enclosure you built up to the "Suggestions for Finishing" point? This article, by a leading cabinet designer and maker, will tell you what to do with it, or with your other pieces of unfinished hi-fi furniture.

Oscilloscope Comforts

There are a number of things you can do to make the No. 1 piece of test equipment more convenient and easier to use.

What About A Home Study School?

Discusses a number of advantages and disadvantages of the correspondence schools the prospective student may not have thought of. Gives some suggestions on choosing a school.



Photoelectric color-register control for a multicolor printing press. G-E makes this unit.

appeal for it routed through the actual user of the equipment is most likely to be effective. The user is the manufacturer's customer, the distributor's customer, the dealer's customer. When he asks for service information, he almost always gets it, and the service technician gets it from the user he serves.

Thus, the electronic technician who proposes to sell his services to local users of electronic devices should contact the manufacturer to see if servicing cooperation will be extended. If not, he should stipulate as part of any contract that the customer supply the necessary data. It is also possible that the customer already has all needed information—it may have come with the equipment.

Service data and government manuals

Electronic servicing data are easier to come by during the last few years than previously, because so many items of equipment are sold both on the civilian market and (perhaps with some modifications) to the military services. The services in general refuse to accept delivery unless complete instruction manuals accompany the equipment. The reason for this requirement is the very large turnover, both in personnel and in apparatus, in the armed forces.

To make the same instructions available to civilian users of the same equipment, all that is necessary is to print up more instruction books—a comparatively inexpensive procedure. Sometimes, however, there is "classified" information in those books and "classified" details in the equipment. The equipment will not be sold to civilian users unless the hush-hush details are removed. If this can be done, the corresponding information must be removed from the instruction manuals; this may involve a matter of some small expense, but if the manufacturer wants to sell his wares in civilian markets he very often accepts that expense and provides himself with instruction manuals slightly modified from the military editions. Either way, data and information are available for general distribution which some years ago would not have been available except at costs few manufacturers cared to accept.

As of today, lack of information will not as a rule prove a barrier in servicing all types of industrial electronic equipment.

Growth of the field

The industrial electronic servicing industry is growing and will keep on growing as industry uses more and more such devices. Office machines, billing machines, payroll machines, bookkeeping machines constantly become less mechanical and more electronic. As factories are increasingly automated, factory machines are becoming less and less manually operated and more and more electronically operated. There is no indication or reasonable expectation that these trends will be reduced; there is every indication that they will be intensified.

Thus the demand for servicing industrial electronic equipment must grow. That demand also must appear in remote and scattered places not within easy reach of centralized servicing organizations, whether those of the manufacturer or a wide-spread service organization. The local electronics technician, with or without a dealership or distributorship, must come into his own.

In its readers' interest RADIO-ELECTRONICS will watch these developments very closely and will report on them in these columns from time to time. END

SECTION V

TROUBLE SHOOTING

5-1. TROUBLE SHOOTING CHART.

5-2. The procedure for trouble shooting the receiver is given in table 5-1.

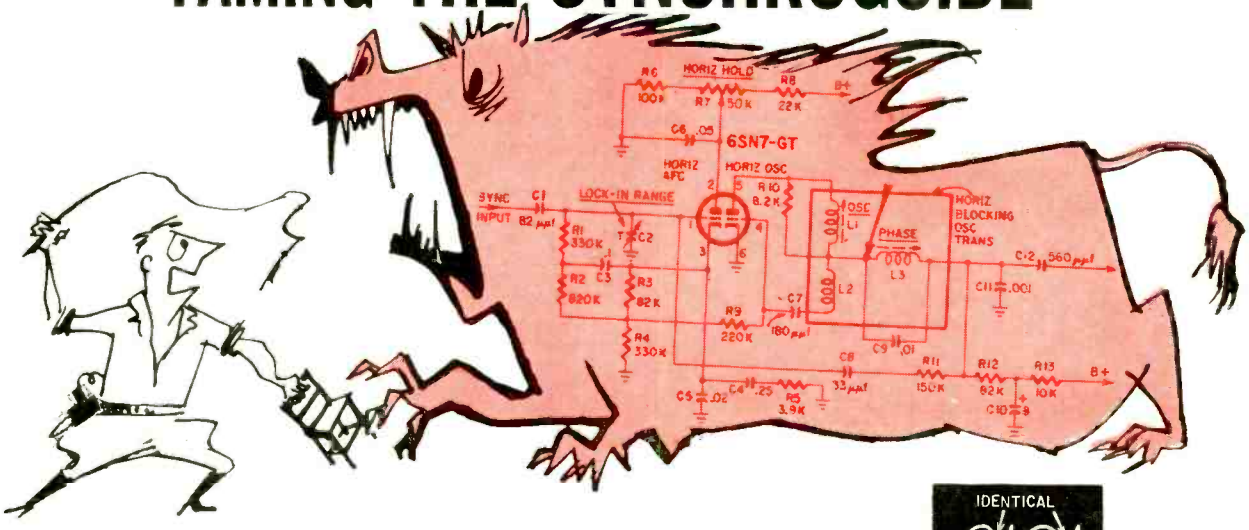
TABLE 5-1. TROUBLE SHOOTING

Trouble	Probable Cause	Remedy
Equipment inoperative	Blown fuse	Replace fuse
	No power supply	Check for power at power source. Check that power cord is not broken and that plug is connected securely
No signal received	Defective tube	Replace tube
Receiver noisy	Defective tube	Replace tube
Oscillation in receiver	Defective ground connection	Secure ground connection
	Defective tube	Replace tube
Signals weak	Defective tube	Replace tube
	Low voltage	Check output of power source
	Improper tuning	Retune receiver accurately

Typical page of instructions from a military service manual.

A long-time service technician tells how to keep this type of horizontal oscillator circuit behaving properly

TAMING THE SYNCHROGUIDE



By WAYNE E. LEMONS

THE Synchroguide is perhaps one of the most widely used horizontal sync circuits in the modern TV set. It is normally stable. However, when the circuit is internally upset by improper adjustments or component failure, it has idiosyncrasies unlimited! So, to troubleshoot a Synchroguide circuit sensibly (see Fig. 1), the service technician must be familiar with its peculiarities.

Even an engineer would not always make a good technician when repairing a Synchroguide, because the inoperative circuit no longer docilely abides by the engineering design built into it. A good practical technician, unencumbered by excess theory, may often find and repair the defect while a theory-oriented man is still wondering how it could possibly occur. It is much easier to apply the proper theory after the defect has been found!

The Synchroguide breaks down into three parts: the blocking oscillator, the control circuit and the stabilizing circuit.

The blocking oscillator is rather conventional and may be redrawn as in Fig. 2. A number of good texts are available to explain blocking oscillator theory, but, for the practical technician, it may not be particularly important. All the technician has to know is that the circuit, properly connected, will operate if all components are OK.

Stabilizing the oscillator

The control circuit is somewhat more complicated and requires some explanation. For control it uses the pulse-width method—phase relations between the sync input and the sampling pulse

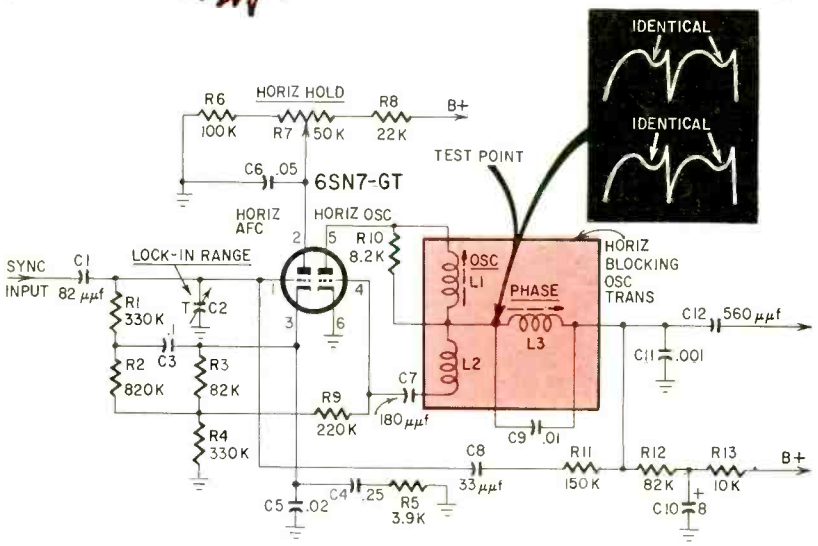


Fig. 1—Basic Synchroguide circuit. Either waveform is correct. See fig. 3.

(through R11–C8) from the oscillator's output are compared. Since the sync pulse occurs at a specific time as compared to the sampling pulse, the composite width is definite. When adjusted properly, the picture locks in horizontally at this point.

Should the oscillator slow down, the sync pulse appears on the sampling pulse earlier and the composite width of the grid pulse is greater. This causes the control section of the tube to conduct for a longer period, increasing cathode bias in a positive direction. The cathode voltage is applied to the oscillator grid through resistor R9 (see Fig. 1).

The more positive voltage from the cathode to the grid speeds up the oscillator. When the oscillator speeds up, the width of the composite pulse is reduced and balance is re-established. The opposite effect reduces the oscillator's frequency, if it should go up.

Remember, as in most controlled oscillators, the control circuit cannot change the oscillator's frequency very much. In fact, the control circuit should operate *before* the oscillator changes frequency (1 cycle or more). The correcting circuit operates on the change of *phase*. Actually, phase change corresponds to frequency change of less than a few cycles in this discussion. The phase angle is, of course, changed when the oscillator changes frequency.

In a circuit operating properly, the leading edge of the sync pulse always comes before the peak of the sampling

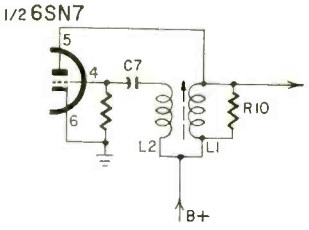


Fig. 2—Basic circuit of blocking oscillator found in Synchroguide.

QUICK CHECK CHART

Defect	Possible Cause (In order of probable failure)	Remedy
Drift	Leaky C6, C7, C1, C9, C8	Check and replace
	Defective transformer	Replace
	Leaky C5, C4	Check and replace
Instability	Incorrect waveform	Adjust with scope (see text)
	Open C10, C4, C5, C3, C9, C8	Check and replace
	Open R10	
	Leaky C7, C8, C1	
	Defective transformer	
	Open L1	
	Open R5	
Off Frequency	Incorrect adjustment	Readjust
	Shorted or leaky C6	Check and replace
	Open R8, R6, R7	
	Broken slug in transformer	Replace slug or transformer
	Shorted C5	Check and replace
	Open C10	
	Shorted or leaky C1, C3	
	Incorrect adjustment C2	Readjust

pulse, regardless of whether the oscillator is moving up or down in frequency. The shape and phase of the sampling pulse are controlled by R11–C8.

The anti-hunt circuit consists of R5, C4, C5 and C3. It prevents overcorrection, which would cause weaving. It also helps keep the oscillator from triggering on individual pulses or on noise.

Stabilize the Synchroguide

Network L3–C9 is the stabilizing circuit, often called the phase adjustment. The correct setting for the circuit is important for stable Synchroguide operation.

The stabilizing circuit is shock-excited into sine-wave oscillation during the passage of the sawtooth blocking-oscillator plate current. It is interesting to note that this circuit is not resonant at the horizontal oscillator frequency, but is resonant at a somewhat higher frequency (about 1½ times). This is apparent when we look at the Synchroguide waveform on the scope. What we see is a sine wave superimposed on the sawtooth wave (see Fig. 3-a).

The stabilizing circuit is needed because a blocking oscillator tends to fire as soon as any pulse arriving at the grid makes the tube start conducting. It is obvious then that, if a large pulse occurred, at any time during the period just before the oscillator was ready to conduct, the tube would fire. This means that an unstabilized oscillator would not necessarily follow the sync-pulse frequency and could be triggered into oscillation by noise pulses, voltage changes, etc.

The superimposed sine wave, however, causes grid and plate voltages to go down during the time the oscillator would be most susceptible to random firing. The sine wave also causes the grid and plate voltage to rise very quickly from this low value so any triggering pulse has to fall near the natural frequency of the oscillator. This waveform is shown in Fig. 3-b and will be recognized as the normal Synchroguide waveform! Stabilizing the blocking oscillator is important to proper operation of the circuit, as we have said, but it is also responsible for the condition called "mode hopping," "gun boating" or "squegging."

This comes about because (as mentioned earlier) the stabilizing circuit is not tuned to the horizontal frequency. When the stabilizing circuit takes over, because of improper adjustment or a circuit fault, we get the characteristic condition. It is the effect that makes the raster appear to overlap in the center and is usually accompanied by an audible output caused by the violent fluctuation of the blocking oscillator.

Actually the oscillator is firing twice, once during the normal peak of the waveform and once again when the sine wave or broad hump causes the tube to conduct. As the sine wave and the sawtooth are not in harmonic relation, the erratic condition of squegging exists.

Service

A number of faults appear in the Synchroguide and are often hard to troubleshoot—symptoms between one defective component and another are very similar.

Squegging is perhaps the most prevalent defect and often happens when the set is off channel. It is a fair test of Synchroguide stability when it does not squeg off channel. This doesn't mean that the Synchroguide should not be checked with an oscilloscope for the proper waveform. It will work even with an incorrect waveform but, because it has a very critical squegging point, a slight drift may throw it into tantrums. Always check with a scope, using a low-capacitance probe at the *test point* (junction of L1, L2, L3). If a low-capacitance probe is not available, a 5-$\mu\mu$f capacitor in series with a direct probe will work satisfactorily.

The waveform should conform with those shown in Fig. 3. Waveform C is recommended by some manufacturers; partially to compensate for drift in the circuit. You will note the sharp peak is about 10% higher than the broad portion of the curve.

Drifting oscillator

If the Synchroguide drifts more than a few parts in 15,000, it must be repaired. No instrument available to the service technician can detect such small drift, so he has to work at the problem slightly backward. In nearly all cases, drift is caused by either the blocking-oscillator transformer or by leaky capacitors in the oscillator or control circuit. Fortunately, only a few transformers have been found defective, except some on specific runs of sets which are now out of production. The most frequent cause of drift is leaky capacitors. It is not unusual to find two or more that are leaky and causing drift.

As little as 20 megohms of leakage should not be ignored in any circuit, especially not in the Synchroguide. *This is not leakage measured by a low-voltage ohmmeter.* A regular ohmmeter is practically useless as a capacitor checker, yet many technicians still rely on it.

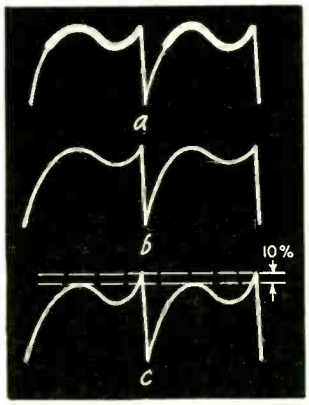


Fig. 3—Synchroguide waveforms: a—Superimposed sine wave shown in heavy lines. b—Normal waveform at test point in Fig. 1. c—Some manufacturers recommend this waveform.

A capacitor that shows a 1-megohm leakage on a capacitor checker using 200 or 300 volts may show no leakage at all on a sensitive ohmmeter.

Capacitor checker

Fig. 4 is the circuit of an inexpensive capacitor leakage tester that will find 99% or more of the faulty capacitors in a Synchroguide or any other circuit. It applies about 300 volts to the capacitor under test through an indicating device consisting of an NE 2 neon lamp. It is sufficiently isolated from the power line so that an isolation transformer is unnecessary. Just be sure you don't make any connections to the instruments' chassis. One end of the capacitor must be lifted for the test, of course, and the TV set should be disconnected from the power line to eliminate any possible false indication. The neon lamp will blink on, then go out if the capacitor is good and there is no leakage.

An spst pushbutton switch prevents accidental shock by shorting the test leads except during the test and discharging the capacitor after the test.

Check all capacitors in the Synchroguide circuit if drift is suspected. It doesn't take very long and often saves untold grief.

On occasion, and with certain circuits, drift or apparent drift is caused

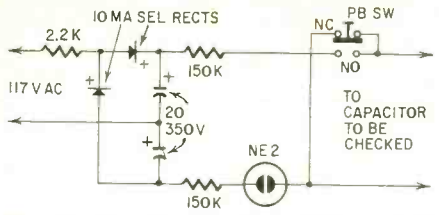


Fig. 4—Simple capacitor checker tests for leakage.

by defects in the preceding sync circuit. If the oscillator will not lock in, except at the extreme range of the controls or perhaps not at all, the sync circuit should be eliminated as suspect by removing the sync tube or grounding its grid. If doing this affects the position of the controls very much, check the sync circuit.

Off frequency

A Synchroguide's operating on the wrong frequency is often caused by the same things which cause drift. Another item which causes off-frequency operation is a broken slug in the oscillator coil. This sometimes happens in shipment. Simply inclining the set to make the slug move in the coil form usually uncovers this defect.

An especially frequent offender is C6, the capacitor from the arm of the horizontal hold control (R7) to ground. On rare occasions, resistors may change value and cause off-frequency operation. But this is not likely unless some other component in the circuit has caused extra current flow through them.

Open resistors are common and often for no apparent reason. Resistors of normal tolerance may be used as replacements in a properly operating Synchroguide. If a critical value of resistance is required to make the circuit operate properly, there is probably another fault in the circuit. A normally operating circuit that suddenly develops trouble can never be considered cured just because a certain value resistor used to replace one of a different value causes the circuit to operate with apparent normalcy! A circuit that has worked will work again, so don't do a makeshift repair—more than likely you will be borrowing trouble!

Instability

Improper adjustment of the phase stabilizing coil causes instability more often than almost any other one thing. It can also be caused by any of the troubles which result in drift or off-frequency operation. The point is, don't let Synchroguides get you down. Even if it means checking each part separately, it is still worth the effort and it really doesn't take long once you make up your mind to it.

Don't imagine that the instability is inherent. It just isn't true! The Synchroguide will operate without instability. Don't overlook C10, the decoupling filter used in many designs. If it opens or develops a high impedance, instability is sure to result. A quick look across it with the scope will satisfy your mind on this one. Less than 0.5 volt peak to peak should be across this filter, at the horizontal frequency.

In the home

Although field adjustment without a scope is not recommended, it can sometimes be done with a fair degree of accuracy.

Simply connect a jumper across the stabilizer coil and remove the sync from the control tube either by lifting the sync tube or grounding its grid (**not the control tube**).

Adjust the oscillator slug until a picture is visible floating by. Remove the jumper and adjust stabilizer or phase until picture floats by with no instability. Reinsert sync and make any minor adjustment necessary to lock the picture. If a major readjustment is required, it is likely that some component is defective, and the entire circuit should be checked.

The Synchroguide is stable when operating properly, but *extremely* unstable otherwise. It is susceptible to internal troubles as much or more than any other circuit in the TV. A capacitor leaky by a given amount will give altogether different symptoms than the same capacitor with a different amount of leakage. It is impossible to picture all the symptoms prevalent in defective Synchroguides, but fortunately for the technician, they all bear a family resemblance. So, with a little experience, it shouldn't be difficult to spot the wild Synchroguide and tame it right there on the spot! END

Day in the Service Shop

By LAWRENCE SHAW

WE started the day with a Crosley H21CKBF. That the symptom was high-frequency disturbance was demonstrated by the fact it occurred only on channel 7. And since it remained a fixed distance from the top of the picture, it had to be in the vertical section. The entire lower quarter of the picture was mottled by faint moving lines at a slight slant to the horizontal (see photo below). The lines did not remain as illustrated but interleaved in a manner similar to the moire effect when the interlace is wobbly.

Another receiver was used as a monitor to trace the trouble to the vertical

output transformer. A short length of wire to the monitor set's antenna was used as a pickup. The disturbance on the monitor set's picture reached a maximum when the probe wire was near the plate of the vertical output tube.

A resistor wired across a section of the vertical output transformer (see Fig. 1) was the cure. This autotrans-

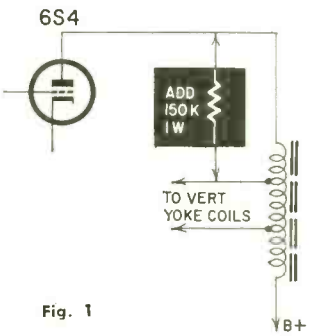
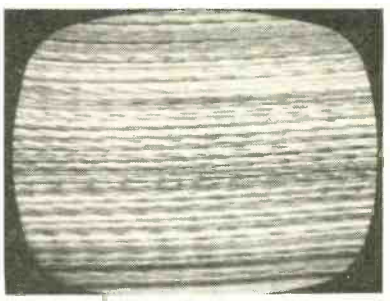


Fig. 1

former had too high a Q, and the shunt resistor lowered the Q so it would not ring during the latter part of the sweep because of shock excitation of the sweep pulse. Similar cases with other sets have been cured by a resistor across the secondary or the primary winding. The value across a secondary section will be lower than across the primary or the primary section of an autotransformer as shown here. It may depart considerably from the 150,000 ohms used for this set.

Next on the bench was a Montgomery



Ward 25WG-3075-A. This set may lose horizontal sync (see photo above) intermittently because of capacitor C57 (see Fig. 2) developing intermittent leakage. The phase and the shape of the sampling pulses from the flyback are changed, and complete loss of horizontal sync results. Replace the unit for normal operation. END

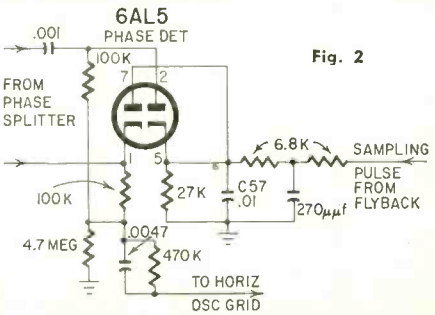
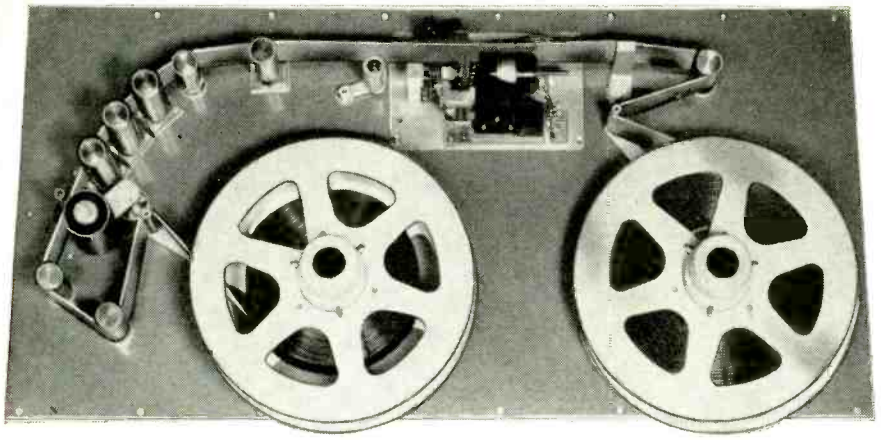


Fig. 2



Tape-transport panel of RCA TV tape equipment.

TAPING A TV PROGRAM

Putting color TV on tape isn't easy. Neither is playing it back. It takes a heap of interesting equipment to do the job.

By JULIAN L. BERNSTEIN*

TELEVISION stations throughout the country are installing video tape recorders as rapidly as they can get them. A substantial number of these machines are now being used by the networks for time-zone delay of their big shows as well as for prerecording programs, both in black-and-white and color. The machine's popularity stems from its many operational advantages. Improved resolution as compared to kinescope recordings (resolution of a video tape recording is almost as good as a live program) and immediate playback after recording are two. The latter feature permits checking the final result as soon as a scene has been shot, without waiting for film processing.

RCA is currently manufacturing a television tape recorder. This recorder, mounted in six racks, was originally designed to handle color television signals. A black-and-white version is also available—simply eliminate the rack of color equipment. To insure accurate timing and good picture quality, the recorder uses three servo systems, and is locked to the horizontal sync of the incoming video. Four tracks are recorded on the tape: one for the video signal (complete with sync and color burst), the second for the associated sound, the third for control signals used to operate a part of the servo system, and the fourth for cuing information which may be needed in editing the final tape. The tape itself is 1-mil Mylar, 2 inches wide, with an extremely fine-grain uniform oxide coating. Standard tape reels hold up to 4,800 feet of tape, giving 64 minutes of playing time per reel at the required tape speed of 15 ips.

Wide-band recording problems

The basic difficulty in recording wide-band signals on magnetic tape is due to the tape and the playback head, which together limit the band of frequencies that can be recorded. Playback heads, for instance, have a rising characteristic of 6 db per octave, simply because the head output is proportional to the *rate of change* of the flux on the tape. Thus, if we have an adequate signal at some high frequency, as the frequency is reduced the output falls off. In other words, good high-frequency response is accompanied by poor low-frequency response. To illustrate, suppose we play back a test tape with signals ranging from 20 cycles to 20 kc. Suppose also that at 20 kc we get a good strong signal. Then, at 10 kc we get 6 db less output; at 5 kc another 6 db loss will appear, until finally, at 20 cycles, the output will be 60 db less than it was at 20 kc. The 60-db reduction is as far as we can go, for at this point the tape noise becomes excessive and blanks out the signal. The important point is that regardless of the upper frequency selected, today's magnetic tape recording systems can handle only a range of approximately 10 octaves.

Let us now consider the video signal which extends from 30 cycles (neglecting the dc component) to upward of 4 mc—a spread of more than 18 octaves. To fit this wide band into a spread of 10 octaves or less, early attempts split the video signal into smaller bands, each of which was then recorded separately. Such a system is being used by the BBC in England. The RCA machine, however, translates the video information into a vestigial sideband FM signal which extends roughly from 1 to 7 mc, thereby reducing the band to several octaves. In addition, using FM permits recording all the signal at the saturation level of the tape, which improves the system's signal-to-noise ratio.

The FM signal recorded on the tape is unusual and deserves some mention. Customarily, the deviation and the carrier of an FM signal are much higher in frequency than the modulating signal. In the television recorder this is not so. The deviation is much smaller, approximately 500 kc, and the carrier is in the vicinity of 5.7 mc. What is more, the carrier frequency is not fixed. Instead, it is the lower limit of deviation, corresponding to the peak of sync in the original video signal, which is clamped to 5.2 mc. Thus, the carrier and the upper deviation limit vary with signal content. With this type of signal we get enough information if the upper and lower deviations plus all of the lower first sideband and part of the upper first sideband are recorded.

The width of the air gap in a playback head (distance across the gap) limits high frequencies. When the physical length of 1 cycle on the tape equals the gap width, currents induced in the head by the positive and negative half-cycles of the recorded signal cancel each other, resulting in zero output. But the physical wavelength of a signal on the tape is determined by both the frequency of the signal and the speed with which the tape passes the head.

At 15 ips, a 15-kc signal occupies .001 inch of tape per cycle. To reproduce this signal, a *maximum gap width* of 500 micro-inches may be used. Now, if we want to extend the upper frequency limit beyond 15 kc, we can increase the tape's speed so each cycle occupies more space along the tape or decrease the gap width or perhaps both.

Suppose we reduce the gap width to 100 micro-inches, which is about the smallest practical size we can build. This extends the high-frequency response out to 75 kc. But we want to record frequencies much higher than this. Some simple arithmetic shows that if the tape speed is increased 100 times, to 1,500 inches per second, we would be able to record up to 7.5 mc. Pulling tape past a recording head at this speed (which is equivalent to 90 mph) means we would need about 450,000 feet of tape for a 1-hour program.

*RCA Institutes, New York.

Fortunately, however, it is not the speed of the tape itself which is important, but the relative head-to-tape speed. So if we move the head as well as the tape, the problem can be solved.

In the RCA recorder, four heads are mounted on a wheel which rotates at 14,400 rpm (240 rps) while the tape is moved past this rotating assembly at 15 ips. The resulting relative head-to-tape speed is better than 1,500 ips.

Fig. 1 shows the head-wheel assembly. The wheel has a 2-inch diameter, and the four heads are mounted at 90° intervals, ±30 seconds of arc, around its circumference. Each head (see Fig. 2) is held together by clamping blocks made of a nonmagnetic material. The gap width in the heads is 80 microinches, maintained by a spacer mounted between the pole tips. The gap length is 10 mils. Each pole face on the head is slightly curved to coincide with the wheel on which it is mounted. The inductance of each head is 25 μh at 100 kc, and all are resonant at approximately 6.5 mc. In the complete assembly, one lead from each head is connected to a slip ring which contacts a silver-graphite brush. A fifth ring is added to provide a common ground for all the heads.

Recording the video signal

The magnetic pattern laid down on the tape by the rotating heads may be examined visually. This is done by coating the recorded tape with a carbonyl iron suspension and transferring the resulting pattern to a sheet of paper with transparent tape. Fig. 3 is a photograph of a typical section of recorded tape. To understand the pattern, let's follow the recording process step by step.

In the record mode, the tape is erased thoroughly and then curved to pass over the head wheel. All four heads are fed with the same video recording signal through the slip rings and brushes. As the head wheel spins the heads past the tape, the capstan moves the tape 15.6 mils for each quarter-revolution of the headwheel. This results in a series of lateral tracks, as shown. Each track is 10 mils wide, leaving a guard band of 5.6 mils between adjacent tracks. Because of the head wheel's velocity, 18.4 horizontal lines are recorded on each lateral track, and 16 such tracks make up one field, which occupies only ¼ inch along the tape. A frame is 32 tracks, or ½ inch of tape.

Now, it is an axiom of tape recording that good contact between tape and heads is necessary at all times if a strong signal is to be recorded. To insure this contact across the entire tape surface, the tape is curved by a vacuum guide as it passes over the head wheel. The guide bends the tape into an arc of approximately 113°. Since the heads are spaced 90° apart on the head wheel, and since they all receive the same recording signal, it becomes apparent

Fig. 1—Motor and head-wheel assembly with open vacuum shoe.

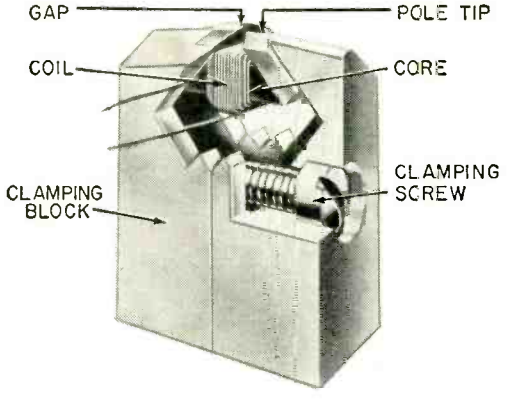


Fig. 2—Video head assembly.

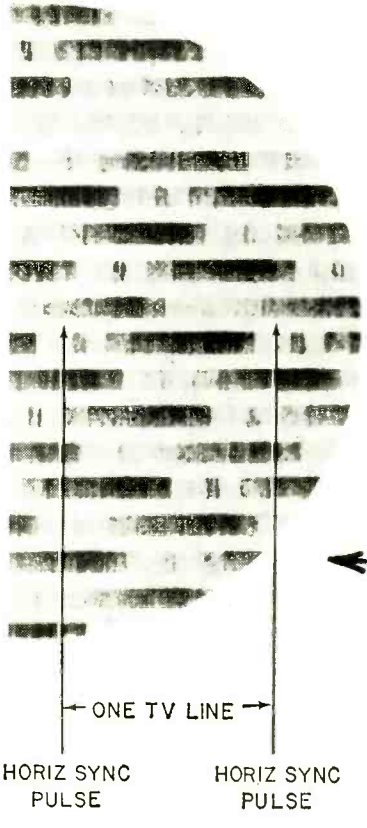
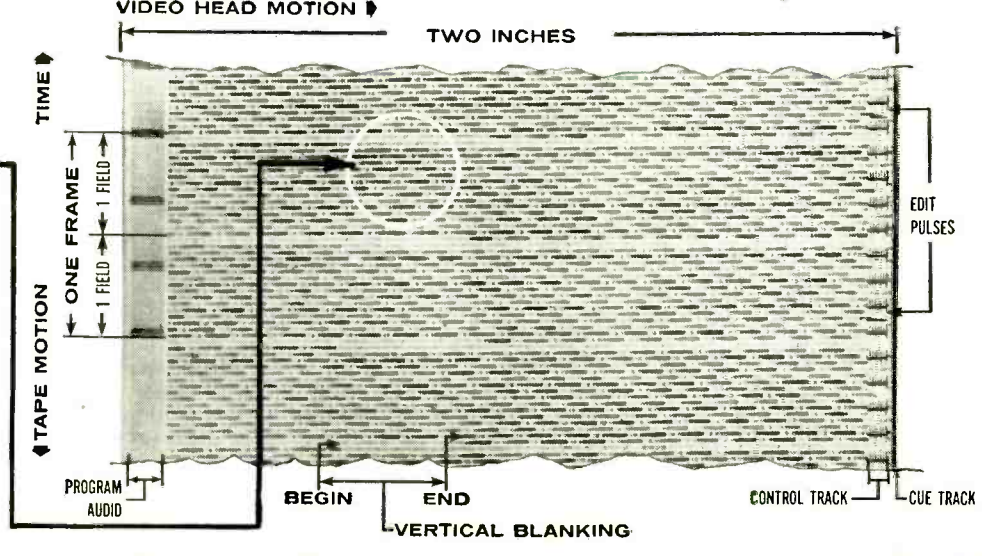


Fig. 3—Tape-track pattern (shown twice up in size). Enlarged photograph shows the developed magnetic tracks produced by the recorder.



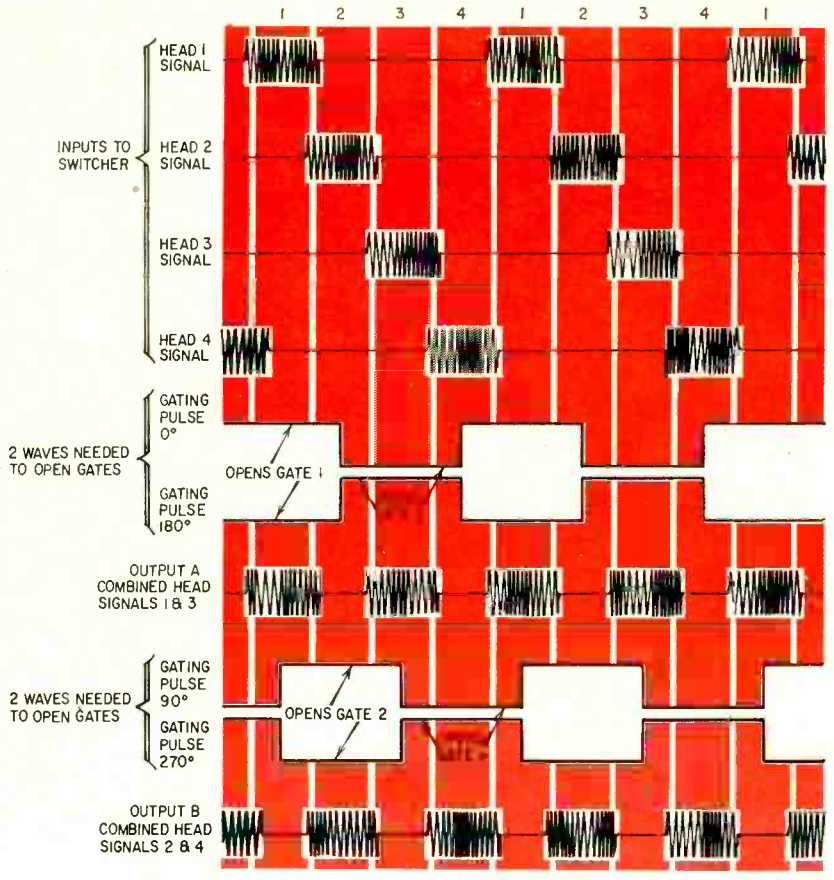


Fig. 4—Waveshapes of the head switchers, showing development of the final video output signal.

that some duplication of information will appear. Thus, the last two lines on any track are the same as the first two on the next track. This overlap causes no trouble, as it is removed during playback.

After the tape has passed the head-wheel, the other three tracks are added. Program audio is recorded at the top of the tape, as shown, while the control track and the cue track are recorded at the bottom, using separate heads for each track. A 240-cycle signal, derived from the rotating head wheel, is placed on the control track at this time. It is used in playback for accurate timing. A pulse occurring once per field is placed on the control track at the same time. This pulse identifies every vertical blanking interval and indicates where splices that won't be visible to the viewer may be made.

Servo systems

Let's turn our attention for a moment to the problem of playing back the recorded video signals. First, the rotating heads, which are now connected to the playback circuits through a relay, should be made to go over the exact same tracks laid down on the tape during recording. This provides maximum output and the best possible signal-to-noise ratio. Second, head-wheel speed must be accurately maintained so the time required to read out a line of video information is correct. And, third, any additional timing errors due to varying contact pressure between the tape and the heads has to be corrected. To do this, servo control of the head wheel, the capstan and the vacuum shoe is necessary. Suppose we examine each one individually.

Head-Wheel Servo. This circuit makes sure that the head wheel is always operating at 14,400 rpm. The three-phase head-wheel motor is driven, through amplifiers and phase splitters, from a stable R-C oscillator operating at 330 cycles. Attached to and rotating with the head wheel is a tone wheel which provides 240- and 960-cycle pulses, assuming the wheel is spinning at the correct speed.

In the record mode, horizontal sync is stripped from the incoming video signal and converted into 240-cycle pulses. These are compared to the 240-cycle pulses from the tone wheel and an error signal is developed if they are not at the same frequency or in phase with each other. The error signal changes the gain of the amplifier stage following the oscillator, which changes the head-wheel's speed.

In playback, the same system is used, but this time the tone-wheel signal is compared to the horizontal drive signals from the station's own sync generator, thereby tying the machine into an exact timing reference. In the fast forward or rewind mode the head-wheel motor is disconnected from the oscillator and does not rotate at all.

Capstan Servo. In the record mode, the two-phase capstan motor is driven from the 60-cycle line through appropriate amplifiers but without any servo control. However, the velocity of the capstan determines the physical wavelength of the 240-cycle signal being recorded on the control track.

In the playback mode, the control-track signal is read out by the same head which recorded it and compared to the 240-cycle signal being generated by the tone wheel. The resulting error signal controls a 60-cycle R-C oscillator which drives the capstan. To see how this is done, let us assume that for some reason the capstan speeds up slightly at one point in the recording process. In turn, the wavelength of the 240-cycle control-track signal increases. In playback, then, the control-track signal could not be in step with the 240-cycle tone-wheel signal and the error signal would be, let's say, some positive dc value. This increases the oscillator's frequency, speeding up the capstan to the same extent as in the record mode. If, on the other hand, the capstan had slowed up during recording, the control-track signal read out in playback would be out of step with the tone-wheel signal in the opposite direction, producing a negative-going error signal which would slow up the capstan. A manual control is incorporated into the capstan servo circuits to adjust the capstan speed initially so each sweep of the heads across the tape is centered on the recorded tracks.

Shoe-Position Servo. During the recording process the vacuum guide, or shoe, which holds the tape against the heads is locked in position. As the heads rotate past the tape, they dig into the tape surface, causing some slight stretching. In playback, if the shoe is improperly positioned, this stretching, small as it may be, might cause a time displacement of the horizontal lines read out by any one head. Furthermore, no two machines exert exactly the same pressure on the tape. So, if a composite tape made up of segments recorded on several different machines is to be played back, the head-to-tape pressure must be properly adjusted for each segment. This is done automatically by the shoe-position servo.

Briefly, the servo circuit applies a correcting voltage to a motor which, through appropriate gearing, moves the vacuum shoe in or out the required amount. Manual controls are provided in the circuit to compensate for the effects of changing temperature or humidity.

Video playback

In the playback mode, the rotating heads pick up the signal from the tape. A record–playback relay connects each head to separate preamplifiers and equalizers, which raise the signal to a suitable level. Now it is necessary to

switch from one head to another so that the two-line overlap which appears at the bottom of one track and the top of the next is eliminated. At the same time, the nonoperating heads (those not actually in contact with the tape) must be disconnected from the circuits that follow, to remove any noise they might produce.

A very important requirement of the switching system is that switching transients and noise must be invisible in the final picture. For this reason, the switch between successive heads is made during the horizontal sync interval of any one of the last three lines which appear on the track. The line selected is unimportant, since the next track duplicates the information being switched out in any event.

In the RCA recorder, switching is handled by two separate units: a 4 x 2 switcher which combines the four-head signals into two composite signals, and a 2 x 1 switcher which selects the sync period during which the switch is made. In the 4 x 2 switcher, all four head signals are delivered to two sets of diode gates which are opened and closed by a square wave triggered from the 240-cycle tone-wheel signal. Fig. 4 shows the waveshapes of the switcher.

Two heads which are 180° apart on the head wheel, called heads 1 and 3 for convenience, are combined into a single signal since at no time will they both be in contact with the tape simultaneously. Thus, output A represents the playback signal of alternate tracks on the tape. Similarly, the outputs of the other two heads (2 and 4) are combined into output B. No attempt is made at this time to remove the two-line overlap between channels A and B. So each block in the output signal represents 18.4 lines of video information.

Channels A and B are now fed into the 2 x 1 switcher, which also uses diode gates. In this circuit, however, the gates are opened and closed by a combination of the 960-cycle tone-wheel pulse and one of the horizontal sync pulses from the last three video lines on the track. Switching is done by having the 960-cycle pulse deliver a get-ready signal to a stabilized multivibrator. The first horizontal sync pulse to arrive after it triggers the circuit. The output pulse of this multivibrator triggers a second multivibrator, which is used to insure switching should the first circuit fail to operate.

The video output from the switchers is still FM so it is routed to a demodulator. The demodulator's output is a standard video signal but, due to the action of the switchers, both sync and color burst have deteriorated. In addition, switching transients and noise may also be present. To remove these conditions, the signal is passed on to a sync restorer which strips off the old sync and adds a reconstituted sync pulse at the proper time. If there is no color burst in the signal, the sync restorer's output is fed into a distribution amplifier from which it may be delivered to the transmitter or a program video line. If a burst is present, the signal is routed to a color-corrector circuit before going to the distribution amplifier.

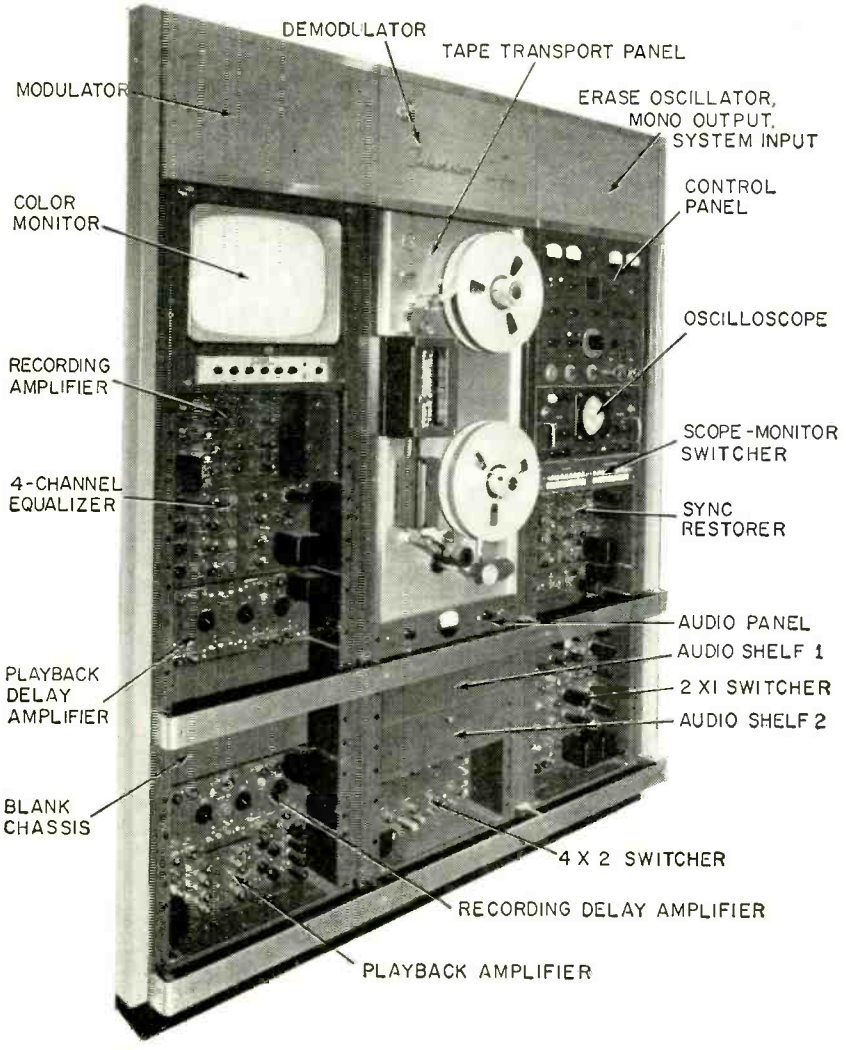


Fig. 5—RCA TV recorder rack layout. Scope is for rapid checks of system operation.

Color corrector

Although head-wheel speed is held fairly constant by the servo system, small line-to-line variations do exist. For monochrome they are not important, but with color they tend to shift the phase of the color subcarrier, resulting in a hue change. The color processor cancels these phase errors in the subcarrier, and at the same time does another important task. Since the color burst which appears on the back porch has been deformed by the switchers, a new burst must be manufactured. A signal from the station's local 3.58-mc oscillator is used, together with a gating pulse derived from the reconstituted sync. The gating pulse adds the new burst to the signal at the proper time, resulting in a standard color signal ready for transmission.

Monitors and controls

As shown in Fig. 5, the RCA recorder includes both a waveform monitor and a picture monitor. The waveform monitor is used for checking various operating waveshapes and is push-button-operated. The required sweep speed is automatically applied by the pushbuttons, resulting in steady displays of the selected waveshape. A calibration circuit is included in the monitor.

The switching circuits are designed to operate without introducing noise into the system. The picture monitor may be used for viewing either the input signal during record, or the output signal during playback.

The RCA recorder is operated from a master control panel located immediately to the right of the tape-transport mechanism, or from a similar panel at a remote position. The control panel contains meters for measuring the control-track recording current, master erase-head current, video-head currents and the audio signal. An elapsed-time meter indicates the number of hours the heads have been in use, and a monitor speaker is mounted at the top of the panel.

Local or remote control is selected by a switch and pushbuttons are supplied for the usual tape controls: stop, record and playback. A variable-speed rewind and fast-forward control are provided for ease in spotting a particular section of the tape. END

TV Service Clinic

conducted by

ROBERT G. MIDDLETON
RADIO-ELECTRONICS TELEVISION CONSULTANT

SERVICE technicians frequently ask why so many of the newer receivers do not maintain the dc component of the video signal. The full answer to this question takes in both design and merchandising decisions.

All early black-and-white receivers used dc restorers. The early color sets also used them. More recently, color receivers have gone to dc-coupled picture-tube feed, and have eliminated dc restorers. On the other hand, far fewer black-and-white sets are using dc coupling, although dc restorers have been equally eliminated.

All black-and-white television receivers are divided into three classes from the manufacturer's viewpoint. The public tends to prefer either the "economy" or the standard type. The deluxe set runs a distant third. These three types of receivers can be roughly classified as in the chart.

A few receivers use ac-coupled circuits to the video output stage, but take care of dc restoration in the output tube, which is dc-coupled to the picture tube (Fig. 1). Its grid is driven into grid current, and it functions as a diode rectifier on sync tips. Restoration is not complete, because the grid–cathode perveance is less than that of a suitable diode.

Many designers hesitate to use dc coupling (in black-and-white receivers) because they feel that drift in component values could cause objectionable shift in the tubes' operating points. This point of view is summed up in the statement that the justification for eliminating the dc component is the fact that viewers do not generally complain about the loss in picture quality. The same logic applies to bandwidth reduction from 4.1 mc in early receivers to 3.5 mc in deluxe sets.

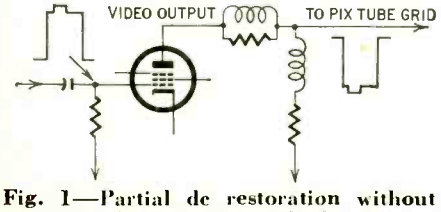


Fig. 1—Partial dc restoration without using a separate diode.

TV RECEIVER CLASSIFICATION

Characteristic	Type Receiver		
	Deluxe	Standard	Economy
Sensitivity (μv)	6	10	30
Selectivity*	250 times	125 times	50 times
Noise figure (db)	6	6	9
Bandwidth (mc)	3.5	3.2	3
Video drive (volts)	150	125	80
If stages	4	3	3, 2 or 1
Agc	Gated amplified	Supplemental averaging	Averaging
Agc range control	Automatic	Manual	Eliminated
Linearity control	Yes	Yes	Eliminated
Linearity accuracy (%)	10	10	20
Dc restoration or coupling	Yes	Usually no	Eliminated
Line-voltage tolerance (%)	10, −20	10, −10	0, −5
Underwriters approval	Yes	Yes	Sometimes
Audio drive (watts)	5	3	1

*Figures refer to adjacent-channel selectivity. Example: a deluxe receiver, for a given picture-detector output, requires 250 times as much input signal voltage at the adjacent channel frequency as at the frequency to which the receiver is tuned.

Designers say that sync percentages, black level and white level are not always closely maintained by transmitter operators. High noise pulses or strong interference, and line-voltage variation are also cited as reasons why dc restoration can be omitted. Blanking circuitry becomes more elaborate when a dc restorer tube is used, although this is not a drawback of the dc-coupled video amplifier.

In the final analysis, the increased cost tends to tip the balance against maintaining the dc component.

Yoke arcing

We are working on an RCA KCS83A which is arcing from one winding of the yoke to the other, causing a short. We have repaired or replaced the yoke three times within the last 3 months, which takes care of the trouble from 2 days to 2 months. All components associated with the circuit are found to be OK. Please list components or conditions which could cause the trouble.—J. S. M., Stanford, Ill.

This report is typical of spurious damper transients, which break down the insulation between the yoke windings. This trouble can often be cured quickly by connecting a 150-$\mu\mu$f capacitor from plate to cathode of the damper, as shown in Fig. 2. The peak-to-peak voltage to be handled here is not given in service notes. However, being high, you must use a capacitor that will withstand the crest voltage—4 or 5 kv.

Picture smear

Can you offer any suggestions regarding picture smear and trailing whites in an RCA 6T53? Using a 1,000-ohm pot across the antenna terminals with a 300-ohm resistor between the arm and chassis, I am able to obtain a very acceptable picture, with less noticeable smear. However, the pot must be readjusted on rainy days. I use two folded dipoles.—R. M., New York.

From the data given, I would suspect tuner trouble. Either there is a very bad mismatch from the lead-in to the tuner, or the tuner is regenerative. The first test to make is an rf response check with a sweep generator and scope. You will probably find a very peaked and unstable response. Tuner repair work is a specialized job and, if the tuner is faulty, you may wish to replace it outright.

Red is green

In an RCA CT-100, large areas of red are displayed as green, while smaller areas remain normal. On either side of the red areas, all hues containing red at any saturation have a greenish cast. All hues on either side of large red areas shift in color. Sometimes color sync is lost completely, and rainbows appear on the screen.—J. W. R., Jr., New York, N. Y.

This is evidently a symptom of faulty burst separation. The first step is to

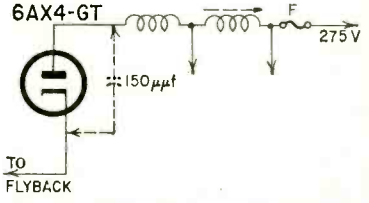


Fig. 2—A 150-$\mu\mu$f capacitor with a proper voltage rating will bypass spurious transients that break down yoke windings.

check the dc voltages in the burst amplifier and keyer circuit, shown in Fig. 3. It is possible that this will indicate the trouble area. If the dc voltages are correct, make waveform checks with a scope (4 mc) and low-capacitance probe. Check peak-to-peak voltages and waveshapes of the burst and the keyer pulse. These are specified in the receiver service notes. While using the

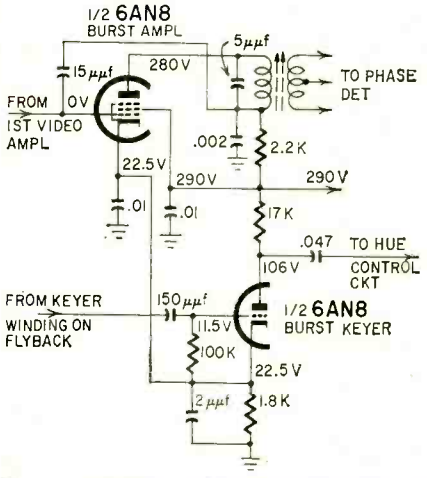


Fig. 3—Shifting color reproduction can be caused by faults in the burst amplifier and keyer circuits.

scope, do not fail to check the dc supply lines for abnormally high ac voltages. The dc supply must be reasonably clean for proper circuit operation.

Check sweep generator

What is the proper procedure for testing a sweep generator with a demodulator probe?—C. N., Belleville, N. J.

The generator's output cable should be terminated in its characteristic resistance (usually about 75 ohms). This avoids cable resonances which can cause lack of flatness. A suitable demodulator probe is shown in Fig. 4-a. Operate the generator on 10-mc sweep width. Tune it to 23 mc and to 44 mc center frequency for an if output check. Operate the scope on 60-cycle sine-wave sweep. Use the 0-volt base-line function of the generator. Phase the 60-cycle sine-wave sweep for proper lay-over of trace and retrace. The scope pattern should appear rectangular, as shown in Fig. 4-b. Note that some simplified sweep generators have a complex mixture of output frequencies. With such units, the test shows the composite flatness (or lack of flatness) of all the frequencies in the output. The more elaborate sweep generators are designed to supply an unmixed signal output.

Too much width

I am working on a receiver which has been converted from a 10-inch tube to 17-inch. It is a 630 chassis, converted according to the January, 1952, issue of RADIO-ELECTRONICS. *It has a DuMont H1A1 flyback and Y2A1 yoke. I am getting too much width. If I use a smaller width coil, it overheats. I appreciate your interest in our problems.—G. S., Kenilworth, N. J.*

If the receiver is operating OK otherwise, I would suggest that you use a large width coil, and supplement it with a sleeve of aluminum foil under the yoke. Reduce the width to any desired extent by adjusting the number of layers of foil.

Low frequency problem

I am working on an RCA 21S362MU which operates satisfactorily on the uhf and upper vhf channels. However, on channels 3 and 5, a vertical black line appears on the raster just to the left of the center line. The line modulates the picture in a herringbone fashion. The line disappears when using a CRT substituter.—J. R. McC., Warren, Ohio

This is one of the symptoms of parasitic oscillation in the damper circuit. It can be suppressed by inserting heater chokes in series with each of the leads to the damper tube. In some cases, the parasitic is generated by the horizontal output tube instead of the damper. The cure is the same for the output tube.

Dc restorer

I am installing a dc restorer circuit in a Hoffman receiver, according to the enclosed diagram. I suppose that the next job will be to find a suitable retrace-elimination circuit, unless this is not necessary when dc restoration is used.—W. L. J., Pasadena, Calif.

You are quite correct in your supposition. If a dc restorer circuit is used, retrace elimination is not normally required. The sync tips are clamped to black level. On the other hand, if the picture tube is weak, brightness may be forced by advancing the brightness control too high, and retrace lines will then appear.

Spot killer

In a Hoffman 21M143U, chassis 300-21, we replaced the 21YP4 with a 21YP4-A. There is now an intense afterglow spot on the screen which remains for a long time after turning the set off. How can we get rid of it? —P. L., San Pedro, Calif.

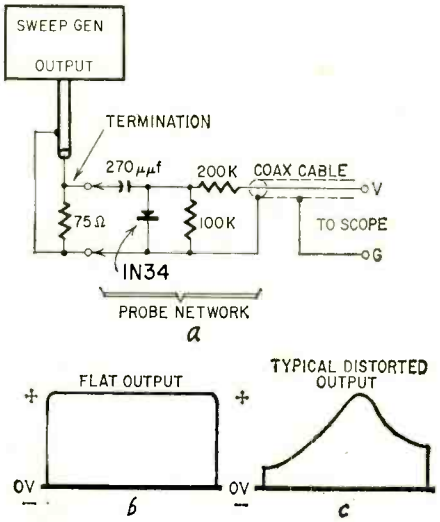


Fig. 4-a—Demodulator probe connections for testing flatness of sweep generator output. b, c—Typical test patterns obtained.

We are interested in giving the best possible service in the Clinic.

To do this, we occasionally need your cooperation.

All inquiries received during the course of a month cannot possibly be printed in RADIO-ELECTRONICS. The number is far too great.

On the other hand, each and every inquiry is given a personal reply by mail, *if you include your name and address, and if we can read the correspondent's handwriting.*

Your name will not be used (only your initials), if the query should appear in the magazine columns. If you *request* that the inquiry *not* be printed, *it will not be printed* under any circumstances. Hence, no one need feel reticent to sign an inquiry with his name and address.

Typewritten letters do not require deciphering, and can be processed more promptly in many instances. When correspondence must be handwritten, a good test of its legibility is to have someone read it back.

Of course, complete descriptions and data concerning the problem help both you and us.

If you should be one of the occasional inquirers who did not receive a reply, please take head!

ROBERT G. MIDDLETON

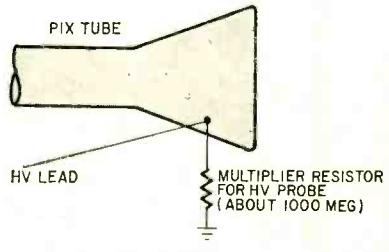


Fig. 5—A 500–1,000-megohm bleeder resistor often makes a good spot eliminator. It must be designed for high voltages.

Several spot-elimination circuits can be used. You will often find that a simple high-resistance bleeder at the picture tube, as shown in Fig. 5, is satisfactory.

No sound or picture

I am servicing an RCA 21T8202 with symptoms of no sound or raster. The fuse resistor in the B-plus line was burned out. I replaced it, and the 6AU4 damper started to arc. It was also replaced. The receiver operated for 5 minutes and the 6CZ5 (vertical-output) plate was running red. The series resistor to the 6CZ5 circuit was charred. This trouble recurred promptly. Then, after replacing the original tubes, the set has been operating over a week.—H. C., New York, N. Y.

The basic trouble is probably in the vertical multivibrator circuit. The 6CG7 grid will go from —26 volts to zero or a small positive bias if the

multivibrator fails. In turn, the bias failure to the 6CZ5 causes excessive plate-supply drain. The fuse resistor and series resistor blow, the damper arcs and sound disappears with picture with this current demand. The multivibrator in this chassis is an extensive circuit. Each component must be checked out, including the vertical output transformer to find the intermittent.

21- or 24-inch conversion

We have a job that calls for converting a Zenith 24H20 from a 19AP4 to a 21-inch or 24-inch picture tube. Would this be a practical conversion?—V. S., Wittenberg, Wis.

A 21EP4 is easier to sweep than a 19AP4 and is a very practical conversion. However, the picture size is not much greater, because the 21EP4 has a rectangular screen. Although a 24AP4 could be used, a standard conversion kit is necessary. Of course, the much higher price of the 24-inch picture tube would make the conversion cost about twice as much as the 21-inch conversion.

Horizontal pulling

I have spent considerable time in an attempt to correct pulling at the top screen in a Crosley H-21HCWHb. The chassis has been worked over by several technicians, without locating the malfunction.—E. M. N., Westbrook, Me.

This is a typical symptom of sync clipping caused by slightly low agc bias. Apply override age bias to determine if a slightly higher bias will correct the trouble. If this works, adjust the agc circuit to supply the needed bias. There are other possibilities, such as spurious ac in the dc supply lines. However, the most likely trouble area is the agc system. END

"You want a place to put your antenna, don't you?"

fm tv dx

By ROBERT B. COOPER, Jr.

NINE dreary months the dxer waits . . . for those magic days in June, July and August when TV and FM bands go wild for hours and, occasionally, even days at a time. Sporadic E skip, bringing in stations 400–2,500 miles distant. Tropospheric bending, sending high-band vhf and uhf signals on the snow bands, and FM signals on the hi-fi band, hundreds of miles beyond the horizon. Meteor scatter, with two of the biggest showers of the year during the period—Yes, June, July and August *DO* make TV and FM dx interesting.

And the dxer who *does not* make the most of this period is probably the fellow who complains how poor conditions were this year, when September rolls around. Some readers have asked what a good *dxing timetable* might look like. Or in other words, what is the best way to make the most of the time you have available for dxing. We feel that many hours are wasted by the dxer who concentrates on vhf when he should be watching uhf, etc. In short, many good openings are missed by being at the wrong place at the right time. Newcomers to dxing might find the following table helpful, while old hands will probably have one all worked out from past experience. All times are in local standard time.

The validity of table below runs through the period of June 15 to Aug. 10, with no allowance made for the meteor showers listed in the table of meteor showers.

Aurora and F2

Continuing with our section devoted to an explanation of the various forms of dx reception on the TV and FM bands, we discuss Aurora and F2 dx this month.

Aurora: One of the least understood forms of dx reception involves the reflection of a TV (and possibly FM-band) signal from the Northern Lights display. Actually, there is no concrete information to confirm that the visible aurora display (Northern Lights) acts as a mirror for the TV signals. It is more likely that reflection of the signals is from a region in the ionosphere *not* visibly lighted by the magnetic disturbance which causes the auroral displays. Aurora reception is always garbled by the rapidly changing (oscillating) reflecting surface on the aurora. In fact, the garbling is so bad that the video is *almost always unwatchable*, and *audio is distorted*. Under some conditions, audio on low-band channels (2–6) becomes identifiable, but hardly hi-fi quality. Aurora reception is greatest during years of high sun-spot activity and is a spring and fall phenomenon. Best hours—1800–0200 LST. Great Lakes and Canadian dxers have the advantage.

F2 skip: Also coinciding with high sun-spot activity, the F2 layer of the ionosphere (180–250 miles above the earth's surface) reacts to the bombardment of its surface with high-energy particles from the sun by acting more and more like a mirror to TV signals (there has never been a verified incident of FM-band reception via F2, nor of TV skip above channel 4). F2 skip is a fall and early winter phenomenon for TV signals in the 41–55-mc range. (European TV channels are in this range) during the peak 2–4 years of the 11-year sun-spot cycle. On a few very rare occasions, at the *peak of peak*, the particles from the sun spots (bombarding the F2 layer) may allow US TV frequencies (channel 2) to skip over paths 2,200–3,500 miles long. For all practical purposes, we can forget about F2 reception until the fall of 1967! (The sun-spot cycle peaked in January, 1958.)

Feb. 16, 1959

From British Honduras, in Central America, to the State of Washington, and all points between along the Pacific coast, the Sporadic E *type* opening which occurred on the TV band on this evening was most unusual. It seemed to be limited to areas west of the Rockies, with special emphasis on the path from Arizona and southern

Time	Type DX	Channels	Area of USA
0500–0900	Trops	2–83, FM	Midwest, South, Northeast, Pacific Coast
0700–1000	E Skip	2–6, FM	All Areas
1130–1400	E Skip	2–6, FM	West, South
1300–1600	E Skip	2–6, FM	East, South
1500–1800	Trops	14–83	Great Lakes, Atlantic Coast
1700–2200	E Skip	2–6, FM	All Areas
2100–2300	E Skip	2–6	Pacific Coast, South
2300–0200	E Skip	2–6, FM	East of Rockies
2300–0500	Trops	2–83, FM	East of Rockies, Pacific Coast
0000–0300	Trops	2–13, FM	Great Lakes, South, Atlantic Coast

METEOR SHOWERS

Name	Date	Time (LST) Maximum Burst Rate	Direction	Grade
Pons Winneckeid	June 27–30	1500–1800	NW–SE	C
		1830–2230	E–W	B
		2330–0300	SW–NE	C
Cygnids	July 14	2100–2330	NW–SE	B
		0130	E–W	B
		0330–0600	SW–NE	B
Capricornids	July 18–30	2300–0200	E–W	C
		2200–2300	SW–NE	C
Perseids	July 25–Aug. 4	0130–0430	NW–SE	B
		0830–1130	SW–NE	B
Aquarids	July 26–31	0000–0100	SW–NE	A
		0100–0500	E–W	A
Perseids	August 10–14	2330–0300	NW–SE	AA
		0300–0800	E–W	A
		0800–1130	SW–NE	B
Cygnids	Aug. 10–20	1700–1930	NW–SE	B
		2130	E–W	B
		2330–0200	SW–NE	B

California to northern California and southern Oregon.

Ron Pugh—Fort Bragg, Calif.—noted reception from Phoenix and Tucson stations on channels 3, 4 and 5, at 1915 PST. Then at 2030 the opening peaked, and KOLD-TV, channel 13, Tucson, 800 miles, sneaked through for 5 minutes of some sort of very unusual high-band skip. We also have several reports of heavy interference in the 152-mc police band at the same time that evening, with stations in Lake County in northern California, talking to stations in the Imperial Valley along the Mexican border. The last time such an opening occurred was in the spring of 1956, just before the sun-spot cycle started its meteoric climb. Could be that this summer will bare close watching on all quarters.

Dx predictions

Meteor Showers: The June 20–Aug. 30 period is just about the best meteor shower time of the entire year. In column after column, we mention that through careful dxing practices both TV and FM dxers can log burst reception from stations 500–1,500 miles away *any day of the year*. Yet few dxers seem to give MS dx a play. Perhaps the problem is that too few dxers know how to MS dx. Comments are invited as to why *you* haven't made use of this form of dxing, TV and FM alike.

Readers are referred to the FM–TV Dx column for March, 1959, for an explanation of the use of the table of meteor showers.

Trops: During the past few years, the month of June has gone out with a real bang-up ground-wave opening, affecting vhf and uhf alike, over much of the USA east of the Rockies. Watch for signs of general fringe-area improvement around June 30 (5 days either side) and again near July 20–27. If vhf coverage is good out to 500 miles in one direction or more, keep an eye on the uhf band for stations over similar distances in the same direction(s). Late evening trops openings (2300–0300 LST) often provide good coverage along the Great Lakes, eastern seaboard and Gulf area. Atlantic seaboard dxers should be aware of the special potential during the last 2 weeks of August. Seaboard openings are usually first apparent around 2000 LST with reception peaking around 2400 (midnight).

E-Skip: This type of dx often drops in frequency around June 15 and does not regain full strength until around June 25–28. Good openings may be expected in eastern, southern and western areas during June 25–July 5, with special emphasis between 0700–1000, 1200–1400 and 1700–2100 LST. Another good series of openings is likely to hit all areas of the country from July 20 to July 29, with special emphasis between 1000–1400 and 1600–2000 LST. Watch July 27–28 for special action. Other openings of lesser stature can be expected on most other days during the predictions period.

Reporting forms

As a special service to readers of this column, we make dx logging and reporting forms available for both FM and TV dx work. Readers need only send a postcard with their name and address to FM–TV Dx Column RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y. The report forms are free, of course. END

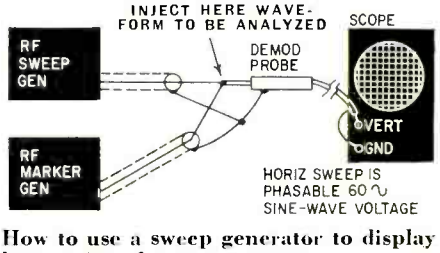
Scope as Spectrum Analyzer

By R. M. CENTERVILLE

YOU can use a sweep generator to display the harmonics of a square wave, sawtooth wave, sync pulse or any other waveform on a scope screen. Just use the hookup shown in the diagram below.

Connect the rf sweep and marker generators in parallel and feed their outputs to a demodulator probe and scope. Also feed the square wave or other waveform to be analyzed to the probe. The marker generator puts a bug on the swept trace at the zero-frequency point.

As you tune the marker generator, the bug moves across the trace. Hence, you can mark off ¼-, ½- or 1-mc intervals. When the waveform to be analyzed is added to the circuit, marker bugs appear along the swept trace. As in the photo (it shows the harmonics in a distorted 250-kc sawtooth waveform), there is one bug for each harmonic.



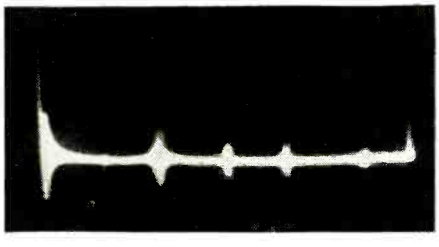
How to use a sweep generator to display harmonics of a square wave.

By its location along the base line, each bug shows the frequency of the waveform's harmonic. Each bug also shows, by its height, the relative voltage of the harmonic. Thus the arrangement is an electronic Fourier analyzer. Any waveform can be analyzed for even and odd harmonics, and their voltages, with this easy to use arrangement.

Here are a few useful operating tips:

1. The demodulator probe is not a good modulator for low-frequency waveforms. For low-frequency waveforms it is advisable to include a standard rf modulator using a crystal diode between the demodulator probe and the other test equipment. (This removes low-frequency interference from the scope pattern.)

2. As you vary the frequency of the square-wave input (if you are analyzing a square wave), you will see all the bugs running toward or away from zero frequency point on the trace. This is because the spectrum shifts with the fundamental frequency of the square wave.

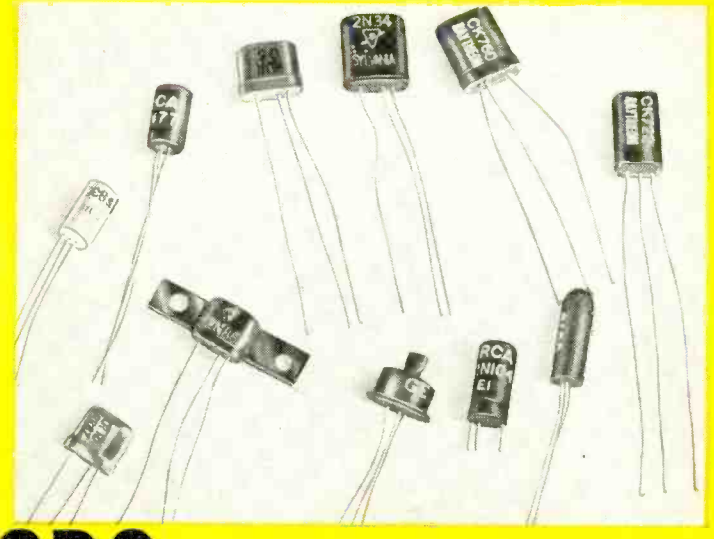


Square-wave harmonics show up as bugs on the scope screen trace.

3. Unless the marker generator is tuned to bring zero frequency to the end of the pattern, you will have a twin display, which repeats itself. This is not desired, as it contributes nothing to the information obtained and can be confusing.

4. The demodulator probe is not strictly linear for low input voltages. When the available voltages are weak, the heights of the bugs will not be strictly proportional to the voltages of the harmonics. The stronger harmonics will appear somewhat emphasized. Keep the input to the probe at least above 1 volt to obtain accurate oscilloscope indications.

Part I—The truth about transistors may be startling. There are many common misconceptions—things accepted as true, which just aren't



Coyne Electrical School

TRANSISTORS... *fact and fiction*

By LOUIS E. GARNER, JR.

WHEN Dr. Lee de Forest invented the triode amplifier in the early 1900's, he laid the foundation stone for the enormous electronic industry we know today. Before the invention of the triode, no practical amplifying device had been available to electrical or radio design engineers, and, for many decades after its development, the vacuum tube ruled supreme in its field. Since there was no prior art in the use of electronic amplifiers, the terms amplifier and vacuum tube became synonymous expressions to many.

As a result, when Drs. Shockley, Bardeen and Brattain invented the transistor in 1948—nearly a half-century after the invention of the triode—this completely new type of amplifier was introduced to a technical world whose thinking was already heavily oriented in terms of vacuum-tube technology.

It was only natural for engineers and technicians to try to equate transistor operation, design techniques and circuitry in terms of vacuum-tube operation—even though the two devices are based on entirely different principles.

Design engineers, for example, developed and used the "theory of duality"—a design method based on the dual characteristics of vacuum tubes and transistors.

Thus, the vacuum tube was considered to be a voltage amplifier and the transistor a current amplifier. Transistor circuit design was carried out using vacuum-tube design techniques by first converting circuit parameters into their dual. Resistances became conductances, voltages became currents, inductances were treated as capacitances, and so on. Once a design had been completed, each parameter was converted back to its dual.

The technically workable but awkward theory of duality, when combined with an incomplete understanding of transistor behavior and a tendency to think of all transistors in terms of the now obsolete point-contact units, resulted in a number of basic misunderstandings about transistor operation. Today, these misunderstandings limit the effectiveness of design engineers and, at the practical level, seriously hamper the work of technicians and service technicians called on to assemble, or maintaining transistor.

Whether you work with transistors as a hobby or as a profession, and whether your approach is at the design or the practical level, your job will become easier (or your hobby more enjoyable) if you dispel any misconceptions you may now have about transistors and start to think in terms of semiconductor rather than vacuum-tube operation when dealing with transistor circuits.

Common misconceptions

Let's take a look at the more common present-day misconceptions regarding transistor operation.

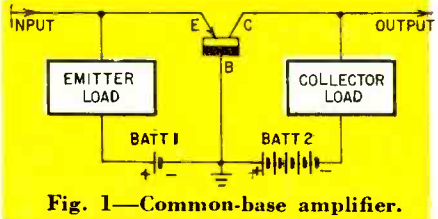


Fig. 1—Common-base amplifier.

Transistors are noisy. True enough at one time, and true today as far as some types are concerned. However, a properly designed and selected transistor may have a lower noise figure than a vacuum tube of comparable quality. An important factor here is the absence of excessive thermal agitation (which contributes to noise generation in vacuum tubes) since most transistors operate at relatively low temperatures.

Transistors are unstable. The first transistors were point-contact units. These transistors, by their very nature, had very high gain—so high, that they exhibited a negative resistance characteristic in some circuit configurations. As a result, amplifier circuits using these components had a tendency to oscillate and oscillators would often change their mode of operation. To combat this tendency, the common-base circuit configuration (see Fig. 1) was almost mandatory when point-contact units were used in practical equipment. Modern transistors, on the other hand, are very stable, and a properly designed transistor amplifier may have superior stability characteristics when compared to a vacuum-tube amplifier with similar performance specifications.

Transistors are low-frequency devices. This is one of those odd misconceptions that persist and are difficult to trace. The first (point-contact) transistors *were not* low-frequency devices. Many point-contact units could be used as amplifiers and oscillators well into the amateur radio bands. True, the

first low-cost (junction) transistors were essentially audio devices, but high-frequency transistors have been available commercially for several years. Today, units can be purchased across the counter which may be used as oscillators and amplifiers into the hundreds of megacycles, and experimental transistors have been developed which operate into the thousands of megacycles.

Transistors are low-power devices. Another of those hard-to-dispel misunderstandings. Transistors are highly efficient because they require only microwatts of power when handling microwatt signal levels. This, plus the fact that early transistors were limited to milliwatt ratings, has led many to feel that the transistor is basically a low-power device. However, today we have transistors capable of handling kilowatt loads, and multikilowatt transistors are in the works. Especially interesting is that the first large-scale commercial application of transistors was as power amplifiers in auto radio receivers. Today, transistors are often preferred

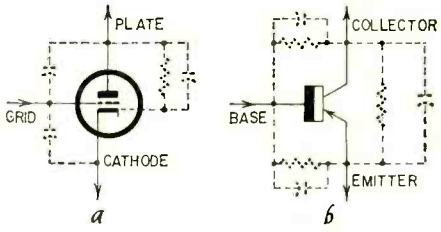


Fig. 2-a—Important internal impedances in the vacuum tube, b—and in the transistor.

to vibrators, vacuum tubes and rotary motor generators, as power inverters and converters.

Transistor bias voltages are critical. This statement becomes true if we replace the word "voltages" with "currents," and is easy to understand if we think of the transistor as a current- (rather than voltage-) amplifying device.

Adherence to this misconception has resulted in many authors suggesting that transistor batteries should be replaced if their voltage measures 10% low. In practice, a transistor power supply battery's internal impedance is much more important than its terminal voltage in determining circuit operation. A battery with high internal impedance may cause interstage coupling through the power supply, resulting in distortion, oscillation and other equipment defects.

Transistors are similar to vacuum tubes. A common misconception resulting from attempts to explain transistor behavior in terms of vacuum-tube operation, this statement is completely wrong unless modified to read: *Transistors are similar to vacuum tubes only in the respect that both are amplifying devices.*

Aside from differences in construction, physical shape, size, basic principles of operation, internal impedances and methods of application, these two devices perform almost in opposite fashion.

Except at uhf, where lead inductances become important, a vacuum tube's important internal impedances are its interelectrode capacitances and its cathode–plate resistance, as shown in Fig. 2-a. There is no direct connection between any pair of electrodes. The cathode–plate resistance is actually a unidirectional stream of electrons in a vacuum—they can flow from cathode to plate but not vice versa.

In a transistor, on the other hand, there is a direct resistive connection between each pair of electrodes in addition to the interelectrode capacitances, as shown in Fig. 2-b. And these resistances are bi-directional—current can flow in either direction (although a higher resistance may be offered to current flow in one direction than in the other).

There are other differences. In a vacuum tube, plate current is at a maximum with zero grid bias, and decreases as bias voltage is increased. In a transistor, collector current is at a minimum with zero base bias, and increases as bias current is increased.

In a vacuum tube, in general, an increase in bias voltage reduces stage gain. In a transistor amplifier, on the other hand, an increase in base bias current increases stage gain. This characteristic is important in understanding avc action in transistor receivers.

A class-B vacuum-tube amplifier is operated with a moderately high grid bias. A class-B transistor amplifier is operated with close to zero base bias current.

As a general rule, most vacuum-tube oscillators are class-C amplifiers. Transistor oscillators are generally class-A amplifiers. This is important to the service technician determining whether a local oscillator is functioning properly.

Half-truths

A couple of statements about transistors are part true and part untrue. Some did apply in the early days of transistors, but today are meaningless.

Transistors are temperature sensitive. This is one of those half-true half-false conceptions often used as an argument for vacuum tubes and against transistors. Actually, the vacuum tube is *more* temperature-sensitive than the transistor, but is equipped with a built-in oven to help maintain its temperature.

Transistor operating characteristics do vary with their temperature. And since most transistors are used under ambient temperature variations, the circuit design must compensate for possible temperature variations if optimum circuit operation is to be maintained. Now in the development stage are semiconductor devices capable of operating between 2° Kelvin and 1,500°C.

Reversing battery voltage will ruin transistors. This is the most common misconception of all, mainly because it is sometimes true. It is repeated frequently in books and magazine articles. To understand how this came about, we have to go back to the old point-contact transistor and to its almost mandatory common-base circuit configuration (see Fig. 1).

When a transistor is used in the common-base circuit, its emitter–base junction is generally biased in its forward or low-resistance direction. In Fig. 1, this bias is furnished by BATT1, with emitter-base current limited only by BATT1's value, the emitter load's dc resistance and the very low emitter–base impedance. The collector–base junction, on the other hand, is biased in its reverse or high-resistance direction by BATT2. Here, collector–base current is determined by BATT2's value (which is relatively high compared to BATT1), by the collector load's dc resistance and by the relatively high collector–base impedance.

Under these conditions, if the collector bias battery (BATT2) is reversed, the collector–base junction will be biased in its forward or low-resistance direction, and collector current will rise to a value determined primarily by BATT2's voltage and the collector load's dc resistance. If the collector load has a low dc resistance, the collector current may rise to the point where the transistor is damaged.

Today, however, the common-base circuit is seldom used in practical equipment. The common-emitter configuration, shown in Fig. 3-a, is by far the most popular. With this circuit arrangement, reversing the battery polarity will not damage the transistor. In rare instances, the circuit may even perform better with reversed battery polarity.

Referring to Fig. 3-a, a p-n-p transistor is used as a common-emitter amplifier. A single battery, BATT, furnishes base bias current through voltage divider R1–R2 and collector bias through collector load R3. Base bias current is determined primarily by

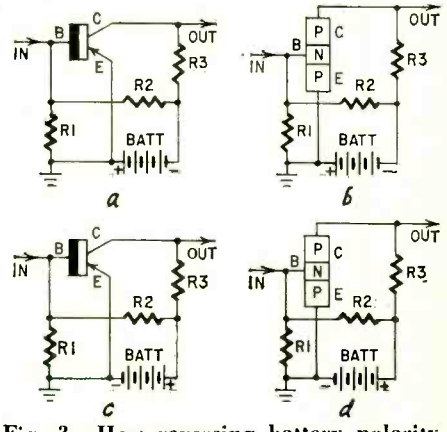


Fig. 3—How reversing battery polarity affects circuit operation: a—Typical common-emitter amplifier using a p-n-p transistor. b—3-a redrawn to emphasize junction biasing. c, d—Correspond to 3-a, and-b, respectively, but with battery polarity reversed.

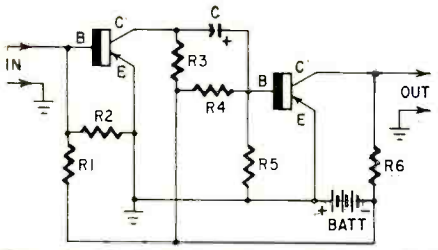


Fig. 4—Typical two-stage R-C-coupled amplifier. P-n-p transistors in the common-emitter configuration are used in both stages.

the battery voltage and R1–R2's ratio. Collector current is determined by the battery voltage, by R3's value and by the transistor's base bias.

The basic circuit has been redrawn in Fig. 3-b to better illustrate inter-electrode junction biasing. Note that the base–emitter (n-p) junction is biased in its forward direction. There are two junctions between the emitter and collector electrodes. Thus, the positive side of the battery (BATT) connects to a p-type electrode (emitter) while the negative terminal connects to another p-type electrode (collector).

Let's suppose, now, that BATT's polarity is reversed. This condition is illustrated in Figs. 3-c and 3-d, corresponding to Figs. 3-a and 3-b, respectively.

With BATT reversed, the base–emitter (n-p) junction is now biased in its reverse or high-resistance direction. As a result, base bias current will drop to a very low value.

Referring to the collector circuit, we find that the positive side of the battery still connects to a p-type electrode (collector in this case), while BATT's negative terminal is still connected to a p-type electrode (emitter). Thus, there is virtually no change as far as collector–emitter impedances are concerned, except for the drop in base bias current which, in itself, tends to reduce collector current.

In other words, reversing the battery polarity in this circuit reduces (rather than increases) both base and collector currents. In most cases, collector current will be reduced almost to cutoff and the circuit will no longer operate, but the transistor will not be damaged. In fact, transistor damage due to overload is less likely to occur with reversed than with normal biasing.

Under rare conditions, however, circuit operation may be improved by reverse biasing—a circumstance which has caused much scratching of heads among experimenters and engineers who have accidentally connected a battery to a test circuit with reverse polarity.

To see how this can happen, refer again to Fig. 3. Suppose, now, that the transistor is very leaky. Under these conditions, considerable collector current may flow even without base bias, and a small bias may take the transistor to saturation. In this case, applying a small reverse base bias might well reduce the collector current to the point where linear circuit operation is possible. The fact that collector voltage polarity is reversed at the same time may be relatively unimportant.

At this point, you may wonder why one outer electrode is called an emitter and the other a collector, if they can be used interchangeably. It's a matter of convention, coupled with the fact that the emitter is generally designed to perform this role better.

Several firms manufacture symmetrical transistors in which the collector and emitter electrodes have almost identical characteristics. Here, either can be used as an emitter or collector.

Leaky coupling capacitors will ruin transistors. This is another of those half-truths deriving from vacuum-tube circuit operation. It might never have become a common misunderstanding had not a national service technicians' magazine published a feature article pointing up the dangers of leaky coupling capacitors in transistor circuits.

The effect of a leaky coupling capacitor in a R-C-coupled amplifier can be determined by an examination of the basic circuit shown in Fig. 4.

In this circuit, two p-n-p transistors are used as common-emitter amplifiers. A single battery supplies all operating currents. Base bias for the first stage is supplied by voltage divider R1–R2; for the second, by R4–R5. R3 and R6 serve as collector loads for the first and second stages, respectively. Capacitor C couples the two stages.

In a typical circuit, R1 and R4 will be about 47,000 ohms, R2 and R5 about 3,900 ohms, and R3 and R6 about 4,700 ohms. C is generally an electrolytic with a value between 2 and 20 mf. The battery may range from 1.5 to 9 volts.

Referring to Fig. 4, suppose that C became leaky, or even shorted, what happens?

If C is shorted, R3 and R4 are connected in parallel and their total resistance drops to a value somewhat under that of the lower unit (for example, a little under 4,700 ohms). The second stage's base bias current will increase somewhat, but not enough to damage the transistor, since bias current is limited by the dc resistance (R3 and R4 in parallel) in series with the base electrode.

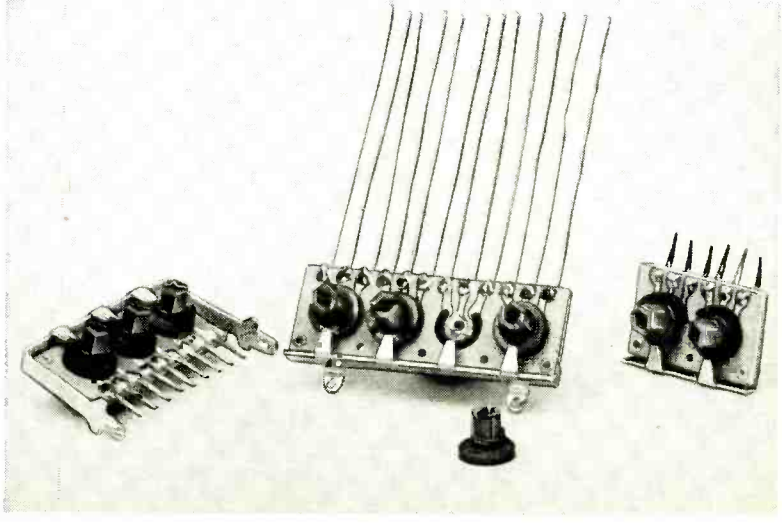
What about collector current? It can increase, too, due to the increase in base bias, but its maximum value is limited by the collector load resistance (R6) and BATT's voltage. supplies 9 volts. The maximum collector current that can flow is less than 2 ma, well within the maximum ratings of commercially available transistors.

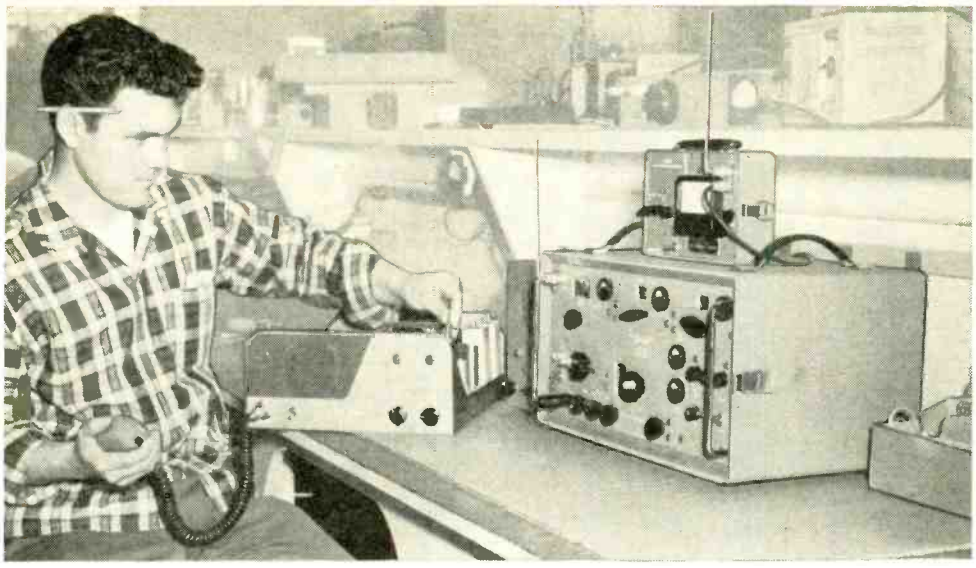
Thus, a leaky coupling capacitor in a circuit similar to that shown in Fig. 4 may introduce distortion and clipping, but will not damage the transistors unless the collector loads have very low dc resistances.

Next month we will examine some typical transistor circuits with an eye toward servicing. TO BE CONTINUED

New Miniature Pots

MINIATURE variable resistors especially suited to mounting into printed-wiring boards or wherever space is at a premium are now being manufactured by Centralab. These small pots come one to four units on a single steatite base. Base is available with small brackets (see photograph) and with either long wire leads or plug-in terminals. The variable arm may be adjusted by hand, with any screwdriver, or with a large Allen wrench or small hex socket. A wide range of values from 1,000 ohms to 5 megohms is being supplied. Because of the steatite base construction, other components can be wired directly onto these pots, making complete subassemblies for later insertion into the main chassis or assembly. Units are rated at ¼ watt, have linear taper and breakdown voltage of 1,250. They are being supplied by Centralab to manufacturers of original equipment only, and are already showing up in some of the newer television receivers. END





ABC's of MOBILE RADIO

By LEO G. SANDS

Part VI—Test instruments and tools for the mobile-radio service technician

LAST month we took a look at the fees charged and the personnel requirements for mobile servicing. Now we continue with a brief survey of tools and instruments for faster repairs.

Frequency measurement

Transmitter frequency must be measured to an accuracy prescribed by applicable FCC regulations. With split-channel operation, these regulations have been sharply tightened. Several manufacturers offer frequency meters for this purpose. Some are crystal-controlled and are useful for measuring from one to four transmitter frequencies. Continuously tunable frequency meters are also available and can be used for measuring any frequency within their tuning ranges. *When measuring transmitter frequency, the FCC requires an entry in the log which indicates the frequency as measured in kc, not just "OK within limits."*

A suitable frequency meter is relatively expensive, but essential, costing from about $250 to as much as $2,500. Its accuracy must also be checked at frequent intervals against a secondary frequency standard or signals from WWV, the US Bureau of Standards radio station.

Electronic counters are also used to measure transmitter frequency accurately. These instruments indicate frequency directly in megacycles and kilocycles.

A way of measuring frequency deviation of FM transmitters must also be provided. A frequency-deviation meter is often a built-in feature of a crystal-controlled frequency meter. A separate deviation meter is generally used with continuously tunable frequency meters. Now that split-channel operation is in common use, frequency-deviation measurement is more important than ever. Excessive deviation can cause harmful interference to others operating on an adjacent channel.

Power measurements

Transmitter power output can be measured roughly by using a lamp as a dummy load for the transmitter and noting its brilliance. But this is a very rough measurement. An rf wattmeter indicates actual rf power delivered into a calibrated dummy load. Without such an instrument, actual power output is only a guess. Such an instrument is also extremely valuable when testing transmitter tubes by substitution, noting any improvement as new tubes are substituted.

Test devices

Most mobile radio equipment manufacturers offer special test meters for use with their equipment. They are usually provided with plugs which connect directly to the equipment being tested and measure grid-drive and plate current of certain stages as well as various voltages. Such instruments are extremely valuable servicing aids.

Typical of the general-purpose testers for mobile radio servicing is the Bendix Radio 2TM-1 battery-operated portable test set shown schematically in Fig. 1. This instrument includes a crystal-controlled signal generator, a 20,000-ohms-per-volt dc voltmeter, a relative field-strength indicator and metering for tuning Bendix as well as Dumont, Motorola and Link mobile radio equipment when suitable adapters are used.

Sockets are provided for four internally mounted crystals (XY101, XY102, XY103 and XY104) and one socket (XY105) for an external plug-in crystal. They are connected to a front-panel SELECTOR switch which enables the user to select any of four semipermanent output frequencies between 250 and 7,000 kc for if alignment and a fifth for use when a hf, vhf or uhf signal is required, with frequency determined by the plug-in crystal.

When switched to use one of the internal crystals (position 1, 2, 3 or 4 of S101), the output of the 1AD4 oscillator (V101) is fed directly to output jack J101. When set to use the external crystal (position 5 or 6 of S101), the output of the oscillator is fed to the 1AD4 amplifier (V102) and then to

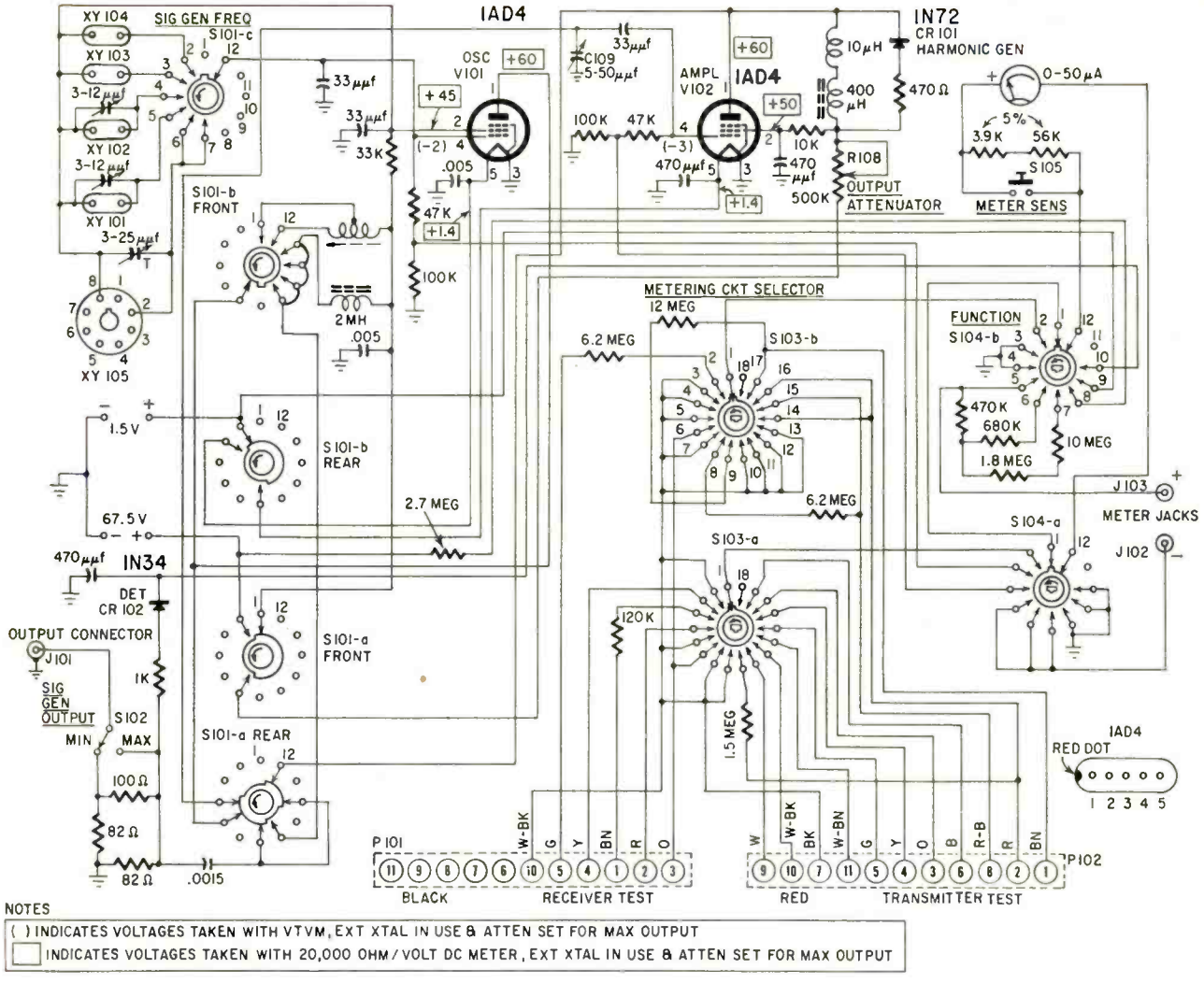


Fig. 1—Circuit of the Bendix Radio 2TM-1 portable test set.

J101. Position 5 is for output frequencies between 36 and 50 mc and 144 and 174 mc. Position 6 is for 24–36-mc and 450–460-mc signals. Trimmer C109 is provided for tuning the amplifier stage's input. Attenuator R108 varies the amplitude of the output signal. Attenuator switch S102 when set in the MIN (minimum) position cuts the output by an additional 6 db.

When used as a relative field-strength meter, a telescoping whip antenna is plugged into J101. The rf signal picked up by the antenna is rectified by diode CR102, and the signal strength is measured in terms of dc by the 0–50 dc microammeter. Here again switch S102 can be used as a two-step attenuator.

Metering of various circuits of mobile equipment being tested is by the 0–50 dc microammeter through various resistor networks which limit current so that only 3 volts dc is required for full-scale deflection of the meter. An 18-position switch (S103) permits selection of up to 17 circuits (and one "off" position). When required, the 0–50 microammeter may be used directly by pressing push-button S105, which shorts out the series resistor.

In addition, the instrument may be used as an independent dc voltmeter with three dc voltage ranges (3, 60 and 600) available at pin jacks J102 and J103.

Shop power supply

Since mobile units are operated from a 6- or 12-volt dc source, a suitable power supply should also be provided in the shop. If a rectifier is used, it should have good regulation characteristics so that available voltage will not drop beyond limits when a mobile unit is switched from "receive" to "transmit."

Often, storage batteries are used which are shunted by a battery charger as shown in Fig. 2. In a vehicle equipped with a 6-volt battery, the voltage reaching the equipment may vary between 5.5 to over 7. When a 12-volt battery is used, the range may vary from 11 to as much as 15 volts. These field conditions must be duplicated in the shop so that variations in transmitter power output, frequency deviation and receiver sensitivity can be checked at various input voltages.

Those who contemplate servicing railroad radio equipment will require a source of dc at 32 and 64 volts. Most railroad passenger cars are equipped with 32-volt and locomotives with 64-volt batteries. Voltage variations are apt to be considerable. Special shop power supplies for this purpose are manufactured by Electronic Communication Equipment Co. (Chicago).

Those who can afford it should consider a multi-voltage motor generator set which will deliver 6, 12, 24, 32, and 64 volts dc for shop operation of mobile radio equipment used in automobiles, trucks, materials-handling vehicles and trains. Such motor generator sets, equipped with magnetic amplifier voltage regulators as well as manual voltage adjustments, are available on a

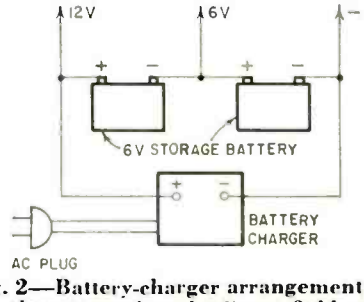


Fig. 2—Battery-charger arrangement for the shop is used to duplicate field operating conditions.

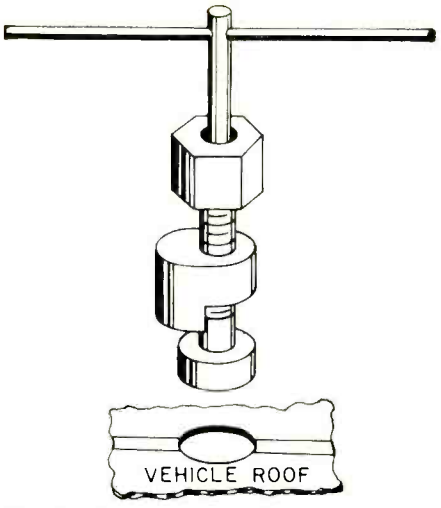


Fig. 3—Antenna mounting tool speeds installation of whip antennas.

custom-built basis from such rotating electrical equipment manufacturers as Bogue Electric Manufacturing Co., that specialize in the design of special power supplies.

Test jigs

When a radio–TV repairman pulls a chassis, he generally brings the whole set including the speaker to the shop. But, when removing a mobile unit for shop repair, the control head, cabling, speaker, microphone and antenna system are left in the vehicle. Obviously, substitutes must be provided in the shop in the form of a test jig which duplicates conditions in the vehicle.

For any one type of equipment this is easy. But, when a shop services several makes, it takes ingenuity to design a jig that works with all sets. Sometimes, several jigs are provided to meet all requirements. When designing test jigs, it is important that all field conditions be duplicated. The various equipment manufacturers are generally eager to provide the necessary information.

Tools

Very few special tools are required. However, every once in a while a service technician or a manufacturer devises a new tool which makes servicing or installation easier and is worthy of special mention.

Motorola, for example, recently introduced a new antenna mounting tool (Fig. 3) which speeds up installation of whip antennas on 1958 Fords and other cars which have a middle groove running the length of the rooftop. It flattens the groove and provides firm seating for the antenna washer to prevent leakage and assure a secure fit.

Typical service problems

A survey indicates that defective tubes are the most frequent causes of trouble, followed by worn-out vibrators and failures of selenium rectifiers. In some makes of sets, capacitor failures are common; in others they seldom occur, even after 10 years of use.

When replacing parts, especially in rf circuits, exact replacement parts must be used to avoid improper operation due to slight variations in electrical characteristics.

Relays, frequent sources of trouble, require careful attention. Relay contacts should never be sandpapered, only burnished with a proper burnishing tool. It is better to replace a doubtful relay than chance further field failures.

Dynamotors require proper maintenance. One who is not familiar with servicing rotating electrical equipment should farm out such repairs to electrical shops with the required know-how.

Equipment modifications

Much of the equipment now in service can be improved by making factory-specified modifications. Information on such modifications can be gleaned from applicable service manuals, and the necessary parts can usually be obtained from the equipment manufacturer.

Many sets can be modified for split-channel operation by replacing if filters with new types which provide greater selectivity. Some are lumped filters, replaceable as a unit In some sets, one or more if transformers or filters may be replaced with more selective types.

Several equipment manufacturers build transistor power supplies which can be added to existing sets as a vibrator replacement. Most 6-volt sets can be readily modified for 12-volt operation by rewiring heater circuits and replacing the power transformer and vibrator.

These modifications can mean more income for the service shop equipped to perform them.

Getting into the business

To get into the mobile radio service business, the first step is to get in contact with equipment manufacturers, most of whom are actively looking for service outlets. To shops with qualified personnel and adequate equipment, most manufacturers will furnish service manuals and assistance.

Some manufacturers are:

Bendix Radio Div., Bendix Aviation Corp., Baltimore 4, Md.
Bennett Laboratories, Bay Road, Redwood City, Calif.
Communications Co., Coral Gables, Fla.
Allen B. Dumont Laboratories, Inc., Clifton, N. J.
General Electric Co., Lynchburg, Va.
Kaar Engineering Corp., 2996 Middlefield Road, Palo Alto, Calif.
Link by Gonset, 801 Main St., Burbank, Calif.
Motorola Communications & Electronics, 4501 W. Augusta Blvd., Chicago 51, Ill.
RCA, Building 15-2, Camden 2, N. J.

Scope of the business

It has been estimated that as many as 5,000 independent service shops are in the mobile radio business in varying degrees. Based on 1,000,000 mobile units in service, at an average of $10 per unit per month, the mobile radio service business should be accounting for billings in the order of $120,000,000 per year, which is quite a chunk. And, it's just getting started.

The recent move by the FCC in establishing the Business Radio Service, the Manufacturers Radio Service and the Local Government Radio Service, opens new and very large markets for the mobile radio industry. These hundreds of thousands of potential users of mobile radio have all become prospective customers of the independent service industry.

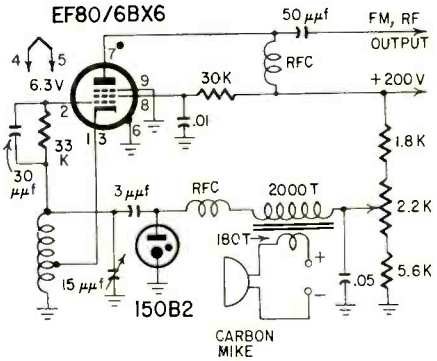
TO BE CONTINUED

Frequency Modulation With a Gas Tube

A simple device that produces frequency modulations has been described in the Russian magazine *Radio*, Moscow, 3-58. It is based on the fact that the interelectrode capacitance of a gas tube varies with the applied voltage. Moreover, this variation is linear for a given voltage range. For example, the gas tube shown in the schematic is the European type 150B2, similar to the American 0D3. It has a capacitance variation of 60 to 160 $\mu\mu$f as the voltage increases from 150 to 160.

Among the numerous possible applications, a simple FM transmitter for amateurs can be made according to the diagram, for the 40-mc band. A carbon microphone is used. The voltage appearing across the secondary of the microphone transformer (primary 180 turns, secondary 2,000 turns) varies the tube capacitance and hence the oscillator frequency. The swing may reach 1 mc, for less than 10% amplitude modulation.

The drawback, as for practically all gas tubes, lies in its temperature sensitivity. The frequency decreases .08%



for each °C increase in temperature. However, this thermal drift can be compensated by using a capacitor with a suitable temperature coefficient for C.

This trick of using a neon or gas diode as a variable capacitor was also used by RCA for fine tuning in the Magic Brain TV control. See "Remote Controls for TV," September, 1956. One experimenter built an FM sweep generator using a circuit like the one shown here with a sawtooth voltage substituted for audio from the microphone. —*A. V. J. Martin.*

The difference between a good and a bad piece of kit-built equipment is usually how it was put together. Here are some suggestions for happier kit building

STEPS TO CAREFREE KIT BUILDING

By GEORGE KRAVITZ *

ELECTRONIC equipment kits are enjoying unprecedented popularity. They are being built by newcomers and old-timers, by skilled technicians and those with little or no technical training or experience in assembling and wiring equipment. Kits are popular for two reasons: first, low price; second, the pleasure derived from doing it yourself.

If you intend to enjoy doing it yourself use an organized and orderly procedure for assembling your kit. This article will not give unbreakable rules which you must follow. Instead it will provide some suggestions that can make the kit-building job easier and more efficient.

When you receive a kit, it is rather tempting to plunge right into the project without a moment's delay. Armed with a soldering iron, pliers and screwdrivers, and driven by unquenchable enthusiasm, most of us want to finish the job in a hurry. Experienced kit builders, however, know that a complicated kit takes time to build. And it's a good idea to make haste slowly.

A place to work

The first thing you need is a suitable work area. The best is one where you can leave the work undisturbed in a partially completed state. If you have a basement workshop, you are among the fortunate. Otherwise, set up a work table in a room that can be closed off. This lets you leave the work as is, and return to it when you have the time. But if you are like most apartment dwellers, you don't have a secluded nook in which to build equipment. You may have to put the kit and tools away after each construction session. If this is so, don't use the kitchen table as the temporary workbench. In your wiring and soldering zeal, you may damage a good piece of furniture. (I now own a partially demolished kitchen table, complete with soldering-iron burns, nicks, scratches and assorted gouges.)

A bridge table (preferably an old beat-up one) can serve as a temporary work table if the equipment you intend to build is relatively light in weight. Set it up against a wall which has an electric outlet.

The work area should be comfortable. Light should be adequate—a small desk lamp helps provide extra illumination when needed. And take note of the area beneath the work table. If you drop a small part, will it be easy to find? It won't be if there are many crevices where small items can hide.

Hang up the pictorial wiring diagrams, with masking tape, on the wall in front of the work area. It's a good idea to keep the table clear of everything which is not needed. For example, tubes, a subassembly or other parts which will not be needed for a while can be placed in a carton on a chair near the work table.

Cartons are very useful. One large box can be used to hold everything if the kit is not too large or complicated. Or two or more smaller ones may serve. When you finish the evening's work, put everything in one carton if possible (or in two or three, if the project is a big one). Then, put the carton(s) in a safe out-of-the-way place.

Tools and material you may need

Tools can be grouped as essential or useful.

Essential tools include diagonal cutting pliers, long-nose pliers, gas pliers, screwdriver (medium size) and soldering iron. For some kits, other tools may fall in the essential category. If the kit uses Phillips-head screws, you need a Phillips screwdriver of the correct size. If the controls have set screws, you need a suitable screwdriver. It is unlikely that you'll need more specialized tools.

The largest number of tools are in the useful category. For example, hex-nut drivers, fixed- and adjustable-end wrenches, wire strippers and a soldering aid. A C-clamp is handy for holding small subassemblies during soldering. A small vise serves the same purpose. If the kit contains transistors, keep several copper alligator clips on hand to use as heat sinks. When clipped between the point to be soldered and the transistor, the alligator clip absorbs heat, thereby preventing damage to the transistor.

If your kit does not include solder, you'll have to buy some. Use only rosin-core solder. *Never use acid-core solder.* Acid-core solder is corrosive and may damage components. Then, too, the guarantee that comes with most kits is void if acid-core solder is used. Use a 40-60 solder for best results. Pound rolls are most economical.

Wire is usually included in the kit. Sometimes it is cut to size; sometimes it is not. It's always useful to have a little extra wire on hand. You may make an occasional mistake in cutting the wire.

Invariably, kit manufacturers provide all necessary hardware. Nevertheless, it's advisable to have a small quantity of 6-32 screws, about ½ inch long, and 6-32 nuts. Size 8-32 bolts (½ inch) and 8-32 bolts are also handy to have around. It's rather annoying to have to stop work on a kit because one nut or bolt cannot be found. Spare lockwashers are also helpful.

Unpacking and initial steps

When the kit is unpacked, make sure you don't throw out any parts with the packing paper. Examine each piece of packing. Save all cartons and packing until the kit is completed and working. If you should have to return a kit for repairs, the packing it came in can usually be used.

Check the parts against the parts list. By so doing, you make sure all are there and you also become familiar with the ones used. Separate the parts according to type, and use smaller boxes or cartons to subdivide them. For example, if several transformers are used, they can be put into a small carton. Of course, the complexity and type of kit you're building will determine how much subdivision is necessary.

Here's an idea that may prove helpful. Buy a quantity of small envelopes. Coin envelopes will do. Separate your resistors according to R number. Insert R1 in an envelope, mark R1 and the resistance value on the envelope. Use one envelope for each resistor, each marked with its reference number and value. Then, stack the resistor envelopes in numerical sequence (R1, R2, etc.). If you're not a skilled color-code reader, this gives you a chance to determine slowly and carefully the value of each resistor. With the R number and value clearly marked on the envelopes, you're not likely to wire in the wrong resistor. Capacitors (except large filters) can also be put in envelopes and stacked. This makes them easy to find when needed. All resistors can be put in one small box, all capacitors in another.

The kit manufacturer's diagrams show how the parts should be mounted. Proceed in the order given by the manufacturer. Assembly steps have been carefully worked out and should not be "improved upon." Be sure to insert tube sockets correctly, with the keyway pointing in the direction indicated in the diagrams. Soldering lugs should be correctly oriented and all parts placed as indicated.

* Publications Dept., Autonetics Div., North American Aviation Co. Downey, Calif.

Use a lockwasher under 6-32 and 8-32 nuts to prevent loosening. Tighten the nuts adequately, but *don't overtighten.* If you do, the threads of the bolt may strip and cause a weak mechanical connection. Or the bolt may break off. A large lockwasher should be used between the volume (or similar) control nut and the panel to prevent the control from turning. Tightening the nut that holds the control may be difficult. The best tool is a large hex-nut driver with a long hollow shaft. If you don't own one, an adjustable- or fixed-end wrench will do. When tightening the nut, avoid scratching the chassis and hold the control firmly to keep the control from turning.

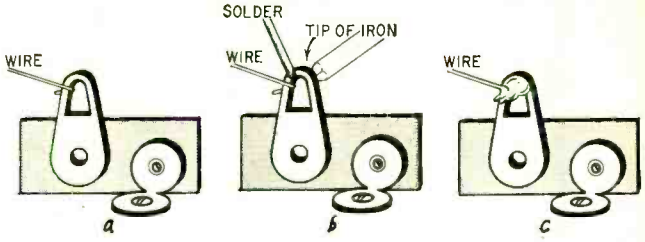
Wiring and soldering

Follow the pictorial diagram when wiring, even though you may be accustomed to working from a schematic. The pictorial should be used because parts placement is often critical. This also holds true for lead dress.

Usually, wire connections should be short and direct. Run leads exactly as shown in pictorial diagrams. Don't make square corners if the diagrams don't call for them. When stripping the wire, expose only the necessary amount of bare wire. Always keep in mind the possibility of a short when checking connections. Tape or insulated tubing (spaghetti) should be used where there is a possibility of a short. Make sure that a strand of stranded wire does not protrude, causing a short. Careful visual examination as you build the kit is important in preventing shorts.

Often a clipped piece of wire or small blob of solder will fall into the wiring. Remove it before continuing with the job. If you don't, you may forget to remove it later or be unable to find it. The metallic particle may cause a short as soon as you test the completed equipment, or months later.

Connections to be soldered must be clean—free of grease, dirt or other foreign matter. Occasionally, you may encounter enamel-covered wire which must be soldered. The enamel must be scraped off before soldering.



Correct soldering procedure: a—Hook lead on lug. Make a good mechanical connection. b—Hold soldering iron on lug. Apply solder to lug. c—Good soldered connection: neither too much nor too little solder.

If you have no soldering experience, the following procedure is recommended before you start work: Examine a good commercial soldering job—the underchassis of a piece of surplus electronic equipment or a radio or TV set. Learn what a good soldered connection looks like. Neither too much nor too little solder is used. The solder does not form a large lump or ball, but flows into the lug hole and seems to blend into the metal.

If you have little or no experience soldering, practice making soldered connections before starting work on the kit. Buy some inexpensive tube sockets or a handful of soldering lugs for the purpose. After making a dozen or two practice connections, you'll find yourself getting the knack and soldering will present no problem.

The lug to be soldered must be heated so that the solder melts when applied to the lug. Touch the hot iron tip of the soldering iron to the lug and hold it there long enough to heat the lug before applying solder. The solder should melt onto the connection (see diagram). Do not apply solder directly to the iron tip. A word of caution: if the joint is too hot or if you hold the soldering-iron tip to the joint too long, the solder will run and drip onto the chassis. Remove the iron when the soldered connection looks right.

Wire capacitors so that capacitance markings remain visible. If the resistors are marked with decimal numbers (in addition to the color-code markings), position them so that the value can be read easily. This helps when checking your work—a most important part of kit building.

Check and double check

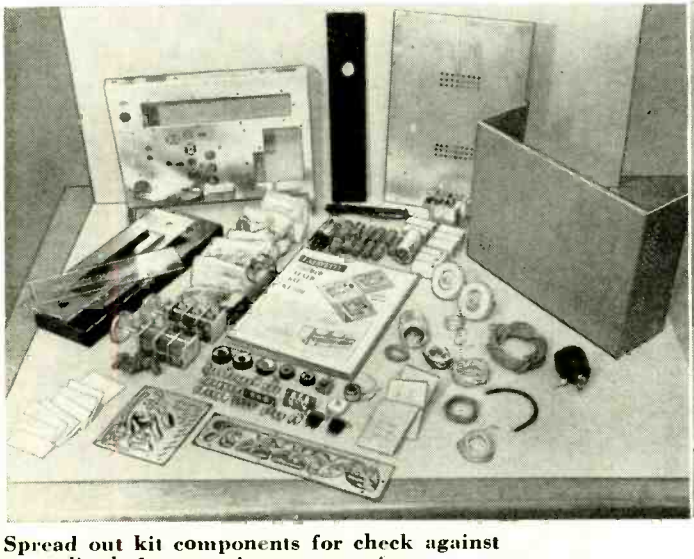
A kit is a well designed piece of equipment. The construction process may involve hundreds of connections. If you make *just one* wiring error, the equipment may not work and sparks may fly. Should this occur, you'll have to check all the wiring against the diagrams—a rather unpleasant chore. Because you want the equipment to work perfectly as soon as it is initially tested, use a good checking system *as you wire the kit.* Consider the following suggestions:

1. Put a check mark on the instruction sheet after each step is completed. (This is standard practice followed by almost every kit builder.)

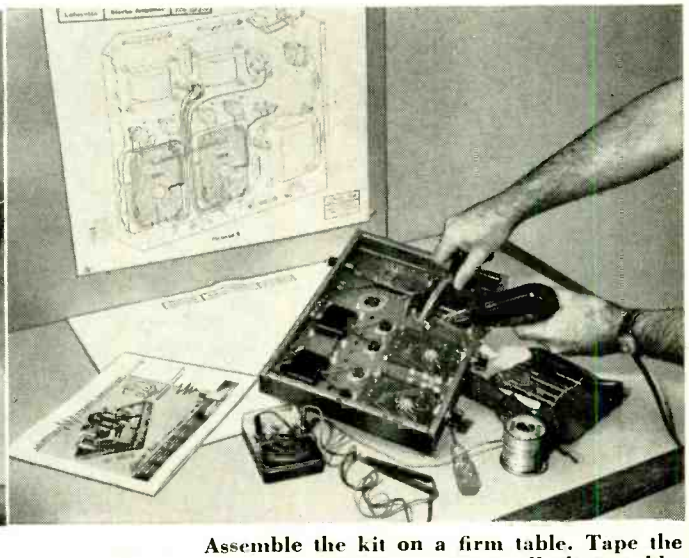
2. After completing five steps, recheck them and put a second check mark after each step.

Here's another idea: After each two steps are completed, examine the steps just performed. Then, write down the steps performed. But, do so by looking at the work, not the instruction booklet. Next, compare your notation with the instructions in the instruction booklet. The steps you wrote and the steps in the booklet should agree. If they don't, something is not right and you've nipped an error in the bud. This method of checking avoids the tendency to repeat the same error when checking.

The importance of carefully checking your work, no matter what system you use, cannot be overstressed. Pleasant kit building! END



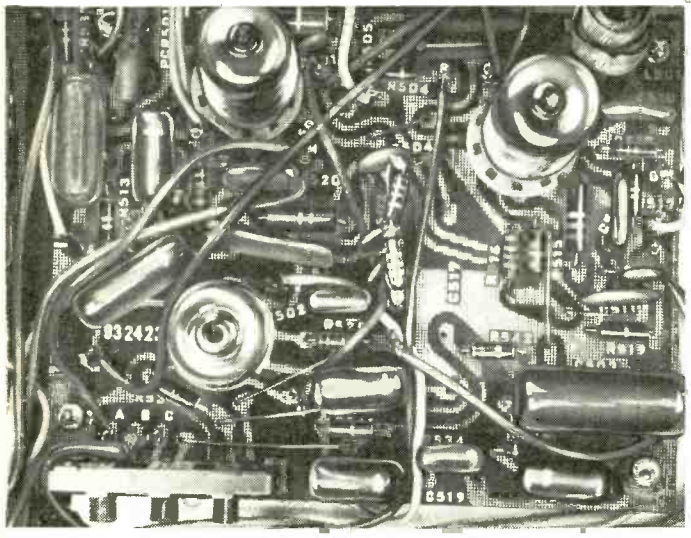
Spread out kit components for check against parts list before starting construction.



Assemble the kit on a firm table. Tape the assembly diagram to wall above table.

what's new?

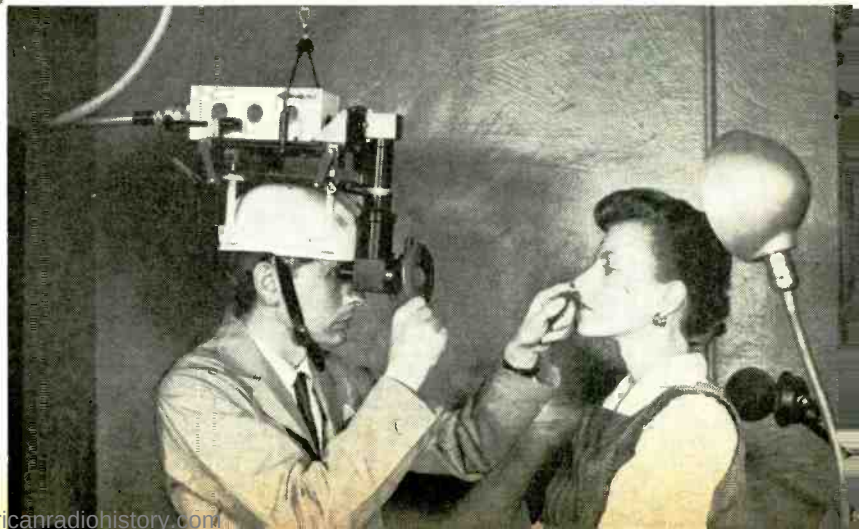
TRANSISTOR TV shown by Philco is a true portable, and can also be operated on ac. Weighing only 15 pounds, the shaded viewing lens gives a good picture even in sunlight. A small picture tube plus a lens system produces "apparent image" equivalent to that seen on a 14-inch tube, according to the manufacturer. The set has 21 transistors, is powered by an Eveready alkaline battery that will operate the set for 4 hours and can be recharged about 20 times. To charge, the battery is simply plugged into an ordinary household outlet overnight. It will be part of Philco's new line.



PRINTED-CIRCUIT BOARDS will carry more information in the future, as manufacturers learn of technicians' complaints of difficulties servicing these units. Shown here is a board from a current RCA portable TV set, with part numbers and circuit wiring indicated on the top in white ink. Westinghouse, Philco and others are also joining in, some even providing test points, voltages and schematics on the boards.

ULTRASONIC THICKNESS TESTER is hand-size and battery-powered. *Audigage* uses 2- to 4-mc carrier to measure thickness of metals, glass and other solids with 5% accuracy. Ceramic transducer goes against material, indication on dial and in phones. Because of its complete portability and small size it can be used to inspect ships' hulls and on other jobs impossible to older and larger ultrasonic thickness testers. Developed by Branson Instruments, Stamford, Conn.

CAMERA ON HEAD aids medicine men teaching ear, eye, nose and throat work to future doctors. Periscopic lens and standard vidicon provide students with the same view on TV receivers that the instructor has as he examines or operates. The 18-pound camera is too heavy to wear, so is suspended (note chain above camera) from a counterweighted bar which takes most of the weight while allowing the operator considerable freedom of movement. Developed at William and Harriet Gould Foundation, Northwestern University, Chicago.



DON'T LET YOUR SCOPE MISLEAD YOU

Misused, a scope can do more harm than good. Do you know how to avoid being trapped by yours?

By CYRUS GLICKSTEIN

THE oscilloscope is one of the electronic technician's most reliable and useful troubleshooting tools. Some technicians use it regularly for troubleshooting, others less frequently. But when the going gets rough, the scope is usually dusted off and hooked up to the chassis. It often provides valuable information which helps track down difficult troubles that might not be located by most other methods.

The oscilloscope is most helpful in locating troubles which result in waveform distortion or incorrect peak-to-peak voltages. Yet, while it is relatively easy to use, it doesn't provide answers automatically. The information on the screen may occasionally throw the technician off the track and cause needless waste of time. While the examples cited here are from the field of TV, the same difficulties can crop up in servicing any electronic equipment.

There are three main sources of possible difficulty:

1. Incorrect interpretation of the observed waveshapes.
2. Incorrect operation of the scope.
3. Defects in the scope.

Incorrect interpretation

Some of the trickiest sections of the TV set to service are the horizontal sweep, horizontal afc and the agc circuits. What makes them tricky is the interaction between input and output stages. Normally, when signal tracing with a scope, a faulty waveform at the plate of the first stage of a section shows that stage to be faulty. And this is usually so *unless* there is feedback from a following stage. In horizontal sweep, afc and agc circuits, a fault in the output stage can affect the operation of the input stage and be the cause of a faulty waveform at the plate of the input stage because of feedback.

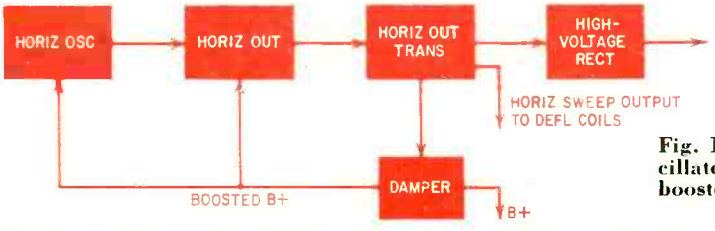


Fig. 1—Horizontal oscillator is returned to boosted B-plus line.

In these circuits, it is particularly easy to misinterpret faulty waveforms.

In many sets, the plate circuit of the horizontal oscillator is returned to boosted B plus. The boost in B plus is obtained from the horizontal output circuit (Fig. 1). A defect in the horizontal output circuit can cause a drop in boosted B plus. This lower voltage, in turn, may be responsible for the defective horizontal oscillator output.

The usual procedure in troubleshooting with a scope is to start at the first stage of a section and check the waveforms stage by stage to the output or until a faulty waveform is found. If a defective waveform appears in the first stage, the usual assumption is that the trouble is located there. Obviously, this is not necessarily correct in the type of horizontal sweep circuit just discussed.

To make a valid check of the horizontal oscillator, the plate circuit must be connected to an auxiliary boosted B-plus supply which provides the correct B-plus input. If it is not feasible to disconnect the feedback to the input stage, further waveform, voltage and resistance checks should be made through the entire sweep circuit before deciding where the trouble is located. In sets where the horizontal oscillator is not connected to boosted B plus, the usual procedure for making waveform checks can be followed.

Sometimes a defective waveform is caused by a trouble immediately *after* the point being checked. This happened in a case of horizontal instability in a

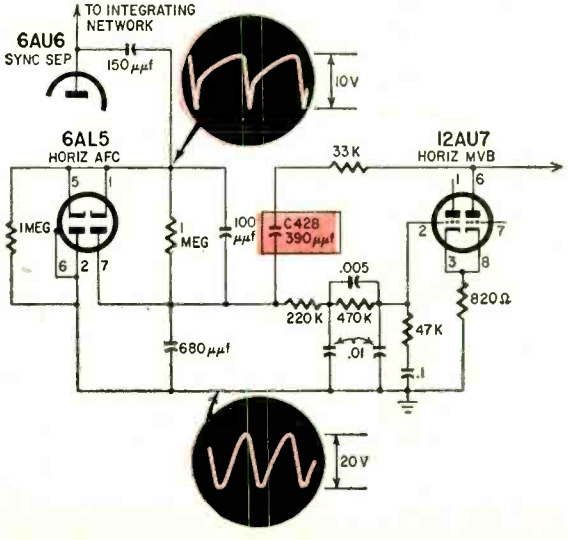


Fig. 2—Horizontal afc circuit in a Westinghouse chassis.

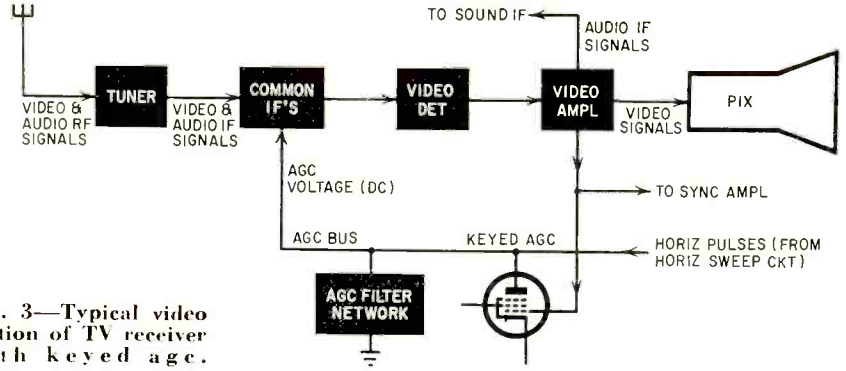


Fig. 3—Typical video section of TV receiver with keyed age.

Westinghouse Chassis V-2313. The horizontal afc circuit is shown in Fig. 2. A check at the plate of the sync separator showed an apparently normal horizontal sync-pulse waveform. A scope check of the horizontal sync-pulse input to the afc diodes (pins 1 and 5) showed a completely distorted waveform full of hash which couldn't be synchronized.

Next, a check of the horizontal sawtooth input to the diodes (pin 7) showed a waveform that was approximately correct.

Subsequent voltage checks revealed that capacitor C428 was leaky. The resulting positive dc voltage applied to the diode plate (pin 7) made the diode conduct continuously. The steady current loaded down the diode and caused more distortion at its cathode (which was further from the trouble) than at its plate. While the scope didn't pinpoint on which side of the diode the defect was located, it did indicate the approximate trouble area.

Another example demonstrates the same point—the trouble may not be exactly where the first defective waveform is found. In this set, the picture on the screen was too contrasty, pointing to possible age trouble. A scope check around the keyed-age stage (Fig. 3) showed a normal horizontal pulse input at the plate but an abnormal waveform at the control grid. It would be wrong to assume, on the basis of this check, that the trouble is caused by defective video input to the keyer stage. Most age faults are caused by a partial or complete loss of age control voltage which lets the common if stages overamplify the video and audio if signals. The video amplifier is overdriven, causing a contrasty picture and a defective video input to the keyed-age stage. But this defective input is an effect not a cause of the trouble in the set. The cause is often a faulty component in the age bus.

Finally, the most common difficulty in interpreting scope patterns is unfamiliarity with the waveforms to be expected at a given stage. To minimize difficulties on this score, the technician must have reference material which gives correct waveform information, he must understand the operation of the equipment he is servicing, and he must know the limitations of his scope in terms of frequency response and similar characteristics so that he can tell whether a normal waveshape is being displayed.

Incorrect operation

Incorrect operation covers poor techniques in the use of the scope. As technicians gain more experience with the instrument, they eliminate these faults, except for an occasional lapse every now and then.

Incorrect settings. Most incorrect settings are immediately evident to the technician. For example, a completely incorrect horizontal frequency setting gives an unintelligible waveform. Therefore, the setting is changed until a recognizable pattern is obtained. Other incorrect settings are less obvious and cause misinterpretations of the waveform seen on the scope screen. Too high a setting of the sync control can cause a distorted waveform and a lot of time can be lost troubleshooting a good stage.

If a very large amplitude signal is applied to a scope while its vertical input attenuator is set to ×1, the waveform on the screen may be distorted. This occurs at any setting of the vertical gain control. A glance at the schematic will clarify why this can happen (Fig. 4). The ×1 setting in some scopes is connected directly to the grid of the first stage of the vertical amplifier. The vertical gain control is connected between the first and second stages, and even if it is set to zero, it cannot keep the first stage from being overdriven if the signal input is too great. A waveform seen on the ×1 setting may seem distorted. Yet the stage being checked can be normal and the distorted waveform caused by the incorrect setting of the scope controls.

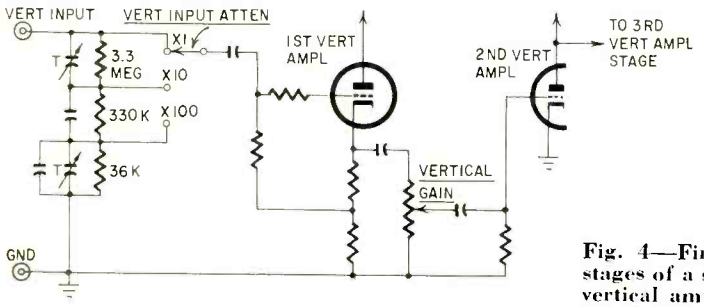


Fig. 4—First two stages of a scope's vertical amplifier.

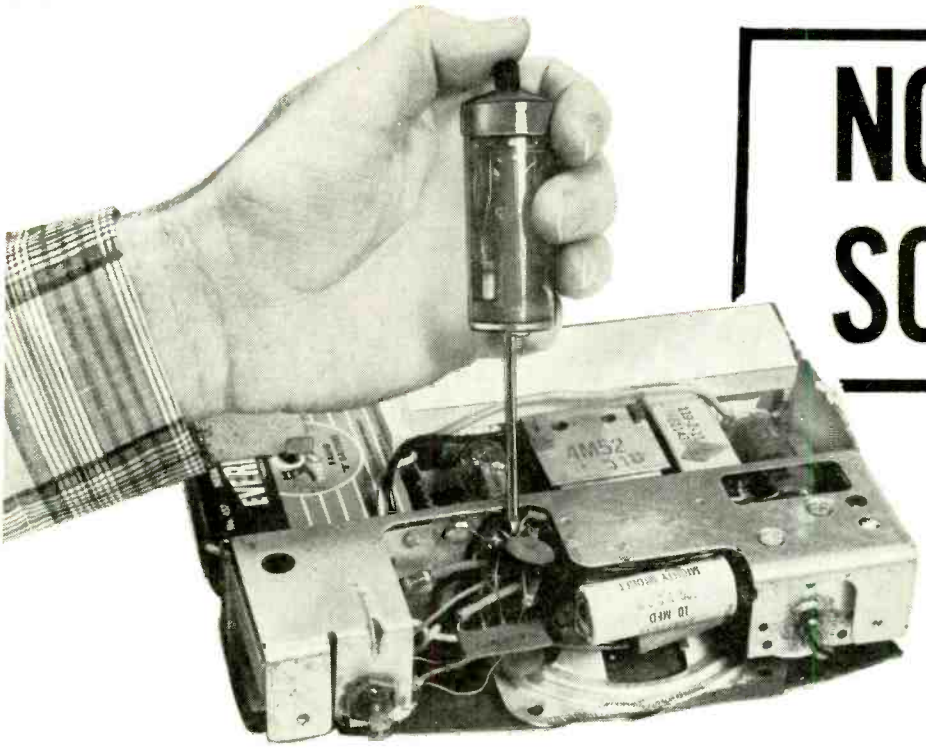
Failure to check P–P voltage. One other type of faulty operating technique is fairly common—checking a waveform for distortion only and not bothering with its peak-to-peak amplitude. When the scope is used to signal-trace a fault such as low output (weak video, raster does not fill screen vertically, etc), most technicians carefully check the observed patterns for waveshape and amplitude. Yet, other faults such as sync instability can also show up as a low-amplitude waveform rather than a distorted one. Neglecting to check waveform amplitude can result in considerable delay in finding the trouble.

Surprising as it may seem, it is important to check amplitude even if the waveform is obviously large enough—it may be too large. In some sets, a typical age fault shows up as a loss of picture and sound, raster normal. A scope check at the grid of the video amplifier stage shows an apparently normal waveform while the plate shows a very small and distorted or no waveform. A lot of time can be spent troubleshooting the video amplifier before discovering that the input waveform is much too large because of no age voltage to the if stages. The excessive video signal, with its pulsating dc component, at the grid of the video amplifier biases the stage close to or beyond cutoff. This results in a loss of both picture and sound, when the sound takeoff is at the plate of the video amplifier. The trouble is not in the video amplifier stage but in the age circuit.

Scope faults

A defective scope or faulty interconnections can result in a good deal of wasted time if not spotted immediately. An open scope ground lead or failure to connect the scope ground lead to the chassis being checked can result in some weird waveshapes, even through the stage being checked is normal. If the waveshapes of a stage look completely unfamiliar or full of hum, check a section of the receiver you know to be good. If the waveshapes are normal there, the scope is OK. If not, there is trouble in the scope, incorrect interconnections, or incorrect settings in the scope or the equipment being serviced. These must be corrected before the scope can be used for any further troubleshooting.

This article is not meant in any way to minimize the scope's utility as a servicing tool. The oscilloscope is one of the technician's best tools for many kinds of tough troubleshooting problems. Knowing how to interpret the information the scope screen more expertly makes the scope even more useful and a better time-saver. END



NOISE SQUIRTER

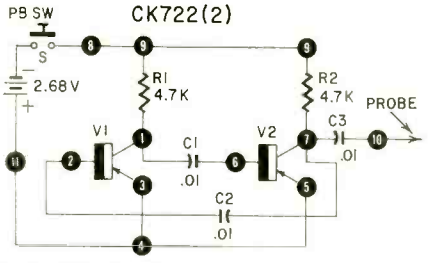
Two-transistor audio generator with a built-in probe fits in the palm of your hand, makes an excellent audio troubleshooter

By IRVIN C. CHAPEL

SIGNAL injection is a commonly used audio circuit servicing technique. The usual signal injector is an audio signal generator. But it is sometimes annoying to use. It has to warm up, you have to attach a probe —time-consuming tasks. For speedy signal injection, try a portable unit. The one described here measures only 1 x 2½ inches, is completely self-contained, and goes into operation at the push of a button.

Two transistors are connected in a multivibrator circuit (see Fig. 1) in which the feedback signal is fed from the collector of each transistor to the base of the opposite one. Emitters are connected directly to the positive side of the battery supply—limiting resistors are not used. Base-return resistors, which are normally used to generate a bias voltage, are not necessary in this circuit. Collector current is limited to a very small value by the near-cutoff characteristics of CK722's. This is unusual, but practical when transistors are used instead of vacuum tubes.

Basically, the circuit is a free-running multivibrator. One transistor is driven from the saturated-current condition to current cutoff by the other transistor. The frequency of this alternation is the fundamental audio tone produced by the Noise Squirter. The oscillator's output is fed to the probe affixed to one end of the Squirter. A switch on the other end turns the unit on and off.



R1, 2—4,700 ohms, ½ watt, carbon
C1, 2, 3—.01 μf, disc ceramics, 600 volts
S—see Fig. 2
V1, 2—CK722
Battery, 2 mercury cells, 1.34 volts (Mallory RM630R or equivalent)
Machine screw, 4-36, 2½ inches long
Machine screw, 4-36, 3 inches long
Blank washers, Micarta or fiber, 1/6 thick (to fit dust cover) (2)
Dustproof case (used to package small screw and nut attachments) approximately 1 x 2½ inches
Solder lug
Miscellaneous hardware

Fig. 1—Simple multivibrator circuit of the miniature tone oscillator.

To build one

Construction of the unit is divided into four parts: making the upper disc; making the lower disc; mounting resistors and capacitors; testing and assembling in its case (see Fig. 2).

The upper disc is a Micarta or fiber washer about 1/16 inch thick that will fit inside the dustproof case. The cell holder is made from thin tin-can stock —use a strip ½ inch wide and 1½

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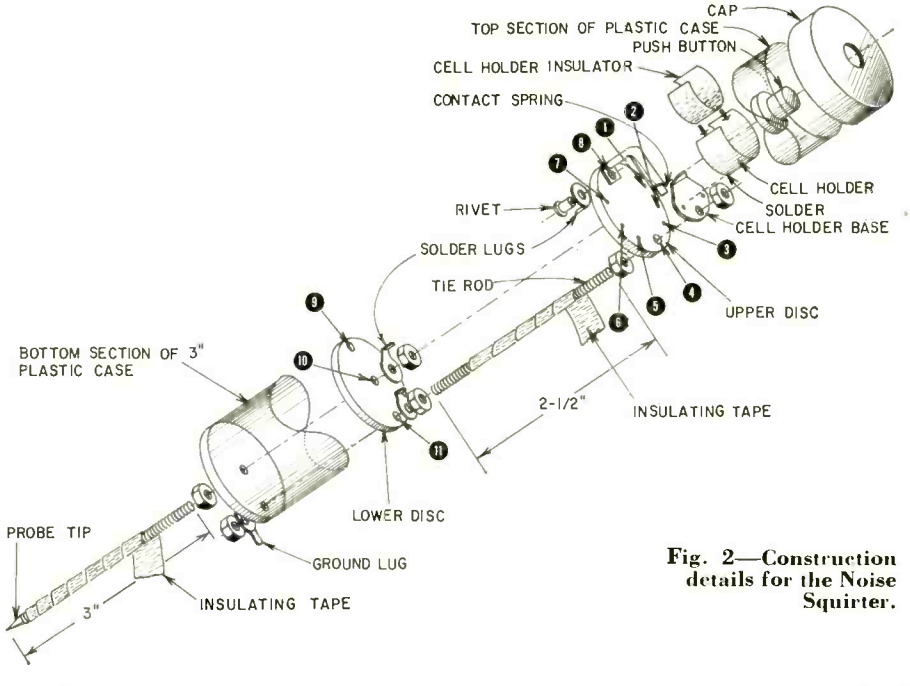

Fig. 2—Construction details for the Noise Squirter.

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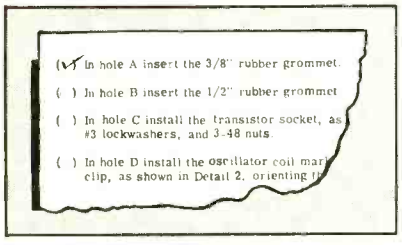
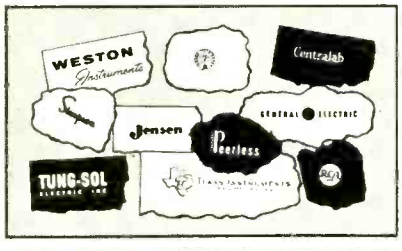
Absolutely no electronic or soldering experience necessary!





BEST INSTRUCTIONS

Recognized by leading consumer research organizations as the tops in the field of kit construction manuals, the Heathkit step at a time instructions leave absolutely nothing to question. Giant size pictorial diagrams and everyday, non-technical language make every Heathkit easy for anyone to build. No electronic or soldering experience is required; the Heathkit manuals teach you the right way to do a professional job the first time.

BEST QUALITY

Only top quality, name brand parts go into Heathkit equipment assuring you of a finished product unsurpassed in performance, dependability and endurance. Rigid quality control standards are maintained at the Heath factory; all Heathkits are conservatively rated; no Heathkit performance claims are made that are not thoroughly proven and tested under the most stringent laboratory conditions. You can see as well as hear the quality of Heathkit . . . the neat layout, the sturdy panels and cabinets, the rugged, accurate parts . . . and when you're finished, the incomparable performance of your Heathkit . . . unmatched anywhere.

BEST ENGINEERING AND STYLING

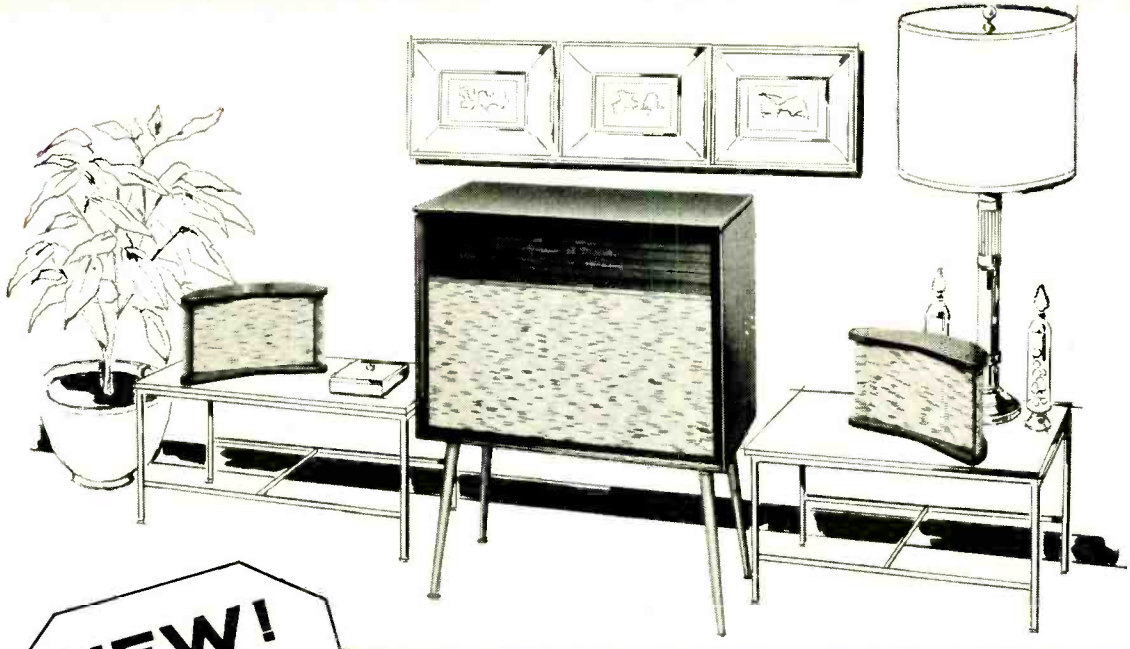
The latest developments in circuitry and components are combined into Heathkit equipment that is designed from the start to be beginner built. The Heath engineers, first in the field of kit engineering, are constantly at work creating ever-easier paths to the best in kits for beginner building. New kits from the Heath laboratories are proof-built by beginners to field test the clarity of instructions, ease of physical assembly, and the attainment of advertised specifications. The praise-winning styling of all Heathkit equipment is universal in appeal, function, beauty.

HEATHKIT®

HEATH COMPANY

Benton Harbor, Michigan

a subsidiary of Daystrom, Inc.



NEW! from the HEATHKIT AUDIO LABS

BRAND NEW!
a complete Heathkit Stereo "Package"

THRILL TO A NEW DIMENSION IN STEREO SOUND

HEATHKIT SD-1 B (birch or SD-1 M (mahogany)
$179.95
(cabinet legs included; end tables not included)

HI-FI STEREO SYSTEM KIT

For the first time anywhere . . . a stereo-kit package, ready-to-play after only a few hours assembly time and complete with cabinet, stereo amplifier, stereo record changer, bass woofer and stereo speaker wings. And the unbelievably low price sets an unprecedented record for stereophonic systems of this quality anywhere on the market. One of the factors behind this phenomenal achievement is the introduction of the revolutionary stereophonic "sum and difference" amplifier used in this kit—licensed in kit form exclusively by Heath Company from CBS Laboratories. This unique development in audio science employs a new principle of stereophonic reproduction. The single chassis amplifier separates the individual stereo channels by utilizing the sum and difference of the total signal and directing the sound to the appropriate right and left channels, reproduced by the stereo wing speakers. The centrally located woofer reproduces the non-directional bass frequencies. The result of this modern stereo reproduction is a breath-taking experience of sound coming to you with depth and direction seldom achieved by conventional stereophonic methods. The beautifully styled console cabinet houses the stereo amplifier, stereo record changer and low-frequency woofer. Controls on the handsome black and gold amplifier panel consist of: on-off switch, bass and treble tone controls, input selector switch and level balancing control. The new CBS sum-and-difference or matrix-type circuit employs only four tubes and is extremely easy to assemble. The woofer, mounted behind the attractive grille cloth, is a high compliance 8" speaker capable of 30 cycle response when housed in the acoustically designed ducted-port enclosure. The specially designed crossover employs a dual bass-mixing 250 cycle network. The twin stereo speakers are 6" x 9" extended range dual cone oval speakers. The completely automatic, four speed record changer employs a ceramic stereo cartridge with micro-groove diamond stylus capable of obtaining the best from the latest stereo or LP monophonic recordings. A 45 RPM spindle is also included for 45 RPM monophonic or stereo records. Separate inputs are provided for AM/FM tuners or multiplex. Both in styling and performance, the all-new SD-1 Stereo offers you the greatest Heathkit value in years. Shpg. Wt. 88 lbs.

- Complete—No "Extras" to Buy
- Revolutionary Stereo Amplifier
- Assemble in Just a Few Hours From Easy Step-By-Step Instructions
- Beautifully Styled Cabinetry
- Stereo Sound With Such Impact You'll Find It Hard to Believe!

SPECIFICATIONS—Overall System Frequency Response: ±5 db, 30-16,000 cps. Amplifier: (push-pull conditions except where specified). Power versus Distortion: 10 watts, less than 3% THD from 30-16,000 cps. 9 watts, less than 2% THD from 30-16,000 cps. 1 watt, less than 0.7% from 30-16,000 cps. Peak Power: 20 watts. Mid-range individual channel power, 5 watts. Frequency Response: Tuner input, tone controls in mid-position, 1 watt level, ±1 db, 30-16,000 cps. Ceramic cartridge input—equalized for RIAA characteristics. Input Sensitivity: 0.1 volt at 1000 cps to each tuner input for 10 watt output. Hum and Noise: 70 db below 10 watt level with inputs shorted. Channel Separation at Significant Frequencies: (2 watt level on operating side). 250 cps—29.0 db. 1 kc—34.0 db .2 kc—35.0 db. 2 kc—35.0 db. 5 kc—36.0 db. 8 kc—37.0 db. 12 kc—35.0 db. 16 kc—29.0 db. Overall Channel Separation: using RCA test record #1427-1, cartridge supplied, 1000 cps, 20 db. Bass Tone Control 50 cps: accentuation 8 db. Attenuation 9 db. Treble Tone Control 10 kc: accentuation 9 db. Attenuation 7 db. Power Requirements: 117 volts, AC, 60 cycles, 75 watts. Cross-over Network: crossover freq.—250 cps. Attenuation rate 12 db per octave. Power rating—5 watts per channel. Changer: speeds—16, 33⅓, 45, 78 rpm. Cartridge: ceramic stereo, out-of-phase connected (.0008" diamond stylus). Cabinets: dimensions—main cabinet, 30" wide x 34½" high x 15" deep. Satellite speaker, 14¼" wide x 8" high x 6½" deep.

EASY TIME PAYMENTS

The thrills of stereo sound from this New Heathkit Stereo System can be yours NOW . . . while you pay in easy installments.

a complete line of stereophonic and monophonic

NEW! from the HEATHKIT AUDIO LABS

HEATHKIT®

Tape Recorders

Field Tested for One Year

SPECIFICATIONS—Tape Speed: 7.5 and 3.75" per second. Maximum reel size: 7". Frequency response: (record-playback): ±2.5 db, 30-12,000 cps at 7.5 IPS, ±2.5 db, 30-6,500 cps at 3.75 IPS. Harmonic distortion: 1% or less at normal recording level; 3% or less at peak recording level. Signal-to-noise ratio: 50 db or better, referred to normal recording level. Flutter and wow: 0.3% RMS at 7.5 IPS, 0.35% RMS at 3.75 IPS. Heads (3): erase, record, and in-line stereo playback. Playback equalization: NARTB curve, within ±2 db. Inputs (2): microphone and line. Input impedance: 1 megohm. Outputs (2): A and B stereo channels. Output levels: approximately 2 volts maximum. Output impedance: Approximately 600 ohms (cathode followers). Recording level indicator: professional type db meter. Bias-erase frequency: 60 kc. Timing accuracy: ±2%. Power requirements: 105-125 volts AC, 60 cycles, 32 watts. Dimensions: 15¼" W. x 13½" D. total height 10¾". Mounting: requires minimum of 8¼" below and 1⅛" above mounting surface. May be operated in either horizontal or vertical position.

NEW PROFESSIONAL-TYPE TAPE RECORDER KITS

Designed to take their place in the finest of hi-fi systems, the new models TR-1C and TR-1D Tape Recorders will provide superb performance for years to come. These completely field tested, precision engineered instruments provide monophonic record and playback in the TR-1C or monophonic record and playback plus stereo playback in the TR-1D.

The mechanical assembly, with fast forward and rewind, is completely finished and adjusted—you build only the tape amplifier. Easy to assemble, the amplifier features two circuit boards which virtually eliminate wiring errors and assure the high stability necessary for consistently good results.

Low noise EF-86 tubes in input stage and push-pull bias erase oscillator assure maximum freedom from hum and noise in recording and playback.

Two inputs are provided (mike and high level line) for recording from microphone, preamplifier, tuner, phono, or TV. In the TR-1D, a separate playback channel with cathode follower output is provided for each stereo track—one of the stereo channels is used for monophonic playback.

Separate record and playback heads and amplifiers allow monitoring from tape while recording. Built-in sound level meter indicates proper recording level and bias for top quality recordings. A pause control allows instant starting and stopping of tape for accurate cueing and tape editing. Kit includes counter for cueing and editing ease.

The precision tape mechanism features heavy duty fan cooled motor, balanced flywheel, long-life bearings, and positive acting braking system. Push button provides instant selection of 3¾ or 7½ IPS tape speed. Safety interlock on record switch minimizes the possibility of accidental erasing. The handsome styling includes plastic escutcheon in soft gold mounted on semi-gloss black panel with black knobs with gold inserts. Complete instructions provided for assembly and operation. This outstanding kit offers a combination of features found only in higher priced professional tape decks selling for $350 to $400.

MODEL TR-1C Monaural Tape Deck: Has all features of model TR-1D with the exception of stereo playback. Shpg. Wt. 30 lbs. **$159.95**

MODEL TR-1D Stereo Tape Deck: Provides monaural record and playback and stereophonic playback of the pre-recorded tapes (stacked). Shpg. Wt. 30 lbs. **$169.95**

MODEL C-TR-1C Conversion Kit: Converts model TR-1C to include stereo function of model TR-1D. **$19.95**

NOW! FULL STEREO CONVERSION FOR TR-1A OWNERS

MK-4 Half-Track Stereo Conversion Kit: Modifies TR-1A monaural tape recorder to include function of record and playback of half-track stereo program material. Consists of a TE-1 tape preamplifier, a stereo head array plus components and instructions to convert TR-1A to TR-1AH. **$62.95**

MK-5 Quarter-Track Stereo Conversion Kit: Modifies TR-1A monaural tape recorder to include function of record and playback of quarter-track stereo. Allows playing stereo both ways on standard tape for twice the playing time or four times playing time with monophonic recordings. Consists of a TE-1 tape preamplifier, a stereo head array plus components and instructions to convert TR-1A to TR-1AQ. **$62.95**

HEATHKIT®

NOW! TWO NEW STEREO-MONO TAPE RECORDERS IN THE TR-1A SERIES

Our most versatile tape recorder kit, the model TR-1A now can be purchased in any one of three versions. You can buy the new half-track (TR-1AH) or quarter-track (TR-1AQ) versions which record and play back stereo and monophonic programming, or you can buy the original monaural version (TR-1A) and add either half-track or quarter-track stereo provisions later using the MK-4 or MK-5 Conversion kits. The tape deck is extremely simple to assemble and uses precision bearings throughout the rugged mechanism assuring long and faithful service. One control lever selects all tape handling functions on the deck, greatly simplifying operation. Speeds of 7.5 or 3.75 IPS are available. Flutter and wow are held to less than 0.35%. Each tape preamplifier features NARTB playback equalization, separate record and playback gain control, cathode follower output and provision for mike or line input. Record level is indicated on "magic eye" tube. A safety interlock is provided to minimize accidental erasure of tape. Filament balance control allows adjustment for minimum hum level. Cathode follower output from playback channel is approximately 600 ohms impedance. Two circuit boards are used for easy assembly. Supplied with attractive vinyl-clad steel cover in black leather texture, with inlaid gold design. Templates and instructions provided for panel mounting or equipment enclosure installation.

NOW AVAILABLE IN THREE MODELS!

MODEL TR-1A: Monaural record/playback with fast forward and rewind functions. Shpg. Wt. 24 lbs. **$99.95**

TR-1A SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 50-12,000 cps. 3.75 IPS ±3 db 50-7,000 cps. Signal to Noise Ratio: Better than 45 db below full output of 1.25 volts /channel. Harmonic Distortion: Less than 2% at full output. Bias Erase Frequency: 60kc (push-pull oscillator).

MODEL TR-1AH: Monaural and half-track stereo record/playback with fast forward and rewind functions. Shpg. Wt. 35 lbs. **$149.95**

TR-1AH SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 40-15,000 cps. 3.75 IPS ±3 db 40-10,000 cps. Signal to Noise Ratio: 45 db below full output of 1 volt /channel. Harmonic Distortion: Less than 2% at full output. Bias Erase Frequency: 55 kc (push-pull oscillator).

MODEL TR-1AQ: Monaural and quarter track stereo with record/playback fast forward and rewind functions. Shpg. Wt. 35 lbs. **$149.95**

TR-1AQ SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 40-15,000 cps. 3.75 IPS ±3 db 40-10,000 cps. Signal to Noise Ratio: 40 db below full output .75 volts /channel. Harmonic Distortion: Less than 2% at full output. Bias Erase: 55 kc (push-pull oscillator).

monophonic or stereo Hi-Fi

HEATHKIT Program Sources

NEW

MODEL FM-4
$34.95

SPECIFICATIONS—Tuning Range: 88—108 mc. Quieting Sensitivity: 2.5 uv for 20 db of quieting, 3.5 uv for 30 db of quieting, 25 uv for maximum quieting (45 db). IF Frequency: 10.7 mc. Image Ratio: 45 db. AFC Correction Factor: 75 kc per volt. AM Suppression: 25 db. Frequency Response: ±2 db 20-20,000 cps. Harmonic Distortion: Less than 1.5%, 1100 uv, 400 cycles 100% modulation. Intermodulation Distortion: Less than 1%, 60 cycle and 6 kc mixed 4:1 1100 uv, 30% modulation. Antenna: 300 ohms unbalanced. Output Impedance: 600 ohms (cathode follower). Output Voltage: nominal .5 volt (with 30% modulation, 20 uv signal). Power Requirements: 105-125 volts 50/60 cycle AC at 25 watts. Overall Dimensions: 4¼" H. x 13¼" W. x 5½" D.

MODEL PT-1
$89.95

MODEL BC-1A
$26.95

HIGH FIDELITY AM TUNER KIT (BC-1A)

Delivers AM broadcast reception comparable to FM quality. Features a special detector using crystal diodes and broad-band IF circuits for low signal distortion. Prealigned RF and IF coils eliminate the need for special alignment equipment. Sensitivity better than 3 microvolts for one volt output. Two output levels provided. Built-in power supply. Special antenna supplied, also provision for outside antenna. Shpg. Wt. 9 lbs.

MODEL FM-3A
$26.95

HIGH FIDELITY FM TUNER KIT (FM-3A)

Featuring broad-banded circuits for full fidelity and better than 10 microvolt sensitivity for 20 db of quieting, the FM-3A pulls in stations with clarity and full volume. Incorporates stabilized temperature compensated oscillator, built-in power supply, prealigned IF transformers and ratio detector. The pre-assembled tuning unit is pre-aligned. Two output levels provided. Shpg. Wt. 8 lbs.

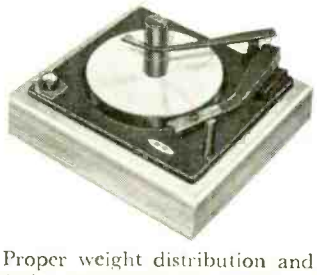
NEW HIGH FIDELITY FM TUNER KIT (FM-4)

This superbly designed unit incorporates advancements in circuit design with features asked for by hi-fi fans everywhere. Better than 2.5 microvolt sensitivity, automatic frequency control (AFC) with defeat switch, flywheel tuning and prewired, pre-aligned and pretested tuning unit . . . bring you the finest in FM listening entertainment. The exceptionally clean chassis layout, prealigned IF transformers and the prewired, pre-aligned tuning unit insure ease of construction with no further need of alignment after the unit is completed. The five tube circuit features a generous power supply utilizing a silicon diode rectifier for cool running operation and low power consumption. The attractive styling of the FM-4 features a vinyl-clad steel cover with leather-like texture, soft black front panel, set off with brushed-gold trim and new soft evenly-lit dial scale. A multiplex adapter output is provided. Feature for feature the FM-4 offers the most outstanding dollar value in FM entertainment available today. Shpg. Wt. 8 lbs.

MONOPHONIC-STEREO AM-FM TUNER KIT (PT-1)

Outstanding features in both styling and circuitry are combined in this 16-tube deluxe stereo AM-FM combination tuner to bring you the very finest of program sources for your listening enjoyment. Features include three printed circuit boards for easy construction and high stability—wired, prealigned 3-tube FM tuning unit—built-in AM rod antenna—tuning meter—automatic frequency control (AFC) with on-off switch—and flywheel tuning. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. AM and FM circuits are separate and individually tuned so they can be used simultaneously for stereo applications. Cathode follower outputs with individual level controls are provided for both AM and FM, with a multiplex adapter output provided. A tuning meter and flywheel tuning combined with two edge-lit slide rule scales provide effortless tuning. Styling features vinyl-clad steel cover in black with inlaid gold design and soft black, rigid die-cast panel set off by brushed gold trim, black knobs with gold inserts. Shpg. Wt. 24 lbs.

AUTOMATIC HI-FI RECORD CHANGER KIT (RP-3)



Combining automatic convenience with turntable quality through unique and simple design the Heathkit RP-3 handles your records with the finest of care for full fidelity reproduction. The unique "turntable pause" feature during change cycle and smooth friction clutch start prevents record damage. Proper weight distribution and low pivot point friction of the tone arm minimize arm resonance, tracking error, and record wear. All record changer kits come equipped with changer base, stylus pressure gauge, 45 RPM spindle, and necessary wire.

STEREO MODEL RP-3S: Equipped with Shure diamond stylus magnetic cartridge providing frequency response of ±4 db from 30 to 14,000 CPS. Shpg. Wt. 19 lbs. **$74.95**

MONAURAL MODEL RP-3-LP: (monaural microgroove recordings only): Equipped with Fairchild Magnetic diamond stylus cartridge. Shpg. Wt. 19 lbs. **$74.95**

MONAURAL MODEL RP-3: Features a GE VRII magnetic cartridge with diamond LP and sapphire 78 stylus. Shpg. Wt. 19 lbs. **$64.95**

SPECIFICATIONS—Operates from: 105-130 volts 60 cycles. Wow and Flutter: Less than 0.18% peak at 33-1/3 RPM. Turntable Speed: Accurate within ±2%. Change Cycle: Completed in 9 seconds. Dimensions: 13½" wide x 12" deep. 5" above and 3" below mounting board. Motor Type: 4 Pole hum shielded. Type of Drive: Friction. Record Speeds: 4 speeds. Automatic and manual 33-1/3, 45, 78 RPM. Manual only—16 RPM. Variations in Tracking Force: Less than 0.9 gram from first record to tenth record. Controls: "ON-OFF" switch. Manual Reject. "Speedminder" (automatic speed selection and indexing). Manual speed selector (4 speed). Finish: Midnight Gray. Base: Maple (unfinished). Mounting Board: Birch (unfinished).

NEW from the HEATHKIT AUDIO LABS

a complete line of monophonic and stereo

HEATHKIT®

Hi-Fi Amplifiers

MODEL SA-3

NEW **$29.95**

NEW LOW COST STEREO AMPLIFIER KIT (SA-3)

The answer to budget cost stereo is now found in the all-new Heathkit SA-3 Stereo Amplifier. All the convenience of complete dual channel control can now be yours at a fraction of the cost of comparable equipment. The high level preamplifier section of the SA-3 provides complete control for both channels. Ganged tone controls provide convenient "boost" and "cut" action for base and treble while dual concentric volume controls make possible precise channel balancing. A channel reversing switch and a speaker phasing switch allows optimum performance. Two separate inputs are provided for each channel to accommodate ceramic cartridge phonographs, AM-FM tuners, or tape recorder. Program source may be reproduced in either monophonic or stereo form. A really big package of stereo performance for the small investment!

SPECIFICATIONS—Power Output: 3 watts per channel. Power Response: ±1 db 50 cps—20 kc at 3 watts output. Total Harmonic Distortion: less than 3% 60 cps—20 kc. Intermodulation Distortion: less than 2% at 3 watts output using 60 cycle and 6 kc signal mixed 4:1. Hum and Noise: 65 db below full output. Controls: dual clutched volume, ganged treble, ganged bass, 7 position selector, speaker phasing switch, on-off switch. Inputs: (each channel) tuner, crystal or ceramic phono. Outputs: (each channel) 4, 8 and 16 ohms. Finish: black with gold trim; Dimensions: 12½" W. x 6¾" D. x 3¼" H.

MODEL EA-1

NEW **$15.95**

NEW "ECONOMY" 3 WATT AMPLIFIER KIT (EA-1)

More than enough for room filling volume . . . ideal for getting started on a low cost individual component system. Designed for use with ceramic cartridge record players, tuners, tape recorders, etc. Built-in preamplifier provides you with all the necessary tone and volume controls for adjusting the sound reproduction to your personal taste. Smart appearance, quality components, assemble it in a few hours for years of trouble-free enjoyment. Shpg. Wt. 7 lbs.

SPECIFICATIONS—Power Output: 3 watts. Input Sensitivity: 100 mv for 3 watts output. Power Response: 60-20,000 cps with less than 3% total harmonic distortion at full output. Frequency Response: ±3 db. 20-40,000 cps at 0.5 watt output. Hum and Noise: 70 db below full output. Power Supply: transformer operated full wave rectifier. Inputs (2): crystal or ceramic phono cartridge, tuner. Output Impedance: 4, 8 and 16 ohms. Dimensions: 3¾" H. x 9½" W. x 6" D.

MODEL EA-3

NEW **$29.95**

NEW! 14-WATT HI-FI ECONOMY AMPLIFIER (EA-3)

From HEATHKIT audio labs comes an exciting new kit . . . New Styling, New Features, Brilliant Performance! Designed to function as the "heart" of your hi-fi system, the EA-3 combines the preamplifier and amplifier into one compact package. Providing a full 14 watts of high fidelity power, more than adequate for operating the average system, the EA-3 provides all the controls necessary for precise blending of musical reproduction to your individual taste. Clearly marked controls give you finger-tip command of bass and treble "boost" and "cut" action, switch selection of three separate inputs, "on-off" and volume control. A hum balance control is also provided.

NOTE THESE OUTSTANDING SPECIFICATIONS: HARMONIC DISTORTION, less than 2% (20 cps-20 kc) at 14 watts. I.M. DISTORTION, less than 1% (60 and 6,000 cps, 4:1) at 14 watts. FREQUENCY RESPONSE, 20 cps-20 kc, ±1 db at 14 watts. HUM & NOISE, mag. phono input, 47 db below 14 watts, tuner and xtal phono input, 63 db below 14 watts.

PREAMPLIFIERS

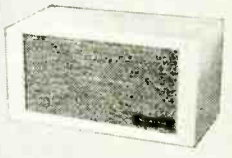
Model WA-P2 "Master Control" hi-fi preamplifier kit. 7 lbs. **$19.75**
Model SP-2 Mono-Stereo (2 channel mixer) Preamplifier kit. 15 lbs. **$56.95**
Model SP-1 Single Channel version of SP-2. 13 lbs. **$37.95**
Model C-SP-1 Converts SP-1 to SP-2. 5 lbs. **$21.95**

HEATHKIT®

POWER AMPLIFIERS

Model UA-1 "Universal" hi-fi 12-watt amplifier kit. 13 lbs. **$21.95**
Model W-4AM Single Chassis 20-watt hi-fi amplifier kit. 28 lbs. **$39.75**
Model W-3AM Dual Chassis hi-fi 20-watt amplifier kit. 29 lbs. **$49.75**
Model W-7M "Extra Performance" hi-fi 55-watt amplifier kit. 28 lbs. **$54.95**
Model W-5M high fidelity 25-watt amplifier kit. 31 lbs. **$59.75**
Model W-6M high fidelity 70-watt amplifier kit. 52 lbs. **$109.95**

SPEAKER SYSTEMS



Model SS-3 "Basic" flr hi-fi speaker system kit. 26 lbs. **$34.95**
Model SS-2 "Basic Range" hi-fi speaker system kit. 26 lbs. **$39.95**
Model SS-1B "Range Extending" hi-fi speaker system kit. 80 lbs. **$99.95**

Model HH-1 "Legato" hi-fi speaker system kit. 195 lbs. **$299.95**

HEATH COMPANY, Benton Harbor, Michigan

a subsidiary of Daystrom, Inc.

NEW: Heath Now Puts 2-Way Radiotelephone Communications in Reach of Everyone

Citizen's Band Transceiver Kit

NEW: No Radio Operators License Necessary!

NEW from the HEATHKIT COMMUNICATIONS LABORATORIES

- Designed to meet all FCC requirements for new 11-meter "Citizens Band" class D operation.
- Any U.S. citizen 18 or older eligible for license.
- No theory to study—no tests to take.
- Hundreds of uses in business or pleasure.
- Top quality components—proven performance—easy to build.

SPECIFY FREQUENCY CHOICE

CLASS D CITIZEN'S BAND FREQUENCIES

26.965 mc	27.035 mc	27.115 mc	27.185 mc
26.975 mc	27.055 mc	27.125 mc	27.205 mc
26.985 mc	27.065 mc	27.135 mc	27.215 mc
27.005 mc	27.075 mc	27.155 mc	27.225 mc
27.015 mc	27.085 mc	27.165 mc	*27.255 mc
27.025 mc	27.105 mc	27.175 mc	

*This channel shared with Class C Radio Control.

NEW

MODEL CB-1

Includes transceiver, microphone, and special power cords.

$42.95

First and only kit of its kind . . . designed to meet all FCC requirements for two-way radio telephone communication on new class D 11-meter "citizens band" . . . any U.S. citizen eighteen or older eligible for license . . . no code test, no radio theory exams, no knowledge of specialized operating procedures required . . . just fill out simple form included with kit and mail to FCC for registration. The Heathkit CB-1 Transceiver is light, compact, simple to assemble, easy to use. Buy two or more units, have your own communications system . . . talk with family, friends, associates from your car, home, boat or office . . . cover distances from one to ten miles depending on location and type of installation (extensively field tested). A flick of a switch selects "transmit" or "receive" while single receiver tuning control selects any of 23 assigned channels . . . third knob controls volume and turns set on and off. With separate vibrator power supply available from Heath, along with two special power cords included with kit, you can convert transceiver from fixed location at home or office to mobile operation in cars, boats, etc., in minutes, after initial installation, with no tools or adjustments. There's a Heathkit accessory antenna for any application, mobile or fixed. Kit comes complete with microphone, station identification card which fits in plastic window at end of cabinet, all pertinent FCC regulations and application forms, a sheet of adhesive-back letters and numbers to affix call letters in space provided on front panel, and crystal for one channel. Specify your frequency choice or we will supply crystal of appropriate frequency. The famous Heathkit quality coupled with the market-shattering low price of this kit make it truly a value of a lifetime. Shpg. Wt. 10 lbs.

SPECIFICATIONS—Receiver Type: Superregenerative detector w/rf stage. Power Input: 5 watts to plate of final RF amplifier (FCC maximum). Transmitter Frequency Control: Third overtone type quartz crystal operating within 0.005% of marked channel frequency between 32 F and 140 F. Modulation: AM plate modulation automatically limited to less than 100% (FCC requirements). Power Supply: 117 V 50/60 cycle, AC, 6 V battery using Model VP-1-6 Vibrator Power Supply or 12 V battery using Heathkit VP-1-12. Power Requirements: 117 volts 50/60 cycle AC 35 watts; 6 V battery w/VP-1-6, 6.5 amps., 12 V battery w/VP-1-12, 4.0 amps. Total B + requirements, 260 volts at 60 ma; total heater requirements, 6.3 volts at 1.8 amps. or 12.6 volts at 0.9 amps. Power Rectifier: 2 silicon diodes in full wave voltage doubler circuit. Microphone: Combination hand-held and desk type, ceramic element, plastic case, with cord and connector. RF Output Impedance: 50 ohms. Speaker Size: 4 inch (round). Undistorted Audio Power Output: Approximately 1 watt. Line Cords: Two supplied, one for AC operation, one for battery operation. Power circuits automatically switched when appropriate line cord is plugged in. Cabinet Dimensions: 8" H. x 6" D. x 9¾" W.

ANTENNAS

MODEL CBU-1 "UTILITY" ANTENNA

Low cost, portable antenna for CB-1 Transceiver for temporary installations, mobile or fixed, where maximum coverage is not required. Rugged clip for mounting on eaves-trough of house or rain gutters of cars, trucks, etc. Bracket supplied for mounting on transceiver or any flat surface. 45½" base-loaded, antenna with 12' connecting cable comes complete, ready to use. Shpg. Wt. 3 lbs

$9.95

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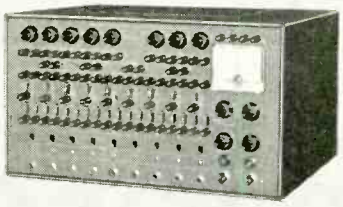

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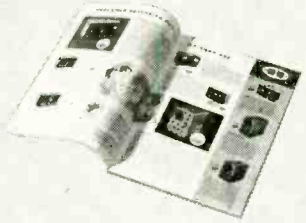

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TEST INSTRUMENTS

(*Continued from page 59*)

inches long. The cell-holder base can be made of the same material. It extends inside the cell holder far enough to contact the outside shell of the lower mercury cell. Cut the cell-holder base to size and drill three holes in it, as shown. One is for the tie rod and the other two are for connecting the transistors' emitters. Solder the center of the cell holder to the cell-holder base. Now drill all holes for connecting resistors and capacitors, through the insulated washer before mounting the cell holder and base. The hole drilled at point 8 is for the rivet that holds the spring contact to the upper disc. Insulate the inside of the cell holder to keep it from contacting the shell of the upper mercury cell.

The lower disc is another insulated washer. It has three holes in it. No. 11 holds the lower end of the tie rod; 10 is the top support for the test prod, and 9 is a solder terminal. The tie rod is a 4-36 machine screw, long enough to space and support the upper and lower discs.

Component wiring

Mount capacitor C2 between points 2 and 7, letting it hang about ⅜ inch below the upper disc.

Mount C3 between points 7 and 10. Cover the lead to point 10 with spaghetti.

Mount C1 between points 1 and 6. Cover the lead to 6 with spaghetti.

Mount R1 between points 1 and 9.

Mount R2 between points 7 and 9.

Check all resistors and capacitors to be sure they are in the correct position. Then solder them together at the various points.

Feed V1's emitter lead through point 3, and solder.

Feed V1's base lead to point 2 and solder.

Solder V1's collector lead to point 1.

Leave the leads long enough so the transistor hangs below the capacitors.

Feed V2's emitter lead through point 5 and solder.

Solder V2's base lead to point 6.

Solder V2's collector lead to point 7.

While soldering transistor leads, use pliers or other form of heat sink between the soldered connection and the transistor.

Connect points 8 and 9.

Connect points 3 and 4.

Check all joints for mechanical and electrical connections and possibility of shorts.

Insert the mercury cells with the positive side down and the instrument is now ready for testing. Hook up a pair of headphones to the prod and ground connection and close the switch. A tone should be heard. If the unit is working satisfactorily insert it in its plastic case, put the pushbutton (from an old ballpoint pen) in the cap and place the cap on the assembly.

Using the instrument is easy. If the prod is touched to a high-gain section of an operating amplifier, the

tone will be heard. If it is not loud enough, connect a flexible wire from the ground lug at point 11 to the chassis of the amplifier under test.

When using signal injection, start with the plate circuit of the last stage, then its grid circuit, the plate of the preceding stage and so on toward the front of the amplifier.

When you find a spot where the signal is weaker or disappears, the faulty stage has been located.

The Noise Squirter uses components that will stand up under normal bench usage. It can be stored in any position, except with the button down. Power drawn from the two mercury cells is 230 μa at 2.68 volts—little enough to insure long battery life. END

TIPS FOR EASY SOLDERING

By JOHN A. COMSTOCK

If the heating element of your soldering iron has aged to the point where it has appreciably reduced your iron's heat output, here's how to extend its useful life. Wrap the iron's barrel and all except the extreme end of the tip tightly with asbestos. Hold the asbestos in place with a length of stiff wire wound in a spiral. This will enclose much of the heat and bring the tip's temperature back to normal.

Handy iron cleaner

Do you use a wad of steel wool on your service bench to clean the tip of your soldering iron? Actually it's mighty risky business—what if a small

strand or two of the steel wool should stick to the tip of your iron temporarily then drop off down among circuit wiring when you go back to the soldering job? That conductive strand or two could cause a short circuit.

Unlike a wad of steel wool, a copper pot cleaner isn't magnetic, is tightly woven together and won't come apart. To make the pot cleaner easier to use, just stuff it into a plastic vial. END

VOLUME VETO

By Phyllis Barlow

With hi-fi fans
I don't agree
That *volume* must equal
Fidelity!

To keep leakage from giving false gain readings, try this ac transistor checker

CHECK TRANSISTOR GAIN

The completed unit, with earphone connected for null detection.

All parts easily fit into the pocket-size case.

By I. QUEEN
EDITORIAL ASSOCIATE

MOST popular low-priced transistor gain checkers use a dc meter to measure gain, though most transistors are *ac* amplifiers or oscillators. This instrument uses ac and relies on a bridge network to do the measuring. Gain is read from the dial of a potentiometer. This makes it a rugged, compact and accurate tester.

The measurement is based on patent No. 2,847,645, issued to Donald E. Thomas of Madison, N. J., and assigned to Bell Telephone Labs. Fig. 1 is the basic circuit. V is the transistor being tested. An ac signal is fed to it.

Amplified current (aI) flows in the collector circuit. Current through R1 is (I − aI), so the voltage drop across R1-a is (I − aI)R1-a and the drop across R1-b is aIR2. (Note that R1-a and R1-b are simply two parts of the potentiometer, and vary with the position of the center arm.) If the resistors can be adjusted for no voltage across the total resistance (R1-aR1-b), we have

$$(I - aI)R1\text{-}a = aIR1\text{-}b$$

and a little mathematical manipulation shows that $\alpha = \dfrac{R1\text{-}a}{R1\text{-}a + R1\text{-}b}$

At null, the transistor's alpha gain is known from the resistor values.

Fig. 2 shows a circuit I devised for practical and convenient measurements. Transistor V generates a 1,200-cycle audio signal. Several p-n-p transistors have been tried here and all work well.

Audio for external tests and measurements is at J1. This is another advantage of the ac bridge type tester.

If there is no plug in J1, the signal is fed directly to the transistor under test. Its output appears across the bridge, which consists of R1 and R2 in series. R2 is a fixed 90-ohm resistance made up of a 68- and a 22-ohm resistor. R1 is a 100-ohm potentiometer with a linear taper.

A null is obtained at J2 when the alpha (common-base gain) of the test transistor is equal to

$$\frac{R2 + R1\text{-}a}{R2 + R1\text{-}a + R1\text{-}b}$$

To make a test, the transistor is plugged into the test socket. The circuit is switched on and the potentiometer adjusted for a null. The transistor gain is read from the potentiometer reading.

Testing transistors

For the bridge tester to maintain its advantage over the dc meter, it must be direct-reading. This is easy. I got a calibrated dial with linear divisions marked from 0 to 10 for the pot. The dial covers the same total angle of

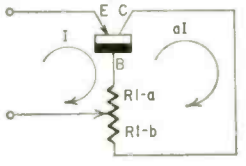
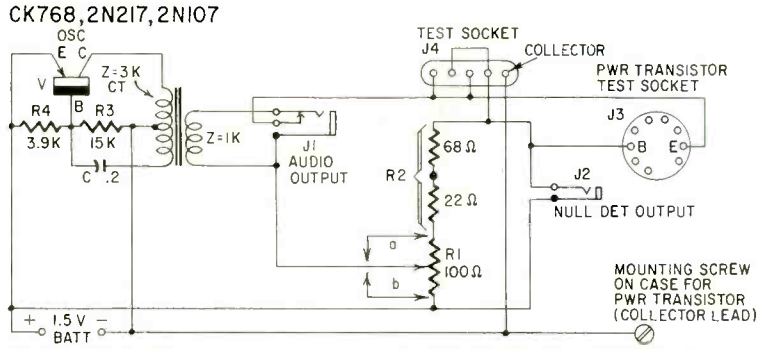


Fig. 1—Basic test circuit.



R1—pot, 100 ohms, linear taper
R2—90 ohms (use 68 ohms and 22 ohms in series)
R3—15,000 ohms
R4—3,900 ohms
All fixed resistors ½-watt 10%
C—0.2 μf, disc ceramic, 75 volts
J1—subminiature phone jack, normally closed
J2—subminiature phone jack
J3—9-pin miniature tube socket
J4—5-pin in-line tube socket
T—driver transformer, subminiature; primary, 3,000 ohms, ct; secondary, 1,000 ohms (Argonne AR-113 or equivalent)
V—CK768, 2N217, 2N107
Dial plate, 0–10, see text
Penlight battery
Holder for battery
Case (Lafayette MS-302 or equivalent)
Mounting board, 1¾ x 1¾ inches
Miscellaneous hardware

Fig. 2—Ac gain checker derived from the basic circuit in Fig. 1.

rotation as the linear pot (300°). (Dial plates are sometimes marked tone or volume, but as long as the divisions are linear and correspond to the full range of the pot, they are suitable.)

With 0 and 10 aligned with the ends of the pot's rotation you can read alpha gain directly. Simply take the reading off the dial, say 85 (8½), put a decimal point and a 9 in front of it and there it is—alpha equals 0.985. To read beta, you use a chart taped to the side of the instrument. The reading of 85 corresponds to a beta of 65, $\left(\beta = \frac{\alpha}{1-\alpha}\right)$. The dial calibration is shown in the table.

Bridge balance is very good at all settings, and a sharp null is obtained with a high-impedance earpiece. Use a sensitive earpiece for best results. Transistors with abnormally large leakage may show a broad null.

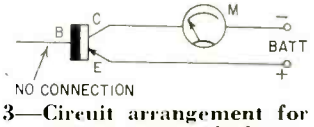


Fig. 3—Circuit arrangement for measuring transistor leakage.

The tester handles various transistor basings. The common in-line three-pin base is plugged into J4. Transistors with flexible leads around a small circle are plugged into the same socket.

Power transistors are plugged into J3. This nine-pin miniature-tube socket is fastened to the case with its No. 2 and No. 7 pins connected to the emitter and base conductors, respectively. A 4-40 machine screw through the side of the case becomes the collector terminal. The hole in the transistor case fits on the screw. A nut holds the transistor on the screw during the gain test.

Dial Calibration

Dial*	Beta
00	9
30	13
50	20
70	32
80	50
85	65
90	100
92	125
94	165
95	200

*Note that the dial reading is alpha with the first digit (.9) omitted.

Three questions still need answering.

- Where is the battery switch?
- How are n-p-n transistors tested?
- How about leakage?

To keep the instrument compact and uncomplicated, I don't use a switch. Inserting the battery turns the unit on. Take out the battery and you turn the checker off.

Checking n-p-n types

N-p-n transistors are far less common than p-n-p types so there is less need to test them. To do so, remove the penlight cell, substitute an n-p-n transistor for V (2N169, 2N170 or 2N647) and replace the battery, reversing its polarity. Remember to switch V and the battery again the next time you check a p-n-p unit.

If you plan to check n-p-n types often, a separate socket can be added.

There is no provision for measuring leakage. I find that aging often lowers gain and increases leakage, so a single test may be enough. Besides, an ohmmeter will measure leakage, so you don't need another meter or a separate device.

Take a look at Fig. 3, a typical leakage detector. It is nothing but a series ohmmeter set to measure the reverse conduction of a transistor with its base open. A low-leakage unit measures above 2 megohms while a high-leakage unit usually reads about 100,000 ohms or less.

I have compared this pocket tester with the dc-meter type of instrument and find it gives accurate results. Gain values compare well when low-leakage transistors are tested. High-leakage transistors rate higher on the dc testers, however. This is because the *dc* collector current of a transistor is composed of two parts: one due to the dc signal and the other due to leakage. The latter gives a false indication, making the gain seem higher than it actually is. Here only *ac* is the factor and leakage has no effect. END

TEST INSTRUMENTS

Time-Interval Marker

For Your Scope

By ROBERT G. MIDDLETON

TO mark microseconds, fractions or multiples of microseconds on a square wave, chroma or other complex waveform, a synchronized ac signal is usually applied to the scope's Z axis. This blanks the trace at microsecond intervals if the applied signal has a frequency of 1 mc.

The difficulty with this method is its cost and complexity. A high-level (25 to 50 volts) ac signal is required.

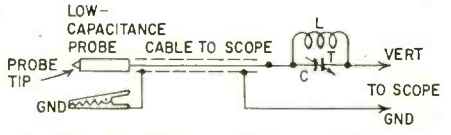


Fig. 1—Circuit of the marker.

Furthermore, synchronizing facilities are needed to prevent the marked intervals from "running" along the pattern.

The simple wavetrap method shown here is effective, low in cost, accurate once calibrated and automatically synchronized. It requires no tubes or power supply.

The marker unit is a coil and trimmer capacitor connected in parallel (see Fig. 1). It can be used with a low-

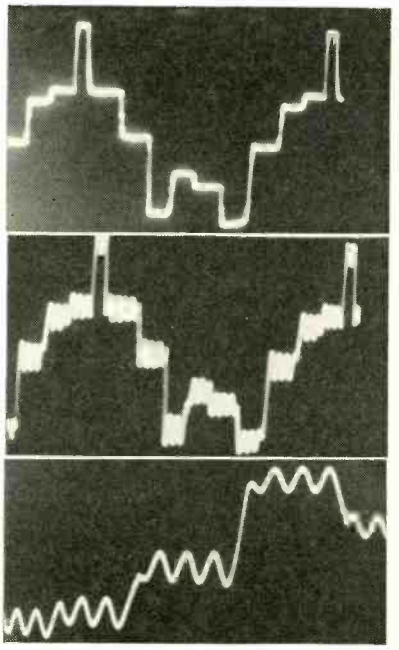


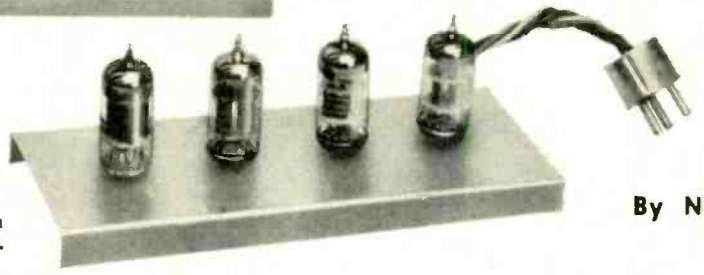
Fig. 2-a—Unmarked Y-signal; b—Y-signal with interval markers; c—same pattern expanded to show detail.

capacitance probe or a direct cable. L and C form a parallel-resonant circuit. It works by trapping out any one of the sine-wave components from the complex wave. This leaves a wiggle in place of the trapped frequency (see Fig. 2). If L and C are tuned to 1 mc, the time from the peak of one wiggle to the peak of the next is 1 microsecond. END

Calbest model 8105, an AM–FM–multiplex tuner.

more about MULTIPLEXING for STEREO

No one can say which of the many stereo multiplex systems the FCC will approve. But we can tell you how the various systems work



Harman-Kardon multiplex adapter.

By NORMAN H. CROWHURST*

IF you're confused about stereo multiplex, don't think it's your fault. Lots of other people, including many engineers who are working on the proposed systems, are confused too.

Most of the mixup arises because of the way claims are made, and the corresponding efforts to discredit those made by others. To avoid that kind of confusion, no claims are made here, because very few actual measurements have been made, and it's strictly a matter of one person's theory against another's. We will concentrate on clarifying just what each system does, whether good or bad only time and tests will tell.

Crosby system

The previous article (What Is Compatible Stereo FM Multiplex?, March 1959, page 91) explained this system, and showed one adapter for receiving it. Since then two more adapters have come to hand that reach the same objectives in slightly different ways.

The Harman-Kardon version, see Fig. 1, uses a straight limiter, instead of the triggered multivibrator used by Madison Fielding. Then the counter detector uses a voltage-doubler pair of semiconductor diodes. While the Madison Fielding unit only varied the difference signal with its Dimension control, the Harman-Kardon circuit reduces the sum component as the difference component is increased, by using a ganged control.

In the Fisher version, the multiplex demodulation is essentially the same as in the Harman-Kardon, but the matrixing is different again. Channel separation, another name for dimension control, adjusts only the sum signal here. But the matrix circuit provides for precision adjustment of balance, which is set at the factory. This means that, when the separation control is correctly set, perfect restoration of the original left and right results.

*Author of *Understanding Hi-fi Circuits* (Gernsback Library, Book No. 64).

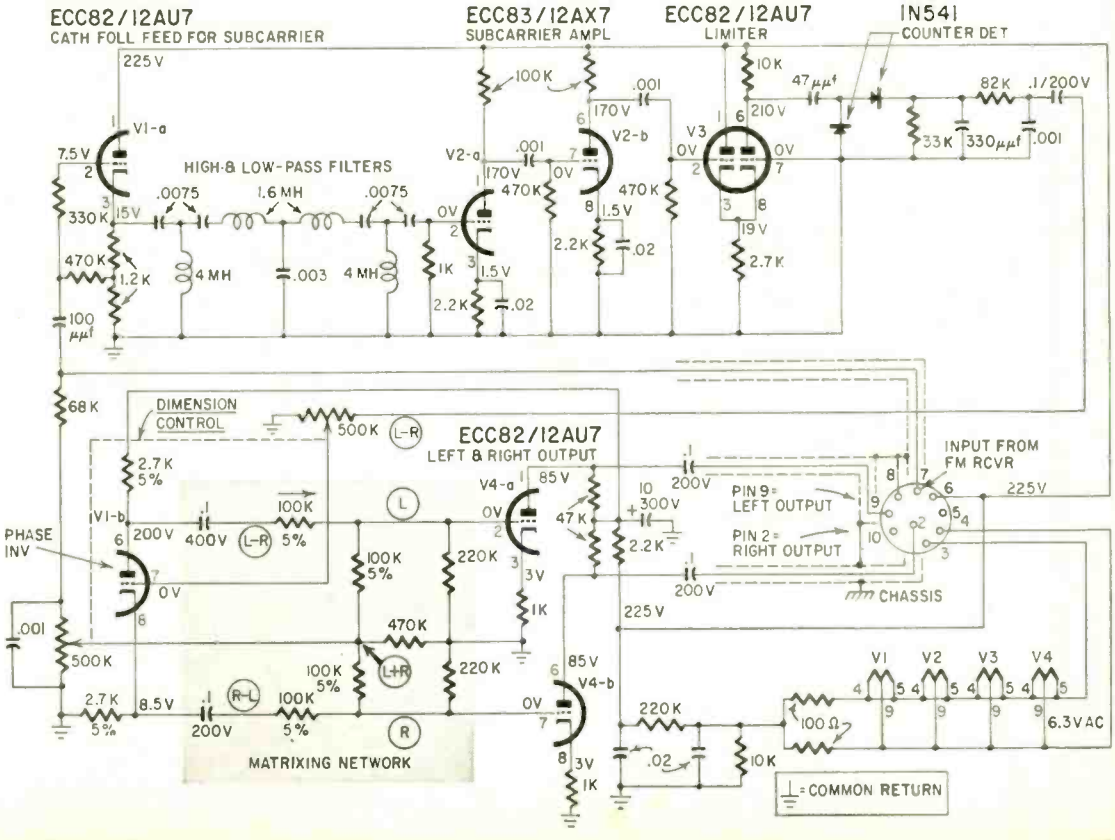


Fig. 1—Circuit of the four-tube Harman-Kardon MA-250 multiplex adapter.

Thus we see considerable variety is already showing itself in circuit design with this system. As with other high-fidelity features, different people prefer different ways of doing essentially the same job. Whichever way it is done, the Crosby system involves basically a multiplex carrier detector plus a matrix circuit to produce left and right from sum and difference.

The multiplex detector is needed with any of the others. The matrix circuit requires only a triode section used as a phase inverter with the few extra resistors. With many arrangements this is a matter of utilizing the other half of a double triode already needed for some other function. If there is no such spare section, it does, of course, mean an extra tube.

Halstead system

Basically, this is the same thing without matrixing. Left goes directly on the main channel and right on the multiplex subcarrier. The Madison Fielding adapter provides switching (in back) so it can receive either way. On any unit, the change necessary between the two is small—just bridge out the matrixing.

It would be a little more complicated to convert *to* the Crosby system from "straight" multiplex, because you'd need the extra tube for phase inverter.

The system described here is no longer actively proposed, but it provides a stepping stone for its successor. The original Halstead proposal was for a right channel restricted to 8,000 cycles for its high-frequency limit, so as to use a subcarrier of similarly restricted deviation. A demonstration was presented to show that an 8,000-cycle limit made no audible difference, but it is highly probable the stereo program used had little or nothing up there (as very little so far issued does).

Burden system

The successor to the Halstead system aims at overcoming the objections that were raised to it. At the transmitter a double matrixing operation is performed, so the main channel gets (2L − R), and the subcarrier (2R − L). Thus both transmission channels get both a sum and a difference component in this system.

Played through a straight adapter, as was the original intention, the left speaker gets (2L − R) and the right (2R − L). The theory was that matrixing occurs acoustically in the room. The (L − R) part from the left gets mixed with the (R − L) from the right and they disappear, leaving an audible L and R, respectively. The only comment here is that, if such acoustic matrixing (which is only a fancy word for cross-mixing) occurs, then the L and R will also mix and produce mono. In short, stereo doesn't and cannot work!

Of course, it would not be difficult to add a double matrix circuit to the receiver adapter to restore true L and R, but this then becomes slightly more complicated than the Crosby system, rather than simpler. The proposal seems to be that cheaper tuners could skip the matrix and use the partial acoustic matrixing originally intended, while the hi-fi variety, for a few extra dollars, includes the matrix and gets true left and right.

Background music

It appears to be part of the Halstead–Burden plans to include a secrecy circuit, so the home stereo listener (or anyone else) cannot "pirate" background music or other private services using the same FM carrier. To date, no such secrecy circuit has been released, but it may function in one or both of two ways.

The first is to turn off the subcarrier output *except* when a stereo subcarrier is being transmitted. It would be operated by a code tone transmitted along with the subcarrier when stereo is transmitted. Absence of this code tone would then disable the subcarrier detector in domestic receivers.

This system would be adaptable to using the same subcarrier on a divided-time basis, using it for private and stereo transmission at different times.

The other secrecy method is intended for a system with two separate subcarriers, so stereo and the private service can be transmitted together. This method requires filtering in the receiver, rather than a code-operated switch, but we are assured that such a filter would be an inexpensive addition to the adapter. No details of a practical design for either secrecy section for use in an adapter have been forthcoming.

Every time a proponent of the Halstead or the more recent Burden system explains the matter, we are told that the Crosby system produces much more inherent distortion *because it uses matrixing*. There is also the suggestion that the Crosby system has to use a wider deviation of subcarrier than the other system.

As a long-time audio man, I know there is no distortion inherent to the matrixing operation. The question arises whether applying a matrixed signal to multiplex is more likely to distort than an unmatrixed one. This seems to be related to the question of subcarrier deviation, which is the other issue repeatedly raised.

What I do know is, *if* it can be shown that stereo does not derive any effect above some frequency, such as 3,500 or 8,000 cycles, it definitely *does* produce a noticeable difference if one stereo speaker has the top end and the other doesn't. On this basis, a matrixed transmission, using the difference channel on the subcarrier, will suffer less loss of stereo (and according to some authorities, no loss at all) by restricting the subcarrier's bandwidth.

To this I understand Crosby has no objection, if someone really needs some of the available total bandwidth for something else. I haven't seen the code-switching circuit proposed, but I cannot see any reason why it should not work equally well (if we have to have it) on a subcarrier with matrixed program as any other. So why the argument?

Bell system

This is the one used by NBC on the Perry Como show. It did not use multiplex, so far has not been proposed for multiplex, and is mentioned here only because it has a certain similarity to the Burden system. It differs in the cross-mixing between left and right. Whatever circuit is used for the Burden system, the resulting channels are (2L − R) and (2R − L). In the Bell system, a short time delay is introduced in both channels, after which the full right is added to the undelayed left and the full delayed left is added to the undelayed right.

Thus each transmitted channel contains full left *and* right, in equal proportions. But there is a time difference that is not noticeable on each channel by itself. However, when both are played over separate loudspeakers in the same room, the fact that the left speaker reproduces its own program a split second ahead of the right speaker, and vice versa, results in the proper stereo association.

This *is* an alternative possibility for transmitter matrixing. But it destroys any possibility of separating true left and right again, which can still be done with the Burden method.

Tabulation of Properties of Multiplexing Systems

SYSTEM	MAIN MODULATION	SUBCARRIER	ULTIMATE OUTPUT LEFT	ULTIMATE OUTPUT RIGHT	COMPATIBLE AM–FM	SYMMETRICAL L–R CHANNELS	†ADAPTABILITY
CROSBY	L + R	L − R	L	R	NO	YES	EXCELLENT
ORIGINAL HALSTEAD PROPOSAL	L	R	L	R	YES	NO	GOOD
BURDEN	2L − R	2R − L	2L − R L	2R − L§ R	YES	NO	LIMITED
BELL*	L + Rφ	R + Lφ	L + Rφ	R + Lφ	YES	NO*	LIMITED
CALBEST	L + R	Rm	Lm + ½ (Lt + Rt)	Rm + ½ (Lt + Rt)	YES	NO	VERY LIMITED

*This is somewhat hypothetical, assuming the Bell Labs method is applied to multiplex. Its tests to date have been on TV-FM or AM, which are basically asymmetrical.
†Adaptability refers to how the system provides for future potential development in stereo program or playback technique.
§The second line here is possible by electrical matrixing in the receiver.

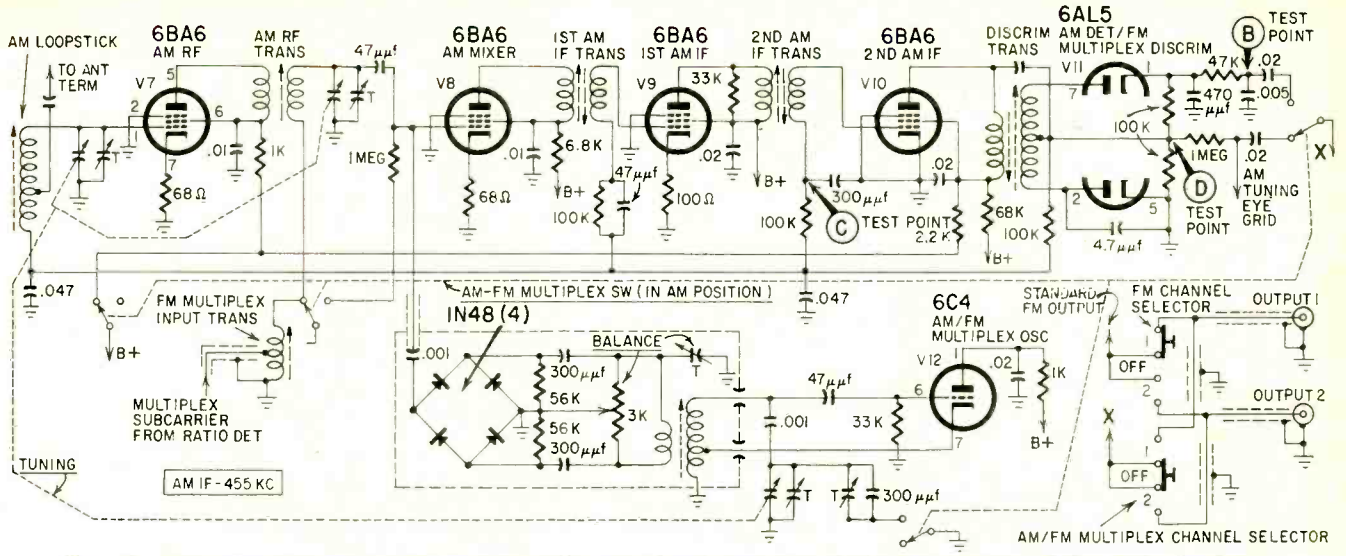


Fig. 2—Multiplex section of Calbest AM–FM–multiplex tuner model 8105 is also used for AM reception.

Calbest system

Halstead once said that frequencies above 8,000 cycles do not contribute to the stereo effect. In other words, so long as you have them, it doesn't matter where they come from. Calbest has gone a lot further, now that Halstead no longer makes the claim. According to Calbest, the frequency where stereo illusion ceases is 3,500 cycles.

This alleged fact is used to justify much greater restriction of the subcarrier bandwidth. If the claim is true, the subcarrier could equally well be restricted in the Crosby system. But Calbest uses a different matrixing, on a claim of better compatibility.

On the main channel, they just mix left and right together, to give a sum. Thus far, the same as Crosby. But for the subcarrier, they take one channel (the right—but it does not matter basically which, so long as it is standardized) and filter off everything above 3,500 cycles.

At the receiver, after the subcarrier is detected, it is phase-reversed and combined with the main carrier output to cancel the right component there (below 3,500 cycles). At the same time, a high-pass filter picks off everything above 3,500 cycles and combines it with the subcarrier to get a right channel with highs.

This again is theory as far as having a practical circuit is concerned. But it has been tested, and we are told it works. The current Calbest tuner is not set up for this system, although it does provide for multiplex reception (no one particular system). As it has an interesting variation in operating method, it is shown (in part) in Fig. 2.

The multiplex subcarrier uses the same if's needed for AM reception when the tuner is used for AM–FM stereo. But a multiplex oscillator is tuned to select the multiplex subcarrier frequency in the if. This enables any multiplex carrier present to be frequency-changed to the standard AM if. It is then detected by a conventional ratio detector. By stepping up the subcarrier frequency first, it is possible to use a ratio detector instead of the counter type necessary when the subcarrier is detected directly. The if's provide for better separation where more than one subcarrier may be present.

Percival system

Another system, developed in England and demonstrated here on a few occasions, puts all the audio on the main channel and uses a narrow subcarrier—100 cycles—to carry information telling the receiver how to divide the audio between the two speakers. Called the Percival system after its inventor, it uses the narrow subcarrier to indicate changes in the direction information as often as every 5 milliseconds.

A coding device samples the output of the two microphones, using not only the relative strength but other characteristics believed to be important to stereophonic listening. Thus the beginning of a sound is weighted, as are higher-frequency sounds, to have more importance in the directional information than the body of a sound or low-frequency notes. (Unlike Calbest, Percival believes that the higher frequencies are important in the directional signal.)

The directional signal represents the ratio of sound in the two microphones, ranging from zero for a signal on the extreme right to 1 for a signal in the left speaker only. It modulates the subcarrier, which can be inserted on the main carrier just above the highest audio frequency, at 22 kc in the demonstration system.

At first glance, this would not seem to be stereo at all; one would think that the same program would appear in both channels, though in different quantities. But according to the best testing device—a pair of human ears—it does produce excellent stereo.

The reason apparently is that at the instant when the left speaker is producing four-fifths of the sound, some loud instrument is sounding off on the left side. And since at a bandwidth of 100 cycles, changes at 5-millisecond intervals can be noted, an instrument breaking in on the right side immediately sets up a new balance of sound, furthering the stereo illusion.

Conclusions

Our investigation has shown that there are several ways of making multiplex adapters, as well as several systems contending in the field. None of the systems will go into commercial use until the FCC, probably in collaboration with the EIA, settles on a standard. But a few observations may be offered here.

Principal of these is that the whole thing may be better understood as two separate problems rather than a choice between any number of complete and more or less complicated systems. One of these problem areas is the transmission channels and the other the audio or stereo channels.

As far as transmission channels are concerned, many more facts are needed to make a decision: What deviation to allow the main channel? What subcarrier frequency or frequencies to use, and how many can be used, with how much deviation on each, and how much "guard band" is needed? The following problems are basic to the transmission medium: its distortion, noise level and intermodulation.

Having optimized these transmission factors, or at least having decided on some standards, the question that remains is how two channels may be used to transmit stereo: whether or not to matrix, and if so, how.

Various systems recommended so far have mostly made recommendations in both these areas, with a few stray ideas along the side in some instances, such as the code secrecy system. But the best final result may well be a mixture of all of them—and perhaps even of some systems we have not yet heard about. END

ALL ABOUT THE REFLEX ENCLOSURE

Part V—For perfect audio reproduction, hangover must be eliminated. Lowering a speaker enclosure's Q will bring you closer to this ideal.

By P. G. A. H. VOIGT

IN Parts III and IV, some of the pros and cons of large and small reflex cabinets were discussed, together with the disadvantage of hangover caused by resonances. For perfect reproduction, aperiodic working is the ideal—working with no hangover at all. As this requires a very low value of Q, any resonant system's Q should be kept to a minimum.

The easiest way to examine the effect of damping (see Fig. V–1) is to imagine a signal that is cut off suddenly while the cone or the air at the port or both are in motion. How long does it take before all motion ceases? If the motion ceases instantly when the signal is cut off, we have the ideal aperiodic, a fully damped system without hangover.

Given infinite damping or moving parts with zero mass, there would be no difficulty, but neither is available. With simple reflex cabinets, we must try to reduce the Q by improving the damping-to-mass ratio.

It is work done, together with any damping, which absorbs the kinetic energy of motion. These represent the load on the moving parts. The work done on the air in the room represents the direct acoustic load. It takes up energy and has a damping action.

With a loudspeaker–reflex-cabinet combination, four basic types of damping action are involved:

- Electromagnetic damping of the coil–cone system.
- Damping caused by work done by the front face of the cone in producing sound waves directly.
- The work load on the back of the cone which may or may not become sound in the room.
- Any damping caused by inherent or deliberate frictions of various kinds.

Electromagnetic damping

The electromagnetic damping of a speaker depends on the voice-coil, on the flux density in which it is immersed and the effective resistance the coil looks into. The last is important because it means that the amplifier is involved too.

When the coil moves in the magnetic field, a voltage is generated. If the coil is short-circuited externally at the time, a current, proportional to the voltage generated and the resistance of the coil, flows. Since the current is flowing across a magnetic field, a force is set up that opposes the motion, and deceleration brings the system to rest.

In a weaker magnetic field, the coil motion generates less voltage. The current is less, in proportion. The reduced current interacting with the reduced field produces a deceleration force reduced on two counts, thus reducing the magnetic damping considerably. Therefore, other things being equal, *magnetic damping is proportional to the square of the flux density.* At half the flux density, the magnetic damping goes down to one-quarter. Thus, one of the several advantages of a powerful magnet is that, by using one, considerably higher electromagnetic damping is possible.

Such damping acts directly on the voice coil, and with it the energy of motion is converted into electrical energy. If the generator—the moving coil in the field—is short-circuited, it cannot supply electrical energy to anything external. However, the coil itself has resistance. So the current which flows raises the coil's temperature very slightly. Thus, with electromagnetic damping, in the case of the shorted coil, the kinetic energy is eventually turned into heat at the coil.

Normally, the voice coil is not short-circuited. However, if the coil is coupled through a good transformer to a low-resistance power triode or to a pentode with plenty of feedback, it looks at something which behaves like a low resistance, and conditions are very nearly the same as when it is shorted.

If, instead, the coil is *not* connected to anything and is left open-circuited, no current can flow when a voltage is generated. Consequently, there is no coil current to interact with the field and no deceleration. So there is no electromagnetic damping and no heat is produced.

Normally, of course, voice coils do not operate under open-circuit conditions. However, if a coil is connected through a good transformer to a pentode with *no* feedback, when a voltage is generated in the coil, the transformer steps it up and applies it to the pentode's plate. The pentode, because of its constant-current characteristic, takes very little notice of the voltage change. So there is practically no change of current and, to the coil, it

(*Continued on page* 80)

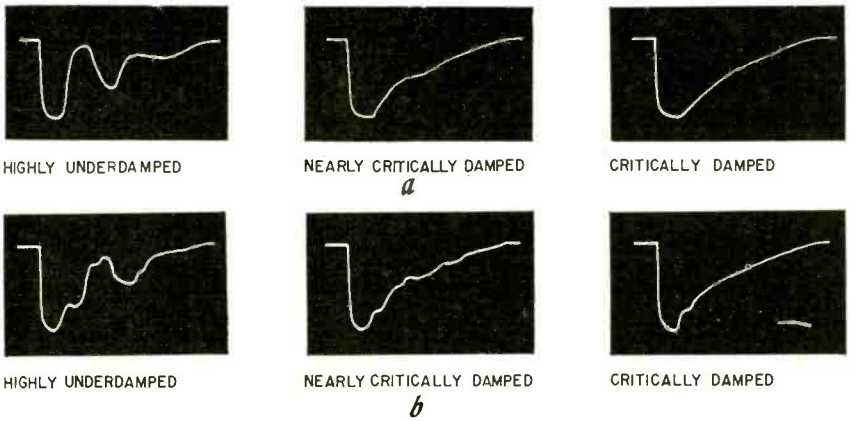


Fig. V–1—Oscilloscope traces: a, three conditions with speaker in an infinite-baffle enclosure; b, same conditions with speaker in large reflex enclosure.

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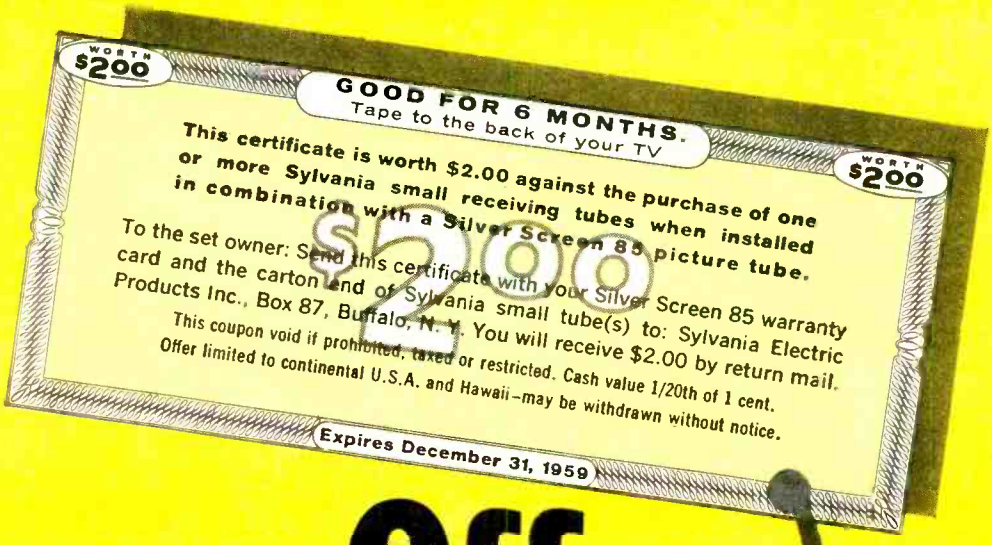

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(*Continued from page* 76)

seems as though it is looking into an open circuit.

The effectiveness of electromagnetic damping thus depends, not only upon the magnet–coil system, but also upon the circuit in use. It almost vanishes with pentodes unless feedback or some special circuit is used.

Magnet and voice coil

Let us now compare a 5-inch speaker with a 15-inch one. The voice coil might, in both cases, have a dc resistance of about 10–12 ohms. For a 5-inch speaker, the coil winding might consist of a relatively short length of fine wire, immersed in a weak magnetic field from a low-cost 2-ounce magnet. The larger speaker might have a similar coil (although this is unusual) operating in the gap of a magnet just as cheap. Or, the large speaker might be a very fine unit with a voice coil wound with much more wire (which, to keep the dc resistance down, has to be thicker) and which is immersed in the gap of a magnet using many pounds of modern magnet material. The gap flux density from such a magnet might well be twice or perhaps even three times that obtainable from the 2-ounce magnet.

The bigger cone and its coil together would certainly have more mass than the little one. If both speakers have the same coil–magnet system, the big one will be a very poor speaker, with a low damping-to-mass ratio. If it has a good powerful magnet in the big speaker, the damping is probably so much greater that there is a better damping-to-mass ratio than with the little one.

Quite apart from the reduction of the speaker's own hangover at resonance with good magnetic damping, there are other gains. First, under normal working conditions, the buildup of motion at resonance is limited by the back emf. The cone excursion is reduced and troubles caused by overrun are less likely. Second, the increased effectiveness of the interaction between speech current fed into the coil and the more intense magnetic field produces greater forces and more motion on *each* side of the speaker resonance. Together these make the audio response much smoother in the region concerned. Thus, in a speaker with good magnetic damping fed from a low-impedance circuit, the speaker's excesses at resonance are already controlled to some extent. The reflex cabinet then has less correcting to do. Consequently, tight coupling between cabinet and speaker is not so essential and a large, low-Q cabinet with its reduced coupling to the speaker is appropriate. The high Q and excessive peak spread of a small cabinet can thus be avoided.

Cabinet vs port

With a larger cabinet a larger port is used to maintain the frequency of the air resonance. From the discussion in Part III, we know that a change in the

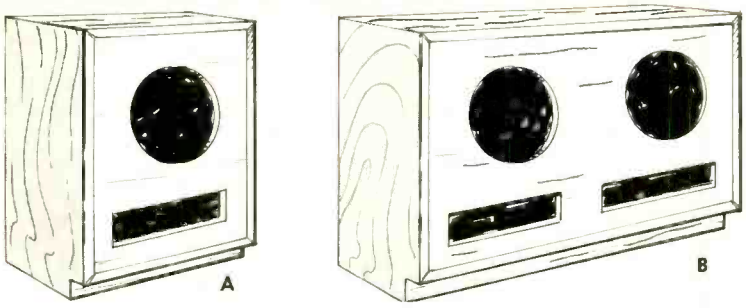


Fig. V–2—Cabinet A is a small unit with one port; cabinet B, a double unit with two ports. If low-frequency sound is produced only by the ports, approximately equal air volumes must flow in and out of the room no matter which cabinet is used. With the large cabinet, effective port area is doubled. Therefore the air-flow velocity is only half that of the smaller cabinet.

area of the port has other effects besides adjusting the resonant frequency, for port area is involved in the way the cabinet is coupled to the room. This subject is so important that it deserves further examination. One of the objects of the reflex system after all, is to help the speaker, and one of the ways it does this is by radiating sound from the port.

Let us assume for a moment that the sound in the room is produced solely by air motion at the port. When sound is produced in the room, the air pressure outside the cabinet varies cyclically. When air rushes out of the port into the compression half of a sound wave it does work, just as the piston of a pump does work when moving against a force. Similarly when sucking against a rarefaction. The air is working against a mechanical resistance. The work done on the air in the room produces sound and is the primary useful load on the port.

Now suppose we have two reflex systems, A and B, tuned to identical frequencies but with different size cabinets and therefore with different ports. Suppose further that larger cabinet B, see Fig. V–2, has double the volume of A and has two well-spaced ports each exactly similar to the single port in cabinet A. The equivalent piston area with cabinet B is double that of cabinet A. If we had two of the smaller cabinets side by side, each with its own port, we would also have double the piston area. The tuning of each cabinet would be unchanged, but the total volume would be double. Since the pair together corresponds to the single large cabinet B with its two ports, B will tune to the same frequency.

For the same sound radiated into the room at the low frequencies (frequencies with a wavelength large relative to the cabinet dimensions), with cabinet A or B, approximately the same total cubic-inch air displacement into and out of the room is required. Therefore, the air in the two ports of B moves at only half the speed of the air in A's single port. Thus, when comparing B with A, we have double the port area and air mass, but only half the air speed.

The kinetic energy of motion depends on the mass and on the square of the velocity. With the large cabinet there are two ports. Therefore, there is double the mass in motion. The velocity, however, is halved and, with velocity halved, kinetic energy per unit mass is only one-quarter. The total kinetic energy involved with B is exactly half that with the smaller cabinet A.

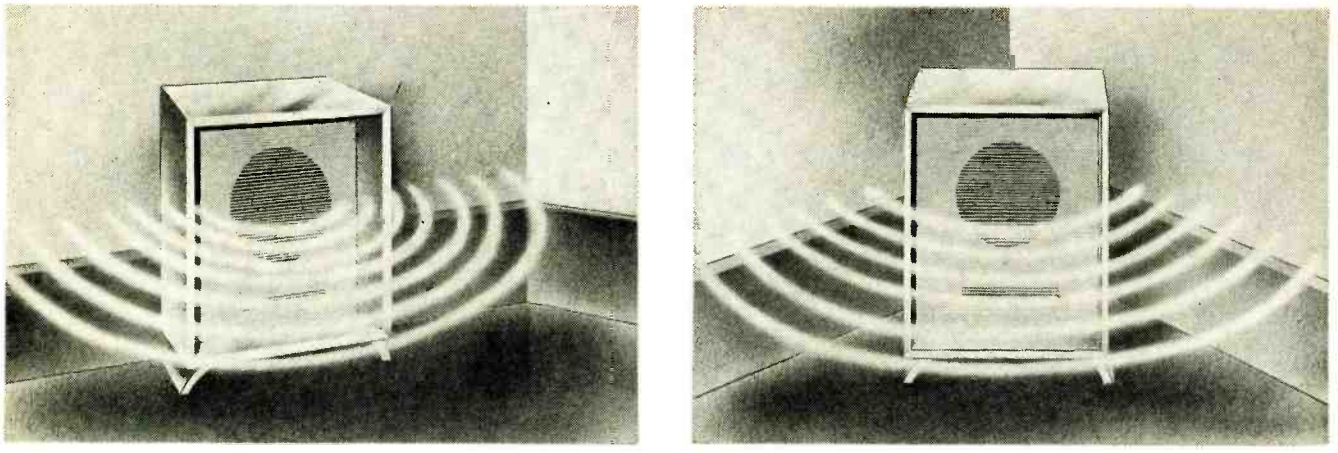
In an electrical resonant circuit, there is an interchange of inductive and capacitive energy every quarter-cycle. In a mechanical system such as a Helmholtz resonator, the corresponding interchange is between kinetic energy and pressure (potential) energy. So, if a change in a mechanical resonant system cuts the overall kinetic energy in half, there should be a corresponding halving of the pressure energy.

Cabinet B has double the internal volume of cabinet A. Therefore, for the same total oscillating air volume displacement at the ports, the pressure variations within cabinet B will be only half those in A.

Pressure energy per unit volume varies according to the square of the pressure. With only half the pressure variation, only one-quarter of the pressure energy is involved per unit volume. However, with B we have twice the volume, so the total pressure energy involved is exactly half that with A. Both pressure and kinetic energy are reduced in the same proportion, which is as it should be. This also explains why large cabinets can be described as low-pressure, slow-flow systems.

For the same oscillating air displacement, we have, with double-volume cabinet B, only half the resonant energy to be damped out when the signal is cut off. If the room takes up energy at the same rate with cabinets A and B, the available energy in case B will be taken up in half the time, thus cutting short the hangover.

The rate at which the room takes up energy depends on displacement at the port. Since pressure variations in cabinet B are half that in the other, there is only half the acceleration force to set in motion the air in and near each port. This produces only half the air velocity and displacement at each port. However, as cabinet B has two ports, the total oscillating air vol-



a **Fig. V–3-a—When placed against a wall, a reflex enclosure radiates into a 180° arc. b—When placed in a corner, the reflex enclosure radiates into a 90° arc.** b

ume is the same in both cases.

Thus, with the two ports in parallel, we get the same total oscillating air volume from half the pressure difference. The two ports together have only half the air-inertia factor just as two similar inductances in parallel have only half the inductance of either. Since the air-inertia factor corresponds to the barrier between the cabinet and the room, we have, with the larger cabinet and its reduced air-inertia-factor port system, a port system which provides a closer coupling to the room.

In practice, as will be shown, next month, a *single* larger port can replace the two separate ports we have been considering. When correctly tuned, the effective port air-inertia factor, the total air-volume displacement, the air-inertia barrier and the room coupling all correspond.

In Part III, it was suggested that the reduced Q with a bigger cabinet was caused by the reduced air-inertia barrier of the larger port that went with such a cabinet. Now that we have worked things out in more detail, we find that there is reduced hangover with the larger cabinet because there is less resonant energy to be damped out. Nevertheless, the closer coupling is *essential* if that reduced hangover is to be obtained, for the closer coupling makes possible the transfer of energy at the same rate in spite of the reduced pressure difference between the air in the (larger) cabinet and that in the room.

The corner-loaded reflex

So far we have considered the room as loading the port in a definite way. This is a simplification. If the cabinet stands at the side of a room in the normal way, the displacement of volume radiates into 180° horizontally (see Fig. V–3-a). If the cabinet is moved into a corner, that radiation is concentrated into a smaller angle, which in the extreme case is only 90° horizontally (see Fig. V–3-b).

For a given volume displacement into and out of the room, the air within the room now moves faster and exerts a greater back pressure. Piston action at the port has to work harder and we find that the simple process of moving the cabinet into a corner improves the loading on the port. This is equivalent to increasing the coupling to the room. It increases the damping and lowers the Q, thereby cutting down hangover, and in addition it increases the efficiency, all without extra cost. What could be better?

At low frequencies, the reduced angle of radiation has especially beneficial effects and this applies to the cone too. So the location of the cabinet in the room determines in part the load into which both port and cone work and so affects efficiency, damping, Q and hangover. When the load is increased, the resonance is less marked and any tendency to emphasize a specific frequency is diminished, flattening the response. "Everyone" knows that a flatter response is desirable, but far too few people know that the shorter the hangover, the more nearly do the results approach aperiodic working and better preservation of transient modulations of low frequencies. So the increased loading is beneficial in several ways.

Electromagnetic damping affects the coil and cone motion directly. It also affects the motion of the air in the cabinet, for that air is coupled to the cone. At the frequency of the lower peak in the impedance curve for example, when port air flow tends to push or pull the cone, cone damping is communicated to the air system in a very obvious way. Thus magnetic damping affects the speaker directly and the air volume indirectly.

This effect is decreased if the coupling between the air volume and the cone is reduced by using a larger cabinet. The speaker-magnet damping then provides less indirect damping for the resonating air volume. In practice, however, a larger cabinet with its naturally lower Q is not so much in need of damping by the cone. Consequently, in spite of reduced coupling to the cone, a larger volume cabinet usually has a lower effective Q under working conditions than a small cone.

The larger the cabinet, the shorter its natural hangover. It would seem that the largest possible cabinet would be desirable. Unfortunately, the hangover of most speakers requires a lot of correction. A very large cabinet may not couple closely enough to correct for the speaker's faults appreciably. Cabinet size is therefore a compromise. A specific volume of cabinet which is a good compromise for one 8-inch speaker might not work well with another 8-inch speaker having a widely different free-air resonance frequency or damping-to-mass ratio.

The cabinet should be large enough to avoid having an excessive Q of its own (the corner location helps), small enough to couple sufficiently to the cone to reduce the speaker's deficiencies effectively, but not so small as to produce such a spread of the upper and lower impedance peaks that the upper peak goes too high and serious holes occur in the audio output response. Unfortunately, a reflex cabinet cannot be both large and small at the same time. There is no clear-cut optimum size. Sales people usually demand something they can sell easily—something which is compact and inexpensive. The perfectionist, however, concerns himself with the byproducts—the resonance peaks—and tries to select a size of cabinet which puts these in useful places and then, by using damping, tries to kill them as much as possible.

Obviously, a good well-damped speaker requiring but little correction from its cabinet and therefore associated with a low-Q cabinet, that is a large one, is the best for all-round listening. The magnetic system for good damping is costly—so is the larger cabinet that should be used with it if practicable. It will be no novelty to most readers that the better article is also the more expensive!

When it is not practical to approach these conditions, there are other ways of cutting down the Q and the peaky response that goes with a high Q. Artificial damping intelligently applied is the proper way to tackle the problem of keeping Q low. TO BE CONTINUED

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new DISCS and TAPES

STEREO and MONO

Reviewed by
Chester Santon
Station WQXR
New York City

CUTTING remarks about stereo discs have a more pleasant nature these days. The latest version of the Westrex stereo cutter, the third model released since the stereo record came on the market, is a significant improvement on model 2. Several stereo labels arriving for review early in May contained the first audible inkling that the latest changeover in cutters was taking place. A noticeable reduction of distortion in the highs is one feature of these improved discs, some of which are reviewed this month. The lows also penetrate farther down the spectrum without dredging up the muddiness formerly encountered. It must be admitted that, as in the past, exceptionally wide-range frequency response often results in contraction of lateral stereo panorama. But work is progressing toward the achievement of wide frequency response and normal stereo spread on the same record.

Winds in Hi-Fi

Frederick Fennell conducting Eastman Wind Ensemble

Mercury Stereo Record SR-90173

A good example of improved cutting technique is Mercury's stereo version of *Winds in Hi-Fi*. The distortion figure audible here is similar to that of the earlier monophonic release. A higher stereo listening level is now possible despite the fact that both of my amplifiers are Ultra-Linear and therefore quick to spot any distortion as the gain is brought up. For an interesting test, try the second selection on side 1. In the *Dance with Swords*, one of three *Japanese Dances* by Bernard Rogers, only a small handful of stereo pickups on the market today will do justice to the shimmering highs of the percussion section and the savage but tight impact of tympani.

GROFE: *Grand Canyon Suite*
Mississippi Suite

Howard Hanson conducting Eastman Rochester Orchestra

Mercury Stereo Record SR-90049

In this latest release, the *Grand Canyon's* cloudburst provides a fantastic workout for any top-rated system. As the music swells in dynamic range, the steady roar in the tonal basement of the orchestra is punctuated with the harsh crackle of percussion imitating the play of lightning. In the *Mississippi Suite*, there is new weight in the thud of the bass drum. Both of these old favorites get a new lease on life in this recording.

VILLA-LOBOS: *Fantasia Concertante*
BACH: *Preludes and Fuges from Well-Tempered Clavier*

Heitor Villa-Lobos conducting Violoncello Society
Everest Stereo Record SDBR-3024

The Brazilian composer, Heitor Villa-Lobos, is a long-time expert on the sonority of the cello. Remember his *Bachianas Brasilieras No. 5* for soprano and eight cellos? In this recording, he conducts an orchestra of 32 musicians—each one playing a cello. Stereo is a vital factor in the comprehension and enjoyment of this brand new composition. The cello orchestra is divided into five sections, each section assigned music of equal importance. A provocative idea has been capably miked and processed.

Music for Frustrated Conductors

RCA Victor Stereo Record LSC-2325

This album proves that a sense of humor still lurks in executive quarters where carpets grow the thickest. Nine short selections, in a variety of tempi and moods, have been selected to give one an excuse to use the baton provided with the album. A booklet by Deems Taylor explains the rudiments of conducting and alerts the tyro to tempo changes. Rumor already has it that the conductor's implement, stamped with the legend "Your RCA Victor Baton," cannot be used with other record labels. The compatability of this newest component will have to be determined by the individual listener/conductor.

BEETHOVEN: *Symphony No. 9 in D (Choral)*

Ferenc Fricsay conducting soloists, Choir of St. Hedwig's Cathedral and Berlin Philharmonic Orchestra

Decca Stereo Records (2) DXB-7157

During monophonic days, the first movement of the Beethoven *Ninth* usually occupied one side of a record, the brief second movement and the lower-level Adagio shared a side, and the fourth movement took up the third side of the set. Disregarding the fact that stereo grooves take up more space and the practical consideration that the third movement is the only one lending itself to dynamic compression, Decca elected to squeeze the first and second movements within side one of the album. Recording level is way down on that side. Good work by soloists and chorus in the final movement but the wise money is waiting to audition the forthcoming Angel and Columbia stereo versions of the *Ninth*.

Cugat in Spain

Xavier Cugat and Orchestra

RCA Victor Stereo Record LSP-1894

Those bemoaning the generally lower recording level on stereo records are urged to try this one. There are decibels to spare in a vivid collection by the man who sold this country on Latin music. Webster Hall in New York, scene of this recording, is reverberant enough to permit the close miking used here. You can't miss the rhythm instruments. They're at right, left and center—giving enormous impetus to a variety of Spanish melodies converted to the cha-cha idiom.

SHOSTAKOVITCH: *Piano Concerto No. 2*
RAVEL: *Piano Concerto in G Major*

Leonard Bernstein, pianist, conducting New York Philharmonic and Columbia Symphony Orchestra

Columbia Stereo Record MS-6043

The recent Russian work holds the greater interest here, Bernstein having introduced it in the Western Hemisphere in January, 1958. Where the concerto is forcefully playful in mood, Columbia concentrates attention on the soloist in this stereo setup. Sound has wide-range power beyond this label's past average but the horizontal spread attains full width only in the quiet passages. I suspect that the lateral modulation on this disc reaches quite a high percentage during the piano's louder moments.

The Four Brothers Sound

Jimmy Giuffre

Atlantic Stereo Record 1295

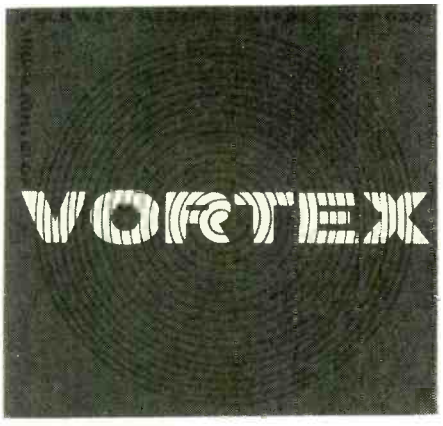
The technique of multiple recording on stereo disc is in its infancy. Atlantic, using a special eight-track tape recorder, has superimposed a series of takes by reed star Jimmy Giuffre. The finished product contains the sound of four saxophones, each played by Giuffre. Although top equipment was used in recording and duplicating, substantial problems remain. The saxophones heard at extreme left and extreme right are louder than those at the center. Room ambience is missing altogether and pre-echo louder than any encountered heretofore on stereo discs mars some of the selections. The "breathy" quality of Giuffre's drawling tone is harshly emphasized by sound-on-sound recording.

VERDI: *The Music of Aida*

Domenico Savino conducting Rome Symphony Orchestra

Kapp Stereo Record KC-9014-S

The Savino name is well-known to old radio hands familiar with the 16-inch transcription platters used by radio stations throughout the country decades ago. In recent months at the age of 78, Savino has been busy in Rome turning out a long series of records for Kapp that feature orchestral versions of operatic scores. The performances are pleasant. Reverberation introduced at these sessions may prove excessive on top-notch equipment.



Highlights of Vortex

Folkways Stereo Record FSS-6301

West Coast audiophiles, since 1957, have had an outlet for an urge to hear 40 loudspeakers beamed at them from all points of the compass. A new kind of theater called Vortex offers such sound-in-the-round at the Morrison Planetarium in San Francisco. During the performance, patterns and moving shapes are projected on the circular dome of the theater while a special remote-control panel channels the sound and rotates it around the audience in the manner of a vortex. Folkways has successfully transferred to stereo disc nine examples of electronic compositions arranged directly on magnetic tape for Vortex display. A sensation of movement is most noticeable during the shifting rhythms of the *Study No. 3* by Henry Jacobs and the piece called *350-2* by

Gordon Longfellow of Ampex Corp. The most expensive stereo cartridges indicate that this disc is ahead of its day in both subject matter and audio quality.

BRAHMS: *Violin Concerto*
Jasha Heifetz, Violinist
Fritz Reiner conducting Chicago Symphony Orchestra
RCA Victor Stereo Record LSC-1903

In terms of performance alone, the recent Heifetz recordings of the Brahms and Beethoven violin concertos are blue-chip investments. The gypsy flavor of the Brahms concerto is well served by the bright acoustics of Chicago's Orchestra Hall. In this concerto and the Beethoven recorded with the Boston Symphony (LSC-1992), stereo imparts warmth to the recorded Heifetz tone.

GERSHWIN: *Porgy and Bess*
COPLAND: *El Salon Mexico*
Maurice Abravanel conducting Utah Symphony Orchestra
Westminster Stereo Record WST-14063

Westminster has an interesting entry in the parade of *Porgy and Bess* recordings occasioned by the movie. Gershwin's own original suite based on the opera, performed in a spacious setting by the Utah Symphony, offers a new glimpse of the American musical scene during the '30's.

Melody
Carmen Dragon conducting Capitol Symphony Orchestra
Capitol Stereo Record SP-8476

In its series of releases offering Carmen Dragon's quiet symphonic arrangements of light classics, Capitol has hit upon an ideal deployment of orchestra and stereo microphones. To the excellent orchestral balance is now added a sweetness in the highs never before heard in the Dragon stereo discs. A smooth nightcap for an evening of attentive listening.

Soviet Army Chorus and Band
Angel Stereo Record S-35411

The monophonic disc featuring this Russian concert attraction confounded many observers in the record field. Released when the Hungarian uprising was in the headlines, the record nevertheless climbed to high position on the Angel best-seller lists and stayed there. Stereo now broadens the impact of the showmanship displayed in these folksongs and army tunes but the mono version still has the better frequency range.

We Three—A Jazz Approach to Stereo
Marty Napoleon, Mickey Sheen and Chubby Jackson
Everest Stereo Record SDBR-1029

If you are a recording engineer, the star performer in this album may be the Belock mixing console under the direction of Aaron Nathanson. He has deployed the instrumental and vocal trio of Napoleon, Sheen and Jackson so that piano occupies left channel, drums are heard in the center and bass in the right channel. Maximum separation and adroit mixing at the console furnish a very realistic illusion of three-channel sound. Highlight of the album is an elaborate drum solo that takes up most of side 2. With the center mike grazing the drums, this disc delivers some of the healthiest jolts to a stereo cartridge that I have encountered to date.

Silk, Satin and Strings
Caesar Giovannini conducting Radiant Velvet Orchestra
Concert-Disc (Stereo) CS-36

One of the convincing demonstrations of stereo is playback of a large string orchestra occupied with a popular melody. This disc offers a good introduction to the added realism stereo imparts to a body of strings. It is impossible to miss the team play of violins on one side and cellos on the other when the tunes are old favorites such as *Sleepy Lagoon, Holiday for Strings, Laura*, etc. Stereo depth and directionality are outstanding. Important when dealing with massed strings, playback in RIAA position provides singularly bump-free response.

Baton and Bows
Morton Gould and Orchestra
RCA Victor Stereo Record LSC-2217

This was one of the first discs to explore the possibilities of arrangements specifically designed for stereo recording of a string orchestra. The

two composers represented are Fritz Kreisler and Jerome Kern. The arrangements for stereo have been carried to an extreme. Each phrase, however insignificant, is answered in the opposite channel. After the first few selections, the formula becomes wearisome since such effects are not encountered in live performances. This drastic formula has not been repeated in subsequent releases. The record may in time become a collector's curio.

DVORAK: *Serenade in E Major for Strings*
Rafael Kubelik conducting Israel Philharmonic Orchestra
London Stereo Record CS-6032

Here's a charmer. The Central European idiom is preserved with flawless ease by a Czech conductor and string players of the Israel Philharmonic, many of whom were at one time members of leading orchestras on the continent. If you don't get radiant and exceptionally transparent string tone on this one, you have reason to suspect the performance of your stereo equipment.

MOZART: *Eine Kleine Nachtmusik*
TCHAIKOVSKY: *Serenade for Strings*
Georg Solti conducting Israel Philharmonic Orchestra
London Stereo Record CS-6066

The record industry claims that stereo discs from the outset have followed the RIAA curve. During the first months, any deviation from RIAA in favor of extra boost between 6,000 and 10,000 cycles was difficult to detect with the stereo pickups then on the market. However, a smooth-sounding cartridge selected within the last 6 months can reveal instances where the recording curve exceeds the treble boost specified by RIAA. Direct comparison proves that the strings in this recording received more treble emphasis than did those heard on London CS-6032 (Dvorak, *Serenade for Strings*). Rolloff of the highs in playback restores listenability to Mozart and Tchaikovsky but this arrangement does not match the natural warmth of the Dvorak disc played without such rolloff.

WAGNER: *Great Scenes for Bass-Baritone*
George London with Vienna Philharmonic Orchestra conducted by Hans Knappertsbusch
London Stereo Record OS-25044

Stereo's enriching qualities are immediately detected in the orchestral panorama that distinguishes this collection of arias. As the characterizations of George London unfold in famous baritone scenes from *The Flying Dutchman, Die Meistersinger* and *Die Walküre*, the part played by stereo in breathing life and dimension into Wagner's heroes takes over our attention. On the evidence presented here, George London is now a plausible candidate for the leading role in a complete London recording of a stereo *Die Meistersinger*. The sound, like that of the top London opera sets, is in a class by itself.

Symphony of Dance
Leonard Sorkin conducting Musical Arts Symphony Orchestra
Concert-Disc (Stereo) CS-42

A collection of dance-oriented pieces performed with brisk competence by an orchestra under the direction of Leonard Sorkin, a guiding figure offstage in the affaire of Concert-Disc. The quality of music per side is slightly below the national average for stereo records. This factor plus straightforward processing of the master recording maintains a pleasant openness in the sound.

Give 'im the Hook
Oscar Brand
Riverside Stereo Record RLP-1118

Old-time vaudeville fans will relish this stereo treatment of tear jerkers and comedy songs that flowered at the turn of the century. A jangling piano, banjo, guitar and percussion furnish a properly gaudy backdrop for the richly sincere songs of Oscar Brand. Everything is old hat except the sound.

Note: Records below are 12-inch mono LP and play back with RIAA curve unless otherwise indicated.

HANDEL: *Water Music*
Eduard Van Beinum conducting Concertgebouw Orchestra of Amsterdam
Epic LC-3551

The famous Concertgebouw orchestra proves a sturdy vessel on which to float Handel's *Water Music* into the living room. This latest version, ebullient and graceful as any in the catalog, features the advantage of a truly firm bass foundation.

The Vibe Sound of Peter Appleyard
Audio Fidelity AFLP-1901

Audio Fidelity's ultra close placement of the microphone exercises its moving element to the limit of its compliance. The affable antics of Peter Appleyard, the British vibraphone player, therefore provide an easy test for unwanted points of resonance in a speaker enclosure. Assuming your system boasts an adequately compliant cartridge, you will find yourself playing host to a potent signal that only the most solid enclosure will be able to handle without a tremor.

Viennese Waltzes
Jo Basile, his Accordion and Orchestra
Audio Fidelity AFLP-1868

Jo Basile's accordion continues its tour of the world with this unexpected stop in Vienna. Unlike the vibraphone in AFLP-1901, the accordion maintains far more transparency of tone under close miking. While presence is just as acute here in AF's full-range processing, the acoustical impact at full room level is far more pleasing to the ear.

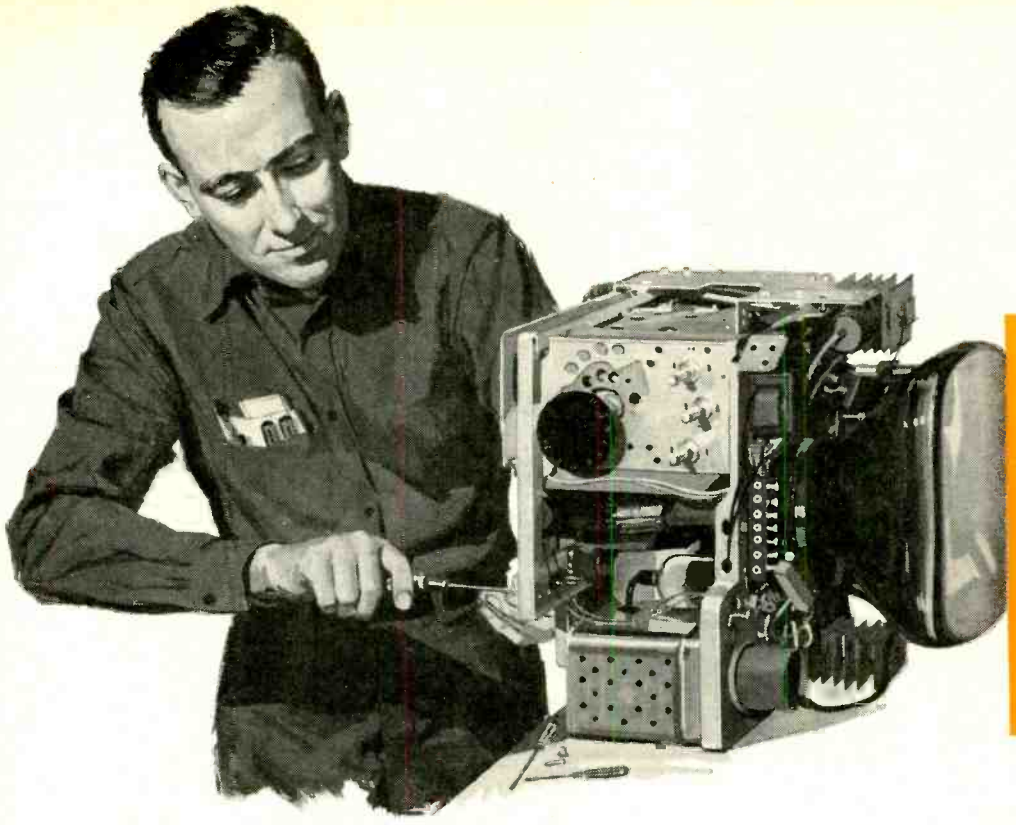
SHOSTAKOVITCH: *Symphony No. 1 in F Major*
Leopold Stokowski conducting Symphony of the Air
United Artists UAL-7004

Invading the field of classical recordings, United Artists follows a course of logic in entrusting this work to Leopold Stokowski. Maestro Stokowski introduced this jaunty symphony to American audiences in 1928 and recorded it on 78's shortly thereafter. Thirty years of performance of this work have not diminished his enthusiasm, as this Carnegie Hall recording testifies. Reflecting a recent pattern in the record industry, another neophyte firm has turned out a recording of high professional competence on a completely free-lance basis. The extended frequency response now almost universal on mono discs is present here. Surface noise, however, is a shade above average.

MAHLER: *Symphony No. 5*
Rudolf Schwarz conducting London Symphony Orchestra
Everest (2) LPBR-6014

The opening pages of this symphony unfold a titantic display of orchestral power. Some of you may recall that, 5 years ago, one of the early hi-fi demonstration records (Westminster DRB) featured an excerpt from the first movement of the Mahler Fifth. This performance by Schwarz and the London Symphony indicates that conductors other than Mahler specialists such as Walter and Scherchen can bring a valid statement of the music to records with the help of blazing recent sound. Previous recorded versions cannot match this one in dynamics, frequency response and clarity of instrumental timbre. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N.Y.*



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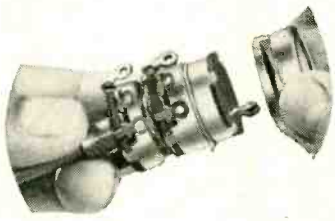

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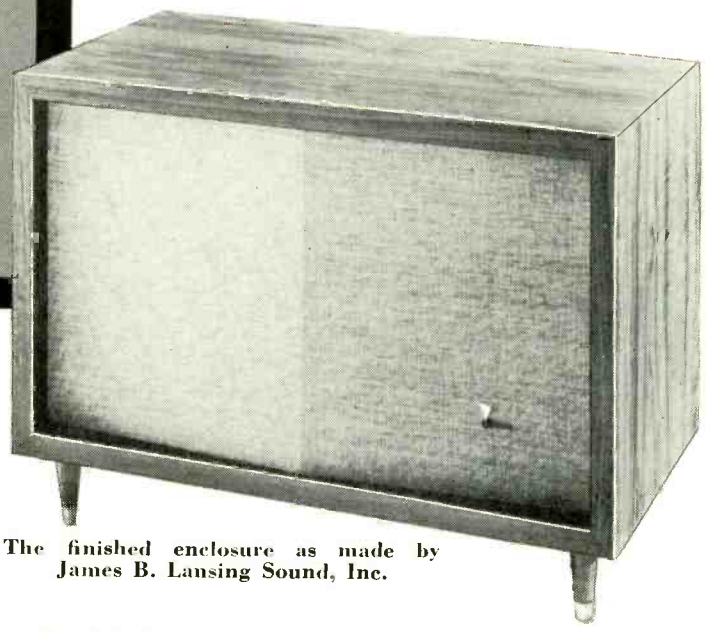


The finished enclosure as made by James B. Lansing Sound, Inc.

By KING BAKER *

AMONG the various types of speaker enclosures, the rear-loading horn has remained a favorite with those who appreciate clean articulation in the bass region. Such an enclosure is fairly complicated and requires considerable diligence on the part of its designer and builder, but the quality of reproduction from a carefully coordinated horn system is impressive enough to override these objections.

Properly engineered, this type of enclosure has three worth-while advantages:

1. Radiation from both sides of the driver cone is used at low frequencies for maximum efficiency.
2. High acoustic loading in the bottom three octaves swamps out driver resonance and presents uniform electrical impedance to the power amplifier.
3. Horn loading gives smooth response to the cutoff of the horn flare, practically unaffected by driver characteristics.

Design considerations

Such an enclosure should not be confused with small cabinets which use a very short horn to load a reflex duct. The operation of these devices is more like that of bass-reflex enclosures than of exponential horns. A true rear-loading horn must have an effective path length of at least 5 feet to load its driver effectively in the 40–50-cycle region. Moreover, the mouth of the horn must be large enough to add substantial radiating area to that of the driver, if you want reasonable efficiency below 150 cycles.

* Technical Assistant, James B. Lansing Sound, Inc.

The JBL model C40 Harkness enclosure is a recent design which incorporates a full-size rear-loading horn in a pleasing lowboy enclosure of reasonable size. The basic configuration is a constant-width 6-foot folded exponential horn having a flare rate of 40 cycles. The combined radiating area of the horn mouth and 15-inch driver is more than four times that of the driver alone. The coupling chamber, horn throat, rate of flare and path length are carefully related to restrict operation of the horn to frequencies below 175 cycles. Above this point, the driver radiates directly from the front of its cone.

Either 12- or 15-inch drivers may be used. Both operate satisfactorily in this enclosure, provided the driver's overall depth does not exceed 5⅝ inches. Since the front of the cone radiates directly into free air, the Harkness accepts either extended-range drivers, coaxial speakers or two-way systems consisting of separate woofers and high-frequency units.

When driven by a quality 12- or 15-inch cone speaker, bass response extends smoothly to below 40 cycles. The impedance curve of a typical 15-inch unit in this enclosure is shown in Fig. 1 (solid line). Note that at 40 cycles the impedance (and therefore cone movement) of the driver is no greater than at 500 cycles. At no point does the impedance exceed 3 times the 500-cycle value. Compare this with the curve of the same speaker in free air (dashed line), where motional impedance at resonance rises to a value approximately 15 times that at 500 cycles.

Remember, in reflex and horn-loading enclosures, (as opposed to "infinite-baffle" arrangements) a rise in motional impedance does *not* correspond to greater acoustic output. On the contrary, any pronounced impedance peak indicates that the driver cone is not loaded properly, and under this condition a very small amount of electrical drive results in excessive distortion. This factor is overlooked in some designs, in which low-frequency impedance peaks may exceed 10 times the mid-frequency value.

Just as important as the increased power-handling ability and reduced distortion afforded by an acoustically

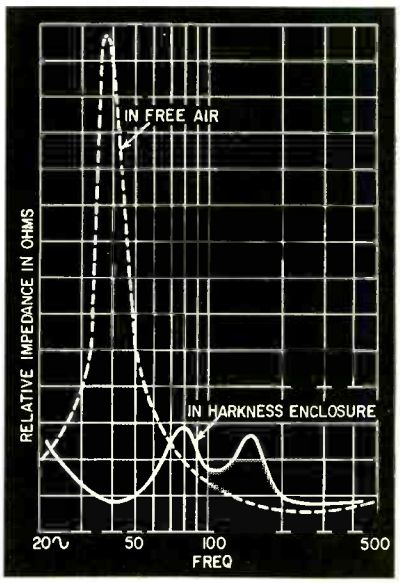


Fig. 1—Impedance of a typical 15-inch speaker in and out of the Harkness enclosure.

Fig. 2—Basic interior construction of the Harkness folded horn. Cleats, glue blocks and trim not shown are added as needed.

Fig. 3—Phantom view with speakers mounted shows placement of interior panels.

Fig. 4—Types of wood joints which may be used in building the enclosure.

Fig. 5—Detail of the curved horn section.

Fig. 6—Layout of parts on plywood sheets: a—the veneer finished panels; b—the unfinished panels.

Fig. 7—Speaker mounting baffle detail.

Fig. 8—The factory method of mounting the grille cloth.

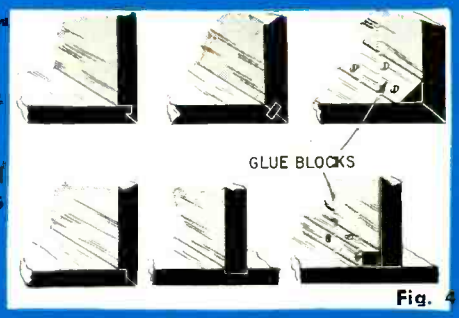


Fig. 4

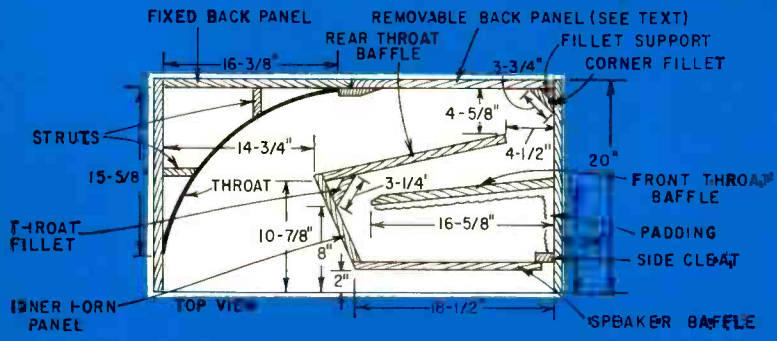


Fig. 2

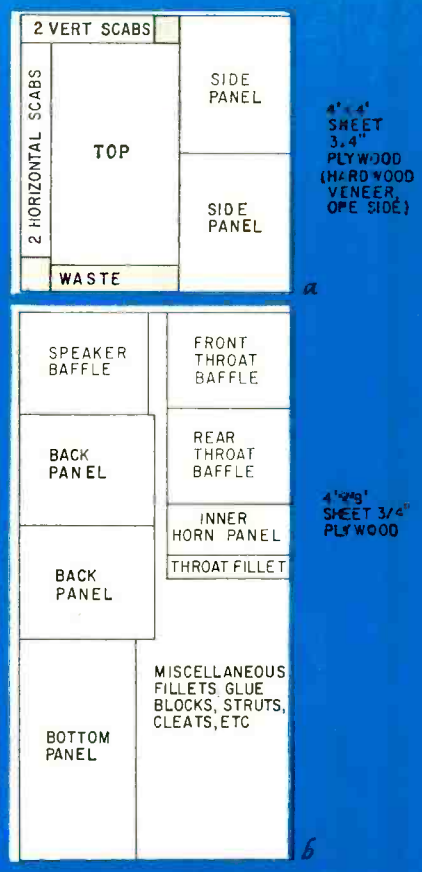
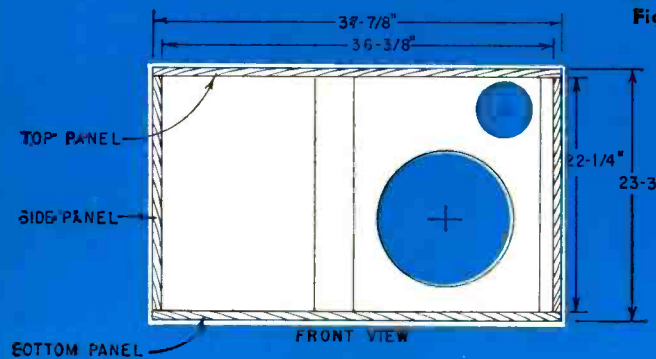


Fig. 6



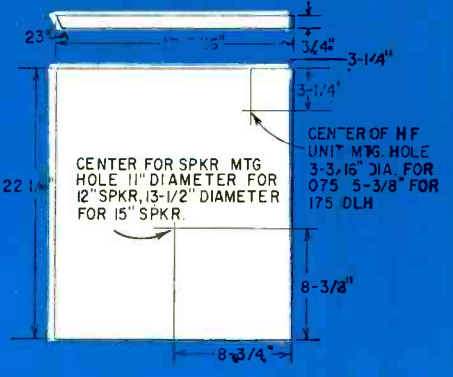


Fig. 7

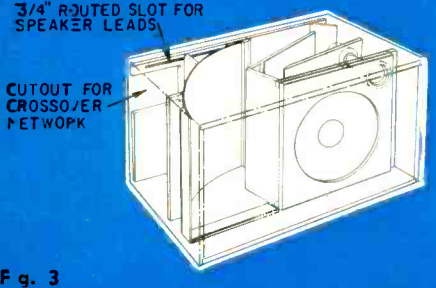


Fig. 3

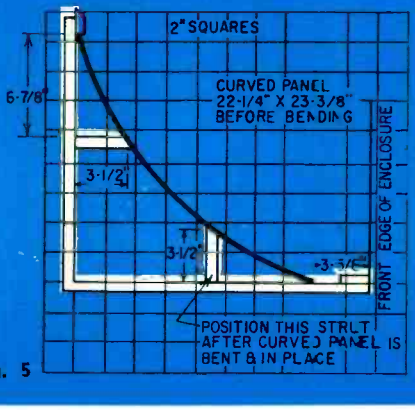


Fig. 5

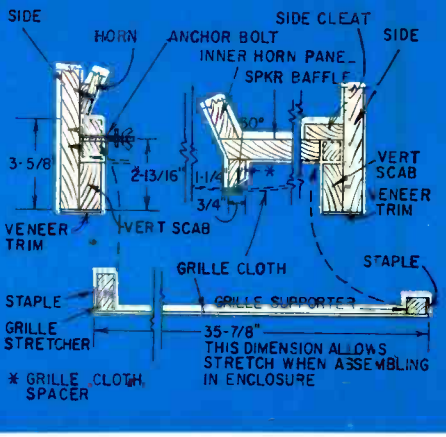


Fig. 8

damped driver is the uniformity in electrical impedance reflected to the power amplifier. Abrupt peaks and dips in a speaker's impedance curve are usually accompanied by sudden reactive shifts in electrical impedance. Such complex reactive loads may seriously limit the amplifier's peak power and lead to momentary instability on transient peaks.

How to build one

The audiophile who wants to construct the Harkness for himself may work from the simplified drawings shown on this page (Figs. 2, 3, 4, 5, 6, 7 and 8) and work out assembly methods, exterior design and final trim to suit his particular installation. Or, if he wishes to build an *exact* copy of the commercial enclosure, detailed shop drawings may be obtained for $3 from any JBL Signature dealer or James B. Lansing Sound Inc., 3249 Casitas Ave.,

(*Continued on page* 90)

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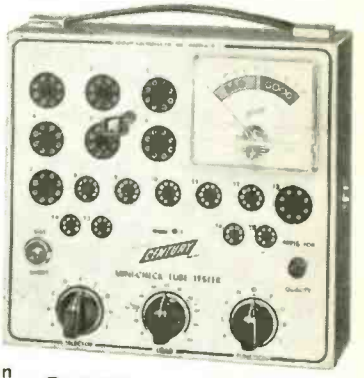
Model MC-1

A Real *ECONOMY* MULTIPLE SOCKET TUBE TESTER without sacrifice in *ACCURACY, SPEED* or *VERSATILITY*

Here is a multiple socket tube tester designed to meet limited budgets. Although low in price it boasts a unique circuitry that enables you to check over 600 tube types — and has a range of operation that far exceeds others in its price class.



Model MC-1 — housed in sturdy wrinkle finish steel case **$39.50** Net

SIZE: W–9" H–8½" D–2¾"

SPECIFICATIONS

• Checks emission, inter-element shorts and leakage of over 600 tube types. This covers 024s, series-string TV tubes, gas regulators, auto 12 plate volt, hi-fi and foreign tubes • 3 settings enable a test of any tube in less than 10 seconds • Employs dynamic cathode emission test principles • 3½" D'Arsonval type meter — most accurate type available . . . its greater sensitivity means more accuracy . . . its jewel bearing means longer life • 17 long lasting phosphor bronze tube sockets • Combination gas and short jewel indicator • 9 filament positions • Handy tube chart contained in special back compartment • New tube listings furnished periodically at no cost • Detachable line cord

plus these BONUS FEATURES . . . found in no other low price tube tester

✓ Checks for cathode to heater shorts ✓ Checks for gas content ✓ Checks all sections of multiple purpose tubes . . . will pickup tubes with one "Bad" section ✓ Line isolated — no shock hazard ✓ Variable load control enables you to get accurate results on all tubes ✓ Positively cannot become obsolete as new tubes are introduced.

IN-CIRCUIT RECTIFIER TESTER

Model SRT-1

Checks all power rectifiers in-circuit whether SELENIUM, GERMANIUM, SILICON, etc.

With the growing trend towards compactness, portability and low price, TV manufacturers are resorting more and more to producing series-string TV sets employing selenium, germanium or silicon power rectifiers. Now the need for an in-circuit rectifier tester is greater than ever.

THE SRT-1 CHECKS ALL POWER RECTIFIERS IN-CIRCUIT AND OUT-OF CIRCUIT WITH 100% EFFECTIVENESS FOR:

✓ Quality ✓ Fading ✓ Shorts ✓ Opens ✓ Arcing ✓ Life Expectancy

Model SRT-1—housed in sturdy hammertone finish steel case complete with test leads **$29.50** Net

SIZE: W–6" H–7" D–3¼"

SPECIFICATIONS

- Checks all types of power rectifiers rated from 10 ma. to 500 ma. (selenium, germanium, silicon, etc.) both in-circuit or out-of-circuit.
- Will not blow fuses even when connected to a dead short.
- Large 3" highly accurate multi-color meter . . . sensitive yet rugged.
- Separate meter scales for in-circuit and out-of-circuit tests.
- Cannot damage or over heat rectifier being tested.

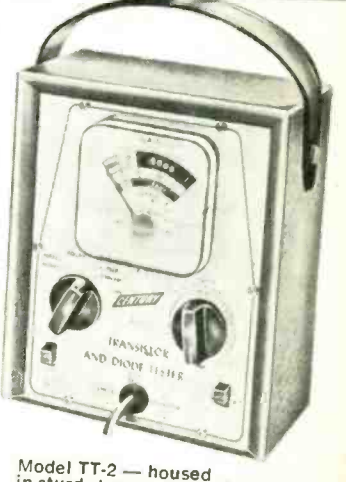
SIMPLE TO OPERATE Just clip SRT-1 test leads across rectifier under test right in the circuit without disconnecting rectifier from circuit. Press test switch and get an instant indication on the easy-to-read three-color meter scales. . . .

TRANSISTOR TESTER

Model TT-2

AN INEXPENSIVE QUALITY INSTRUMENT DESIGNED FOR ACCURATE AND DEPENDABLE TESTS OF ALL TRANSISTORS AND DIODES QUICKLY AND ACCURATELY

Every day more and more manufacturers are using transistors in home portable and car radios . . . in hearing aids, intercoms, amplifiers, industrial devices, etc. Since transistors can develop excessive leakage, poor gain, shorts or opens, the need for TRANSISTOR TESTER is great.



Model TT-2 — housed in sturdy hammertone finish steel case complete with test leads **$24.50** Net

SIZE: W–6" H–7" D–3¼"

SPECIFICATIONS

• Checks all transistors, including car radio, power output, triode, tetrode and unijunction types for current gain, leakage, opens, shorts, cut-off current • Checks all diodes for forward to reverse current gain • All tests can be made even if manufacturers' rated gain is not available • Less than half a minute required for tests of either transistors or diodes • Large 3" meter is extremely sensitive yet rugged . . . with multi-color scales designed for quick easy readings • Power is supplied by an easy to replace 6-volt battery — current drain so small, service life almost equal to shelf life. Battery cannot be drained due to accidental shorting of test leads • Cannot burn-out its own meter or damage transistor or diode under test • Long test leads and insulated test clips enable tests without entirely removing transistor from circuit • Test leads are identified by E.I.A. color code so that connection to the correct terminal is assured • Comes complete with replaceable transistor set-up chart that fits into a special rear compartment.

IMPORTANT FEATURE: The TT-2 cannot become obsolete as the circuitry is engineered to enable you to check all new type transistors as they are introduced. New listings will be furnished periodically at no cost.

EASY TO BUY IF SATISFIED

see order form on facing page

FOR 10 DAY *FREE* TRIAL

Convince yourself at no risk that CENTURY instruments are indispensable in your every day work. Send for instruments of your choice without obligation . . . try them for 10 days before your buy . . . only then, when satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.

NEW Battery Operated Peak-to-Peak VACUUM TUBE VOLT METER Model VT-1

WITH LARGE EASY-TO-READ 6" METER —

featuring the sensational new MULTI-PROBE * *Patent Pending*

No extra probes to buy! The versatile MULTI-PROBE does the work of 4 probes

❶ DC Probe ❷ AC-Ohms Probe ❸ Lo-Cap Probe ❹ RF Probe

The VT-1 is a tremendous achievement in test equipment. With its unique MULTI-PROBE it will do all the jobs a V.T.V.M. should do without the expense of buying additional probes. No longer do you have to cart around a maize of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to do any one of many time-saving jobs. A special holder on side of case keeps MULTI-PROBE firmly in place ready for use.

SIZE:
W–7⅜"
H–9"
D–4¼"

FUNCTIONS

DC VOLTMETER . . . Will measure D.C. down to 1.5 volts full scale with minimum circuit loading, and give accurate readings of scale divisions as low as .025 volts . . . Will measure low AGC and oscillator bias voltages from .1 volts or less up to 1500 volts with consistent laboratory accuracy on all ranges . . . Zero center provided for all balancing measurements such as discriminator, ratio detector alignment and hi-fi amplifier balancing.

AC VOLTMETER . . . True Peak-to-Peak measurements as low as 3 volts of any wave form including TV sync, deflection voltages, video pulses, distortion in hi-fi amplifiers, AGC and color TV gating pulses . . . Scale divisions are easily read down to .1 volts . . . Measures RMS at 1/20th the circuit loading of a V.O.M. . . . Unlike most other V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHMETER . . . Measures from 0 to 1000 megohms . . . Scale divisions are easily read down to .2 ohms . . . Will measure resistance values from .2 ohms to one billion ohms . . . Will detect high resistance leakage in electrolytic and by-pass condensers.

RF and LO-CAP MEASUREMENTS . . . With these extra VT-1 functions you can measure voltages in extremely high-impedance circuits such as sync and AGC pulses, driving saw tooth voltages, color TV gating pulses, mixer output levels, I.F. stage-by-stage gain and detector inputs.

OUTSTANDING FEATURES

● Completely portable — self powered with long life batteries — permits use everywhere ● New advanced pentode amplifier circuit assures amazingly low battery drain ● Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s ● Laboratory accuracy performance — 2% of full scale on DC, 5% of full scale on AC ● Simplified multi-color easy-to-read 4-scale meter ● No heat operation assures rigid stability and accuracy ● Immune to power line fluctuations ● Amplifier rectifier circuit with frequency compensated attenator — a feature found only in costly laboratory instruments ● Meter completely isolated — practically burn-out proof ● Hand-crafted circuitry eliminates the service headaches of printed circuitry ● 1% resistors used for permanent accuracy ● Separate RF ground return for low-loss RF measurement ● Microphone type co-axial connector ● Matching cover protects instrument face — snaps on and off instantly.

SPECIFICATIONS

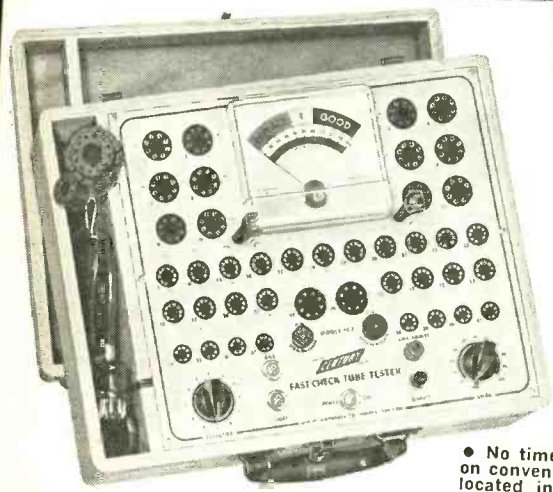
- **DC Volts** — 0 to 1.5/6/30/150/300/600/1500 volts
- **AC Volts (RMS and Peak-to-Peak)** — 0 to 3/12/60/300/1200 volts
- **Ohms** — 0 to a billion ohms, 10 ohms center scale — Rx1/10/100/1K/10K/100K/1M
- **RF** — Peak reading demodulator supplied for use on all DC ranges
- **Zero Center** — available on all DC volt ranges with zero at mid-scale
- **Decibels** — from —10 Db to +10/22/36/50/62 based on the Dbm unit: ODb-1MW in 600 ohms
- **Impedance** — 11 megohms DC, 1 megohm AC, 10 megohms Lo-Cap
- **Input Capacity** — 130 mmfd. RMS, 250 mmfd. Peak-to-Peak, 25 mmfd. Lo-Cap

Model VT-1 — fully wired and calibrated, housed in handsome hammertone finish steel case, complete with MULTI-PROBE, and thorough instruction manual covering all the applications in detail. **$58.50 Net**

FAST-CHECK TUBE TESTER Model FC-2

Simply set two controls . . . insert tube . . . and press quality button to test any of over 700 tube types completely, accurately . . . IN JUST SECONDS!

Over 20,000 servicemen are now using the FAST-CHECK in their every day work and are cutting servicing time way down, eliminating unprofitable call-backs and increasing their dollar earnings by selling more tubes with very little effort. See for yourself at no risk why so many servicemen chose the FAST-CHECK above all other tube testers.



SIZE: W–14⅝" H–11¼" D–4⅜"

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK
Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

RANGE OF OPERATION

- ✔ Checks quality of over 700 tubes types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes, 0Z4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- ✔ Checks for inter-element shorts and leakage.
- ✔ Checks for gas content.
- ✔ Checks for life-expectancy.

SPECIFICATIONS

● No time consuming multiple switching . . . only two settings are required instead of banks of switches on conventional testers ● No annoying roll chart checking . . . tube chart listing over 700 tube types is located inside cover. New listings are added without costly roll chart replacement ● Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale ● 41 phosphor bronze beryllium tube sockets never need replacement ● 7-pin and 9-pin straighteners mounted on panel ● Large 4½" D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out ● Special scale on meter for low current tubes ● Compensation for line voltage variation ● 12 filament positions ● Separate gas and short jewel indicators ● Line isolated — no shock hazards ● Long lasting etched aluminum panel.

Model FC-2 — housed in hand-rubbed oak carrying case complete with CRT adapter **$69.50 Net**

NOTE: The Fast-Check positively cannot become obsolete . . . circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

CONVENIENT TIME PAYMENT PLAN — NO FINANCING CHARGES

ALL CENTURY INSTRUMENTS ARE GUARANTEED FOR ONE FULL YEAR

The extremely low prices are made possible because you are buying direct from the manufacturer.

CENTURY ELECTRONICS CO., INC.

CHECK INSTRUMENTS DESIRED

- ☐ Model CT-1 In-Circuit Condenser Tester ..... $34.50 — $9.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model MC-1 Mini-Check Tube Tester ..... $39.50 — $9.50 within 10 days. Balance $6 monthly for 5 months.
- ☐ Model SRT-1 In-Circuit Rectifier Tester ..... $29.50 — $4.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model TT-2 Transistor Tester ..... $24.50 — $4.50 within 10 days. Balance $5 monthly for 4 months.
- ☐ Model VT-1 Battery Vacuum Tube Volt Meter ..... $58.50 — $14.50 within 10 days. Balance $11 monthly for 4 months.
- ☐ Model FC-2 Fast-Check Tube Tester ..... $69.50 — $14.50 within 10 days. Balance $11 monthly for 5 months.

Prices Net F.O.B. Mineola, N. Y.

111 Roosevelt Avenue, Dept. 107, Mineola, New York

Please rush the instruments checked for a 10 day free trial. If satisfied I agree to pay the down payment within 10 days and the monthly installments as shown. If not completely satisfied I will return the instruments within 10 days and there is no further obligation. It is understood there will be NO INTEREST or FINANCING charges added.

Name .....
Please print clearly

Address .....

City ..... State .....

(*Continued from page* 87)

Los Angeles 39, Calif.

The factory enclosure uses lock-mitred joints and routed slots in top and bottom panels to position interior partitions. You may not be able to make these, but an equally satisfactory enclosure may be built using simpler methods, provided all joints are screwed, glued and sealed. If you use routed slots, add twice the depth of the slots to all inside panels. Use plenty of glue blocks in all corners (see Fig. 4).

Use ¾-inch plywood for all panels with the exception of the curved section which forms the final horn flare. This may be made of 5/16-inch Plyscore sheathing, adequately strutted to prevent panel resonances. Alternatively, a sandwich of thin Masonite or plywood layers may be bent to shape and glued together in a single laminated panel. In any case, the curve profile shown in Fig. 5 should be followed.

Before beginning actual construction, first check the layout of the components you plan to use. Fig. 6 shows how the major parts are cut from plywood sheets. A detailed drawing of the speaker baffle is shown in Fig. 7. Note that, if the 175DLH driver–horn–lens assembly or tweeter of similar length is used it will project back through the rear of the coupling chamber. Therefore a tight-fitting hole must be cut in the front throat baffle to accommodate the horn driver. Soft felt is used to seal the gap between the tweeter horn and panel. The exact position of the hole may be determined geometrically, or the complete shop drawings may be consulted and high-frequency unit mounted exactly as in factory-assembled cabinets.

The rear of the coupling chamber should be completely padded with sound-absorbent material, such as Fiberglas or Tuflex (see Fig. 2). If a dividing network is used, mount it in the space behind the curved horn section.

Since you must be able to remove the speaker mounting baffle from the front of the enclosure, it cannot be glued. Yet it must form an airtight seal with the coupling chamber. Cleats to which the speaker baffle can be tightly screwed are fastened to the side, top and bottom of the enclosure. These cleats are cut from 1½ x ¾-inch stock and glued and screwed edgewise to the enclosure. Use at least four screws per cleat. The left edge of the baffle is screwed to the inner horn panel. Use at least four screws on each edge of the baffle.

If you set up the grille cloth so it can be removed from the front of the enclosure, the remaining outer surfaces can be permanently fixed in place. The more ambitious may not want visible mounting frames or fasteners on the finished enclosure. Fig. 8 shows the factory method of mounting the grille cloth. It is fastened to a supporter *behind* the vertical scab on the right of the enclosure, stretched across a center spreader and then fastened to the interior left-hand side of the cabinet. After a trial fitting of the grille, cut top and bottom scabs to follow the grille's contour. Glue scabs in place and finish edges with 1¾-inch veneer tape.

This method of mounting the grille cloth requires making the horn-mouth interior accessible from the rear of the enclosure. Consequently, a portion of the rear panel of the factory enclosure is made removable. If you do this, make sure that the removable section makes an airtight seal when screwed in place, and that the entire structure is rigid and rattle-free. Cleats, not shown on the diagrams, are screwed and glued to the top, bottom and side to support the removable panel.

When completed, the enclosure may be completely finished and fitted with decorative legs, or it may be incorporated in built-in or wall-hung cabinet units. The enclosure can also be built as a vertical unit, should this orientation better suit existing space requirements. Since the horn is completely self-contained, room placement is not critical.

Testing and performance

After the enclosure is assembled and the speaker system installed, the system should be tested before the grille cloth is stretched into place. A powerful low-frequency signal or program material having a preponderance of bass should be fed to the speakers and the enclosure checked carefully for rattles, buzzes and panel vibrations. Additional struts may be screwed in place as needed to eliminate any panel resonances.

Once the system is operating satisfactorily, suitable music for normal listening may be played as a listening test. If a two-way speaker system is installed, the high-frequency level control should be set to give most natural balance.

The most immediately outstanding feature of the Harkness enclosure is its ability to deliver natural full-bodied bass even at the highest volume levels. But it must be emphasized that, below 200 cycles, individual room acoustics are almost as important as the speaker enclosure in determining quality of reproduction.

The quality of rear-loading horns is often described as "live," "clean," "gets the sound out of the enclosure and into the room." For those who feel these terms describe the ideal speaker system, this enclosure is an ideal choice. END

PENTRON 9T-3C TAPE RECORDER

Excessive hum on a recording, usually becoming progressively louder, is generally due to a defective 6SL7 which may have heater-to-cathode leakage, despite tube tester indications of no leakage. Test by substitution.

V1, the 5879 preamplifier tube, may also have a heater-to-cathode short that does not show on a tube tester so try by substitution too. Loose motor supports may also cause hum.—*Jack White*

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FREE 12 MONTHS SUBSCRIPTION

YOU SAVE $40 BECAUSE WE CAUGHT OUR FACTORY BETWEEN "RUNS"

REALISTIC 8-TRANSISTOR PORTABLE RADIO

1ST TIME EVER!

$29.95 *Battery Included*

$5 down $5 monthly

POSITIVELY UNDUPLICATED UNDER $70!

Rather than shut down, a certain factory waiting for business on its own product built our sensational design to order for less than HALF the going price! VERSATILE! Use anywhere as powerful long-distance radio . . . as low-cost "2nd half" of stereo system . . . as portable amplifier for your phono. Has two diodes, thermistor that extends battery life to save you money, top grain leather case.
Order No. 90LX696. Sh. Wt. 2 lbs.

REALISTIC ELECTROSTAT-3 Tweeter

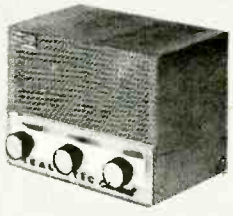
$27.50 $5 Down, $5 Monthly
Factory Assembled; Cabinet: 11⅞ x 5⅞ x 4½"

TO BE SURE OF GETTING the tweeter made world-famous by rave notices of the hi-fi test laboratories, and not an inferior imitation, order ONLY from Radio Shack. ONLY Radio Shack sells the tweeter acclaimed for adding a smooth and silky response from 5,000 cycles to 25,000 cycles with any good compliance speaker system. Order No. 36CX017Y. Sh. Wt. 7 lbs.

8-OHM ELECTROSTAT-3 CROSSOVER NETWORK
Order No. 911534 Sh. Wt. 2 lbs. $6.95

P.A. Miracle! 5-WATT AC "Carnival" AMPLIFIER

$19.95 Completely Wired
Not a kit!
$5 Down, $5 Monthly



P.A.! PHONO! PAGING! IDEAL for Clubs, Schools, Square Dances, Rallies, Paging, Restaurants, Music Lovers! AC circuit, high-z mixable microphone and inputs and gain controls. Hi-fi (low) hum and I.M. 7½ x 5 x ½" cabinet.
Order No. 90LX891 Sh. Wt. 7 lbs.

COMPLETE OUTDOOR P.A. SYSTEM: Amp., University PH horn, 25 W driver, microphone, weatherproof cable.
Order No. 92L520 Sh. Wt. 20 lbs. $49.95

Archer POWER MEGAPHONE $29.95 With Carrycase

$5 Down, $5 Monthly

PUTS YOUR VOICE WHERE YOUR LEGS CAN'T GO! PERFECT for Coaches, Playground Supervisors, Construction Foremen, Yachtsmen, Lifeguards, Scoutmasters, etc. Has variable volume control, weighs 3½ lbs. with 6 flashlight batteries (extra 78c).
Order No. 90L800 Sh. Wt. 9 lbs.

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WRITTEN BY EXPERTS in all fields . . . printed VIVIDLY in rotogravure on fine glossy paper . . . on pages over TWICE the size of this magazine! Mailed POSTPAID — nothing to pay!

250-PAGE COMPLETE GUIDE TO ELECTRONIC PARTS BUYING

Profusely illustrated 8½" x 11" book with authoritative articles plus a complete hi-fi and electronic catalog. Issued in September.

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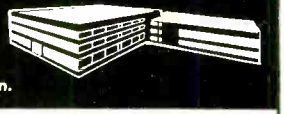

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- ☐ FREE Bargain Bulletins for 12 months
- ☐ 1960 Guide To Electronic Buying @ 35c
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- ☐ Electrostat-3 (#36CX017Y) @ 27.50
- ☐ 8-Ohm wired X-over (#91L534) @ 6.95
- ☐ 16-Ohm X-over kit (#91L505) @ 4.95
- ☐ 5W Amplifier (#90LX891) @ 19.95
- ☐ Outdoor PA (#92LX521) @ 49.95
- ☐ Power Meg. (#90L800) @ 29.50

☐ Check ☐ Money Order ☐ C.O.D.

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City _____ Zone ____ State _____

For Checking Miniaturized Equipment, Pyramid's Model RC-1 New Resistance-Capacity-Ratio Bridge Tester. Budget priced . . . outstanding quality instrument . . . the RC-1 saves you both time and money. Precision-engineered, Pyramid's new model RC-1, Resistance-Capacity-Ratio Bridge Tester has a special low voltage bridge and stable vacuum tube amplifier for safe testing low voltage electrolytics such as commonly used in transistorized receivers.

Pyramid's RC-1, Resistance-Capacity-Ratio Bridge Tester is a functionally designed, sturdy, compact, lightweight unit, ideal for use by technicians, servicemen and engineers in radio, television (color as well as black and white), industrial electronics and all related fields.

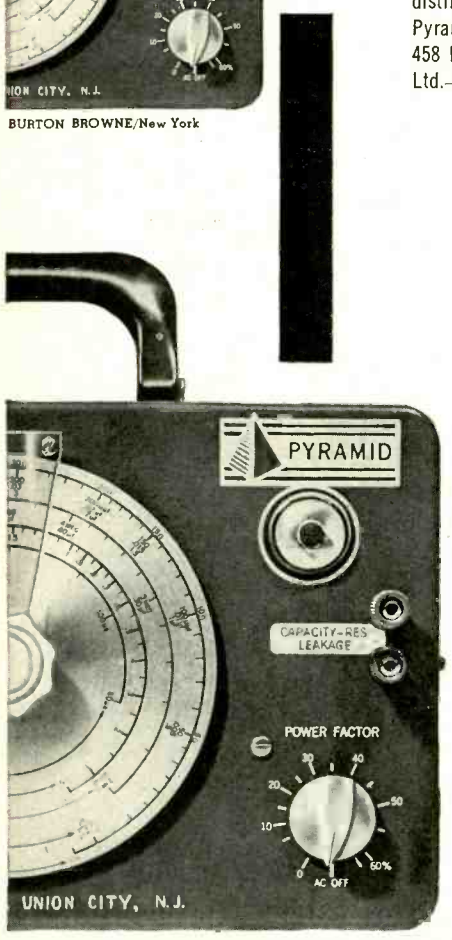
PYRAMID MODEL RC-1 FEATURES:

- Special 3 volt amplifier for checking low voltage electrolytics used in miniaturized equipment such as transistor radios, etc.
- Capacity Ranges—from 10 mmfd. to 2000 mfd.
- Resistance—from .5 ohms to 200 megohms in 4 ranges.
- Ratio Test—provides quick reactance or resistance ratio between any two capacitors, inductors or resistors —range: .05 to 1 and 20 to 1. It can be used also to determine turns ratio of transformer windings within this range.
- Leakage Tests—handles all types of capacitors at rated voltages between 0 and 500V DC.
- Power Factor—0 to 60% (on capacitors from .1 mfd to 2000 mfd).
- Capacitor Test Voltages—variable between 0 and 500V DC in 17 steps.

PRICE: Dealer Net—$44.95

For further information about the RC-1 see your Pyramid distributor or write for complete technical data to: Pyramid Electric Company, Union City, N. J. EXPORT: 458 Broadway, N. Y. 13, N. Y. • CANADA: Wm. Cohen, Ltd.—7000 Park Ave., Montreal.

BURTON BROWNE/New York



PYRAMID
ELECTRIC CO.

TECHNICIANS' NEWS

L. I. GUILD RECOMMENDS $5.50 CALL

As a result of lively discussion at a meeting of the Long Island Radio Television Guild, this group went on record favoring a minimum of $5.50 as a basic home service-call charge. The *Guild News* said, "For many years the average service charge in Queens County has been only $3.50; in Nassau County closer to $4.00. The actual cost of making a service call on Long Island is $5.62. This figure has not been arrived at arbitrarily but by careful ground work and analysis on the part of the Guild. The Guild has also come up with statistics showing that the average call produces an income from parts of $1.17. If your shop charges $3.00 for labor, total income on that call would be $4.17, or a loss of $1.45 on each call. . . . RCA has recently issued a pamphlet bringing out that, when the service charge rate was $4.50, the shop owner could afford to pay just $1.80 per hour salary, or $72.00 a week. At a service charge rate of $3.50, the technician's salary should be only $56.00 a week."

MICHIGAN TSA ELECTS

At the annual meeting of the Television Service Association of Michigan the organization elected new officers including Patrick LaForet, president; Michael Graham, secretary, and Isa Katuah, treasurer. The new officers and board members were installed at a dinner dance 2 weeks later, which marked 10 years of growth for TSA of Michigan.

PHILCO HELPS FIGHT SCARE STORIES

"We propose to write an article defending the service technician and have it published by a national consumer magazine," says the *Philco Service Businessman*. "Let's get mad and stay mad. Let's reply to every single instance of disparagement of the serviceman, by letter, by telephone, by telegram. Write direct to the editor of the offending publication. *Demand* that the publication tell the other side of the story . . .

"In the belief that, if one editor finds one side of a story of interest, others will choose the opposite side, . . . we will seek out the editor who will publish the 'other' side. . . . In order to accomplish this, we need the cooperation of all our readers. Tell us about stories you have read which you have found to be untrue or greatly exaggerated. Give us facts, men—dates, places, names if possible. Armed with

these facts we can write a story about the service technician as a reputable businessman that will be just as convincing as the damaging attacks ever were.

"Address your letters to the 'Get Mad' Editor, Philco Service Businessman, 2nd and Westmoreland Sts., Philadelphia 40, Pa."

TORONTO GROUP DISBANDS

May 9 marked the closing, in Toronto, Canada of an organization dedicated to the cause of the technician.

A resolution, urging all members still in the Association of Professional Technologists of Ontario (the name of the now defunct organization) to apply, individually, for certification under the Association of Professional Engineers of Ontario, was passed with little comment.

The engineering group permits men who work at jobs of a high degree of difficulty and responsibility, yet are not engineers, to be certified by the association. APTO's president hopes that urging the members of his disbanded group (which at its peak numbered more than 300) to join the Engineers of Ontario will encourage the engineering association to deal more specifically with the technician.

OKLA. PARTS SHOW & CLINIC

A 3-day parts show and technical clinic will be held at the Skirvin Hotel in Oklahoma City, on July 17, 18, 19, with six nationally known speakers and over 30 manufacturers' exhibits. Harold Eales, Oklahoma City service dealer who is setting up the show, expects about 700 technicians from Oklahoma and the four neighboring states to attend. TESA of Oklahoma is the sponsor.

The program will include a golf tournament, two banquets, floor shows and other nonelectronic functions in addition to the technical and business meetings and talks. It is anticipated that this will be the first in a series of such annual parts show and clinics.

TEXAS CLINIC AND FAIR

The Texas Electronics Association has announced its seventh annual Clinic and Fair to be held in San Antonio, Aug. 7, 8 and 9. A full program of technical and business discussions led by industry authorities has been planned, including both management and technical sessions on Friday and Saturday. Experts from RCA, Zenith, Sylvania, Delco, G-E, Motorola, Raytheon and Tung-Sol are scheduled to talk. There will be a dance Saturday evening, and complete programs for the 2½ days have been planned both for the ladies and for the children.

SERVICE SHOP ON SHOW

A complete TV–hi-fi–radio service shop in operation is planned as an exhibit at the Chicago International Fair, to be held July 3–18. The exhibit is intended to give TV owners a better appreciation of the real scope of the establishment required to service their sets properly. The shop will be manned by members of the Associated Radio & TV Servicemen (Chicago), who will answer questions from the public.

The Simpson Electric Co. is equipping the shop with a complete set of test equipment. In addition, there will be a closed-circuit TV demonstration and a color set with patterns and color bars displayed continuously. The project is part of an effort by the Chicago ARTS group to improve relations between TV owners and technicians.

DANGEROUS FUGITIVE MAY SEEK TV WORK

TV shop owners and technicians are warned to be on their guard against an individual who may be known as John, Richard or Jimmy Haywood, but is more likely to be using an entirely different name. Wanted by the FBI for unlawful flight to avoid prosecution for

murder, he is said to be sufficiently adept at radio and television to enable him to make a living in the trade. He is alleged to have shot and killed two men, and should be considered armed and extremely dangerous.

Description: age 42, height 5 feet 9 inches, build slender, weight 170 lbs, hair black, eyes maroon, complexion light brown (Negro). Sometimes wears a mustache, has scar on left wrist and left side. As well as TV technician, has worked as mechanic and laborer. Is proficient with an electric guitar and is a motorcycle enthusiast.

Anyone having information that might assist in locating this fugitive is requested to immediately notify the Director of the FBI, US Department of Justice, Washington, D. C., or the special Agent in Charge of the nearest FBI division, the telephone number of which appears on the first page of local telephone directories.

URGES COLOR STUDY

In an address to the annual Pennsylvania Federation of Radio–Television Servicemen's Associations in Harrisburg, Donald Kunsman, president of RCA Service Co., urged alert service technicians to train themselves to be able to service color sets as growing public acceptance of color turns into purchase and home use of the sets.

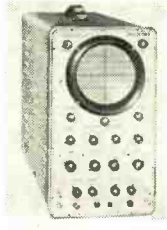
RCA is now sending out complete service data on its color receivers. These manuals are in a format similar to the black-and-white service manuals familiar for a number of years. END

On the Market

IM DISTORTION METER, *Newenco.* Low-priced tester using SMPTE method with 60 cycles and 6 kc at 4:1 amplitude ratio. Readings as low as 0.1% IM distortion can be read on plastic-faced meter. Intended for service technicians,

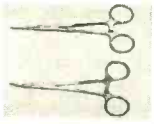
hobbyists and kit builders for checking and balancing amplifiers. Operates on 105–125 volts ac.—**Newbury Engineering Co.,** PO Box 144, Bradford, N. H.

WIDE-BAND SCOPE *model ES-550B.* High-sensitivity 5-inch oscilloscope with camera-mount bezel and edge-lit graticule.



Light intensity in graticule variable by knob on front of scope. Frequency response 10 cycles to 5 mc. Sensitivity 10 millivolts/inch, flat ±1 db to 3.5 mc, frequency compensation on vertical attenuator, vertical pattern-reversing switch, 60-cycle phasing and blanking control.—**Precise Apparatus Co.,** 70-31 84th St., Glendale, N. Y.

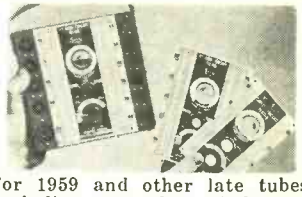
THIRD HAND holding clamps with stepped positions are convenient for keeping wires or small parts in place during assembly or soldering. 6 inches long. *Model 42H* has straight nose, *model 43H* curved nose.—**Xcelite, Inc.** Orchard Park, N.Y.



SELF-POWERED VTVM *model VT-1* has all-in-one probe for dc, ac, rf and low-capacitance. Uses 6-inch meter movement; 7 dc scales, 1.5 to 1,500 volts; ac rms and peak-to-peak, 5 scales, 3 to 1,200 volts; 7 ohms scales to 1,000 megohms; zero center; db, 5 scales, −10 to +10 db. Impedance 11 megohms dc,

1 megohm ac, 10 megohms low capacitance. Input capacitance, 250 μμf in rms setting, 25 μμf for low capacitance.—**Century Electronics Co., Inc.,** 111 Roosevelt Ave., Mineola, N.Y.

NEW PANEL for grid-emission tester, *part no. 598* adapts model GCT-8 tube tester



for 1959 and other late tubes, including popular industrial types. Manual lists foreign tube data. Panel for bringing GCT-5 testers up-to-date is *part no. 595.*—**Seco Mfg. Co.,** 5015 Penn. Ave. South, Minneapolis, Minn.

REPLACEMENT SWITCHES for auto radios. *SP group* exact

replacements for many new car radios.—**Centralab,** 900 E. Keefe Ave., Milwaukee 1, Wis.

ANTI-STATIC SPRAY puts *Sil-Spray* silicone film on phonograph discs. Aerosol bomb container includes cloth applicator.—**Jensen Industries,** Forest Park, Ill.

BURNOUT-PROOF METER *model 102F* has fuse protection. 5 ac and 5 dc ranges to 3,000 volts. 3 dc and 3 ac current ranges, 2 resistance ranges to 1 megohm. Meter is 3 inches square. *Model 103F* has larger

indicating meter, 4½ inches square. Both available as kits or factory-assembled.—**Electronic Measurements Corp.,** 625 Broadway, New York 12, N.Y.

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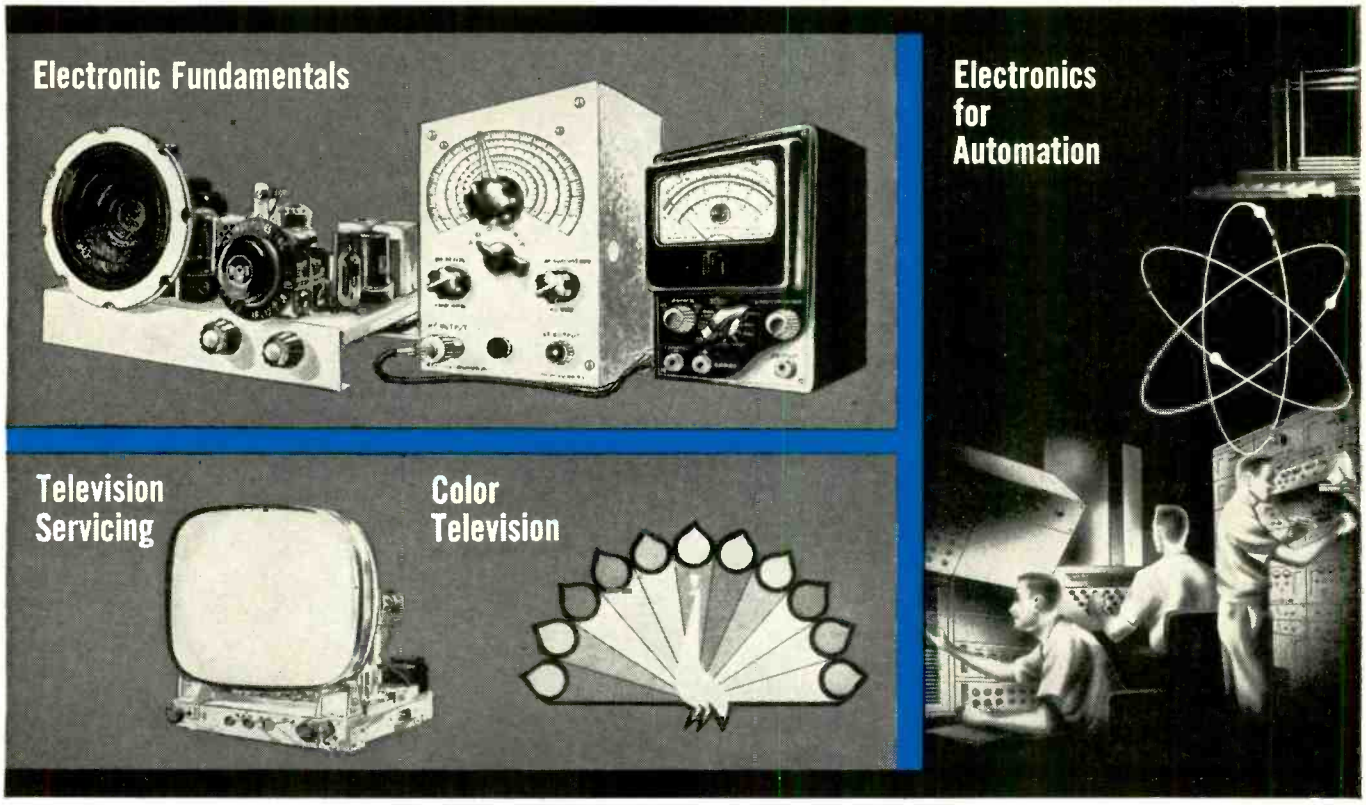

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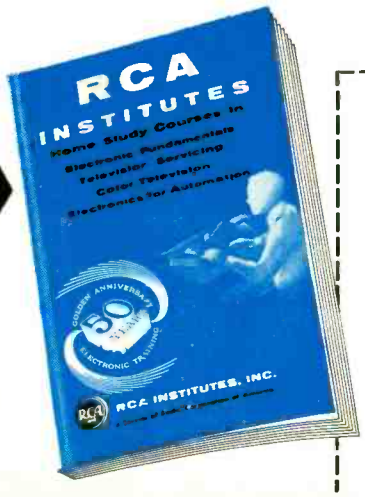

FOR RESIDENT SCHOOL COURSES SEE AD ON OPPOSITE PAGE

Practical work with the very first lesson. Pay-as-you-learn. You need pay for only one study group at a time.

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VOLTAGE REGULATOR *model D-200* boosts line voltage 10 volts when it drops below 110, handles sets up to 300 watts. Plugs in; has no tubes,

relays or moving parts. Turns on and off automatically with power switch of regulated set or appliance.—**Perma - Power Co.**, 3100 N. Elston Ave., Chicago 18, Ill.

TOOL KITS with interchangeable bits for Allen hex screws and fluted-spline recessed screws are *models ZA40* and *ZF40*, re-

spectively. Each kit comes with handle and graduated-size bits in rollup plastic tool case.—**Vaco Products Co.**, 317 East Ontario St., Montreal, Canada.

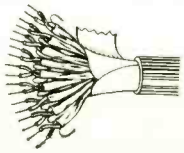
MINIATURE TRANSFORMERS for use with transistors.

27 models, encapsulated for output, reactor, driver, input and interstage applications. Meet Mil - T - 27A specs. — **Chicago Standard Transformer Corp.**, 3509 Addison St., Chicago 18.

SPECIALIZED CAPACITORS for applications requiring unusual values. *Type BPU*, for computer use, range to 150,000 μf at 3 volts and 1,000 μf at 450 volts; immersion - proof, shock-proof. Shown 25,000-μf unit at 15 volts and 12,000 μf at 5 volts. *Energy Storage* capacitors small photoflash units with leakage under 1 ma, long shelf

life, low inductance. *Nonpolarized* tubular electrolytics designed for speaker crossover networks have low power factor, high current capability.—**Illinois Condenser Co.**, 1616 N. Throop St., Chicago 22, Ill.

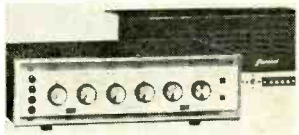
MULTICONDUCTOR SHIELDED intercom cables with either 9 or 15 individually shielded pairs. Shields are isolated from each other. Conductors No. 22 AWG. Available in 100-, 500-, and 1,000-foot spools.—**Belden Mfg. Co.**, 4647 W. Van Buren, Chicago, Ill.



WIRELESS INTERCOM *model CC-60* is powered by 110 volts ac. Includes squelch circuit for

virtually silent standby.—**Vocaline Co. of America Inc.**, Old Saybrook, Conn.

ADD-ON STEREO AMPLIFIER *model S-4400* includes 36-watt power amplifier, dual stereo preamp and controls works with any basic or complete amplifier. Response 20–20,000 cycles ±1½ db. Tape-head input, loudness control with switch, presence control, output current balance. Hum



and noise 60 db down on phono input, radio 80-db.—**Sherwood Electronic Laboratories**, 4300 N. California Ave., Chicago 18.

STEREO AMPLIFIER *Integra Mark XXIV*, 2 power amplifiers 20 watts each, voltage-regulated fixed - bias supply, loudness switch, speaker phasing, ac power receptacle. Response 18

to 75,000 cycles ±½ db, 1M distortion 0.6%.—**Precise Development Corp.**, Oceanside, N. Y.

STEREO SYSTEM KIT *model SD-1* includes cabinet, phonograph changer, amplifier and stereo speakers. Amplifier CBS-

developed sum - and - difference matrix circuit with level balance control, inputs for tuners. 8-inch woofer in tube-vented enclosure in main cabinet goes to 250 cycles. Outrigger stereo speakers 6 x 9-inch oval extended-range units in small cabinets. Ceramic stereo cartridge with diamond stylus.—**Heath Co.**, Benton Harbor, Mich.

STEREO AMPLIFIER *model 222* integrated preamp–control unit–amplifier for 2 complete channels. Includes tape-head in-

put, stereo balance and reverse, loudness control and disable, scratch filter, separate bass and treble controls for each channel, dc preamp heaters. Power output 12 watts each channel at 0.8% distortion, sensitivity 3 millivolts maximum, noise and hum 80 db down. Case optional. —**H. H. Scott, Inc.**, 111 Powdermill Rd., Maynard, Mass.

DUAL POWER AMPLIFIER. 2 basic 14-watt amplifiers and power supply on one chassis. *Model HF86* distortion (IM) 1.5% at 14 watts, response ±0.5

db 10–100,000 cycles at 2 watts output, hum 90 db down, controls for input levels and stereo–mono available kit or factory-assembled. — **EICO**, 33-00 Northern Blvd., Long Island City 1, N. Y.

FM TUNER KIT *model FM-4* includes afc with defeat switch, prewired and aligned tuning

unit, prealigned if's, multiplex jack, 5 tubes and silicon rectifier. Simulated leather metal case.—**Heath Co.**, Benton Harbor, Mich.

FM TUNER *model S-3000 II* with interstation hash silenced by front-panel control. Sensitivity 1 μv for 20-db quieting, hum and noise 60 db down from

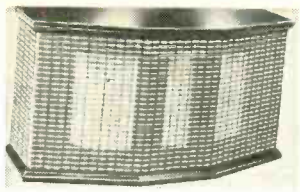
100% modulation, distortion less than ⅓ of 1% at 100% modulation. Afc disable on front panel, tuning eye, cathode-follower output, multiplex jack.— **Sherwood Electronic Laboratories**, 4300 N. California Ave., Chicago, Ill.

PANEL KIT for combining 2 Dynakit preamplifiers and stereo control into integrated unit. *Model PM-2S* has no bolts or

screws visible from front. Will accommodate any thickness wood panel up to 1⅛ inches.— **Dynaco, Inc.**, 617 N. 41 St., Philadelphia 4, Pa.

LOUDSPEAKER *models D8LA* and *D12LA* have response 30–16,000 cycles, handle up to 20 watts audio power. Impedance 8 ohms.—**Utah Radio & Electronic Corp.**, 1124 E. Franklin St., Huntington, Ind.

ELECTROSTATIC TWEETER *model 150-1-2*, low-cost unit with built-in 5,000-cycle crossover,



response up to 25,000 cycles. Self-contained ac power supply for polarization. Features 3 elements. Available in three finishes.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, New York.

OVAL REPLACEMENT speaker *model 48A2*, 4 by 8 inches for

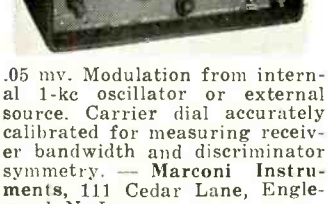
auto and radio–TV use, especially recent model cars and a number of RCA and Sylvania receivers. *Model 69A1* low-cost heavy-duty 6 x 9-inch oval replacement unit.—**Quam-Nichols Co.**, 236 E. Marquette Rd., Chicago 37, Ill.

HEAVY-DUTY TOWER *No. 50* for heights up to 450 feet with guying. 15 ½-inch triangular 10½-foot sections. Galvan-

ized; zig-zag cross braces.— **Rohn Mfg. Co.**, 116 Limestone, Bellevue, Peoria, Ill.

YAGIS in 5-element as well as 10-element models, for individual channels in addition to broad-band vhf TV. *K-series* has removable center piece to keep impedance at 300 ohms whether antenna is used alone or stacked.—**Winegard Co.**, 3000 Scotten, Burlington, Iowa.

FM SIGNAL GENERATOR *model 1064/2*. Lightweight portable unit for servicing mobile radios up to 470 mc. Stabilized power supply, directly heated cathodes for quick warmup, attenuator pad for output down to



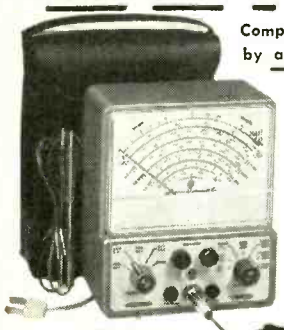
.05 mv. Modulation from internal 1-kc oscillator or external source. Carrier dial accurately calibrated for measuring receiver bandwidth and discriminator symmetry. — **Marconi Instruments**, 111 Cedar Lane, Englewood, N. J. END

All specifications on these pages are from manufacturers' data.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER



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

• Uses new improved SICO printed circuitry. • Employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability • Meter is isolated from the measuring circuit by a balanced push-pull amplifier. • Uses selected 1% zero temperature coefficient resistors as multipliers.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

AS AN AC VOLTMETER: Measures RMS value if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

Model 77—Vacuum Tube Voltmeter
Total Price $42.50
Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

SPECIFICATIONS

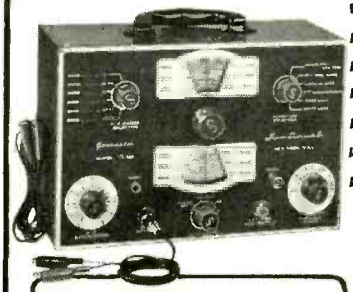
• **DC VOLTS** — 0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)** — 0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak) — 0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER** — 0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBELS** —10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER** — For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Complete with operating instructions, probe, leads, and case. 110-120 volt 60 cycle. Only **$42.50**

SUPERIOR'S NEW MODEL TV-50A

GENOMETER

7 Signal Generators in One!



- ✓ R.F. Signal Generator for A.M.
- ✓ R.F. Signal Generator for F.M.
- ✓ Audio Frequency Generator
- ✓ Marker Generator
- ✓ Bar Generator
- ✓ Color Dot Pattern Generator
- ✓ Cross Hatch Generator

This Versatile All-Inclusive GENERATOR Provides ALL the Outputs for Servicing:

- A.M. RADIO • BLACK AND WHITE TV
- F.M. RADIO • COLOR TV
- AMPLIFIERS

Model TV-50A—Genometer
Total Price $47.50
Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

R. F. SIGNAL GENERATOR: 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: Provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

MARKER GENERATOR: The following markers are provided: 189 Kc.; 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency.)

BAR GENERATOR: Pattern consists of 4 to 16 horizontal bars or 7 to 20 vertical bars.

DOT PATTERN GENERATOR (FOR COLOR TV): The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

CROSS HATCH GENERATOR: The pattern consists of non-shifting horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

The Model TV-50A comes complete with shielded leads and operating instructions. Only **$47.50**

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER

THE *ONLY* 20,000 OHMS PER VOLT V.O.M. SELLING FOR LESS THAN $50 WHICH PROVIDES *ALL* THE FOLLOWING FEATURES:

- ✓ 6 INCH FULL-VIEW METER provides large easy-to-read calibrations. No squinting or guessing. when you use Model 80.
- ✓ MIRRORED SCALE permits fine accurate measurements where fractional readings are important.
- ✓ CAPACITY RANGES permit you to accurately measure all condensers from .0025 MFD to 30 MFD in addition to the standard volt, current, resistance and decibel ranges.
- ✓ HANDSOME SADDLE-STITCHED CARRYING CASE included with Model 80 Allmeter at no extra charge enables you to use this fine instrument on outside calls as well as on the bench in your shop.

Model 80—Allmeter
Total Price $42.50
Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

SPECIFICATIONS:

7 **D.C. VOLTAGE RANGES**
(At a sensitivity of 20,000 Ohms per Volt)
0 to 15/75/150/300/750/1500/7500 Volts.
6 **A.C. VOLTAGE RANGES:**
(At a sensitivity of 5,000 Ohms per Volt)
0 to 15/75/150/300/750/1500 Volts.
3 **RESISTANCE RANGES:**
0 to 2,000/200,000 Ohms. 0-20 Megohms.
2 **CAPACITY RANGES:**
.00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.
5 **D.C. CURRENT RANGES**
0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.
3 **DECIBEL RANGES:**
— 6 db to + 18 db, + 14 db to + 38 db + 34 db to + 58 db

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

FEATURES:

• A built-in Isolation Transformer automatically isolates the Model 80 from the power line when capacity service is in use.

• Selected, 1% zero temperature coefficient metalized resistors are used as multipliers to assure unchanging accurate readings on all ranges.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Only **$42.50**

SUPERIOR'S NEW MODEL 79

SUPER-METER

WITH NEW 6" FULL-VIEW METER

A Combination
VOLT-OHM MILLIAMMETER
Plus
CAPACITY, REACTANCE, INDUCTANCE, AND DECIBEL MEASUREMENTS
Also Tests
SELENIUM AND SILICON RECTIFIERS, SILICON AND GERMANIUM DIODES.

Model 79—Super Meter
Total Price $38.50
Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

SPECIFICATIONS:

• **D.C. VOLTS:** 0 to 7.5/15/75/150/750/1.500. • **A.C. VOLTS:** 0 to 15/30/150/300/1,500/3,000 • **D.C. CURRENT:** 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes • **RESISTANCE:** 0 to 1,000/100,000 Ohms, 0 to 10 Megohms. • **CAPACITY:** .001 to 1 Mfd., 1 to 50 Mfd. • **REACTANCE:** 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms. • **INDUCTANCE:** .15 to 7 Henries, 7 to 7,000 Henries. • **DECIBELS:** —6 to +18, +14 to +38, +34 to +58.

The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.

All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers.
All Silicon Rectifiers.
All Germanuim Diodes.
All Silicon Diodes.

The model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development. It includes not only every circuit improvement perfected in 20 years of specialization but, in addition includes those services which are "musts" for properly servicing the ever-increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale, SICO used its new full-view 6-inch meter.

Model 79 comes complete with operating instructions, test leads, and steamlined carrying case. Use it on the bench—use it on calls. Only .. **$38.50**

EXAMINE BEFORE YOU BUY!

USE APPROVAL FORM ON NEXT PAGE

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

Model TW-11—Tube Tester
Total Price $47.50
Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity fuse types, etc.
★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.
★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.
★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

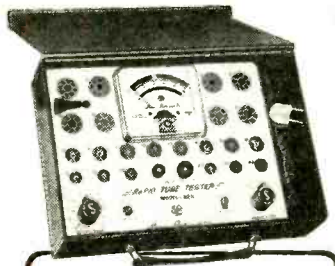
EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES: Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover. **$47.50**

SUPERIOR'S NEW MODEL 82A

Multi-Socket Type TUBE TESTER



Model 82A—Tube Tester
Total Price $36.50
Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
2. Insert tube into a numbered socket as designated on our chart (over 600 types included).
3. Press down the quality button—

THAT'S ALL! *Read emission quality direct on bad-good meter scale.*

SPECIFICATIONS

- Tests over 600 tube types
- Tests OZ4 and other gas-filled tubes
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence
- Dual Scale meter permits testing of low current tubes
- 7 and 9 pin straighteners mounted on panel
- All sections of multi-element tubes tested simultaneously

Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch — THAT'S ALL!. Read quality on meter. Inter-element leakage if any indicates automatically.

Model 82A comes housed in handsome, portable Saddle-Stitched Texon case. Only **$36.50**

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

TESTS AND REJUVENATES ALL PICTURE TUBES

Model 83—C.R.T. Tube Tester
Total Price $38.50
Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

ALL BLACK AND WHITE TUBES
From 50 degree to 110 degree types —from 8" to 30" types.

- Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

ALL COLOR TUBES
Test ALL picture tubes—in the carton—out of the carton—in the set!

- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
- Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only.... **$38.50**

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Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. No Interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

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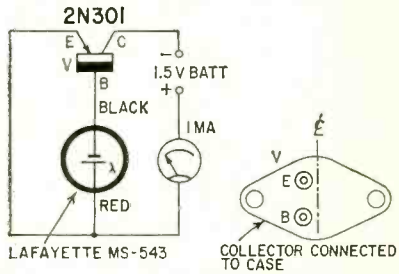
- ☐ Model 77 Total Price $42.50 $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model TV-50A Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 80 ... Total Price $42.50 $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 79 Total Price $38.50 $8.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model TW-11 ... Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 82A ... Total Price $36.50 $6.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 83 ... Total Price $38.50 $8.50 within 10 days. Balance $6.00 monthly for 5 months.

NOTEWORTHY CIRCUITS

LIGHT-INTENSITY METER

To measure medium-level light intensities, try the circuit shown here. The photocell biases the transistor in the *forward* direction. The circuit has a residual dark current of about 0.3 ma.



At 1.5 foot-candles the output rises to about 0.8 ma. An output of 90 ma is observed at 150 foot-candles, which is approximated by a 75-watt lamp at a distance of 1 foot. Use a size-C or -D flashlight battery for power. Current drain is a little too high to get reasonable life from a penlight cell.—*I. Queen*

SCOPE ATTENUATOR

A cathode-follower stage (see Fig. 1) provides the best form of continuous (Vernier) attenuator for a wide-band scope. Its advantages are fredom from pattern bounce when the control is turned quickly, and also complete isolation of succeeding vertical stages from the circuit under test.

On the other hand, a cathode follower means an extra tube. It draws additional heater and plate current from

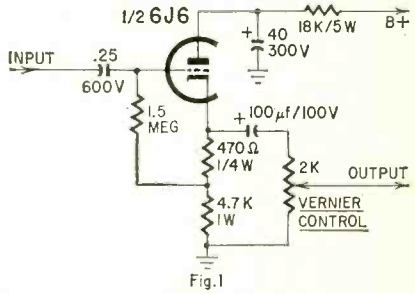


Fig. 1

the power supply In the low-cost area, these disadvantages loom large, both in home-constructed and commercial scopes.

Hence, if you want to eliminate the cathode follower from a wide-band scope, and get "gutless wonder" performance, use the configuration shown in Fig. 2.

This continuous control gives an attenuation range of better than 7 to 1, and fills in adequately between steps of a decade attenuator. Most important,

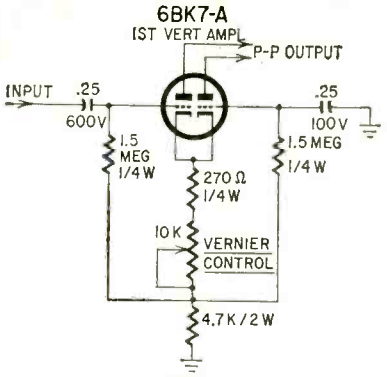


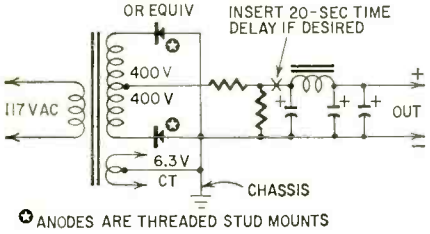
Fig.2

this configuration imposes no frequency distortion. Since it requires only a conventional potentiometer in addition to the components present in a standard vertical amplifier circuit, its cost represents an irreducible minimum.

Since this type of Vernier control necessarily has a time lag and causes pattern bounce when adjusted rapidly, this operating feature might be considered objectionable by some.—*Robert G. Middleton*

MOUNTING SILICON RECTIFIERS

When using stud-mounting silicon rectifiers, no special heat sink is needed if you mount them directly to the chassis. However, you must be sure that the anode connects to the stud. I used this method in building the circuit

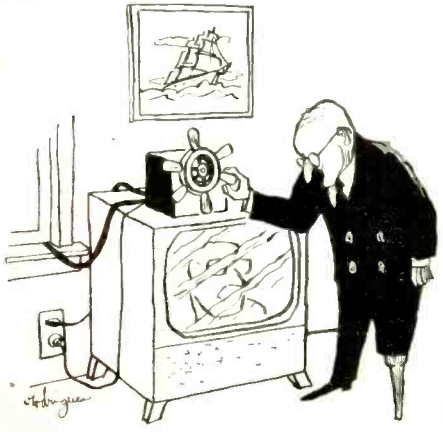


⊙ ANODES ARE THREADED STUD MOUNTS

shown here. It can also be used for half-wave rectifier applications.

In the circuit, note that, with no load during filament warmup, the B-plus may exceed the filter capacitor ratings. A time delay could be used here (point marked x in the schematic). A 20-second delay is suitable. It will also prevent cathode stripping.—*Herbert E. Pasch*

END

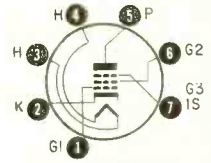


NEW TUBES and SEMI-CONDUCTORS

BOTH tubes and semiconductors are represented this month. In the predominant tube section is a 110° picture tube, a triple triode and a sharp-cutoff pentode. Bringing up the semiconductor division is a germanium n-p-n alloy junction transistor designed for complementary-symmetry circuits.

4EW6

A sharp-cutoff pentode in a 7-pin miniature envelope, designed for inter-



4EW6

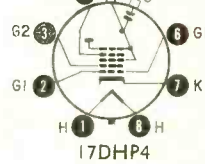
mediate amplifier service in TV receivers. Its 4.2-volt 600-ma heater has a controlled warmup.

Typical operating conditions for this Tung-Sol tube are:

V_P	125
V_{G2}	125
V_{G1} (pos)	0
g_m (μmhos)	14,000
R_K (bias) (ohms)	56

17DHP4

A 110° aluminized rectangular picture tube with a spherical faceplate and an external conductive coating. The



17DHP4

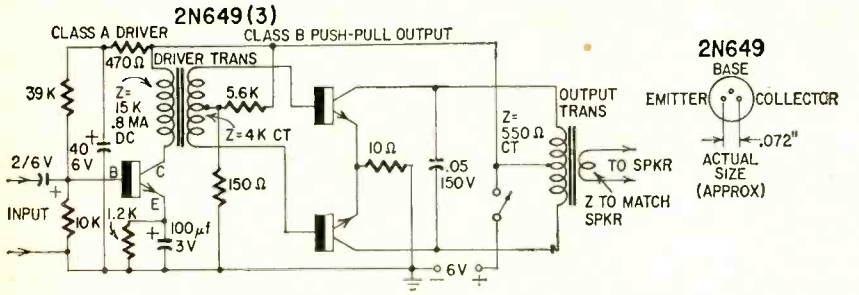
tube has a 6.3-volt 450-ma heater with controlled warmup for use in series-string heater circuits. Its straight-gun design eliminates the need for an ion trap.

Maximum ratings of this Westinghouse tube in grid-drive operation are:

V_{ultor}	16,000
V_{G4} (pos)	1,000
(neg)	500
V_{G2}	700
V_{G1} (neg bias)	140
(neg peak)	200
(pos bias)	0
(pos peak)	2

2N649

An n-p-n germanium alloy-junction transistor, designed for use with its p-n-p counterpart, the 2N408, in class-B complementary-symmetry power output stages of transformerless battery-operated portable radios. The unit may also be used in conventional class-B push-pull and class-A audio amplifier circuits.

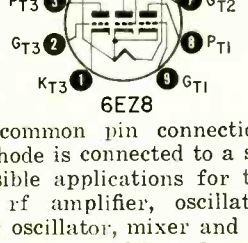


Maximum ratings of this RCA transistor in af amplifier service are:

V_{CB} (peak)			20
V_{CE} (peak)			18
V_{EB} (peak)			2.5
I_C		(ma)	50
	(peak)	(ma)	100
I_E		(ma)	50
	(peak)	(ma)	100
P_c	(mw)	(at 25°C)	100
	(mw)	(at 55°C)	50
	(mw)	(at 71°C)	20

6EZ8

Three triodes in a 9-pin miniature envelope make the tube ideal for use as a 1-tube tuner for the FM band. The cathodes of two of the three sections



have a common pin connection. The third cathode is connected to a separate pin. Possible applications for the tube include; rf amplifier, oscillator and mixer, or oscillator, mixer and afc.

Average ratings for each section of this G-E tube are:

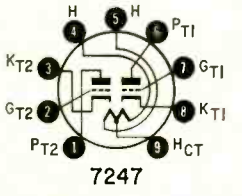
V_P			300
V_G	(pos dc)		0
	(neg dc)		50
P_P	(watts)		2
R_P	(K ohms)	(approx)	13.6
g_m	(μmhos)		4,200
μ			57

Sensistors

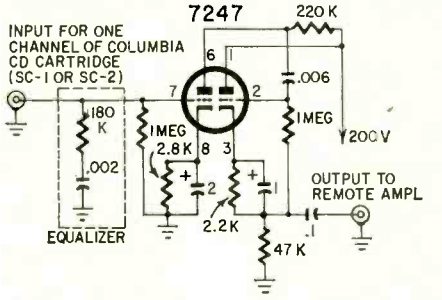
A series of temperature-compensating silicon resistors designed for temperature-sensing and temperature-compensating applications in amplifiers, computer switching circuits, servos and power supplies. In ¼- or ⅛-watt ratings, these resistors have an average temperature coefficient of +0.7%/°C. These units are made by Texas Instruments.

7247

A dissimiliar-section double triode for the first two stages of hi-fi amplification in one 9-pin miniature envelope. Section 1 is a hi-mu triode having low hum and noise output. It is intended for use as an amplifier for low-level inputs. Section 2 is a medium-mu triode having characteristics similar to those of a 6C4. It is suitable for cathode-follower or large-signal phase-inverter service.



The circuit shows an audio preamp with a cathode follower.



Design maximum ratings of this CBS tube are:

V_H		6.3	12.6*
I_H	(ma)	300	150*
		section 1†	section 2‡
V_P		330	330
V_G	(negative dc)	—55	—55
	(positive dc)	0	0
I_K	(average ma)	—	22
P_P	(watts)	1.2	3.0
R_G	(megohms)		
	(fixed bias)	15	0.5
	(cath bias)	—	1

*heater connected in series
†pins 6, 7 and 8
‡pins 1, 2 and 3

Matched audio tubes

For higher fidelity in push-pull amplifiers, CBS-Hytron is marketing a line of

matched-pair audio output tubes. Four types—6BQ5, 6V6-GT, 5881 and 6550—cover a broad range of outputs. END

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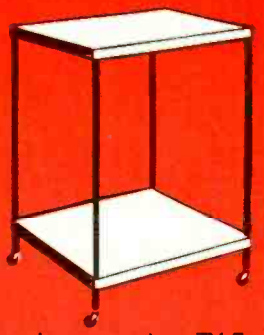
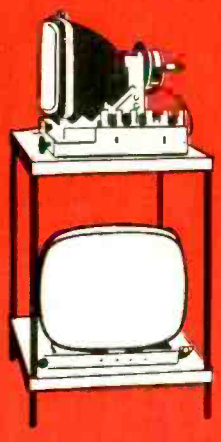
The RCA TV-Toter Table

SAVE LABOR! SAVE TIME! One of the most useful tools you've ever had in your shop, the RCA TV-Toter Table is constructed of 20 gauge reinforced steel with chrome-plated hardened-steel tubular legs, has a durable office grey hammer tone finish. Each table comes complete with four leg extensions and four casters to permit easy change-over from no-tilt table to handy roll-about unit. Measuring 24" x 24" x 33½" high, the RCA TV-Toter Table supports a TV chassis at convenient bench height.

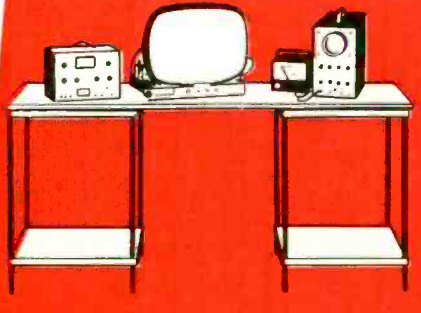


The handy, convenient-TV-Toter Table



Increase your storage facilities

Increase your service facilities



Use two TV-Toters as a fixed bench

Use three TV-Toters as a test bench with roll-out center section

Also available to build business

is the new RCA TV Service Auto Light. A rugged plastic display with built-in light and magnetic base, the TV Service Auto Light is a practical and convenient way to advertise your services and products to everyone who sees your parked car or truck. Also ask your RCA Tube Salesman about the many other RCA sales and servicing aids available to you all year 'round.

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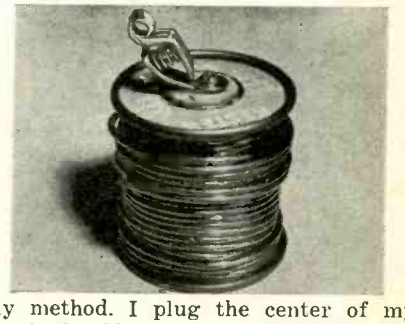
Authorized RCA Tube Distributor for details today!!

HEATHKIT PS-3 POWER SUPPLY

To increase the utility of this unit, mount a couple of extra binding posts on the front panel. Connect one to the cathode of one of the 0A2 regulator tubes and the other to the cathode of the other 0A2. This makes regulated fixed voltages of 150 and 300 available, both negative with respect to the B-minus terminal. These voltages are useful for bias in experimental circuits. Current drain of a few milliamperes is permissible.—*Charles Erwin Cohn*

ANOTHER THIRD HAND

Many service technicians have devised a third hand for holding parts while they are being soldered. Here is



my method. I plug the center of my spool of solder with a cork to which I have screw-fastened a test clip. The clip provides that often needed third hand and can be transferred from one spool of solder to another as solder spools are emptied.—*John Alexander*

NEW TV LINE CORD

When replacing a TV power cord, I do a neat job by cutting the old cord off the rivets with a pair of side cutters. I heat the end of the new cord in boiling water for a few minutes. This makes it easy to slip it over the existing rivets with the aid of a fine screwdriver.—*E. Skitsko*

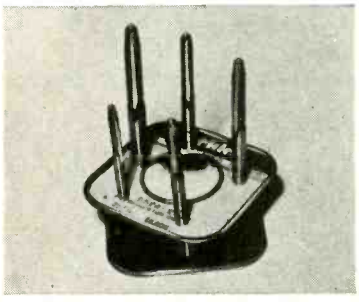
CLIP MAGAZINE OPEN

When I'm building an electronic device from plans printed in a copy of RADIO-ELECTRONICS, I find it convenient to hold the magazine open with a large

paper clip placed over the binder of the magazine. This way I can keep the magazine opened to the right page and, if the bench gets too crowded, I can hang it up on a nail driven into the shop wall.—*J. A. Comstock*

HANDY TAP STAND

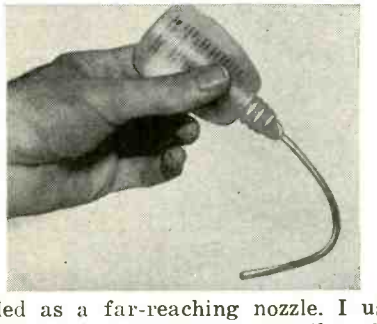
Before you decide to discard an empty spool that once contained hookup wire, consider making it into a handy stand for holding taps. Drill holes of



appropriate size through the upper flange to accept the taps, then rest them in the holes as shown. Or, if you need a small twist-drill stand, make it in the same way.—*Joe C. Allen*

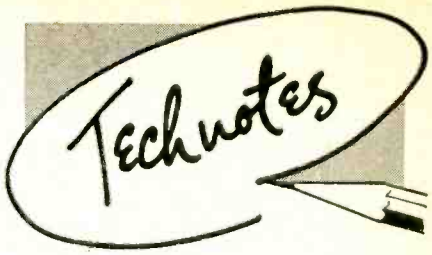
SERVICE SYRINGE

A little gadget I carry in my tool kit is handy as a service syringe. It's a plastic squeeze bottle with a length of small-diameter insulating spaghetti



added as a far-reaching nozzle. I use the tool as an oil can to apply oil to the drives of phonos and tape recorders. It might even be used to apply cleaner to noisy controls. There are probably many other uses which haven't yet occurred to me. In any event, it should be useful to other technicians confronted with everyday service problems.—*Scott Mack* END

"Expecting some night calls?"



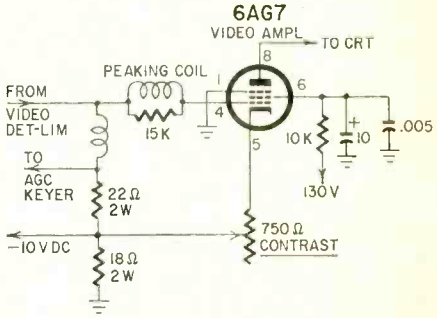
CHEVROLET MODEL 986515

If the set does not tune properly and all voltages and resistances check good, try changing the 160-$\mu\mu$f capacitor connected across the oscillator coil. This is a temperature-compensating unit, so make sure you replace it with a capacitor that has the same compensation rating.—*W. G. Eslick*

STROMBERG-CARLSON SERIES 116

The complaint was intermittent no picture. The set worked perfectly while I was in the house but, as the customer insisted on getting it fixed, I pulled the chassis to the shop.

High-voltage was present, but no video signal was being applied to the



picture tube. Careful circuit tracing during the periods the picture disappeared tracked down the trouble to a broken resistor in the grid–cathode circuit of the video amplifier. The 2-watt 22-ohm resistor had broken in half and any vibration would make the two pieces separate, temporarily blanking out the picture. I replaced the broken resistor with a 22-ohm 5-watt unit and normal operation was restored.—*D. Jacob*

CHANGER STYLUS SKIPS OR STICKS

There are three things to check when you run into this problem. First is stylus pressure. Too light and the stylus skips; too high and it may skip. Next is a worn stylus or one that is clogged with dirt or lint. A tone arm that does not pivot freely or whose movement is limited by tight pickup leads can also cause record skip.—*Mel Norton*

BLOWN HIGH-VOLTAGE FUSES

Next time you run into a set with a blown B-plus fuse give the circuit a quick check before inserting a new one. Simply connect a 500-ma meter in place of the fuse. Turn the set on and check the reading. It should be less, by about 50 ma, than the fuse's rating.

Even if the reading is normal, give

the horizontal output, damper and high-voltage rectifier tubes a rap or two with the eraser on the end of a pencil or a handy slug-tuning screwdriver. Any sudden jump in the reading is good reason for replacing the tube.

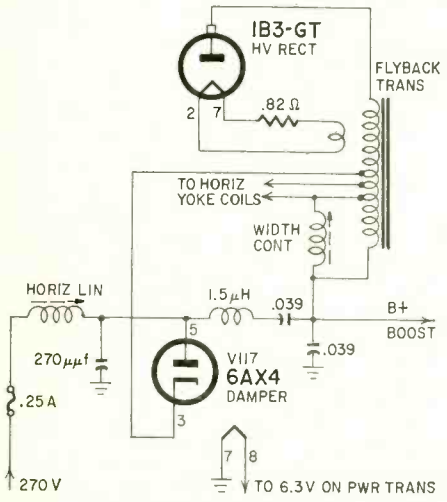
When a set is in the shop for flyback transformer replacement, another current reading should be checked. Insert the milliammeter between the cathode of the horizontal output tube and its cathode resistor. With the set operating, keep the current reading below 100 ma and definitely no higher than about 110 ma. Many replacement flybacks are rated only for this current. If higher currents do flow, the flyback you have just installed may not last out the week. —*C. S. Lawrence*

RCA MODEL 21T363

Complaint: No picture.

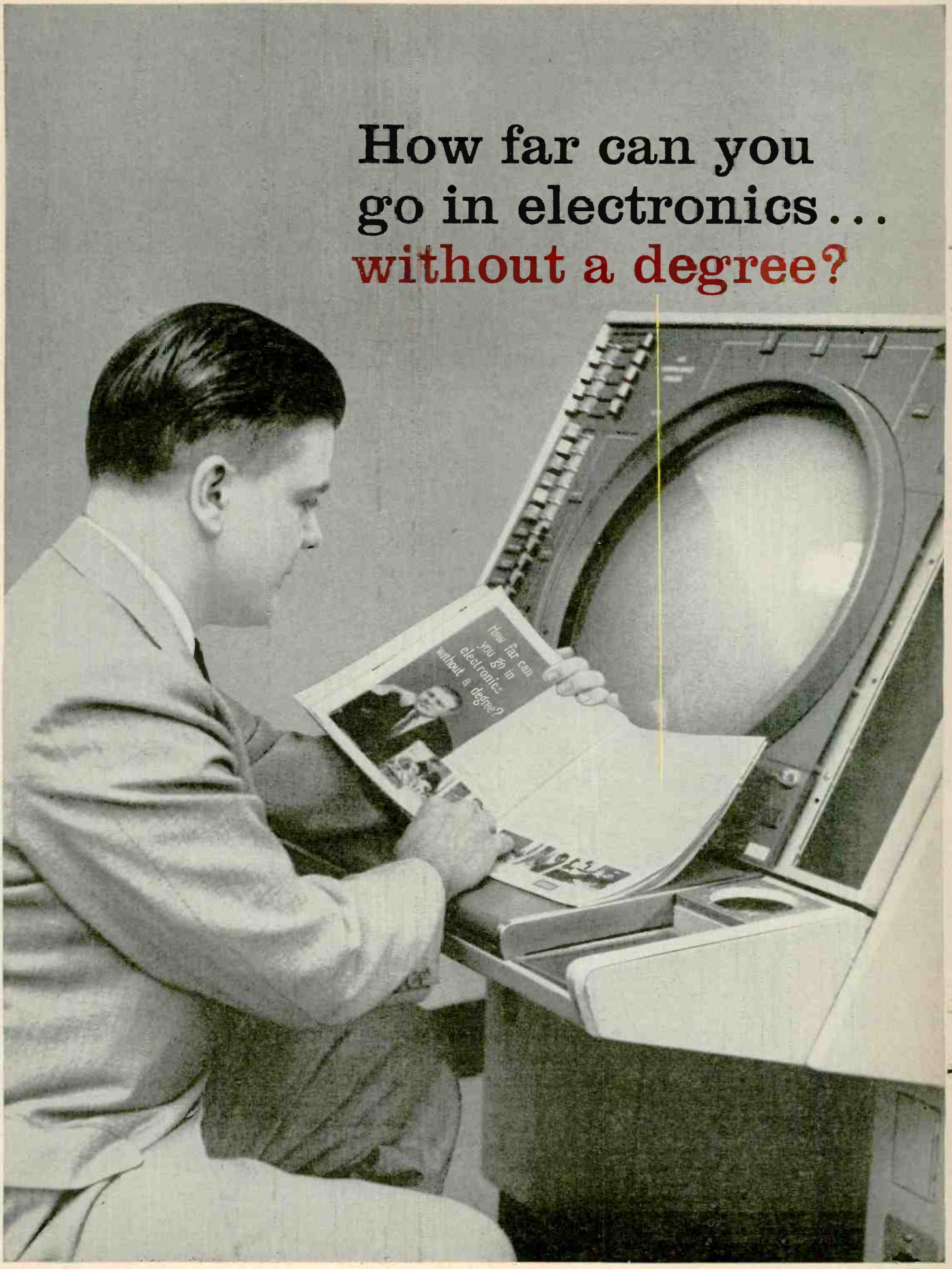
A check disclosed a blown fuse in the B-plus circuit. The ¼-amp unit was replaced and the set turned on. The 6AX4 damper sparked and the fuse blew again. A new 6AX4 and fuse were inserted. The set worked fine. However, later that day it went out again. A check showed the 6AX4 had a cathode-heater short and the fuse had gone once again.

At this point the set was pulled to the shop and the entire flyback and



damper circuits were checked. No high leakages of any type were found. The yoke and all capacitors were also checked—still no apparent defect. In desperation, coupling capacitors in the horizontal oscillator and output circuits were replaced, along with cathode and screen resistors. When hooked up, the set performed perfectly but, a week later, damper tube and fuse were gone once again. As a last resort the heater connections to the damper were connected to a separate 6.3-volt trasformer I added to the set's power supply. This did it; there was no further trouble. Apparently the 6AX4 couldn't take the 450 volts between its cathode and the grounded heater. The separate filament transformer lifted the heater off ground, putting an end to the problem and preventing a recurrence. — *Jacob Dubinsky*

END



How far can you go in electronics... without a degree?

At the SAGE display console, Dick Brani reads 1957 magazine story about his IBM career.

Dick Brani (right) discusses the new SAGE "memory" with a field engineer.

Two years ago, when Richard F. Brani was first asked to review his field engineering progress at IBM, he'd been recently promoted to computer instructor. Now, he has a new and more crucial responsibility: Group Manager of 20 field engineers who keep a SAGE computer operating at its peak, bulwarking America's air defenses. Here's his story.

GIVEN IMPORTANT ASSIGNMENT. "In my first four years with IBM, my field engineering career has taken several giant steps forward—despite my lack of a college degree," reports Dick Brani. "When I joined the Company, my special training consisted of graduation from a technical school, an F.C.C. license, and some Army engineering training. Now, I have a responsible management job in the SAGE Project, my knowledge of electronics has grown tremendously, and my future looks as promising as I could wish it.

"How did I make this progress? IBM believed that—after comprehensive training—technicians like myself could handle assignments generally performed by graduate engineers. And IBM was proved right. Hundreds of technicians are now functioning successfully as IBM field engineers."

20 WEEKS' COMPUTER TRAINING. Dick Brani joined IBM in the fall of 1955. He was immediately enrolled in a 20 weeks' computer units training program. "You learn how the different units of large-scale computers like SAGE operate . . . how the computer itself can help diagnose and locate trouble . . . and how to make fast, precise repairs," he says. "Once assigned to a SAGE site, field engineers may also attend classes—during regular working hours, by the way—to keep up with advanced developments in electronics. Our site, for example, recently had a course on the new, increased-capacity SAGE 'memory'."

ADVANCES RAPIDLY IN FOUR YEARS. I know of few other companies that offer technicians better or more valuable training than IBM," Dick Brani says. "It can prove an 'open sesame' to engineering and management opportunities not usually available to men without college degrees. It was for me."

After his training, Dick Brani's abilities won him a position as instructor in IBM's education program. For two years, he taught courses in computer units and systems. Then, a little over a year ago, he was promoted to Group Manager of 20 field engineers assigned to install—and maintain—a SAGE computer at a new site. "I'm responsible for the successful operation of the computer. I have to check out repairs my men do, schedule maintenance activities, and supervise all new engineering changes."

Introducing a new field engineer to SAGE operations.

WHAT IS SAGE? SAGE is a vital part of America's air defense system. At the core of the SAGE system is a network of fast, extremely reliable electronic computers. In each sector of our nation, a SAGE computer is constantly in operation, 24 hours a day, helping the Air Force prevent surprise aerial attacks. Here's how SAGE works: The computer receives radar data from many observation points. It checks this information against known air traffic for the sector, and presents to the Air Force a pictorial display of the air situation. And, if need be, the computer can guide a BOMARC missile to a target for certain interception.

COUNSELING TO DEVELOP STRONG LEADERS. "My most challenging duty as a SAGE Group Manager? Helping the men in my group advance and develop," replies Dick Brani. "One way I do this is by periodically rotating my men so that they become familiar with all phases of large-scale computer operation. But the most effective way is through counseling—just sitting down with a man and discussing his progress, his prospects, his career goals. IBM encourages frequent and intensive counseling. This is how the Company finds and develops the strong leaders it needs to stay at the head of its field."

SAGE PROGRAM STILL GROWING. "My future? I can advance to still more important responsibilities in SAGE field engineering," says Dick Brani. "SAGE has grown tremendously since its inception a few years ago, and it's still growing rapidly. Or, I can move into major spots in education, personnel, management, development engineering—or nearly any activity you can name. My future at IBM is limited only by my ability as an individual."

* * *

If you have a minimum of 3 years' technical schooling after high school—or equivalent experience—you may be eligible for 20 weeks' training as a computer units field engineer. While training, you receive full pay plus living allowance.

IBM is the leader in a field that offers unlimited horizons. And, as you may already know, at IBM you receive company-paid benefits that set standards for industry today.

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Military Products Division
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Kingston, N. Y.

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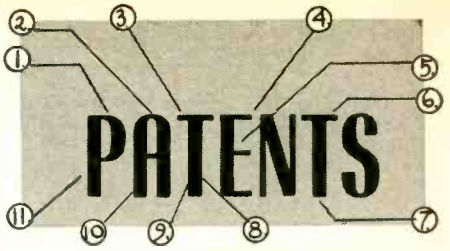
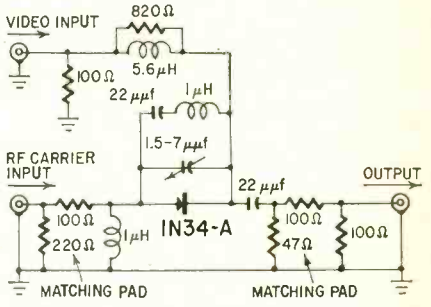


VIDEO MODULATOR

Patent No. 2,875,414

Steven Wiasuk, Brooklawn, N. J. (Assigned to RCA)

Here is a useful modulator for a video test generator. Carriers from 54–88 mc (channels 1 through 6) can be modulated up to 70% by video signals.



The 22-$\mu\mu$f capacitors are for blocking. The 1-μh coil across the 1N34 neutralizes the inherent capacitance of the diode. With the variable capacitor it is tuned for parallel resonance, and, therefore, high impedance at carrier frequencies.

A 1-μh choke across the carrier input bypasses any video that may be present there. The 5.6-μh peaking coil flattens the response throughout the video band.

TRANSISTOR SWITCH

Patent No. 2,855,524

William Shockley, Fullerton, Cal. (Assigned to Bell Telephone Labs)

This is Shockley's famous switch, a tiny two-lead device with immense possibilities. With the polarity shown (Fig. 1) the central junction is reverse-biased and the switch is open. Increasing the bias (with a pulse from the control source,

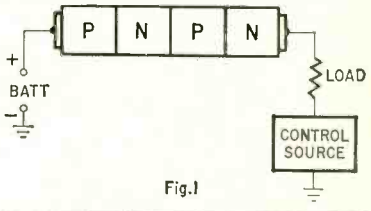


Fig.1

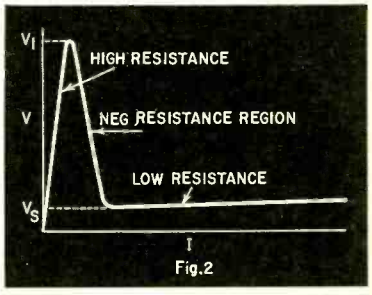


Fig.2

for example) breaks down the junction and the switch is shorted.

Fig. 2 shows the three regions of a typical operating curve. The negative resistance cannot be observed but it serves to trigger the switch from low resistance to high (or vice versa). Conduction may be sustained with relatively low current, after the breakdown.

The patent also describes manufacturing processes to convert a silicon ingot into the finished transistor.

LOUDNESS INDICATOR

Patent No. 2,808,475

Norman R. Stryker, E. Orange, N. J. (Assigned to Bell Telephone Labs, Inc., New York, N. Y.)

Loudness is a function of human hearing and, for a given signal level, varies with frequency. This instrument is designed to indicate

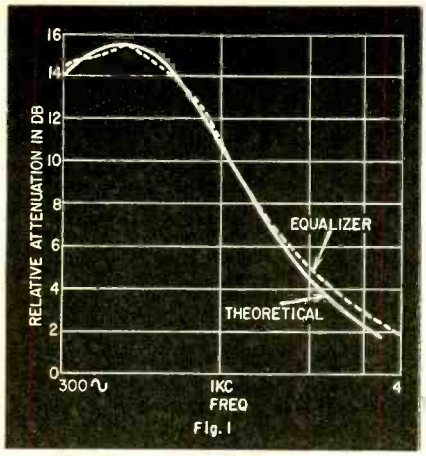


Fig. 1

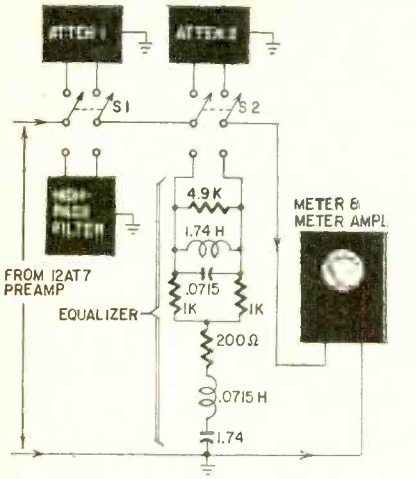


Fig. 2

relative loudness of speech on telephone circuits where the passband is from about 300 to 3,300 cycles. Telephone engineers have computed the response curve needed to equalize for the difference between actual intensity and apparent loudness. This is shown in Fig. 1. The response of a practical equalizer is also shown.

The loudness indicator uses 4 tubes (not shown) plus the equalizer circuit in Fig. 2. The equalizer is inserted into the circuit when switch S2 is down. With S1 also down, a high-pass filter removes frequencies below 300 cycles, which are not ordinarily passed in telephony.

For operation as a conventional volume indicator, the switches are thrown up. ATT 1 compensates for the loss in the high-pass filter, ordinarily 0.3 db. ATT 2 is designed to compensate for the equalizer loss at 450 cycles (at which frequency the loss is maximum). END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In July, 1909, *Modern Electrics*

Dr. Branly's New Apparatus, by A. C. Marlowe.

Wireless in China.

Alternating Current Battery.

Tungsten Oscillation Valve.

Antennae, by Greenleaf W. Pickard.

Wireless Stations About New York. No. 1-Station at the Plaza Hotel.

Recent Developments in Aerophony, by Lee de Forest, Ph.D.

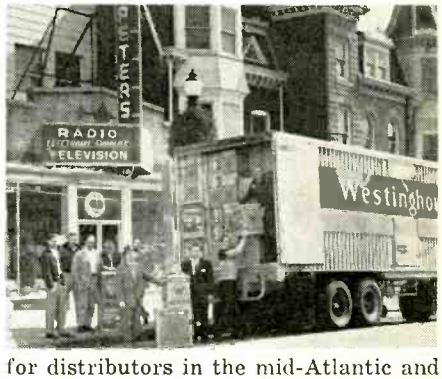
BUSINESS and PEOPLE

Vaco Products Co., Chicago, is featuring a colorful Red Cap screwdriver dis-

play unit, holding a selection of 66 screwdrivers of all popular sizes and types.

Raytheon Co. Distributor Products Div., Newton, Mass., is revitalizing its Bonded Dealer program. A written 90-day repair bond is one of the features of the new program which will be supported with consumer magazine and radio advertising.

Westinghouse Electronic Tube Div., Elmira, N. Y., has established its own truck delivery service on picture tubes



for distributors in the mid-Atlantic and New England states. Photo shows one of the first shipments arriving at A. A. Peters, Inc., Allentown, Pa.

Jensen Industries, Forest Park, Ill., designed a hanging show window for its diamond phonograph needles. The

"Diamondangler" rack or wall hanger mounts six assorted diamond needles with spare parts, tools and a warranty with each unit.

Switchcraft, Inc., Chicago, is offering distributors and dealers a new point-of-purchase display for its interconnecting

cords. It is available through a package deal which includes the display and 17 of the most popular interconnecting cords.

Milton R. Schulte, executive vice president of Tung-Sol Electric, Inc., Newark, N. J., was elected president.

Louis Rieben, former president, becomes chairman of the board. Schulte will be the chief executive officer.

Frank Randall, president of Amperex Electronic Corp., was elected a vice president of the parent company, North American Philips Co., Inc., Hicksville, N. Y. He retains his position as president of Amperex and vice president and director of Ferroxcube Corp., Saugerties, N. Y., another affiliate of Philips.

Richard L. Jacobson was promoted to dealer sales administrator of the Heath Co., Benton Harbor, Mich. Previously he was in charge of the Competitive Analysis Laboratory.

Tom D. Brown was elected vice president of Oxford Components, Inc., Chicago, a subsidiary of Oxford Electric Corp. Since he took over this distributing division of the company 2 years ago, it has doubled its sales.

Aurel G. Petrasek (left) was appointed manager, advanced market planning, Industrial Tube Products Dept., RCA Electron Tube Div., Harrison, N. J. He was formerly manager,

OPPORTUNITY ADLETS

Rates—50c per word (including name, address and initials). Minimum ad 10 words. Cash must accompany all ads except those placed by accredited agencies. Discount, 10% for 12 consecutive issues. Misleading or objectionable ads not accepted. Copy for September issue must reach us before July 15, 1959

RADIO-ELECTRONICS,
154 West 14 St., New York 11, N. Y.

CASH PAID! Sell your surplus electronic tubes. Want unused, clean transmitting, special purpose, receiving, TV types, magnetrons, klystrons, broadcast, etc. Also want military & commercial lab test and communications gear. We swap too, for tubes or choice equipment. Send specific details in first letter. For a fair deal write, wire or telephone: BARRY, 512 Broadway, New York 12, N.Y. WAlker 5-7000.

SELF SERVICE TUBE TESTERS. Now you can trade-in your obsolete testers at Calex Manufacturing Company for latest model, 123 socket console model 603. We allow $65 trade-in value for every unit—any make, any model. CALEX MANUFACTURING, INC., Amityville, N.Y.

HI-FI, Recorders, Tapes. FREE Wholesale Catalogue. CARSTON, 125-T East 88th St., New York 28, N. Y.

STEREO TAPE RENTALS. For the very best at lowest prices. Write CALIFORNIA TAPED MUSIC ASSN., 763 El Camino Real, Redwood City, Calif.

DISCOUNTS UP TO 50% on Hi-Fi amplifiers, tuners, speakers, tape recorders, individual quotations only, no catalogs. CLASSIFIED HI-FI EXCHANGE, 2375 East 65th Street, Brooklyn 34, N.Y.

TAPE RECORDERS: We Will Not Be Undersold! We meet any competition! Send us any competitor's advertising, showing a lower price for a tape recorder and we will not only MEET this lower price, but will include, with your purchase, a 1200 foot tape of your choice, FREE! (73 models in stock). COMMISSIONED ELECTRONICS, 1776 Columbia Road, Washington, D. C.

IF YOU HAVE a background in electronics, but are having trouble passing FCC phone exams, my 12 years experience as chief instructor of electronics school can help you over the hump. Not a course. Write me personally for free information. WALLACE COOK, 1614E Morson Road, Jackson 9, Miss.

LABORATORY QUALITY equipment and Military Surplus Electronics bought, sold. ENGINEERING ASSOCIATES, 434 Patterson Road, Dayton 9, Ohio.

ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. HAZELTON INSTRUMENT Co., 128 Liberty Street, New York, N.Y.

JOBS in foreign countries. Men-Women. Free job reports. DAVENPORT FOREIGN COMPANY, 1354-AA, GPO, New York 1, N. Y.

FREE WRITERS CATALOGUE giving manuscript markets. Write LITERARY AGENT MEAD, 915 Broadway, New York 10, N. Y.

DIAGRAMS FOR REPAIRING RADIOS $1. Television $2. Give make, Model. DIAGRAM SERVICE, Box 672-RE, Hartford 1, Conn.

POPULAR SUPER PRO BC779. Checked out and guaranteed to please, $74.50. Power supply extra, $24.50. GIZMOS & SUCH, Still River, Massachusetts.

1,000 NAME AND ADDRESS LABELS in plastic box $1. HEIGHTS INDUSTRIES, Capitol Heights 27, Maryland.

CAMERA Repairmen greatly needed! You can learn manufacturers' service methods at home, in your spare time! Free, big illustrated book tells how! Write today. NATIONAL CAMERA REPAIR SCHOOL, Dept. RE-7, Englewood, Colorado.

PROFESSIONAL Electronic Projects—Organs, Timers, Intercoms, Counters, etc. $1 each. List Free. PARKS, Box 1665, Lake City Station, Seattle 55, Wash.

SEALED CARTONS: TechMaster 60W $60; Bell T208 $210; GE Arm A1-500 $22; Karlson 15U $60; Catalog Free. HIFI, Roslyn, Pa.

CALCULUS or Algebra, Easy Practical Lessons, First Four $1. MATHCO, 4256-4 Miramor, Cincinnati 17, Ohio.

NEW 1959 AUTOMOBILES to 25% off retail prices. Delivered anywhere. MEDER, 550-RE Fifth Avenue, New York 36, N. Y.

SONGPOEMS and LYRICS WANTED! Mail to: TIN PAN ALLEY, INC. 1650 Broadway, New York 19, N. Y.

UNUSUAL VALUES. Hi Fi components, tapes and tape recorders. Send for package quotations. STEREO CENTER, 51 West 35th St., New York 1, N.Y.

APPLIANCE Parts Wholesale. Catalogue 25c. SECO, 26 South 20 Street, Birmingham 3, Alabama.

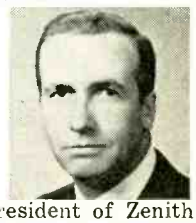
RADIO & TV TUBES at Manufacturers Prices! 100% Guaranteed! Brand New! No re-brands or pulls! UNITED RADIO, Box 1000, Newark, N.J.

THE LAW OF LIFE revealed and How to apply it. $2. THE OPEN WAY, Celina, Tenn.

merchandising—receiving tubes. **Joseph A. Haimes** (right) is now manager, administration and controls, Distributor Products, Dept., for the division. He had been manager, merchandising—entertainment tubes. The following promotions were made in the merchandising activity of the department: **Gerald G. Griffin** to manager, merchandising—parts and equipment; **Joseph J. Kearney** to manager, merchandising—entertainment tubes, and **Morris S. Lewis** to manager, merchandising coordination.

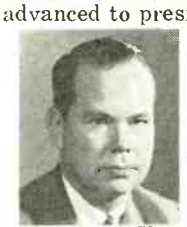
George W. Griffin (right) and **George P. Norton** (left) were elected vice presidents of General Telephone & Elec-

tronics Corp., parent company of Sylvania Electric Products. Griffin, who was a Sylvania vice president in charge of public relations, will guide public relations for General Telephone. Norton, formerly public relations director for the corporation, will now handle financial and stockholder relations and various advertising programs.



John A. Mayberry was appointed merchandising manager for dealer products for CBS Electronics, Danvers, Mass. He had been with Sylvania.

Hugh Robertson, president of Zenith Corp., Chicago, advanced to the position of chairman of the board. He continues as chief executive officer. **Joseph S. Wright** (left), executive vice president, advanced to president and general man-



ager. **Sam Kaplan** becomes executive vice president and assistant general manager and continues as treasurer. **Leonard C. Truesdell** (right), vice president and director of sales, was elected executive vice president, marketing.

Obituaries

Dr. Louis N. Ridenour, Jr., former chief scientist for the United States Air Force and one of the nation's leading nuclear physicists, at Washington, D.C. Age 47.

Dudley A. Buck, assistant professor of electrical engineering at Massachusetts Institute of Technology, of virus pneumonia, age 32. He was famous as the developer of the cryotron, a minute magnetic type amplifier consisting of a few turns of wire wrapped around another wire, operated at temperatures near absolute zero. END

LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

PORTABLE TAPE RECORDERS for professional and other uses are shown and described in *circular No. 6004*. The 6-page catalog shows pictures, operating specifications and prices for units that operate at speeds from 1 15/16 to 15 ips. —**Amplifier Corp. of America,** 398 Broadway, New York 13, N. Y.

1959 INDEX *Supplement* to the *Master Index of Most-Often-Needed Television and Radio Servicing Information* is now available. The *Master Index* issued in 1958 covers television servicing information from 1948 through 1958 and radio from 1926 through 1958.—**Supreme Publications,** 1760 Balsam Road, Highland Park, Ill. 5¢. Master Index 25¢.

TRANSMITTING TUBE CHART in application note *AN-178* gives frequency and power output for several tubes in class-C operation. The chart shows maximum power output, upper frequency limit, and lists the services covered within the frequency limit.—**RCA Electron Tube Div.,** Harrison, N. J.

TRANSISTOR GUIDE and interchangeability chart which may be hung on the wall measures 19 x 25 inches. It shows over 200 types, along with typical applications and heat-radiator requirements. —**Raytheon distributors or Raytheon Mfg. Co.,** 55 Chapel St., Newton 58, Mass.

TUBE TESTER CHART lists 800 tube types with provision for adding new pages in a plastic binding. For use with all tube testers made by the company. —**Vis-U-All Products Co.,** 303 Fuller Ave., N.E., Grand Rapids, Mich. $1.

CERAMIC PICKUPS for phono disc playback are discussed in relation to magnetic units in *"Why a Ceramic Cartridge?", bulletin E-325.*—**CBS-Hytron Adv. Service,** Parker St., Newburyport, Mass.

CABINET KITS and assembled units, both finished and unfinished, are pictured and described in detail in a 4-page brochure. Seven models are shown, including inexpensive speaker kits, bookshelf and larger speaker enclosures, an equipment cabinet and record storage

units. These cabinets and kits are sold only by mail.—**Homewood Industries, Inc.**, 26 Court St., Brooklyn 1, N. Y.

LOUDSPEAKER CATALOG *165-C* is a 16-page bulletin describing a complete line of cabinets, speaker drivers, crossovers and driver kits for home cabinet builders. — **Jensen Mfg. Co.**, 6601 S. Laramie St., Chicago 38, Ill.

TRANSISTOR CHARACTERISTICS and interchangeability for 700 types are shown in the second edition of the *Transistor Guide.* — **Sylvania Electric Products, Inc.**, 100 Sylvan Rd., Woburn, Mass. 10¢.

MICROPHONES and mike stands are pictured and specifications and prices listed in an 8-page catalog. A complete line of over 35 microphones for a wide variety of applications is covered.—**Turner Co.**, Cedar Rapids, Iowa.

SURPLUS GEAR as well as a great variety of standard parts are listed in *catalog 118*, a 52-page book. Special buys on some high-fidelity components, TV cabinets, surplus dynamotors and inverters, as well as a selection of government transmitting and receiving equipment are shown.—**Arrow Sales, Inc.**, 2534 S. Michigan Ave., Chicago, Ill.

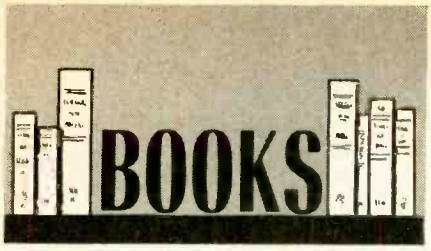
PUBLIC-ADDRESS SPEAKERS, drivers, horns and accessories are shown in an 8-page *P.A. Product Catalog.* The company's complete PA line, including portable megaphones, paging and talkback units, plus a brief listing of their high-fidelity drivers and enclosures are included. Prices are on a separate sheet. —**University Loudspeakers, Inc.**, 80 S. Kensico Ave., White Plains, N. Y.

TRANSISTOR CHART showing interchangeability between various manufacturers lists over 500 types. Compiled by a maker of machines for producing semiconductors, this useful aid includes characteristics of each type.—**Kahle Engineering Co.**, 3322 Hudson Ave., Union City, N. J. **6¢ in stamps.**

ELECTRONIC ORGANS are pictured, and kits for building either a consolette or concert organ are described in this 16-page booklet. Prices of various kits and instruction manuals and demonstration record are included.—**Schober Organ Corp.**, 2248 Broadway, New York 24, N. Y.

TV PICTURE-TUBE *comparison chart for hanging on the wall* gives information on monochrome types from 7- through 30-inch screens. The most popular, 17 through 21 inches, are highlighted for easy reference. Also available is a small pocket *TV Tube Selector Guide* with the same information condensed for carrying in a tube caddy. —**Sylvania Electric Products**, 1100 Main St., Buffalo, N. Y.

SERVICE ORDER BOOK for radio–TV service work is described and a full-size sample order blank shown in a 2-color brochure. Developed as a business aid to the service technician.—**Electronic Publishing Co.**, 180 N. Wacker Drive, Chicago 6, Ill. END



ELEMENTS OF RADIO (4th Edition), by Abraham and William Marcus. Prentice-Hall Inc., 70 Fifth Ave., New York 11, N.Y. 6 x 9¼ in., 667 pp. $7.

A new edition of a fine basic radio text. It is intended for use as part of a 1-year course in basic radio. Well illustrated with numerous diagrams, schematics and photos, it is easy to read and understand. Starting with the history of communication, the authors lead the student into wave motion, a simple receiving set, the detector, electron flow in the tuning circuit. More advanced sections deal with the superheterodyne receiver, resonant circuits and tuning principles and the modulated-wave transmitter.—*LS*

RAPID RADIO REPAIR, by G. Warren Heath. Gernsback Library, Inc., 154 West 14th St., New York 11, N.Y. 5½ x 8½ in. 224 pp. $2.90.

For many years, radio repair has been neglected in favor of TV, but now FM, portables, transistor sets and hybrid auto radios are reviving interest in radio.

There are four sections in this book: receiver types, techniques, servicing, charts. These are subdivided into various topics including intermittents, noise, radiation, drift, codé interference and others. AM, FM and transistor radios, vibrator and printed circuits, modules and cabinet repairs are covered. The final section lists numerous symptoms for quick troubleshooting.

The guide is alphabetically arranged for quick reference and convenient use at the bench.—*IQ*

RADIO ENGINEERING HANDBOOK (5th edition), edited by Keith Henney. McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y. 6 x 9 in. 1,800 pp. $25.

The latest edition of this handbook is still the quickest means of finding electronic information. TV, communications, facsimile and related engineering are all covered. Of the 28 chapters, some are entirely new and others have been revised by a staff of specialists. Chapters include avigation radio, cavity resonators, code, ac measurements, nonlinear circuits, transistors, etc.

There are many hundreds of standards, definitions, formulas, diagrams and schematics. Emphasis is on the practical side of design and engineering. A master index covers all chapters.

KNOW YOUR OSCILLOSCOPE, by Paul C. Smith. Howard W. Sams & Co., Inc., Indianapolis 6, Ind. 5½ x 8½ in. 151 pp. $2.

The oscilloscope is an unmatched tool for measurement, repair and alignment. This author clearly explains the instrument and its circuits. He tells

SCHOOL DIRECTORY

how to use it and how to service it when that becomes necessary. The book has several chapters on applications in measurement, testing, alignment and signal tracing. Probes, calibrators and other accessories are also described. —*IQ*

TELEVISION SERVICING (3rd Edition), by Walter H. Buchsbaum. Prentice-Hall Inc., 70 Fifth Ave., New York 11, N.Y. 6¼ x 9¼ in. 369 pp. $6.75.

Latest edition of a popular text on TV servicing. In the new edition are the latest circuits, troubleshooting techniques, transistor TV receiver, remote control tuning, troubleshooting printed wiring, module construction and packaged circuits.—*LS*

RIDER'S TELEVISION–TRANSISTOR RADIO–HOME RADIO MANUAL. John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, N. Y. 12½ x 15¾ in. Pages equivalent to over 1,800 if 8½ x 11 inches. $27.

A compilation of original manufacturers' circuit diagrams, alignment data, tube layouts, dial-stringing guides and other valuable servicing information on TV, transistor and home radios made in the period from October, 1958, through January, 1959. The TV section covers 20 manufacturers and brands, the transistor section covers 11 and the home-radio section lists 16 brands of AM and FM receivers and radio–phono combinations. The accompanying cumulative index (separate) lists the contents of Vols. 1 through 25 of the Rider Manuals.

FOUNDATIONS OF WIRELESS (7th Edition), by M. G. Scroggie. Iliffe & Sons, Ltd., Dorset House, Stamford St., London SE 1, England. 5½ x 8¾ in. 388 pp. 15s.

This edition of a very popular introduction to radio (over 170,000 copies since 1936) brings it up to date. With his usual clarity the author explains radio, TV, transmitters, radar and other electronic subjects. The book provides beginners with a good basic understanding of theory and applications with little math.

The first chapter tells how to use symbols and graphs. This is followed by a discussion of voltage, phase, tuned circuits, tubes and other basics. There is detailed discussion of the superhet, audio amplification, cathode-ray tube and transistors. Highly recommended to students who want much more than a superficial or "popular" introduction to radio and electronics.—*IQ*

TELEVISION RECEIVER SERVICING (4th Edition), by Milton S. Kiver. D. Van Nostrand Co. Inc., 120 Alexander St., Princeton, N.J. 8¼ x 11 in., 320 pp. $5.95.

As this subject is of interest to the service technician, practical application is stressed and theory is minimized. This latest edition has 150 new illustrations and a new chapter on operating and servicing color TV. Another added section is a TV Defect Directory, in which the author summarizes many possible defects and their probable causes.—*LS*

ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

SCHOOL DIRECTORY PAGE 120

Baltimore Technical Institute
Candler System Co.
Indiana Technical College
Milwaukee School of Engineering
Pacific International College of Arts & Sciences
Tri-State College
Valparaiso Technical Institute

BRANCH ADVERTISING OFFICES: Chicago: 5500 N. Menard Ave., Chicago, Ill., Spring 4-1444. Los Angeles: Harker-Husted-Coughlin, 600 South New Hampshire, Tel. DUnkirk 7-2328. San Francisco: Harker-Husted-Coughlin, 444 Market St., Tel. GArfield 1-2481.

FOREIGN AGENTS: Great Britain: Atlas Publishing and Distributing Co., Ltd., 18 Bride Lane, London E.C. 4.

Printed in the United States of America

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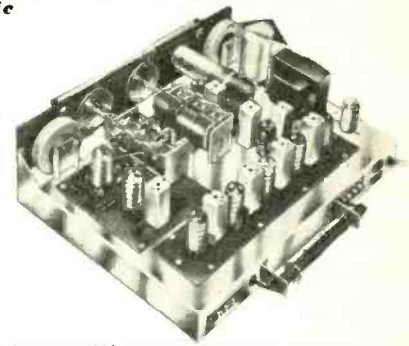
LAFAYETTE STEREO TUNER KIT

Use it as a Binaural-Stereophonic FM-AM tuner
Use it as a Dual-Monaural FM-AM tuner
Use it as a straight Monaural FM or AM tuner

KT-500 IN KIT FORM
74.50 7.45 DOWN 7.00 MONTHLY
LT-50 COMPLETELY WIRED 124.50
12.45 Down—10.00 Monthly

THE MOST FLEXIBLE TUNER EVER DESIGNED

- Multiplex Output for New Stereo FM
- 11 Tubes (including 4 dual-purpose) + Tuning Eye + Selenium rectifier Provide 17 Tube Performance
- 10KC Whistle Filter • Pre-aligned IF's
- Tuned Cascode FM • 12 Tuned Circuits
- Dual Cathode Follower Output
- Separately Tuned FM and AM Sections
- Armstrong Circuit with FM/AFC and AFC Defeat
- Dual Double-Tuned Transformer Coupled Limiters.



More than a year of research, planning and engineering went into the making of the Lafayette Stereo Tuner. Its unique flexibility permits the reception of binaural broadcasting (simultaneous transmission on both FM and AM), the independent operation of both the FM and AM sections at the same time, and the ordinary reception of either FM or AM. The AM and FM sections are separately tuned, each with a separate 3-gang tuning condenser, separate flywheel tuning and separate volume control for proper balancing when used for binaural programs. Simplified accurate knife-edge tuning is provided by magic eye which operates independently on FM and AM. Automatic frequency control "locks in" FM signal permanently. Aside fram its unique flexibility, this is, above all else, a quality high-fidelity tuner incorporating features found exclusively in the highest priced tuners.

FM specifications include grounded-grid triode low noise front end with triode mixer, double-tuned dual limiters with Foster-Seeley discriminator, less than 1% harmonic distortion, frequency response 20-20,000 cps ± ½ db, full 200 kc bandwidth and sensitivity of 2 microvolts for 30 db quieting with full limiting at one microvolt. AM specifications include 3 stages of AVC, 10 kc whistle filter, built-in ferrite loop antenna, less than 1% harmonic distortion, sensitivity of 5 microvolts, 8-kc bandwidth and frequency response 20-5000 cps ± 3 db.

The 5 cantrols of the KT-500 are FM Volume, AM Volume, FM Tuning, AM Tuning and 5-position Function Selector Switch. Tastefully styled with gold-brass escutcheon having dork maroon background plus matching maroon knobs with gold inserts. The Lafayette Stereo Tuner was designed with the builder in mind. Two separate printed circuit boards make construction and wiring simple, even for such a complex unit. Complete kit includes all ports and metal cover, a step-by-step instruction manual, schematic and pictorjal diagrams. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 22 lbs.

The new Lafayette Model KT-500 Stereo FM-AM Tuner is a companion piece to the Models KT-300 Audio Control Center Kit and KT-400 70-watt Basic Amplifier Kit and the "Triumvirate" of these 3 units form the heart of a top quality stereo hi-fi system.

KT-500 ..... Net **74.50**
LT-50 Same as above, completely factory wired and tested..... Net **124.50**

NEW! LAFAYETTE PROFESSIONAL STEREO MASTER AUDIO CONTROL CENTER

KT-600 79.50 IN KIT FORM
7.95 Down
8.00 Monthly

LA-600 COMPLETELY WIRED 134.50

The Lafayette KT-600 Solves *Every* Stereo/Monaural Control Problem!

- **UNIQUE STEREO & MONAURAL CONTROL CENTER FACILITIES!**
- **OUTSTANDING PERFORMANCE SUPERIORITY!**
- **AMAZING NEW BRIDGE CIRCUITRY & CONTROL FOR 3d CHANNEL OUTPUT FOR 3-SPEAKER STEREO SYSTEMS!**
- **VARIABLE CROSS-CHANNEL SIGNAL FEED ELIMINATES "PING-PONG" EFFECTS!**
- **PRECISE "NULL" BALANCING & CALIBRATING SYSTEM — BETTER THAN METERS!**
- **24 EQUALIZATION POSITIONS PER CHANNEL!**
- **CLUTCH-TYPE DUAL VOLUME-BALANCE CONTROLS!**

• RESPONSE 5-40,000 CPS ± 1 DB • TAPE HEAD PLAYBACK EQUALIZATION FOR NEW 4-TRACK STEREO • 2.2 MILLIVOLTS SENSITIVITY FOR 1 VOLT OUT • LESS THAN .03% IM DISTORTION • 6 CONCENTRIC FRONT PANEL CONTROLS • 4 CONCENTRIC REAR PANEL INPUT LEVEL CONTROLS • 180° ELECTRONIC PHASE REVERSAL

A REVOLUTIONARY DEVELOPMENT IN STEREO HIGH FIDELITY. Provides such unusual features as a Bridge Control, for variable cross-channel feed for elimination of "ping-pong" (exaggerated channel separation) effects and for control of a 3d-channel output for 3-speaker stereo systems; the 3d-channel output also serves for converting stereo program material to high quality monaural for recording or to play a stereo program monaurally through a separate amplifier and speaker system. The KT-600 also has full input mixing of monaural program sources (such as tape recorder and phonograph, etc.), a special "null" stereo balancing and calibrating system (better than meters), 24 equalization positions per channel, 12 db per octave rumble and scratch filters, and a loudness on-off switch. Has clutch-type dual concentric volume controls which operate independently for balancing or simultaneously as the Master Level Control. Other features include channel reverse, 180° phase reversal, input level controls at all inputs. Sensitivity is 2.2 millivolts for 1 volt out. Dual low impedance outputs ("plate followers," 1300 ohms) are provided. Frequency response is 5-40,000 cps ± 1 db; less than .03% IM distortion. Uses 7 new 7025 low-noise dual triodes. Size 14" x 4½" x 10⅛". Shpg. wt., 16 lbs. Complete with printed circuit board, modern-styling metal chassis and cage, profusely illustrated instructions, all necessary parts.

LAFAYETTE KT-600 Stereo Preamplifier Kit ..... Net **79.50**
LAFAYETTE LA-600 Stereo Preamplifier, Wired..... Net **134.50**

NEW! LAFAYETTE STEREO/MONAURAL BASIC POWER AMPLIFIER KIT

ONLY 4.75 DOWN 5.00 MONTHLY **47.50**

- **36-WATT STEREO AMPLIFIER - 18-WATTS EACH CHANNEL**
- **EMPLOYS 4 NEW PREMIUM-TYPE 7189 OUTPUT TUBES**
- **FOR OPTIONAL USE AS 36-WATT MONAURAL AMPLIFIER**
- **2 PRINTED CIRCUIT BOARDS FOR NEAT, SIMPLIFIED WIRING**
- **RESPONSE BETTER THAN 35-30,000 CPS ± ½ DB AT 18 WATTS**
- **LESS THAN 1% HARMONIC OR INTERMODULATION DISTORTION**

A superbly-performing basic stereo amplifier, in easy-to-build kit form to save you lots of money and let you **get into stereo now** at minimum expense! Dual inputs are provided, each with individual volume control, and the unit may be used with a stereo preamplifier, for 2-18 watt stereo channels or, at the flick of a switch, as a fine 36-watt monaural amplifier — or, if desired, it may be used as 2 separate monaural 18-watt amplifiers! **CONTROLS** include 2 input volume controls, channel Reverse switch (AB-BA), Monaural-Stereo switch. **DUAL OUTPUT IMPEDANCES** are: 4, 8, 16 and 32 ohms (permitting parallel (monaural) operation of 2 speaker systems of up to 16 ohms. **INPUT SENSITIVITY** is 0.45 volts per channel for full output. **TUBES** are 2-6AN8, 4-7189; GZ-34 rectifier. **SIZE** 9-3/16"d (10-9/16" with controls) x 5¼"h x 13¼"w. Supplied complete with perforated metal cage, all necessary parts and detailed instructions. Shpg. wt., 22 lbs.

KT-310 Stereo Power Amplifier Kit ..... Net **47.50**

LAFAYETTE RADIO
165-08 Liberty Ave. JAMAICA 33; N. Y. PLEASE INCLUDE POSTAGE WITH ORDER

CUT OUT AND PASTE ON POST CARD

Lafayette Radio P.O. Box 511 JAMAICA 31, N.Y.
DEPT. JG-9

☐ Send FREE LAFAYETTE Catalog 590

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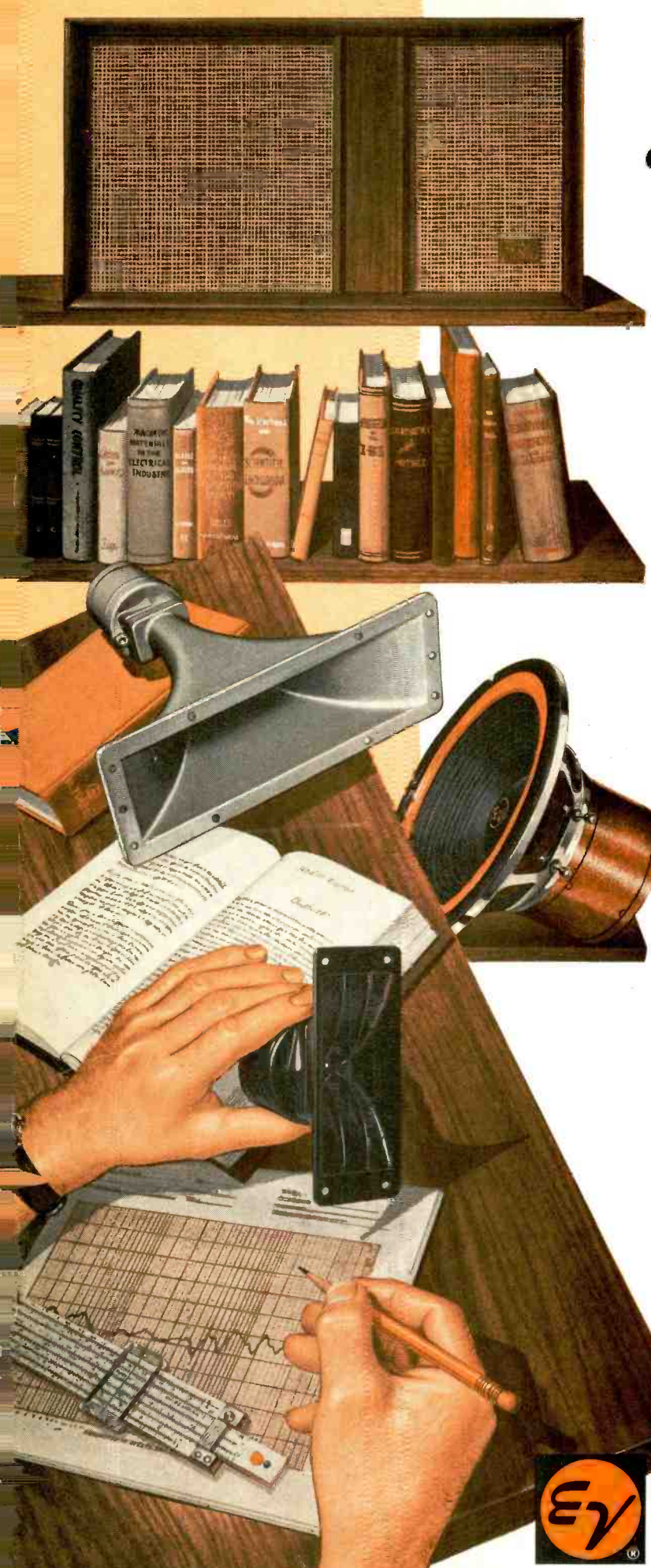
Address.....
City..... Zone..... State.....



THE ONLY ULTRA-COMPACT

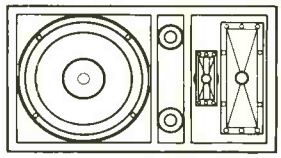
3-WAY WIDE-RANGE SPEAKER SYSTEM

designed for true stereo

Electro-Voice

HIGH FIDELITY

REGAL



Gives you bass so low you can feel it . . . bass you would expect from a conventional enclosure three times the size. Gives you balanced, full-range, flat response without attenuation or peaks.

Ideal as an economical "first" system, an "add-on" or in a pair for stereo

You need not be an acoustical engineer to understand why there is so much stereo value in this ultra-compact speaker system. The same *exclusive features* that have always made ELECTRO-VOICE systems best for monaural are an absolute necessity for true stereo . . . and you *get* these vital features in the REGAL III.

Acoustically-correct enclosure is matched to specially-designed 12-inch LF driver for *exceptional extension of bass response and unusual dynamic range* . . . without sacrificing efficiency and without the need for unusually-large amplifier power.

E-V Super Sonax VHF Compression Driver with exclusive Sonophase* throat design assures you of the *smooth, sparkling highs* so necessary for precise musical blend and balance.

E-V Diffraction, in both the Horn-Loaded Mid-Range Driver and the Super-Sonax Tweeter, gives you all-important

FUSION

so essential for *all-position stereo listening.* By wide-angle (180°) diffraction, the higher frequencies are completely dispersed smoothly and evenly throughout the listening area. This insures proper fusing of the significant stereo sounds from two speaker systems in controlled and varying proportions . . . gives true depth and placement to the musical instruments simultaneously, without spatial distortions . . . assures easy listening from anywhere in the room. Convenient but concealed "Presence" and "Brilliance" controls permit quick and easy musical balancing to room acoustics.

Luxurious furniture-crafted enclosure is finished on all four sides for placement anywhere on shelf or floor.

REGAL III. Complete 3-way system in enclosure, ready to use. Choice of Walnut, Mahogany or Limed Oak. Size 12½"d, 13½"h, 24"w. Net, **$147.50**

ESQUIRE 200. Economical version of the Regal. Complete 3-way system in modern enclosure, with single rear-control. 12-inch bass speaker, special 8-inch cone mid-range driver, and Super-Sonax diffraction-horn compression tweeter. Choice of walnut, mahogany or limed oak. 12½"d, 13½"h, 24"w. Net, $111.00

See it — Hear it — Enjoy it — on Money-Back Guarantee.

At your E-V high-fidelity dealer or write for Catalog No. 134 to Dept. 79-E.

No Finer Choice than Electro-Voice®

ELECTRO-VOICE, INC., BUCHANAN, MICHIGAN

*Design Patent No. 182351

How to keep your profits from going to the "dogs"!

AVOID CALLBACKS DUE TO PREMATURE TUBE FAILURE...

...when you replace a defective horizontal output tube check operating cathode current.

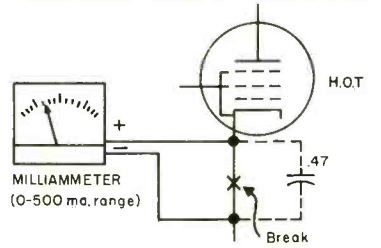
Premature horizontal output tube ("H.O.T.") failure can be caused by excessive cathode current—*higher than recommended by the manufacturer*—due to misadjustment or defective components in the horizontal output stage. Whenever you replace the "H.O.T.", protect your profits with these precautions: (1) measure "H.O.T." cathode current; (2) if excessive, find the trouble and fix it; and (3) adjust Horizontal Drive, Width, and Linearity.

Keep your hard-earned profits to yourself. Take time to check "H.O.T." cathode current. And, do as most successful service technicians do: always replace defective horizontal output tubes with *power-to-spare* RCA tubes. They pay off in fewer callbacks, finer reputation, and bigger profits.

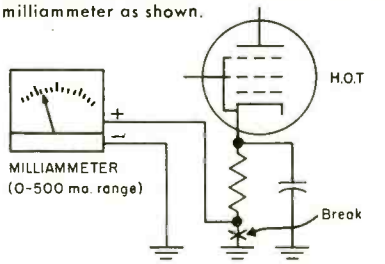
RCA-6DQ6-A—typical of RCA's excellent tube quality. Mount structure is designed to give maximum heat dissipation, prevent "hot spots" on the plate, allow cooler operation of the grids—help cut callbacks! Available at your RCA Tube Distributor.

RADIO CORPORATION OF AMERICA
Electron Tube Division *Harrison, N. J.*

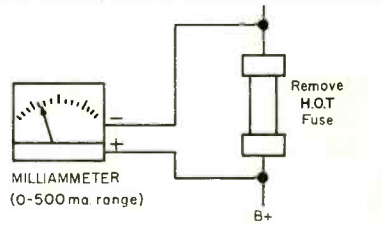
4 SIMPLE WAYS TO MEASURE "H.O.T." CURRENT



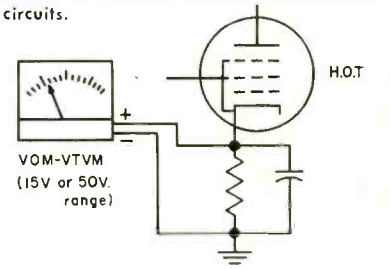
Disconnect cathode circuit at the "H.O.T." socket. Connect 0.47 μf capacitor and dc milliammeter as shown.



If "H.O.T." circuit has bypassed cathode-bias resistor, connect milliammeter as shown.



Remove "H.O.T." circuit fuse. Connect meter across fuse holder as shown. Indicated current will be slightly higher than actual cathode current because it includes boosted "B" current to vertical oscillator and/or other circuits.



Measure dc-voltage across "H.O.T." cathode-bias resistor. Voltage should not exceed value shown in service data for the set. Compute cathode current by dividing the voltage by the resistance.

TYPICAL RCA "H.O.T." TYPES AND MAX.▲ DC CATHODE CURRENT (MILLIAMPERES)	
6AU5-GT	110
6AV5-GA	110
*6AV5-GT	110
*6BG6-G	110
6BG6-GA	110
*6BQ6-GT	110
6BQ6-GTB/6CU6	112.5
*6CB5	200
6CB5-A	220
*6CD6-G	200
6CD6-GA	200
6DQ5	285
6DQ6-A	140
12AV5-GA	110
12BQ6-GTB/12CU6	112.5
12DQ6-A	140
17BQ6-GTB	112.5
17DQ6-A	140
*19BG6-G	110
19BG6-GA	110
*25BQ6-GT	110
25BQ6-GTB/25CU6	112.5
25CD6-GA	200
25CD6-GB	200
25DN6	200

*Discontinued RCA Type—Replaced by RCA "A" or double-branded version.

▲Values shown are measured with the receiver operating at a line voltage of 117 volts, 60 cycles.