OCTOBER 1953

RADIO-ELECTRONICS

LATEST IN TELEVISION · SERVICING · HIGH FIDELITY

HUGO GERNSBACK, Editor

In this issue:

30¢ U. S. and CANADA

Experimental Communication with Light Beams

(See page 4)

RADIO-ELECTRONICS

Formerly RADIO-CRAFT • Incorporating SHORT WAVE CRAFT • TELEVISION NEWS • RADIO & TELEVISION*

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ON THE COVER (See Page 46) Model Rae George is here shown operating one of Leslie Gould's latest light-beam transmitters, in typical Connecticut terrain.

Color original by Avery Slack

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OCTOBER, 1953

MEMBER Audit Bureau of Circulations

Vol. XXIV, No. 10

RADIO-ELECTRONICS, October 1953, Vol. XXIV, No. 10. Published monthly at Erie Ave., F to G Sts., Philadelphia 32, Pa., Gernsback Publications, Inc., Entered as Second Class matter September 27, 1948, at the Post Office at Philadelphia, Pa., under the Act of March 3, 1879.
SUBSCRIPTION RATES: In U. S. and Canada, in U. S. possessions, Mexico, South and Central American countries, $3.50 for one year; $6.00 for two years; $8.00 for three years; single copies 30¢ All other foreign countries $4.50 a year, $8.00 for two years; $11.00 for three years.
EXECUTIVE, EDITORIAL and ADVERTISING OFFICES: 25 West Broadway, New York 7, N. Y. Telephone REctor 2-8630. Gernsback Publications, Inc. Hugo Gernsback, President; M. Harvey Gernsback, Vice-President; G. Aliquo, Secretary.
SUBSCRIPTIONS: Address correspondence to Radio-Electronics, Subscription Dept., Erie Avenue, F to G Sts., Philadelphia 32, Pa., or 25 West Broadway, New York 7, N. Y. When ordering a change please furnish an address stencil impression from a recent wrapper. Allow one month for change of address.
BRANCH ADVERTISING OFFICES: Chicago: 7522 North Sheridan Road, Tel. Rogers Park 4-8000. Los Angeles: Ralph W. Harker, 1127 Wilshire Blvd., Tel. MAdison 6-1271. San Francisco: Ralph W. Harker, 582 Market St., Tel. GArfield 1-2481. **FOREIGN AGENTS:** Great Britain: Atlas Publishing and Distributing Co., Ltd., London E.C.4. Australia: McGill's Agency, Melbourne. France: Brentano's, Paris 2e. Belgium: Agence et Messageries de la Presse, Brussels. Holland: Trilectron, Heemstede. Greece: International Book & News Agency, Athens. So Africa: Central News Agency, Ltd., Johannesburg; Capetown: Durban. Natal. Universal Book Agency, Johannesburg. Middle East: Steimatzky Middle East Agency, Jerusalem. India: Broadway News Centre, Dadar, Bombay #14. Pakistan: Paradise Book Stall, Karachi 3.

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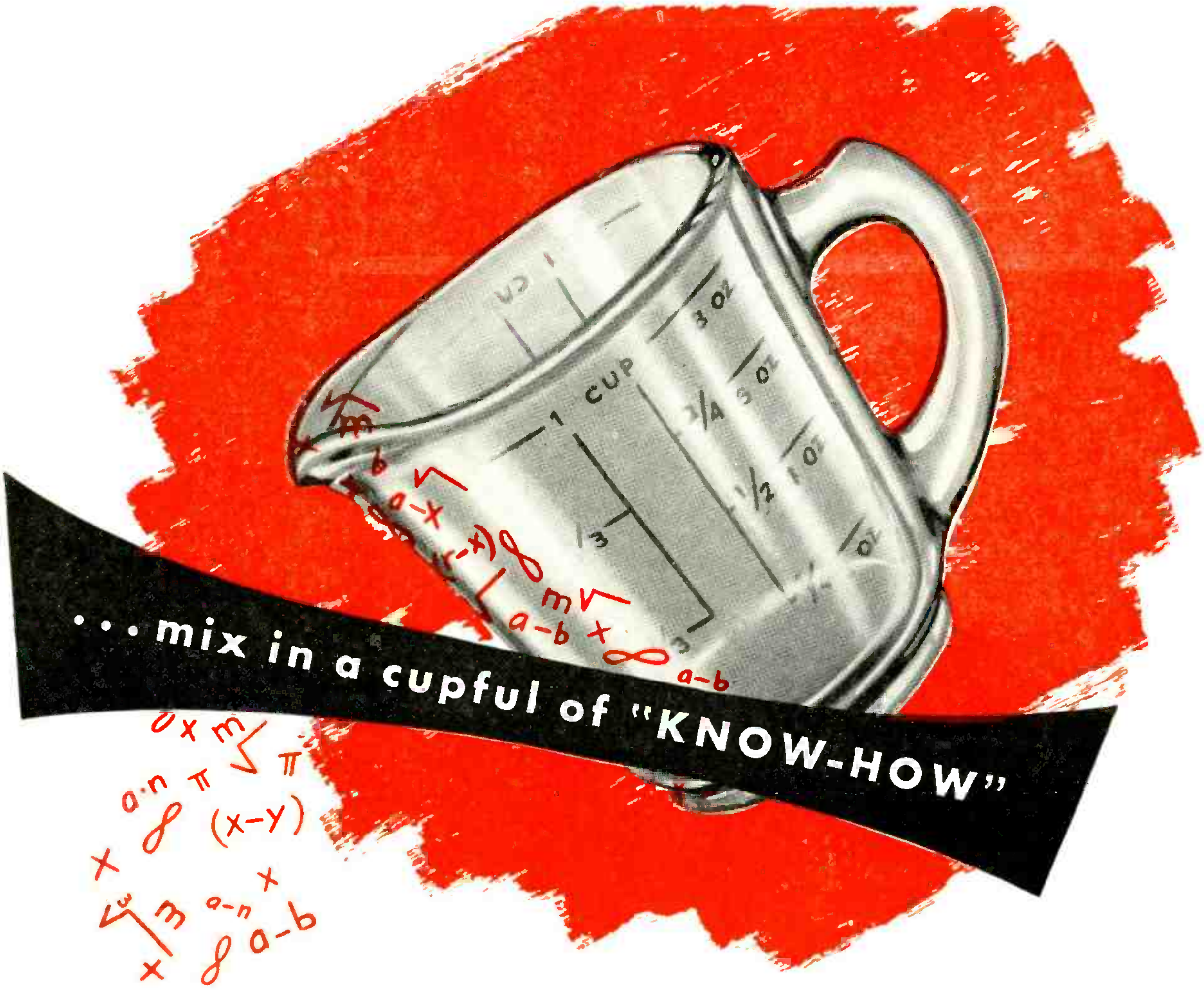

If knowledge came in containers, almost anyone could pioneer in the design and development of Electron Tubes — might even match RAYTHEON'S remarkable record of achievement in the industry.

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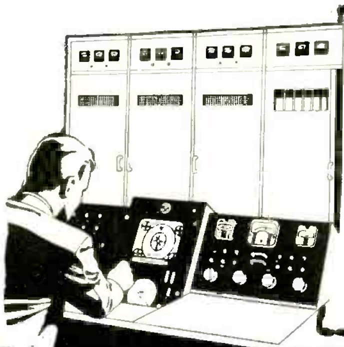

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Clifford E. Vogl, Box 1016, Dania, Fla.	1st Phone	20
Francis X. Foerch, 38 Beucler Pl., Bergenfield, N. J.	1st Phone	38
S/Sgt. Ben H. Davis, 317 North Roosevelt, Lebanon, Ill.	1st Phone	28
Albert Schoell, 110 West 11th St., Escondido, Calif.	2nd Phone	23

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"Your 'Chief Engineer's Bulletin' is a grand way of obtaining employment for your graduates who have obtained their 1st class license. Since my name has been on the list, I have received calls or letters from five stations in the southern states, and am now employed as Transmitter Engineer at WMMT."
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GETS CIVIL SERVICE JOB

"I have obtained a position at Wright-Patterson Air Force Base, Dayton, Ohio, as Junior Electronic Equipment Repairman. The Employment Application you prepared for me had a lot to do with me landing this desirable position."
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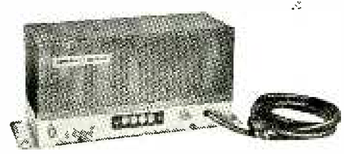

G-E POWER AMPLIFIER
Model A1-300

A medium power, compact amplifier designed to provide needed speaker power. Essential element in the new General Electric "Custom Music" Ensemble. Delivers high-fidelity performance at very low cost.

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Model A1-200

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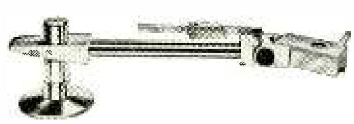

G-E *DELUXE* TONE ARMS
A1-500 (12") A1-501 (16")

For home or broadcast station use. Compatible with the exceptional quality of G-E cartridges. Calibrated stylus pressure adjustment . . . 4 to 14 grams. They were developed to improve record reproduction in every installation.

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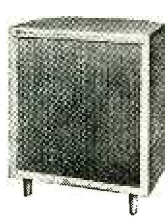

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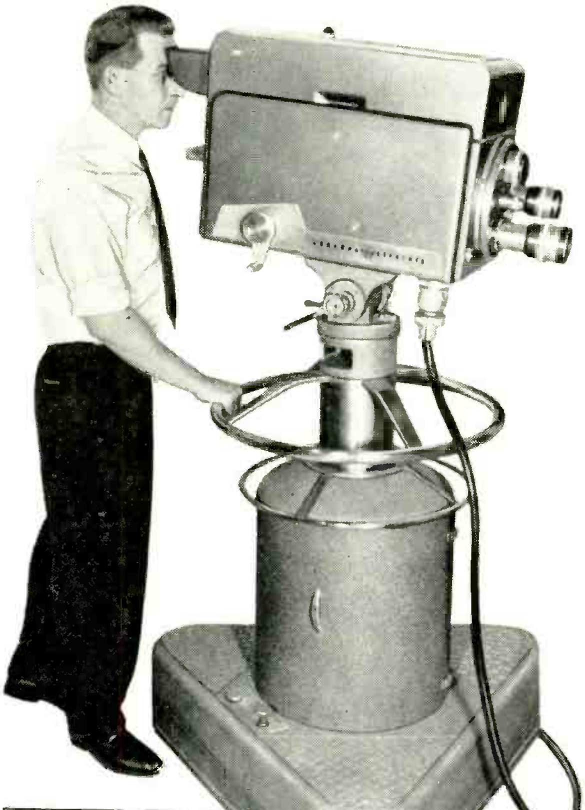

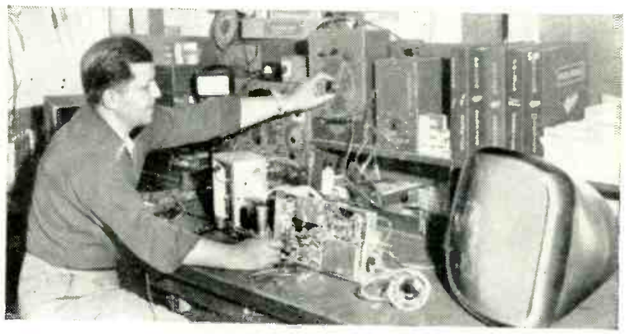

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☐ Lineman

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☐ Mechanical Drafting
☐ Machine Design-Drafting
☐ Machine Shop Practice
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☐ Industrial Instrumentation
☐ Machine Shop Inspection
☐ Reading Blueprints
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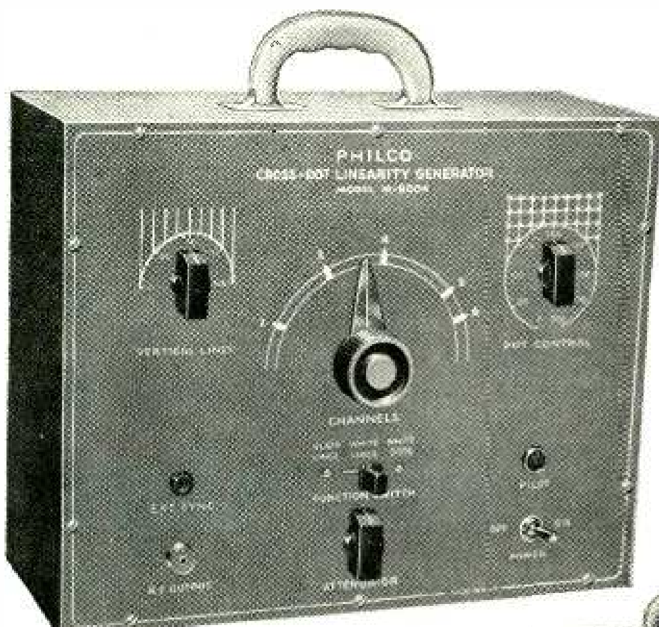

Model G-8004

Specifications: — Self stabilized oscillator • Variable output frequencies • Power consumption approximately 10 watts • Power supply—105-125 Volts, 60 cycles • large easy-to-tune dial • high level output controllable with variable attenuator.

Model M-8104—TV Field Strength Meter • Offers more features than any unit at this popular price . . . Super Colorado Tuner for low noise and high gain . . . May be used to check TV boosters, antenna combinations, interfering signals and picture signal strength.

Model 7008—Visual alignment Generator • Combines in one economical unit functions ordinarily found only in a cumbersome collection of costly devices . . . Includes extra sensitive built-in oscilloscope . . . AM, FM, and audio generators. Sweep output flat to within .2 DB/MC.

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FIVE FIRSTS—Five exclusive sales features

Now! — a new name, and a great new standard of quality and performance in antenna rotators! With FIVE major advances, SUPEROTOR overnight has shot years ahead of the entire field! For the consumer, SUPEROTOR means superb new control and reception. For the serviceman — a remarkable new ease in servicing. And for the distributor — the "plus" business that comes from handling a unit that wins cheers **all the way down the line**. SUPEROTOR will be available in your area soon. Don't miss it!

5 DYNAMIC NEW ENGINEERING FEATURES • • •

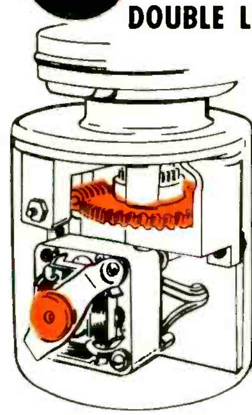
1

QUICK DETACHABLE DRIVE UNIT

Complete drive unit can be replaced in five minutes — by one man, without dismounting antenna. When necessary antenna can be locked in any desired direction with drive unit removed.

A Leader First!

2

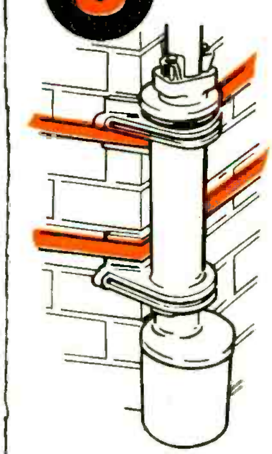


DOUBLE LOCK STOP PREVENTS DRIFT AND COAST

Worm gear lock positively maintains antenna in desired position — no drift. Motor brake prevents transfer of motor inertia to antenna — no coast. Permits smallest increment movement of antenna for precision tuning.

A Leader First!

3



Plus These Other Outstanding Features

- Antenna position readable without rotating antenna
- Operates at upwards of 350 feet from control point
- Dependable high-torque motor
- Wide-span double ball bearing supports

Leader ELECTRONICS INC.

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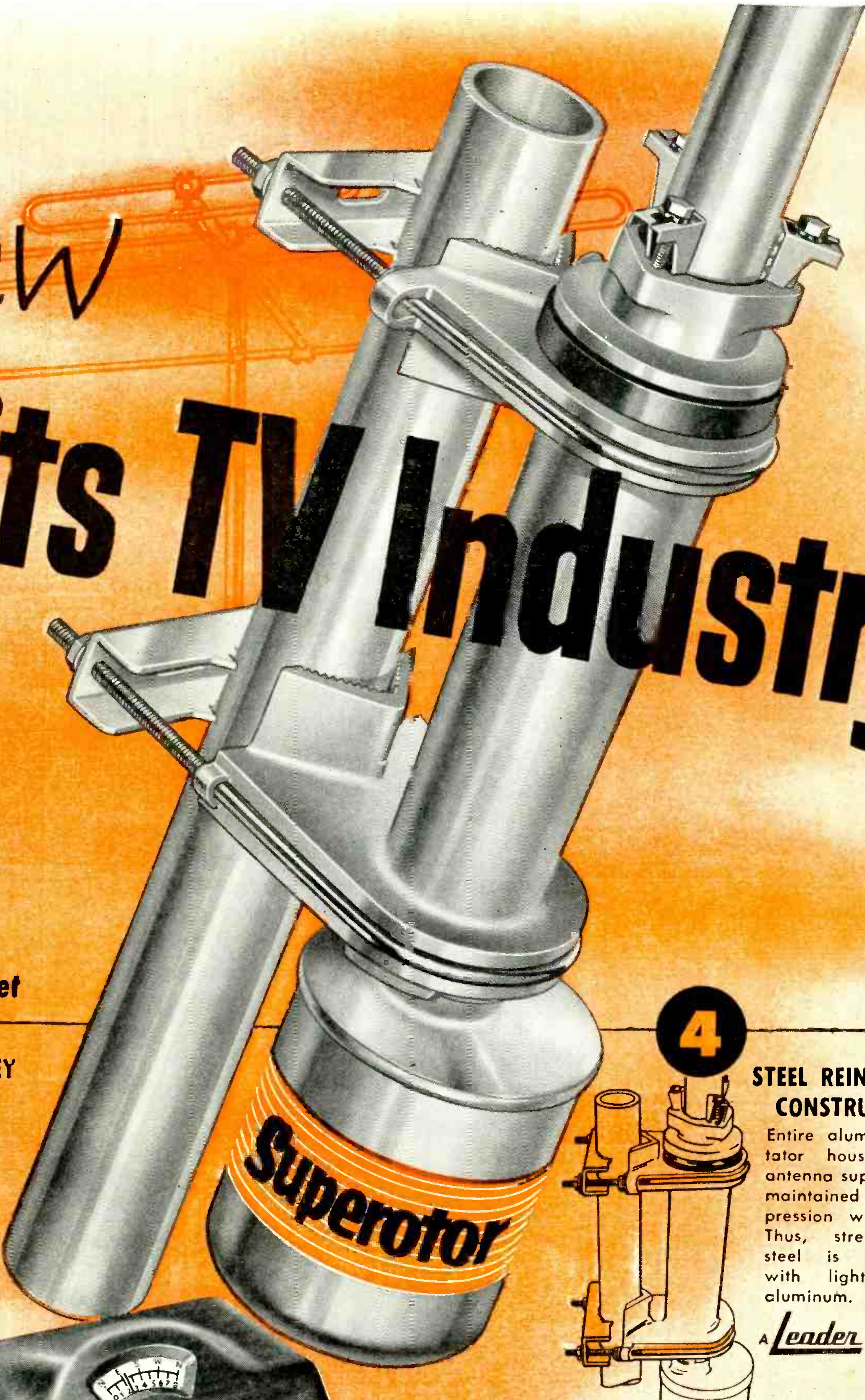
New Hits TV Industry



Years ahead of Anything on the market

BUILT-IN CHIMNEY MOUNT DESIGN

Eliminates need for stub mast assembly. Mounts directly on chimney, and below chimney crown, protecting drive unit from soot and corrosive fumes.

A Leader First!

4

STEEL REINFORCED CONSTRUCTION

Entire aluminum rotator housing and antenna supports are maintained in compression with steel. Thus, strength of steel is combined with lightness of aluminum.

A Leader First!

5

VP TUNING

Only the Superotor with double lock stop, permits "finger tip" Vernier Precision tuning.

A Leader First!

Patent Applied for

TRIPLETT 630 Volt-Ohm-Mil-Ammeter "speaks" for itself in any company

TRIPLETT 630 Volt - Ohm - Mil - Ammeter has many significant advantages and features that make it stand distinctly apart from similar instruments in its price class. Actually in components, in engineering, in minutely accurate performance, Triplett 630 closely approaches laboratory standards.

Since the scales of any VOM comprise the means by which it makes its multiple services most valuable, the legibility and easy-read-ability are of prime importance. Triplett engineers have created in Triplett 630 the longest scales available in this size tester. (The upper arc by actual measurement is four and three-eighth inches.)

This long-scale factor accounts for the ease with which precise readings are easily made. Further legibility is gained by use of black and red scale markings. D.C. and D.B. are black and white. A.C. and Ohm markings are red on white. Ohms from one hundred million to one-tenth ohm mark the range of this amazing scale. On low ohms, center scale reading is 4.5 ohms.

The Single Switch

Futher indication of the practical skill and engineering "know-how" behind Triplett 630 is the Single Switch. Its simplicity of operation assures no burn-outs thru momentary memory lapses. There is instant switching to desired circuit thru a single 2½" knob flush with the face panel. The molded switch itself embodies the most advanced engineering practices. Fully enclosed, the silvered contacts are kept permanently clean. Its rugged construction means stronger performance and longer life.

These two factors are but samples of the many ways in which on-the-job needs have been anticipated and provided for in a beautiful streamlined tester. It provides A.D-D.C. Volts, D.C. Micro-amperes, Milliamperes, Amperes, Ohms, Megohms, Decibel and Out Put readings in a no-short design embodying interior construction with all direct connections; no harness cabling. Its fool-proof unit switch construction houses precision resistors in insulated recesses in direct connection with switch contacts.

Study the following Ranges and descriptions and compare them point by point with *any* similar instrument for conclusive proof that Triplett 630 "speaks" for itself in *any* company.

Ranges

D.C. Volts: 0-3-12-60-300-1200—at 20,000 Ohms/Volt (For Greater Accuracy on TV and other High Resistance Circuits.)
A.C. Volts: 0-3-12-60-300-1200-6000—at 5,000 Ohms/Volt (For Greater Accuracy in Audio and other High Impedance A.C. Circuits.)
Decibels: —30, +4, +16, +30, +44, +56, +70. (For Direct Reading of Output Levels.)
D.C. Microamperes: 0-60—at 250 Millivolts.
D.C. Milliamperes: 0-1.2-12-120—at 250 Millivolts.
D.C. Amperes: 0-12—at 250 Millivolts.
***Ohms:** 0-1,000-10,000—(4,4-44 at center scale).
***Megohms:** 0-1-100—(4,400-440,000 center scale).
Output: Condenser in series with A.C. Volt ranges.

**Resistance ranges are compensated for greatest accuracy over wide battery voltage variations. Series Ohmmeter circuits for all ranges to eliminate possibility of battery drain when leaving switch in Ohms position.*

Get a Triplett 630 into your own hands at your distributor.
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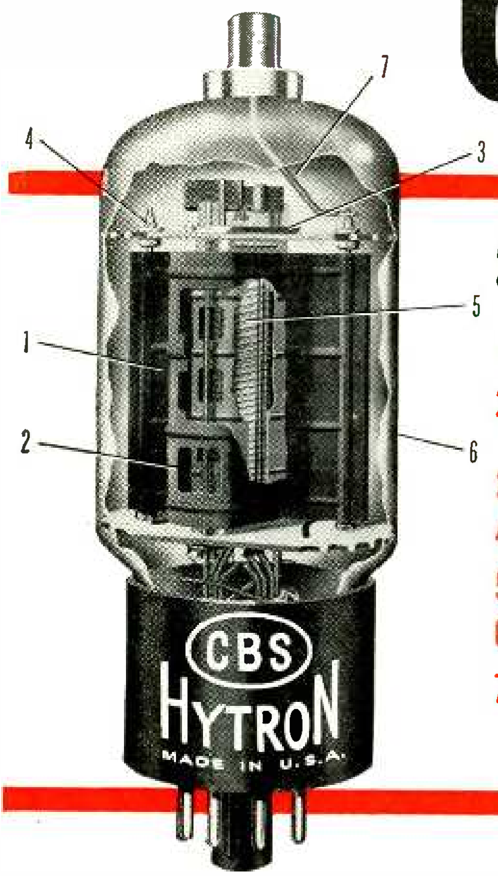
***CTS-RATED:** Rated for Continuous Television Service. In TV receivers, five tubes work . . . like transmitting tubes . . . *hard!* You know them: rectifiers, deflection amplifiers, damper diode. Larger-screen sets aggravate the problem. CBS-Hytron recognizes your need for huskier tubes for these sockets. Brand-new designs, not just improved tubes. CTS-Rated 5AW4 already answers your 5U4G low-voltage rectifier problem. Here is your new replacement for the 6BQ6GT: The new CTS-Rated 6CU6. Yes, more CBS-Hytron CTS-Rated tubes are coming. Watch for them.

FORGET:
- RUN-AWAY PLATE CURRENT
- HIGH-VOLTAGE ARC-OVERS
- SHRINKING TV PICTURES

Replace 6BQ6GT with New Work-Horse

CBS-HYTRON 6CU6



MECHANICAL FEATURES OF 6CU6

1. Heavier-gauge plate with large radiating fins.
2. Vents in beam plates and plate aligned for maximum radiation of heat from grids.
3. Anti-arc rings for uniform distribution of electrostatic field.
4. Anti-arc mica eyelets.
5. Gold-plated control grid to kill primary emission.
6. T-12 transmitting-type bulb.
7. Plate connection: "hard-soldered" and positioned to reduce heat conduction and arcing.

Cut your call-backs by up to 40 per cent with CBS-Hytron 6CU6. It's directly interchangeable with the 6BQ6GT. It's rated the same as the 6BQ6GT. *But* the new CTS-Rated 6CU6 will *live* under 6BQ6GT maximum ratings. How? The 6CU6 has generous *margins of safety* for: plate dissipation . . . plate current . . . high-voltage insulation . . . and high-line protection.

The older 6BQ6GT is a good tube. But remember it was originally designed for 10- and 12-inch TV sets. Today it carries the load in 21-inch sets. Furthermore, it must combat the accumulated dissipation caused by: line-voltage variations . . . faulty receiver adjustment . . . and shifting values of components due to age and overload. Result: the 6BQ6GT may actually be operated well above its maximum ratings in many TV receivers.

In the new CBS-Hytron 6CU6, you have a tube that takes this rough treatment. And continues to ask for more. High voltage and heat meet their match. The weakest link in the TV tube line-up becomes the strongest. And your call-backs plunge downward. Bet you can't wait to try the CTS-Rated 6CU6. We couldn't. It's a honey! Watch for it soon at your CBS-Hytron distributor's.

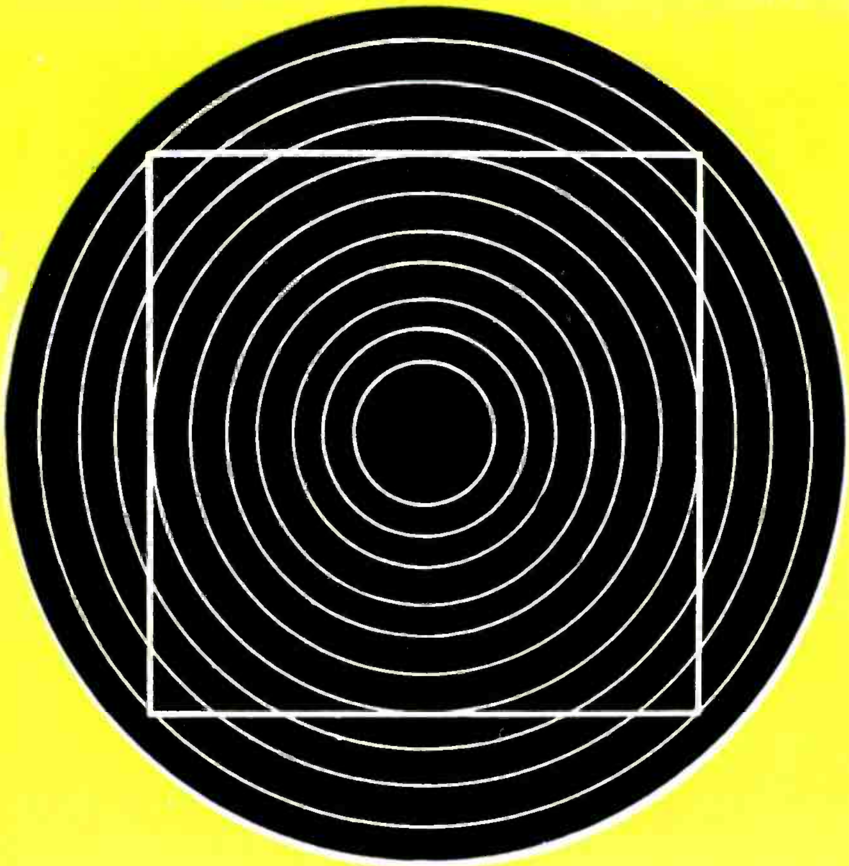
CBS HYTRON

Manufacturers of Receiving Tubes Since 1921

CBS-HYTRON Main Office: Danvers, Massachusetts

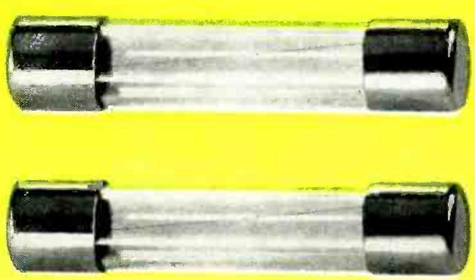
A Division of Columbia Broadcasting System, Inc.

RECEIVING . . . TRANSMITTING . . . SPECIAL-PURPOSE AND TV PICTURE TUBES • GERMANIUM DIODES AND TRANSISTORS



things are NOT *as they seem . . .*

This is a perfect square within the circle — it is an optical illusion that the sides bend.



Things are not as they seem . . .
These two fuses look alike . . .
But they are not.

This fuse may burn out anywhere along the length of the filament even in the cap—this blown fuse is impossible to detect visually.

This Littelfuse has a controlled blowing point—the filament is plated throughout its length except in the very center—the fuse will always blow here. A blown Littelfuse can be detected immediately—a Littelfuse feature.

Littelfuse holds more design patents on fuses than all other manufacturers combined.

LITTELFUSE

DES PLAINES, ILLINOIS

PHILIP S. RAND, project engineer at the Remington-Rand Laboratory of Advanced Research at South Norwalk, Connecticut, was recipient of the American Radio Relay League's Merit Award at its presentation on July 12 at the Seventh ARRL National Convention in Houston, Texas. Goodwin L. Dosland, president of the ARRL, the national association of amateur radiomen, presented a plaque to Rand in recognition of his advancement of the welfare of amateur radio through leadership and technical accomplishment in reduction of television interference.

Philip S. Rand receiving special citation.

Rand has done extensive research in the field of television interference elimination for several years from his home in Redding Ridge, Connecticut. He is the compiler and main author of the book, *Television Interference.* Since October, 1952, he has been associated with the ARRL as Technical Consultant. In that capacity he has given demonstrations in a number of cities to familiarize service technicians and amateur radio operators with the causes of television interference and remedies.

THE COMPATIBLE COLOR TV set is no longer just around the corner. The FCC in its tentative adoption of color TV standards as proposed by the National Television System Committee has opened the way for compatible color TV sets to appear in retail stores by next spring, according to statements made by RCA in its petition to the FCC supporting NTSC standards. Objections may come from the three-dimension color TV advocates, such as Dr. Allen Du Mont and U. A. Sanabria, president of American Television, Inc., Chicago, who said he would oppose the NTSC standards. Already on record in support of the new standards are NTSC itself, an industry-wide committee of engineers and scientists created in 1950; RCA and NBC in a joint petition; Philco; Sylvania Electric Products, Inc.; General Electric; and Motorola. Hazeltine, a research laboratory which has had an important part in color TV, told the FCC it would also support the new standards.

COLOR TELEVISION SETS should be exempted from excise taxes, the RETMA has advised Congress. RETMA said that it is willing to accept a general manufacturer's excise tax which would cover black-and-white TV sets, and called for repeal of the Federal 10% manufacturer's excise tax on TV sets. Congress was told that color TV sets should get special consideration, in conformance with the tradition of withholding of taxes temporarily from new products and industries. RETMA contended that the imposition of the excise tax on electronic equipment used for commercial and technical purposes was costly and confusing. It was stressed that this tax was contrary to Congressional intent, and legislation should be initiated to remove the tax on parts and components of radio and TV sets other than tubes.

FOURTEEN NEW TV STATIONS on between our last report in this column and August 14. Six of these are v.h.f. stations: KBES-TV (5), Medford, Oregon; KMMT (6), Austin, Minnesota; KMBC-TV and WHB-TV who are to share time of the same channel (9), Kansas City, Missouri; KROC (10), Rochester, Minnesota; and KMO-TV (13), Tacoma, Washington.

The new u.h.f. stations are: WTVP (17), Decatur, Illinois; KFSA-TV (22), Fort Smith, Arkansas; WGVL (23), Greenville, South Carolina; KUSC-TV (28), Los Angeles, California; WETV (47), Macon, Georgia; WKJF-TV (53), Pittsburgh, Pennsylvania; WGLV (57), Easton, Pennsylvania and WTVU (73), Scranton, Pennsylvania.

In addition, WSYR-TV, Syracuse, moved from channel 5 to channel 3; and WROV-TV (27), Roanoke, Virginia, went off the air.

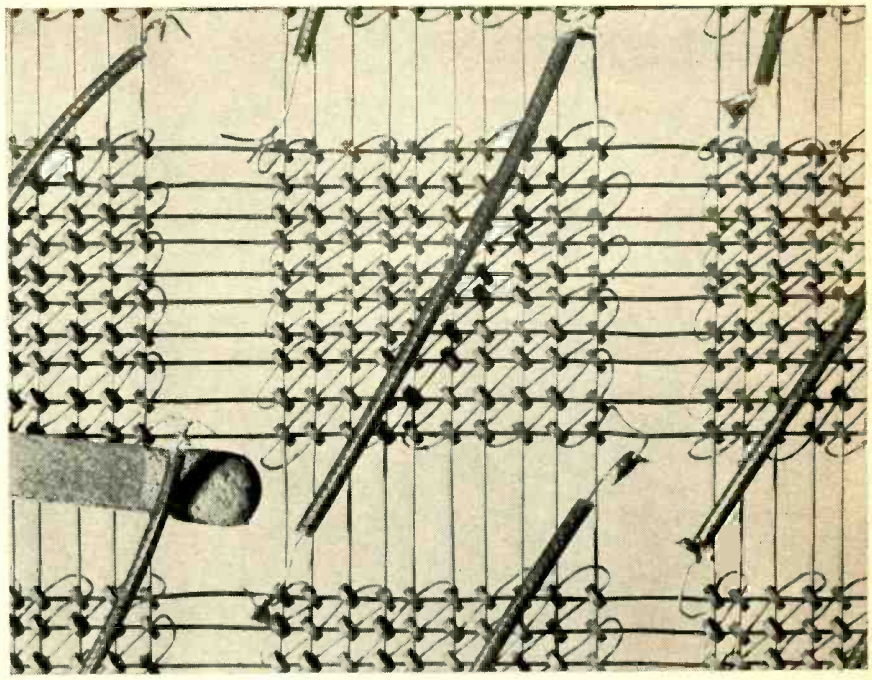
An error in listing a construction permit was made in our August issue. The call given as WMO (Tacoma, Wash.) should be KMO.

WJAR-TV (10), Providence, R. I. was incorrectly listed in our July issue as channel 11.

SUBSCRIPTION TV is the answer to the u.h.f. station's problem of economic survival, according to four u.h.f. grantees who asked the FCC to lay down rules, regulations, and standards for a paid TV service.

The four construction permit holders —Home News Publishing Co. (WDHN, channel 47) New Brunswick, N. J.; Pennsylvania Broadcasting Co. (WIP-TV, channel 29) Philadelphia; Stamford-Norwalk TV Corp. (channel 27, no call yet assigned) Stamford, Conn.; and Connecticut Radio Foundation (WELI-TV, channel 59) New Haven, Conn.—believe that the box-office type of TV will make it possible for them to improve programs and thus compete with older v.h.f. stations who have network affiliations.

A survey of their areas, the petitioners state, shows that prospective set owners would be more ready to buy u.h.f. receivers if they could be assured of receiving (for special fees) first-run movies, nonbroadcast sports events, and other features not normally seen by viewers of free TV.



RCA experimental high-speed memory device. Head of match shows relative size.

A NEW MEMORY DEVICE which combines the features of high speed with a potentially huge information storage capacity, was described by Dr. Rajchman of RCA at a symposium on digital computers sponsored by the Argonne National Laboratory. The device consists basically of 10,000 tiny ring-shaped magnets woven on thin wires. The high-speed electronic memory device promises to help solve scientific and economic problems too vast and too complex for the present capabilities of electronic computers. Dr. Rajchman said the new device offers significant advantages for computers of the future because it can memorize a bit of information in a few millionths of a second; it can store 10,000 "bits" of information at any one instant; it potentially has a very high degree of reliability; and it promises to be relatively cheap, as memories for computers go.

BROADCASTING. A bill has been introduced in Congress which would amend the Federal Communications Act by changing a definition in Section 3. The amendment would define broadcasting as a no-charge activity, as it concerns the listener, and would describe subscription television, community-antenna systems, and theater television as common-carrier services.

NATIONAL CONFERENCE on Tube Techniques, sponsored by the Subpanel on Tube Techniques of the Department of Defense will be held on October 13, 14, and 15 at the auditorium of the Western Union Telegraph Co., 60 Hudson St., New York 13, N. Y.

The program will cover all phases of electron tube making techniques, processes, and materials. Pertinent papers are invited. Anyone interested may attend.

FIVE MILLION MORE RADIOS were in use in the United States on January 1, 1953, than on the same date in 1952. Figures released by the four major networks—ABC, CBS, MBS, and NBC—show that the increase brings the total number of sets in working order to well over 110 million. More radios were sold in this country in 1952 than automobiles, refrigerators, TV sets, or other home appliances.

Home radios of course, form the largest group, with about 75 million receivers in nearly 45 million homes. More than 26 million private pessenger cars have radios, and about 9 million sets are installed in hotels, restaurants, offices, and other more or less public establishments.

ELECTRONICS has again made the power of its name felt. Radio-Electronics-Television Manufacturers Association is the new name of RTMA. Members of the association (which was simply RMA till several years ago) voted to make the change, and approved a reorganization plan which will expand the board of directors and provide larger representation for new segments of the industry, especially in the advanced electronics field.

AUDIO ENGINEERING Society's annual convention, held in New York City October 14, 15, 16 and 17 in conjunction with the Audio Fair, will have no less than 26 technical papers on technical audio subjects. The papers will deal with such subjects as loudspeakers, audio system design, disc reproduction, new developments, amplifier circuit design, home music systems, and multichannel sound reproduction. There will be seven morning and afternoon sessions, all of which will be held in the North Ballroom of the Hotel New Yorker. END

WHY SYLVANIA PRODUCTS MEAN BETTER BUSINESS!

YOU'RE really on board the *better-profit* special when you feature Sylvania Picture Tubes and Receiving Tubes.

Your customers know Sylvania as a pioneer in the development of fine radio and television products. From the very beginning, the name Sylvania has stood for the highest possible quality. And, as the industry has progressed and expanded, Sylvania has taken great care to maintain its recognized leadership.

Now, due to advanced manufacturing techniques and precision testing methods, Sylvania tubes can point to outstanding records, both in long life and fine performance. Today 7 of the 10 leading set manufacturers use Sylvania Picture Tubes and Receiving Tubes.

So, if you want *recognized quality* working on your side . . . *sell Sylvania!* Call your local Sylvania Distributor for the latest fall prices and money-making promotion offers, or write to: Sylvania Electric Products Inc., Dept. 3R-1710, 1740 Broadway, New York 19, N. Y.

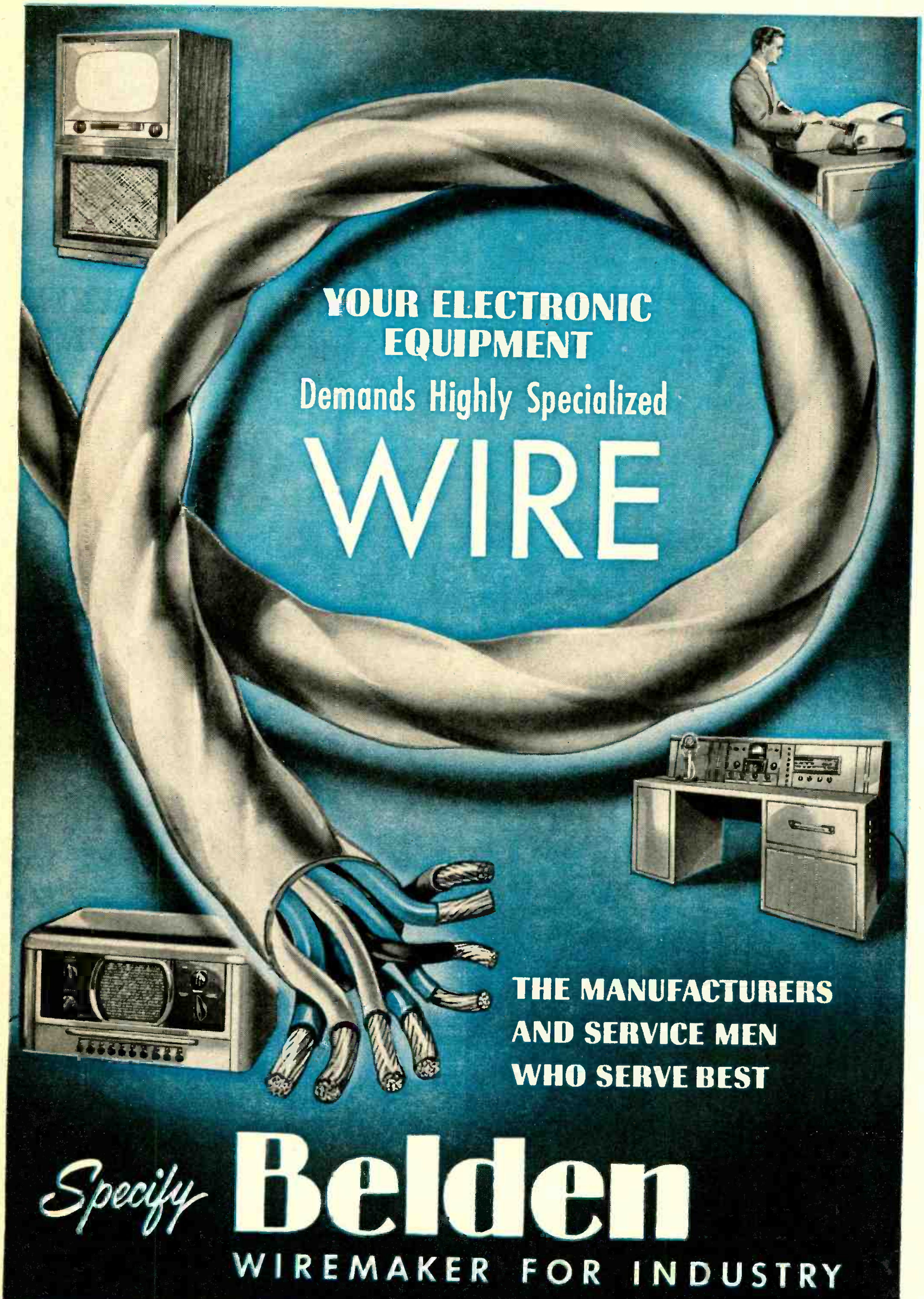
Television keeps telling about Sylvania quality

Sylvania's popular nation-wide television show "Beat the Clock" continues to tell millions of your customers week after week, all through the year, about the unbeatable quality of Sylvania products.

SYLVANIA

LIGHTING • RADIO • ELECTRONICS • TELEVISION

In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., St. Catherine Street, Montreal, P. Q.


YOUR ELECTRONIC EQUIPMENT
Demands Highly Specialized
WIRE
THE MANUFACTURERS AND SERVICE MEN WHO SERVE BEST
Specify Belden
WIREMAKER FOR INDUSTRY

BAROMETER of the PARTS INDUSTRY

During August, 87 of the leading manufacturers of Radio-Electronic-Television parts and equipment made changes in their lines. There was a decrease in "change activity" as compared to July.

In price revisions by the number of manufacturers and products affected, the following summary illustrates the comparative trend for the months of July and August.

	No. of Manufacturers	
	July	August
Increased prices	25	32
Decreased prices	21	16

	No. of Products	
	July	August
Increased prices	783	350
Decreased prices	786	65

For a summary of the most active product categories, see the following tables:

Product Group	Increased Prices		Decreased Prices		New Products		Discontinued Products	
	No. of Mfrs.	No. of Products	No. of Mfrs.	No. of Products	No. of Mfrs.	No. of Products	No. of Mfrs.	No. of Products
Antennas & Access.	7	30*	6	24**	18	153	7	63**
Capacitors	0	0	0	0**	1	198**	0	0
Controls & Resistors	1	7*	0	0	2	105**	1	10*
Sound & Audio	13	141**	5	16**	21	114**	17	131*
Test Equipment	3	25*	0	0**	6	21*	3	6**
Transformer	2	134**	1	20**	2	14**	1	1**
Tubes	6	13**	4	5**	10	61*	5	75*
Wire & Cable	0	0**	0	0**	3	6**	1	17

* Increase over July
** Decrease from July

* Increase over July
** Decrease from July

Comment: For the third consecutive month, over-all product activity continues to be heavy. However, the number of manufacturers making changes in their line has decreased slightly since the last reported period.

This data is prepared by the staff of United Catalog Publishers, Inc., 110 Lafayette Street, New York, publishers of Radio's Master, the Official Buying Guide of the Parts Industry.

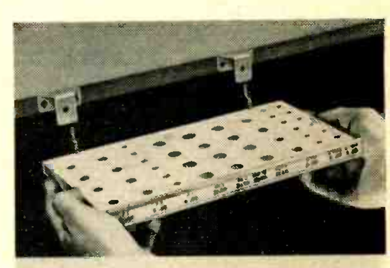
Merchandising and Promotion

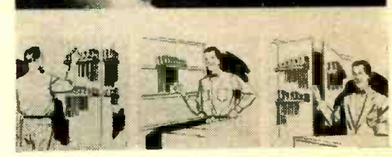
Cornell-Dubilier Electric, South Plainfield, N. J., designed a special display unit for the CDR rotor. Done in full color, the display is adaptable for either window or counter use. Ray T. Leary, jobber sales manager, states that the CDR rotor fits right into the display and may be activated when the customer presses the lever on the control box. At the same time, Cornell-Dubilier and its affiliate, Radiart Corp., Cleveland, announced plans for a greatly accelerated promotion on the CDR rotor at the consumer level beginning early this fall. TV spot announcements, newspaper ads, and promotional kits for distributors will be used.

Simpson Electric Co., Chicago, plans to spend $250,000 in the next 12 months to promote its line of electrical testing equipment, according to Wallace Carroll, Simpson president.

Raytheon Manufacturing Co., Newton, Mass., had a full-page color ad on its Bonded Electronic Technician program in a recent issue of *Life*. It was headlined: "Nice Guy With an Undeserved Black Eye." The ad pointed out the capable and efficient service TV technicians have been rendering. Raytheon also recently announced a new tube promotion item for service technicians, the Tele Jar-Rotor, which consists of 48 transparent plastic jars for storing transistors, diodes and other small parts placed on a "ferris-wheel" holder.

Vaco Products Co., Chicago, introduced new shelf brackets for mounting





its Vari-Board screwdriver display shelf anywhere in the store.

Techincal Appliance Corp., Sherburne, N. Y., antenna manufacturer, held another in its series of Taco U.H.F. Television Clinics for service technicians in Buffalo, N. Y. The meeting was co-sponsored by WBUF, channel 17, Buffalo's new u.h.f. station.

Westinghouse Electronic Tube Division, Elmira, N. Y., launched a new premium promotion campaign for its Reliatron tube distributors.

Philco Corp., Philadelphia, has prepared a new 15-minute 16-mm sound movie, "When u.h.f. Comes to Town," for TV dealers and others interested in building enthusiasm for u.h.f.

RMS (Radio Merchandise Sales), New York City, is continuing its forums on TV antenna problems. Martin Bettan, RMS director of sales and engineering, directed the forums which were held in Ft. Smith, Ark., Zanesville, Ohio, and Fort Lauderdale, Fla. A half-hour TV interview was held after each session.

Heppner Manufacturing Co., Round Lake, Ill., is offering a new sample

rack holding 12 ion traps ranging from 25 to 58 gausses. It is available, without charge, to engineers engaged in TV set manufacture.

Walsco Electronics Corp., Los Angeles, Calif., launched a nation-wide promotion campaign for its new u.h.f. converter, the *Imperial.* Point-of-purchase material will be an important factor in the program.

Production and Sales

The RETMA reported the production of 3,834,236 TV sets in the first six months of 1953, a record high for the period. Radio production was 7,266,542.

New Plants and Expansions

Chicago Telephone Supply Corp., has completed a new building which adds about 65,000 sq. ft. to its manufacturing and office space in Elkhart, Ind.

Gates Radio Co., Quincy, Ill., opened a new West Coast office and distributing branch in Los Angeles. Robert Kuhl, who has been in charge of West Coast sales, is office manager.

Herlec Corp., ceramic capacitor manufacturing affiliate of Sprague Electric Co., moved its operations to its new plant in Grafton, Wis.

Hallicrafters, Chicago, has begun construction on a new $400,000 plant in Toronto, Canada. It is expected to be completed this fall when the company's Canadian subsidiary, Hallicrafters Canada, Ltd., will locate there.

Allied Radio Corp., moved to 100 North Western Ave., Chicago.

Trio Manufacturing Co., completed a new addition to its plant at Griggsville, Ill. Included is 24,000 sq. ft. of manufacturing space and a new laboratory.

International Resistance Co., Philadelphia, is building a new plant in Boone, N. C.

LaPointe Electronics Inc., Rockville, Conn., purchased a 95% interest in Circuitron, Inc., a New Jersey printed-circuit manufacturing corporation. Circuitron operations will be moved to Rockville.

Mosley Electronics, St. Louis, moved all its executive and general offices into new quarters at 8622 St. Charles Rock Road. The company's former quarters are now devoted entirely to packing and shipping operations.

Sylvania Electric Products, Television Picture Tube Division, Seneca Falls, N. Y., is perfecting methods and increasing facilities for the mass production of aluminized picture tubes. At the same time, H. Ward Zimmer, Sylvania president, announced the establishment of an Electronic Defense Laboratory to be located in temporary quarters in Mountain View, Calif.

Teletronics Laboratory, Inc., completed a new engineering building adjacent to its manufacturing plant in Westbury, N. Y.

Westinghouse Electric Corp., purchased the Government-owned plant in Lansdowne, Md., which it had been operating under lease. The plant is used for the large-scale production of electronic equipment for the Armed Forces and more recently, for industrial and commercial customers.

Wincharger Corp., Sioux City, Iowa, a subsidiary of Zenith Radio Corp., is planning for the construction of a new manufacturing plant. It will be located on high ground to keep it safe from flood waters, which caused considerable damage to the Wincharger plant last June.

Business Briefs

. . . NEDA's counsel, Glenn Catlin, announced that as a result of an application by the association, a reduction in rates on the return of defective picture tubes to manufacturers' salvage or inspection points had been granted by the railroads' Uniform, Official, Illinois, Southern and Western Classification Committee.

. . . **Sangamo Electric Co.,** capacitor Division, Marion, Ill., provided funds for a research and scholarship program for students majoring in physics at Southern Illinois University.

. . . **Hughes Aircraft Co.,** Culver City, Calif., is now in full production on hermetically-sealed germanium diodes.

. . . **Willys Motors, Inc.,** Electronics Division, Toledo, Ohio, has entered the television transmitter field. END

FREE—your Choice of

NEW PHONO-CARTRIDGE CARRY-KIT or DISPLAY-DISPENSER

Handy All-Metal Carry-Kit Holds 6 E-V Cartridges

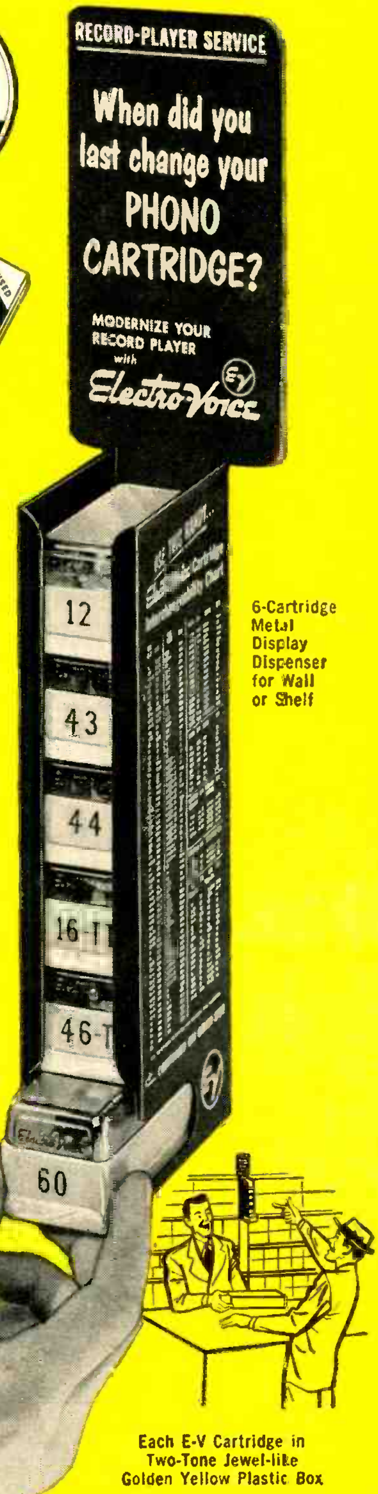
Complete E-V Interchangeability Chart on both sides makes servicing positive and easy

PLUS

WINDOW or DOOR DECAL

PLUS

REVISED SET-MODEL REPLACEMENT GUIDE



6-Cartridge Metal Display Dispenser for Wall or Shelf

10,000,000

PHONOGRAPHS ARE WAITING TO BE SERVICED

Get your share with these E-V aids to sales!

Again E-V gives you a positive profit-maker—and helps make *you* the authority on Phono-Service in your community!

Free of extra cost, from your E-V Distributor, you can get your choice of new Cartridge Carry-Kit or Display Dispenser *plus* professional Decal and up-to-date set-model Replacement Guide, with *every* purchase of *any* 6 E-V Phono Cartridges.

Furthermore, the new E-V high output, high compliance, permanent Ceramic Cartridges revolutionize servicing. They are *not* affected by moisture or heat—can be carried in your service kit or kept on display without fear of deterioration. *And they are directly interchangeable with silent-needle type crystal cartridges that do not use a thumb screw*—yet cost no more than crystal. They are part of the famous E-V Basic 6 Preferred Types that make over 92% of all cartridge replacements.

Take advantage of this offer now! Make money selling cartridge replacements. Cash in on the $70,000,000 phono-cartridge modernization replacement market.

For a limited time only.

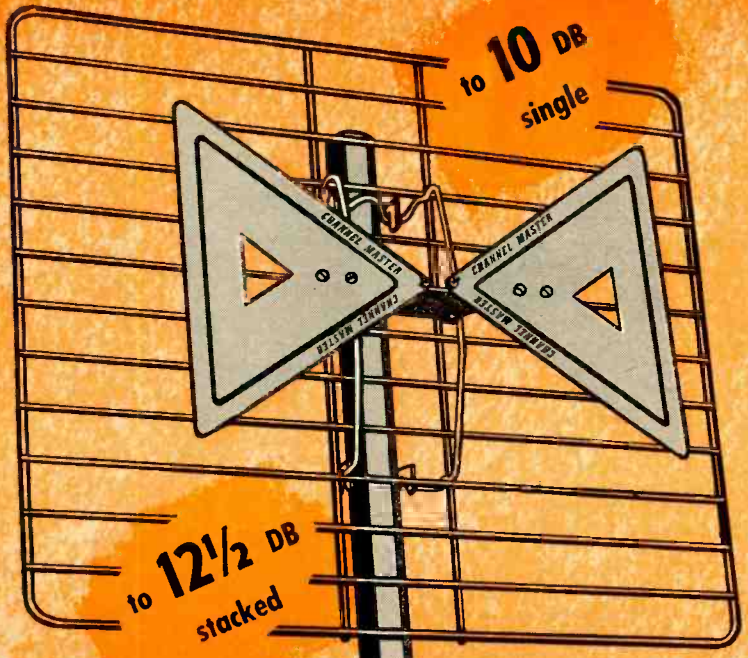
SEE YOUR E-V DISTRIBUTOR TODAY

Each E-V Cartridge in Two-Tone Jewel-like Golden Yellow Plastic Box

Electro-Voice

BUCHANAN, MICHIGAN

3 New Electrical Advances!



CHANNEL MASTER'S

all-new UHF

BOW-FLECTOR

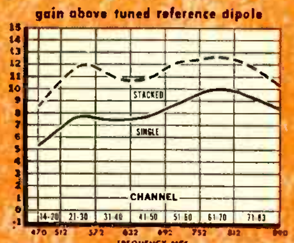
model no. 408

The highest gain Bow and Screen antenna ever developed — single or stacked!

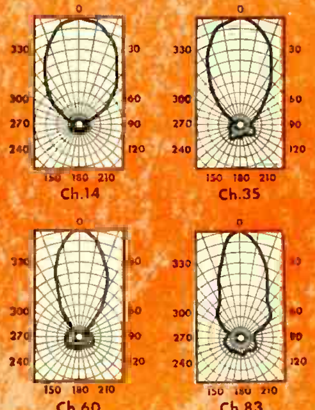
1. ***Enlarged Reflecting Screen.*** 53% more reflecting area — higher, flatter gain level.
2. ***Full-Wave Spacing*** of stacked antennas. Provides highest stacking gain ever obtained in an antenna of this type.
3. ***2-Stage Stacking Transformers*** for broad-band impedance match. Delivers high stacking gain over entire UHF band.

Terrific gain!

gain above tuned reference dipole



Horizontal Polar Patterns (Relative Voltage)



New Mechanical Features

- Deep-embossed "rigidized" aluminum dipoles.
- Snap-in assembly. No U-Bolts.
- High-impact molded insulator.

"Free-Space" terminals that prevent picture dim-out caused by the accumulation of dirt, ice or rainwater between antenna terminals.

Only 20 seconds to install!

Just snap Bow into Screen, then fasten entire assembly to mast with Channel Master's exclusive "SPEED-NUTS." The antenna cannot move, twist, flutter, or vibrate! The light-weight Bow Flector is the most rugged, fastest-installing antenna of its type.

One of 5 Great New Channel Master Products For Fall!

CHANNEL MASTER CORP.

ELLENVILLE, N. Y.

FIRST IN PREASSEMBLED ANTENNAS

Ask your Channel Master distributor for complete technical literature.

WANTED:—INERTIALESS SPEAKERS

. . . High-fidelity sound demands new speakers . . .

By HUGO GERNSBACK

RADIO-ELECTRONICS, during the past few years, has entered a new cycle in which we turn back the clock, look over past accomplishments, and re-adopt them to our advanced age. Thus, the recent transistor development goes back 40 years to the ancient crystal detector, and by using new techniques enables us in many ways to surpass the most modern vacuum tube.

As we develop new techniques in radio-electronics, we find that we often can go back to older ideas which had never been fully exploited, simply because we did not then have the technical know-how. A very recent transistor improvement also reverts back to the silicon detector; it now makes use of the new refined silicon metal. (The silicon used in our old detectors was the natural nonmetallic element).

When we come to our present-day loudspeakers, we are still using the same principles laid down in 1876 by Alexander Graham Bell. Indeed, today's telephones and loudspeakers use the identical principles. We still use diaphragms or cones, which by vibrating displace air in rhythmic fashion so that we hear the sound.

Present-day speakers were good enough until high-fidelity sound came along. It appears certain now that an entirely new instrumentality is needed. One of the chief faults of the present-day speaker is that it gives rise to *transient distortion.* This is so because the loudspeaker uses a cone and moving coil. These, due to their inherent inertia, keep vibrating after the signal has stopped, thereby creating spurious sounds.

There are other faults in the present-day loudspeakers, the chief of these is that if you wish to cover the entire audio frequency band, you must use more than one speaker. Usually the large speaker covers the lower frequencies, and a tweeter is added for the high notes. Occasionally a third or fourth speaker is added to further divide the band covered by each speaker. What is needed for modern use is an *inertialess speaker* which should cover the entire audio frequency range. No electromagnetic speaker built on Bell's principle satisfies such requirements.

It is possible that new inertialess speakers will evolve in the future by going back to old speakers which were invented over 50 years ago. There is a long list of such loudspeakers. Some of the principles of many of these can be adapted for modern usage. We will give here only the most important ones.

The Molecular Speaker. This speaker was designed by Ader and was also called the iron-wire telephone. It never achieved great prominence, because while it produced articulated sounds, spoken words were not intelligible, probably due to poor construction of early models. No diaphragm or vibrating body is used in the molecular phone. It consists of a one-millimeter thick iron wire stretched under some tension between two unequal sized heavy copper masses. Surrounding the center of the iron wire, there is an electromagnetic wire spool. In operation the iron wire becomes shorter or longer by magnetostriction. Such a molecular motion is microscopic. The sound issues at one end from the smaller copper mass referred to above, to which a dish-shaped heavy wooden or hard rubber disc is attached. The sound comes from this disc.

Several decades ago, a Swiss constructor succeeded in making electric dynamos and motors speak loud and clearly. This, too—it was claimed—was done by molecular agitation. Thus one could stand in a large room while a one-horsepower motor would give off sound and talk clearly.

The Capacitor or Condenser Loudspeaker which has been brought out again in recent years, has not as yet been perfected. It is today used for tweeters in German extended range receivers. This speaker is not a truly inertialess speaker, but comes close to it.

The Electrothermal Loudspeaker was first demonstrated by W. H. Preece nearly seventy years ago. It translates electric currents into sound by an electrothermal effect. This is accomplished by using a very fine wire which is heated and cooled by the varying audio currents. The wire is in free air and its expansions and contractions create sound in the surrounding air. Delange used this principle in constructing ear phones which seemed to work quite satisfactorily in the heyday of wireless.

Another electrothermal speaker was demonstrated over 60 years ago. This speaker was in fact an electrical incandescent lamp. By using appropriate circuits coupled to the lamp, an ordinary incandescent bulb could be made to give out loud sounds and music. The sounds issued from the outer glass envelope of the lamp, despite the vacuum. The sound conduction was through the stem of the lamp, then on to the glass envelope.

The Ionophone is also in this category, and it is a true inertialess speaker.* It was developed by the French inventor, Sigmund Klein .This speaker actually works by molecular movement and heat. It is in actual production in France. It requires a large horn in its operation.

The Talking Arc Lamp invented by Valdemar Poulsen is in the same category. This is also an electrothermal speaker and was much in vogue at the turn of the century. In this speaker you merely modulated the flaming arc. It was a rather satisfactory loudspeaker in those early days. It was used also in one of the very first radio telephones.

Talking Crystals also go back to the old crystal days, but here we have an entirely different phenomenon. Early experimenters in some cases, instead of using a catwhisker on the crystal—Silicon preferredly—employed a razor blade. Now, if the latter was properly adjusted—and this was not easy—you could place your ear near the blade and sounds would issue from it. *Here we have a double action. The detector and the loudspeaker have become a single unit.* This is an attractive idea, and if it were engineered for present-day uses, one can see where we would do away with perhaps quite a good deal of sound distortion. To be sure we would not be using razor blades, but some other means would have to be evolved.

This is exactly the same principle as when a housewife suddenly finds that her pan in which she is frying eggs on the stove mysteriously proceeds to give out music, or when an ordinary cold water faucet starts spouting singing commercials. There are many instances where this has occurred, usually in the close vicinity of a radio transmitter. Strange as it may seem, engineers have never seemed to follow up this clue. We believe the idea to be a worthwhile lead today.

*See *RADIO-ELECTRONICS, November 1951*

OSCILLOSCOPE PATTERNS and AMPLIFIER DIAGNOSIS

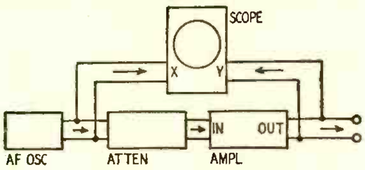


Fig. 1—Simple hookup for diagnosing amplifier with oscilloscope patterns.

Oscilloscope patterns enable complete amplifier analysis

By NORMAN H. CROWHURST

MAGAZINE articles and textbooks often describe the use of oscilloscope patterns to detect or assess amplifier distortion. The method, theoretically, is simple. One merely connects the input of the amplifier to the X plates and the output to the Y plates.

As generally presented in the literature, patterns show the effect of *either* distortion *or* phase shift. In practice, distortion *and* phase shift frequently come together, so a different pattern is produced.

Fig. 1 shows the general arrangement used for obtaining these patterns. Without doubt, the method itself has advantages over either examining an oscilloscope trace of input and output with an ordinary time-base (with or without electronic switching), or analyzing input and output with a wave analyzer. For both methods, the input should be almost a perfect sine wave.

For this method perfection of waveform is not so important—although the source should be at least ostensibly a sine wave. Compared with the viewing of waveform with an ordinary time-base, small degrees of distortion, particularly lower-order harmonics, are easier to detect and identify.

The use of a wave analyzer identifies precisely the component frequencies produced by distortion, but does not indicate how these component frequencies add up to modify the waveform. To diagnose the cause of the distortion, the actual departure of the waveform from its true shape is more helpful than a detailed analysis of the harmonics introduced.

Phase Shift.

To make the whole matter quite clear, we will start by discussing phase shift patterns when no distortion is present. Fig. 2 shows three families of phase-shift ellipses. In each case zero phase shift is indicated by sloping line which means that the spot traverses to and fro along the same trace. Introduction of phase shift opens the line out into an ellipse, and when 90° is reached, the major and minor axes of the ellipse are horizontal and vertical. Beyond 90° the ellipse would tilt the opposite way, finishing up with a straight line sloping the opposite way for 180° phase shift.

The three groups of Fig. 2 help clarify the significance of the mathematical properties of various ellipses: In the center group the deflection due to the X and Y plates is equal, so the zero phase shift line is at an angle of 45°, and the 90° phase shift trace is a circle. The left and right groups of patterns show the resulting pictures when the X deflection is less and greater than the Y deflection respectively. It is most convenient for diagnosis to use the equal-deflection pattern shown in the center of Fig. 2 if at all possible. In some instances this may not be easy with the equipment available, so it is necessary to make out a pattern on unequal X and Y deflections. Ellipses are shown for 10° intervals of phase shift from zero to 90°, and the 30° and 60° phase-shift ellipses are identified and distinguished from the others by being drawn blacker.

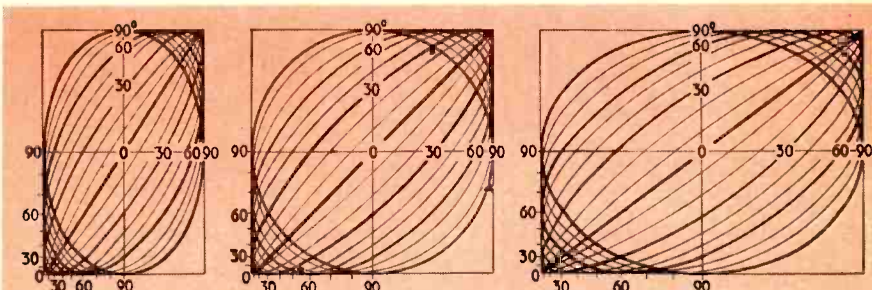


Fig. 2—How phase shift shows up on scope, and how it may be measured.

Points by which to deduce the phase shift of any given ellipse are marked on the figure. The best way to measure such an ellipse is to place a transparent cursor with graph ruling in front of the oscilloscope and adjust both deflections so as to fill an even number of squares. This provides a handy reference. Consider half of one side of the square containing the pattern as equal to the unit "one." Using this graphical unit of distance, the location of the points indicated (along the left and bottom edges) is measured from the center or center line of the pattern.

Finding the phase angle

The point where the ellipse crosses the vertical or horizontal center line, measured from the center of the pattern, is the *sine* of the phase-shift angle. (For example, the 30° ellipse crosses the lines at 0.5 the length of the line.) The point on the boundary square of the pattern where the ellipse touches it, measured along that side from the center line, is the *cosine* of the phase shift angle. The cosine is measured as a decimal fraction of the line, and the angle can then easily be found by reference to a simple table of sines and cosines.

It is naturally easier to use the sine reference for angles between zero and 45° and the cosine reference for angles between 45° and 90°, but it is a good idea to measure off both points as a check, particularly where the angle lies between 30° and 60°. It is also a good plan to take an average of all four possible reading points for each value, to eliminate any error due to the ellipse not being quite correctly centered in its boundary square.

Distortion

If the reader has tried to calibrate an oscillator with Lissajou patterns, as described in the author's article in the November, 1952, issue of RADIO-ELECTRONICS, he will have noticed that when the patterns are not quite locked they appear to be moving around. The direction of movement is somewhat subjective; that is, it depends upon the imagination of the viewer at the moment. The movement could be imagined as

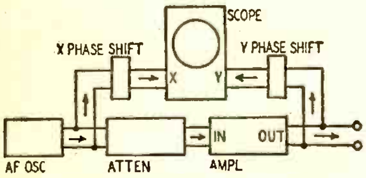


Fig. 3—Setup for injecting phase shift into either X or Y plate feed circuits.

being due to a pattern traced on a transparent cylinder, which is rotated on its axis so the pattern on the far side is viewed as if it were superimposed on the pattern in front. The cylinder could equally well lie on a horizontal or vertical axis, whereupon the movement due to its apparent rotation will appear at right angles. If either of the patterns has a slight distortion, particularly noticeable at one point in the waveform, the direction of the axis of rotation seems to be identified by the movement of this distortion point. For example, if there is a little kink in the 60-cycle waveform due to rectifier pulse current in a power-supply unit connected to the same power line, this kink will maintain a regular position horizontally, moving up and down along a vertical line in the trace, and the kink will appear at all points in the pattern where it crosses this vertical line. This will give the impression that the pattern is moving up and down vertically, or rotating on a cylinder with a horizontal axis. On the other hand, if the output from the oscillator has a similar definite distortion mark, the apparent movement will be the opposite way, the distortion mark traveling along a definite *horizontal* line in the pattern, as if the rotation were due to the pattern being traced on a cylinder with a vertical axis.

All this is perhaps a little easier to visualize with Lissajou patterns where the frequency applied to the two sets of plates differs. For our purpose the frequency applied to both sets of plates is the same and the pattern does not move because the phase difference remains constant. However, there are ways of making the pattern move by introducing phase shift deliberately, and this can be an aid in recognizing the particular form of distortion.

Fig. 3 shows that deliberate phase shift can be introduced into the signal fed to the X plates or that to the Y plates. For practical purposes it is best to introduce phase shift only into the undistorted signal fed to the X plates, because a phase-shift network will alter the shape of waveform distortion, making it harder to recognize.

Fig. 4 shows the effect of phase shift applied in this way, together with construction lines (representing our imaginary cylinder) to help visualize the movement of the trace as phase shift takes place. The pattern at B shows the trace due to simple distortion with no phase shift. This distortion could be due to grid current or similar action producing clipping. The bent thick line can be regarded as an ellipse viewed edge-on, with the ends bent over, rather like what might happen to the rim of a bicycle wheel if it fell into a slot in the paving and the rider fell off the bike sideways. The thin lines are construction lines to identify the position of the sudden bends, and can be regarded as intersecting circles viewed edge-on.

The pattern shown at A is due to phase shift in the deflection of the X plates, and C shows the effect of phase shift in the deflection of the Y plates only.

The remaining patterns, D, E, and F, show the effect of combined phase shift on both sets of plates, maintaining the same phase shift in the Y-plate deflection as that shown at C, which means that the points on the actual trace will move along horizontal lines as the X shift is varied. To aid in visualizing this, horizontal lines are drawn for the points where the curve suddenly changes, at C, D, E, and F. To allow these points to move on a path similar to a point on the surface of our imaginary vertical cylinder, the original construction lines, becoming ellipses, move in the peculiar manner indicated at D, E, and F. The arrows on the ellipses indicate an imaginary direction of rotation consistent with the arrows on the thick line showing direction of spot movement. This direction is arbitrary and might easily be in the opposite sense to the one shown.

At D the phase shift in both deflections is in opposite ways, so the resulting pattern is more opened out. At E the two phase shifts are the same way and the same amount, so, if no distortion were present, the straight line, due to the equivalent ellipse being viewed edge-on, would be restored; but the bent-over portions are now moved round so they appear as loops moving away from this straight line. F shows the way the pattern distorts when the X phase shift is in the same direction as the Y shift, but bigger, so as to turn the pattern inside out.

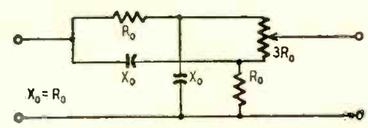


Fig. 5—A simple phase-shift network.

Some of these variations may occur in practical amplifiers. Phase shift may occur before the distortion sets in and further phase shift may be introduced after the point of distortion. If the phase shift is due to the fact that the frequency of the signal is either at the high or low end of the spectrum, it will be progressive, all in the same direction, as the signal goes through the amplifier, before and after the point where distortion occurs, but if viewed from the point of distortion, the earlier phase shift will be in the opposite direction from the shift after that point (the signal on the X plates will be in advance of the point of distortion and that on the Y plates behind it in phase.

So this combination would produce a pattern somewhat like that shown at D in Fig. 4. Phase shift only before or after the distortion point would give an effect similar to the trace shown at A or C respectively of Fig. 4.

To aid in recognizing patterns due to practical amplifier distortion, it may therefore be helpful to inject deliberate phase shift into the signal fed to the X plates. Fig. 5 shows a simple circuit that will give continuous phase shift variation up to about 30° either way from the zero position. The capacitors are marked in terms of their reactance at the frequency for which the network is used. Of course, it can be used only at one frequency, or over a very limited range of frequencies, with any particular set of values, but the arrangement could be modified by switching in different capacitors to provide phase-shift facilities at different preset frequencies. This type of network is used for phase shifting in many test instruments.

Fig. 6 shows the arrangement applied with switching for frequencies of 100, 1,000, and 10,000 cycles. An

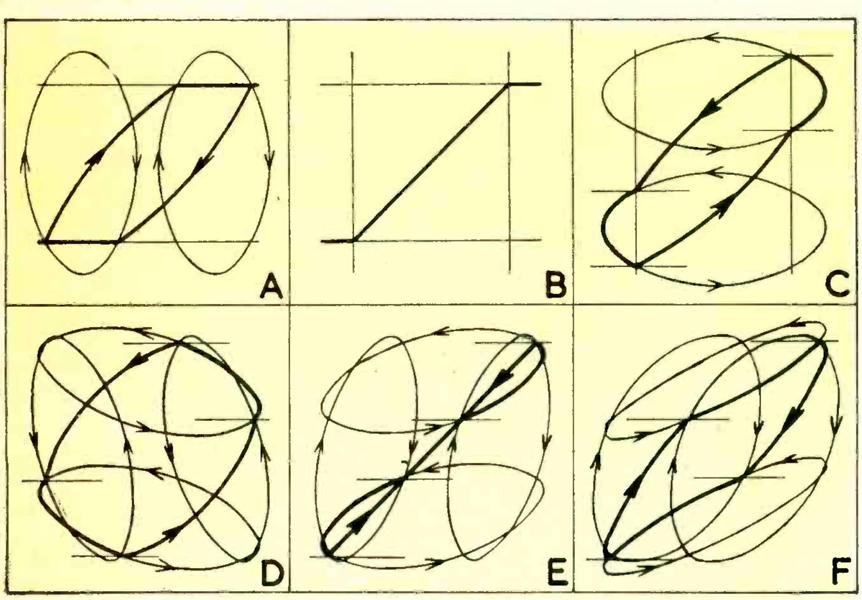


Fig. 4—How a distorted trace's shape varies with phase shifts. See text.

extra switch is provided so the phase shift network can be inserted or removed at will. This enables the frequency applied to the amplifier to be swept through the frequency spectrum without deliberate phase shift, switching over to the phase-shift arrangement at the preset frequencies of 100, 1,000, and 10,000 cycles for more detailed investigation of the pattern at these points.

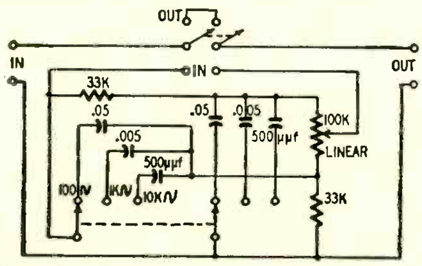


Fig. 6—Three-frequency shift network.

Fig. 7 gives a complete set of prepared patterns for a variety of typical defects in amplifier performance. The pattern for no phase shift is arranged in the second column from the left-hand side for convenience—that for X phase shift only being to the left, and that for Y phase shift only to the right of it. The remaining columns give the effect of equal X and Y phase shift of 30°, the opposite way and the same way. The kind of defect giving rise to the distortion is noted down the left edge of the diagram.

The first four groups of patterns relate to clipping due to grid current or similar action and curvature due to tube characteristics. The former may be due to inadequate grid bias and the latter to too much grid bias. Wrong plate loading can also cause these troubles. Some of the patterns show little difference between the two kinds of distortion. Notice where the X and Y phase shift are the opposite way. Here the difference between the two kinds of pattern is very small, and would be difficult to identify on an actual trace; this means that if some phase shift occurred before distortion, with some more phase shift after it, it would be difficult to determine which of these two kinds of distortion were taking place. Introduction of phase shift in the X plates to neutralize that in the amplifier before distortion occurs would produce a pattern similar to that shown in Fig. 7, in the column "Y phase shift 30°," where the difference between the two forms of distortion is quite clearly identified.

If sufficient phase shift were introduced in the feed to the X plates to offset all the phase shift in the amplifier, the trace would be similar to that in the last column of Fig. 7. Here again the patterns are distinctly different. Probably the easiest point to detect the difference is that where the trace divides: In the pattern due to clipping, the curve splits abruptly, but in the pattern due to curvature it forks apart smoothly.

The next line of patterns illustrates the kind of distortion due to magnetizing current in a transformer core. For the previous patterns it would be immaterial which kind of X phase shift were introduced (by itself), because the pattern with no phase shift has a kind of symmetry demonstrated by the fact that the spot retraces its path to produce a single line trace. With this kind of distortion, such symmetry cannot exist, so 30° phase shift produces a different pattern, according to which way the phase is shifted. One direction is indicated in the figure by the solid line, and the opposite kind of phase shift, where it follows a different course, by the dotted line.

Where the phase shift through an amplifier is progressive, as at low frequency, the dotted line pattern would be the one seen, but where a similar phase shift is inserted in the deflection to the X plates, the solid line pattern would be produced. The effect of phase shift after the point of distortion is shown in the "Y shift 30°" column, and combinations of phase shifts in the remaining two columns.

Another kind of distortion that produces patterns somewhat similar to transformer core distortion in some phases occurs when tubes in class-B operation are badly matched so that one tube cuts off before the other starts to conduct. A variety of patterns for this case is shown in the next line of the figure.

The last line illustrates the kind of pattern produced when high-frequency ringing occurs in the drive transformer of an output stage where positive excursions of the output tube grids are encountered. The ringing is due to shock excitation of an ultrasonic resonant frequency in the drive transformer circuit each time grid current ceases.

A further article will show how the oscilloscope can be used for localizing unexpected factors in the performance of an amplifier. END

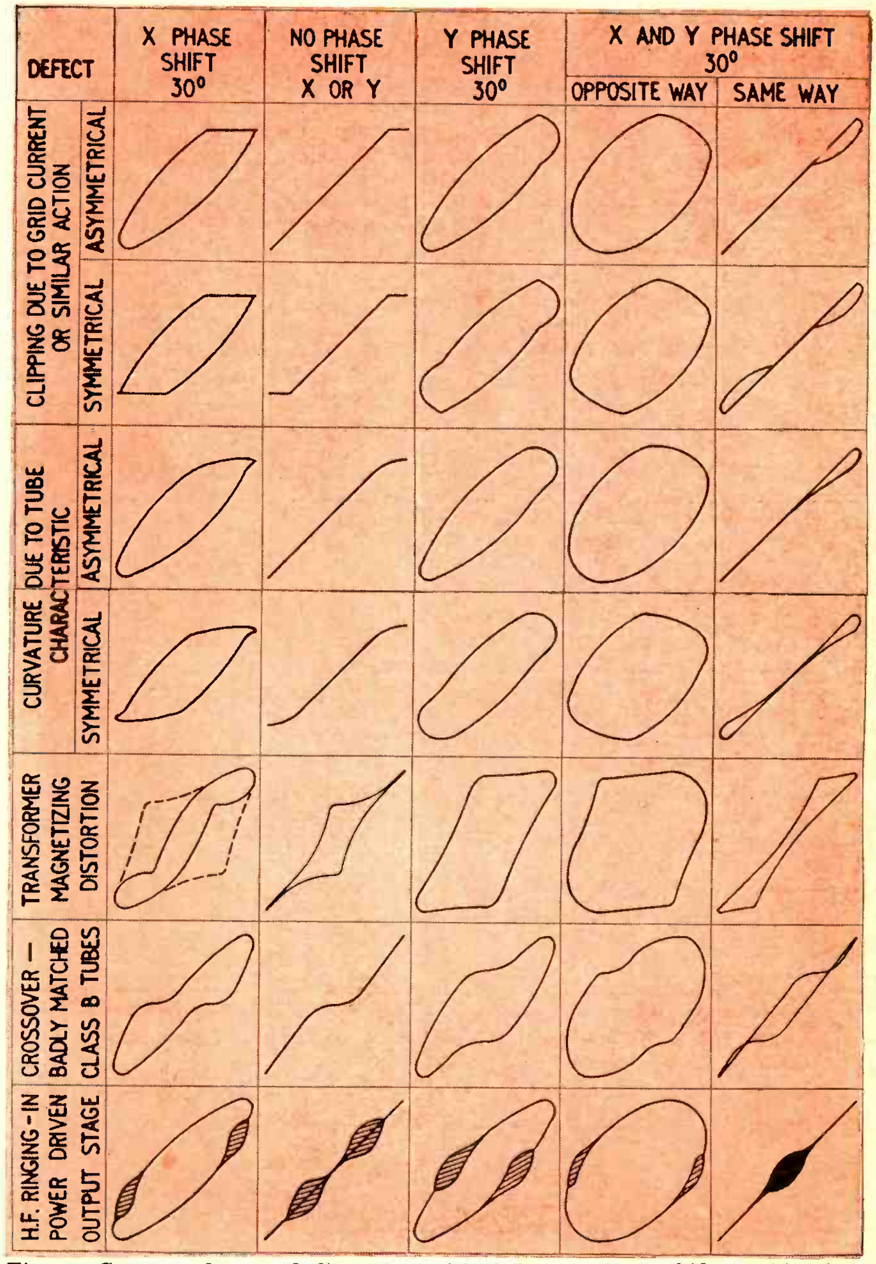


Fig. 7—Common forms of distortion with different phase shift combinations.

HIGH-QUALITY AUDIO

By RICHARD H. DORF*

Fig. 1—Audio room at Terminal Radio Co., NYC, exhibits variety of components.

Part II—Loudspeakers

The loudspeaker is usually the weakest link in a high-fidelity system. A knowledge of loudspeakers makes for a most economical choice

THE INDIVIDUAL who has decided to invest in a custom-made home music system is putting himself in a somewhat different class from those who are satisfied with ordinary department-store combinations. He may be able to find a custom builder and rely wholly on the man's tastes and recommendations, but that procedure is rare. It is much more common to find prospective owners beginning to learn something about audio and electronics so that they can make intelligent purchases of components. Possession then becomes an individual thing as distinguished from the mass-market push-the-button-and-it-goes product.

When a home is to be newly equipped for high-quality audio, the first question is what facilities are desired. Most owners want a phonograph, which consists of a changer or a turntable, arm, and cartridge. Most also desire radio, though not always limited to AM, especially in a city like New York where all major and many minor stations broadcast also on FM. This calls for a tuner. An amplifier is always necessary to convert the voltages from the tuner and phonograph pickup to power, a speaker or speaker system is a necessity.

The most pressing problem is selection of the components. As in any integrated system, the poorest component determines the quality of the final sound. It is foolish, for instance, to have a first-class three-way speaker system in a big, solid box at a cost of four or five hundred dollars, powered by a $30 amplifier. The same money would be better spent on a good amplifier, which can greatly improve the performance of an inexpensive speaker. A good speaker will show up all the faults of the poor amplifier. So when a budget figure is arrived at, the money should be apportioned carefully to achieve an integrated system—each component as good as funds will allow, with the money spent for the various components proportionately to do the most good.

Loudspeakers

The impetus of public demand given to designers and manufacturers of high-quality audio equipment has resulted in vast equipment improvements in a short time. Amplifiers have advanced to the point of near perfection in sound quality. All one has to do to get an entirely adequate amplifier is pay for it. Very high-quality turntables and tuners are available. Records today are not perfect, but they are fine; pickups, while far from perfect, are not quality-limiting factors. The one component which limits the performance of the system when the rest of the components are optimum is the loudspeaker.

The basic reason is that it is a power-producing transducer, of which the utmost versatility is required. It must take electrical signals and translate them to movements of air. It must do this over an exceedingly large range of frequencies, (1,000 to 1 if the limits are 20 and 20,000 cycles), and the air movements it creates take in a range of almost 70 decibels between the smallest and largest. In addition, it must create no movements on its own. This is a tall order and is not fulfilled by any speaker system so far developed. The performance of a loudspeaker is greatly affected by its housing and mounting and by the amplifier which drives it.

Since even the finest of loudspeakers fall considerably short of perfection, the best way to place one in a system is to listen to several within your potential price range, know a little about speakers in general, and then make your choice to take advantage of whichever one within your spending range does best. The listening and initial selection can be done in any of the many audio equipment salesrooms throughout the country, most of which are run by electronics jobbers. Fig. 1 shows a portion of the audio room at a New York electronic parts distributor. Most of the items are actually connected to a central distribution panel so that the customer can listen to as many systems as he wishes, each composed

*Audio Consultant, New York City.

of components of his choice and put together in a few seconds at the distribution panel. Unless mail order is the only means, good audio equipment should not be bought without giving an ear to it at a showroom and comparing it to other models. This is especially true of speakers. Since speakers fall short of perfection, each speaker and each system has to a large extent its own sound character. The only way to get satisfaction is to choose the one whose sound suits *you*.

A loudspeaker is basically nothing more than a reversible d.c. motor. The *motor* is powered by audio currents from the power stage of an audio amplifier. Its output motion is not rotary but reciprocating—back-and-forth. Its load is the air, and thereby hangs one of the great difficulties of good sound reproduction. Air is compressible, and coupling the moving speaker cone to it becomes more difficult as the cone movement becomes slower. You can see that for yourself, by holding a piece of paper in your hand and moving it so that the area of the paper is opposed by the air. If you move the paper slowly it goes quite easily; the air is gently compressed and moves out of the way. If you move the paper fast, it bends, showing marked air resistance. Similarly in a speaker a fast-moving cone (excited by a high frequency) has no difficulty making the air move. But at low frequencies a cone moves practically no air at all. To make it do so, special provisions are required, such as the use of a large cone (obviously a large piece of paper will move more air at slow speeds), an enclosure so the air cannot readily move out of the way; or some artificial reinforcement such as a bass reflex port in the enclosure.

Speaker structure

The General Electric S-1201-D loudspeaker is a 12-inch unit in the low price range but with surprisingly excellent sound characteristics. It is especially built for home music systems of the more modest type where a single speaker does all the work. Its structure is fairly typical of such units. The working parts of the speaker are shown in the cutaway photo, Fig. 2, and the exploded view, Fig. 3.

The primary parts of the speaker are the magnet and voice coil. The magnet is a cylindrical piece of Alnico V, an alloy of magnetic metal which forms a permanent magnet of exceptionally high field strength. Alnico V is used in practically all good speakers. The more sensitive speakers have magnets of greater size and weight, ranging from a few ounces to 5 pounds or more. The magnet shown weighs 14.5 ounces.

The voice coil is a low-impedance coil mounted on a cylinder of aluminum and placed within the field of the magnet. When current flows through the voice coil the magnetic field set up by the current either aids or opposes the field of the permanent magnet. The excitation for the voice coil is a.c. at audio frequencies. This causes the polarity of the magnetic field around the voice coil to reverse every half-cycle. As a result the coil moves forward and back at a frequency determined by the audio excitation.

The nature of the voice coil's movement follows the laws of electromagnetic phenomena. In an ideal speaker, the amount of movement for a given excitation frequency, is proportional to the peak value of the a.c. For a given peak value of a.c. the amount of movement is inversely proportional to frequency; there is greater movement at low frequencies than at high frequencies. It might appear at first thought that this would result in bass emphasis, but, like all of Nature's laws, the relationship of air movement, frequency, and ear sensation fit together nicely. The amount of sound sensed at any frequency is a function of the sound power. The power of a movement is proportional to the product of velocity and distance. The same amount of power is expended in moving a bedroom bureau 10 feet at the rate of 50 feet per minute as you would moving it 20 feet at a speed of 25 feet per minute, other things being equal. At low frequencies the voice coil pushes the cone farther but slower—and at the high it does the job faster but not as far.

The voice coil is part of an assembly which includes the spider. The spider is a piece of fabric with corrugations for flexibility. It holds the aluminum coil form in place, when the edge of the circular spider is fastened in place on the frame as shown in Fig. 2. The steel core is fixed in place by the magnet assembly and the voice coil form slips over it so that the coil stays centered and can move only in its axial plane. A felt dust-cap is cemented over the open outer end of the coil form.

The cylindrical magnet is held in place by compression between a disc-shaped front plate of steel, welded to the frame, and a back plate of the same shape which is pressed against the magnet and secured with three bolts. A cover is fitted over the entire magnet assembly and is held in place with a bolt. This prevents dust and stray magnetic metal particles from getting into the assembly and possibly impeding the movement of the voice coil and distorting the magnetic field, resulting in loss of fidelity.

The cone is the element which actually pushes the air. Its inner (small) end is attached to the outer end of the voice coil form and its outer end is cemented to the outer end of the main steel frame of the speaker. Fig. 4, a front view of a speaker, shows that there is a more or less right-angle fold at the outer edge of the cone as well as a couple of accordion pleats. With this provision the body of the cone can move in and out without being greatly restricted by the outer edge fastening. When the voice coil moves back and forth as a result of the changing magnetic field set up around it by the audio current, it pushes the cone in and out. The cone, in turn, moves air and sets up sound waves.

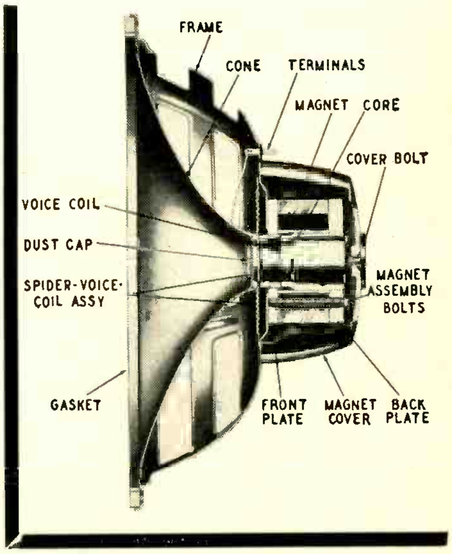


Fig. 2—Cutaway view of modern loudspeaker.

Speaker quality factors

The description we have just given illustrates the essentials of speaker construction. Most speakers, big and little, good, bad, and indifferent, are put together in roughly the same way. What, then, makes the differences between speakers?

We have mentioned that the size of the magnet determines the sensitivity of the speaker. This is because the stronger the magnetic fields the greater will be the motor action. It is also possible with a larger magnet to create a more uniform magnetic field over the distance through which the voice coil travels. Any nonuniformity of the field means that the voice coil will fail to move in exact accordance with the audio output of the amplifier, since a given coil current will not produce the same movement at all voice-coil positions. All other things being equal, look for a large magnet when you buy; catalogs rate them in weight.

Electromagnetic speakers once were common. They had no permanent magnet; the field was created by a large coil of wire in the same position as the magnet in present-day speakers. It was excited by direct current either from a special power supply or from the B supply of the set. Electrodynamic speakers are subject to hum from the field supply, and they waste power. Avoid them for high-quality systems.

Voice coils are invariably of low impedance, never higher (except in very special cases) than about 16 ohms. The reason is that higher impedances could be obtained only by more turns. That would increase the weight of the coil and restrict its ability to move quickly in response to high frequencies. It would also, of course, cause overshoots and lags. The nominal a.c. impedance of a voice coil has no relation whatever to the quality of a speaker, but its actual ohmic resistance does.

Ideally the impedance should be pure inductance, since a pure reactance consumes no power. The power fed to the speaker should be used to move air, not to cause heat in the voice coil. Even a small amount of ohmic resistance in a voice coil creates a surprising loss of efficiency.

In a working speaker the mechanical work done by the cone causes the voice coil to draw current from the amplifier. The situation is somewhat analogous to a transformer whose primary draws more current when the load resistance across the secondary is made smaller. It is only the inductive part of the net voice-coil impedance which can make the cone move. The "reflected" resistance of the cone should be the largest part of the voice-coil resistance. (Resistance is defined in this case as the inclination of the coil to draw current.) Not only does current passing through ohmic resistance of the coil not do any work, but it also contributes to nonlinearity of cone movement. We do our best in high-quality amplifiers to provide enough inverse (and sometimes positive current) feedback to make the resistance the speaker sees a low one. When we do this we expect to have the cone moving according to the current, even though the air represents a constantly changing load. But when the voice coil has d.c. resistance the effect is the same as when a series resistor is inserted in a battery circuit.

Ohmic resistance is reduced by using as large-sized a wire as possible without adding too much to the coil's weight. In the most elaborate speakers the voice coil is made of aluminum ribbon wound on the form on edge so that the result looks like a stack of circular cooling fins. The ribbon presents a large area for current flow, which greatly reduces the resistance of the winding. Aluminum is used rather than copper for the sake of smaller mass. Makers of speakers with aluminum-ribbon voice coils usually feel it worth while to advertise the feature, and justifiably so since it makes for a high-quality speaker. Low d.c. resistance in a voice coil, is useful to preserve the regulation advantages of an amplifier with a good amount of negative feedback. If an ordinary receiver, a department store console or an old-style amplifier, is the audio source, the aluminum ribbon is worth little if anything.

The cone is important because it is the air mover. Its salient features are material, shape, and mounting. Little can be said about cone material because manufacturers choose it without telling the buyer what they have chosen. In general the cone is made of paper and not a very tough paper at that—in fact, when it is not inherently soft and fibrous, it tends to be somewhat brittle. For some unknown reason cones are not usually moistureproofed. So, when handling a speaker, be extremely careful not to let anything touch the cone, back or front, and rest it on a flat surface, face down. I have handled hundreds of speakers and I always treat them gently. While radio-set or public-address speakers can be re-coned by most service technicians, high-quality units require factory repair. Since a new cone is necessary if the old one has even a small rip, hole, or uneven spot from moisture, take care! When mounting speakers in cabinets or on baffles, cut a piece of heavy wire mesh—quarter-inch squares are good—and mount between speaker and panel.

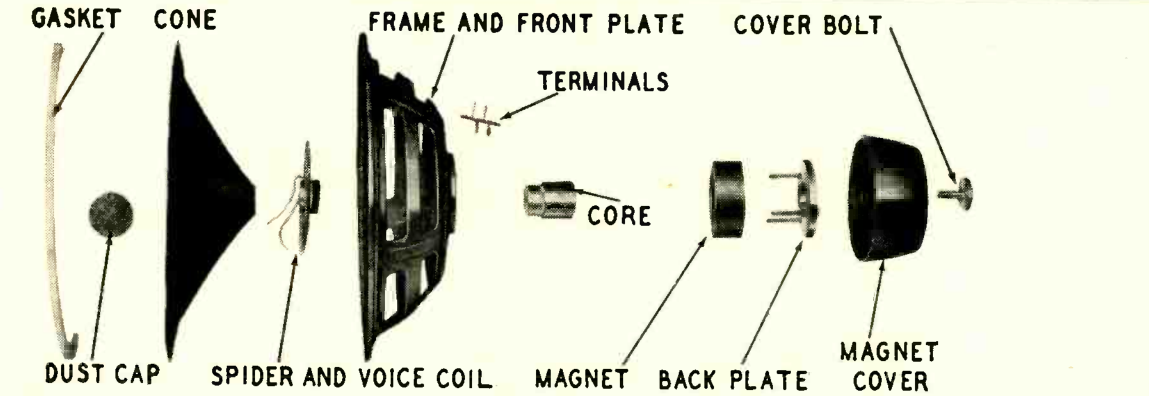
Shapes and mountings of cones differ greatly among manufacturers. In general, cones either have straight sides or are flared. The flare, which can be seen plainly in Fig. 2, seems to be somewhat beneficial, since it approximates the beginnings of a small exponential horn, which is the best way to couple the speaker to the air (more on this subject in the next installment).

Another school holds that the cone ought to be as flexible as possible. In a speaker which reproduces all frequencies (not used with a tweeter) the cone tries to move over a large path slowly and over smaller subpaths quickly at the same time. With stiff cones this may cause cone breakup—different parts of the cone moving in different ways and producing air movements with no predictable relationship to the audio input. Some manufacturers prefer to have very flexible cones. They achieve this by *pleating* the cone in the manner of the wide-range University 6200 shown in Fig. 5. The pleating or accordion principle to achieve flexibility is commonly used around the outer edge of almost all cones. There is so much variety in effect possible, considering the materials and details of shape and mounting, that a blanket recommendation is impossible. The best procedure is to listen to several speakers and take the one that sounds best.

In the next installment we will talk about enclosures, multispeaker systems, and other facts concerned with getting the most out of the speaker you buy.

END

Fig. 3 — Exploded views shows the many integrated parts of a modern loudspeaker.



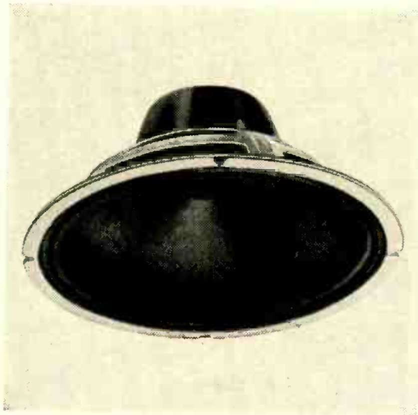


Fig. 4—Front of speaker. Note right angle fold and accordion pleats at edge.

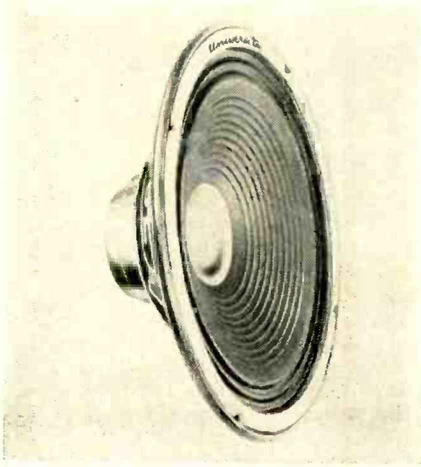


Fig. 5—Loudspeaker using completely pleated cone for maximum flexibility.

Part II—Improving the high-frequency response. The Miller effect, shunt capacitances

extending amplifier BANDWIDTH

By JOSEPH MARSHALL

IN THE first part of this series, we dealt with some of the difficulties in the way of extending the bandwidth of amplifiers and discussed in some detail the problem of extending the bandwidth downward. Having lengthily considered the low end, we now come to the question: What about the highs?

We can take several measures to extend the high-frequency response. It is limited principally by shunt capacitances and the Miller effect. We can start by using miniature tubes in voltage-amplifier and phase-inverter sections. Their capacitances between elements are about half those of the larger tubes. Second, we can design these stages with very low plate loads. Although this results in lower gain and output, it also results in lower losses at high frequencies. Single-ended tubes will deliver enough gain for preamplifier service with plate loads of 50,000 ohms and complementary grid leaks; push-pull tubes can use a higher load. We can improve the h.f. response still further by leaving out the cathode-bypass capacitor and thus producing current feedback. The reduction in gain is not significant at audio frequencies but the improvement in h.f. response definitely is. We can also use, especially with single-ended stages, cathode compensation as in Fig. 1. This method of operation produces degeneration at lower frequencies but full amplification at the high frequencies. For best results the value of the cathode-bypass capacitor should be adjusted with a square-wave generator and a scope. Values from .01-μf downward can be tried until maximum flatness is obtained. This method can also be used with push-pull amplifiers (using *separate bias resistors*) but the same result can be achieved much more simply by inverse feedback.

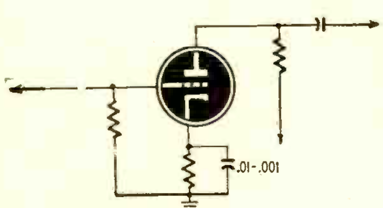


Fig. 1.—A method of h.f. compensation.

The greatest villain in the picture as far as h.f. response in triodes is concerned is the feed-through provided by plate-grid capacitance and the Miller effect. The effective capacitance is the product of the actual grid-plate capacitance times the amplification factor of the tube. Thus, if the tube has a gain of 12, and a grid-plate capacitance of 3 μμf, the effective capacitance becomes 36 μμf. The reactance of this capacitance at frequencies higher than 10 kc becomes low enough in relation to the grid resistance to result in considerable attenuation of these frequencies.

There is an extremely simple means of eliminating the Miller effect which should be used more often in high-fidelity design. That means is *neutralization.* Single-ended stages are hard to neutralize at audio frequencies, but push-pull stages are so easily and cheaply neutralized that there is almost no excuse for not including this means of extending the h.f. response.

Voltage amplifiers are cross-neutralized with fixed capacitors approximately equal in value to the grid-plate capacitance of the tubes. If miniature tubes are used, as they should be for reasons which will follow, fixed gimmicks of 1.5 μμf serve for the 12AT7, 12AU7, 12AX7, 12AY7, 6C4, or 6AB4. They are simply wired in from the plate of one tube in a push-pull stage to the grid of the opposite tube in the same stage, as shown in Fig. 2. Fixed capacitors can be used for output tubes in a similar manner; or, for perfect neutralization, ceramic trimmers of the 4-30-μμf type can be wired in and adjusted for complete neutralization. To adjust, simply break the filament circuit to the output tubes, feed in a signal, and adjust the capacitors for null or minimum output.

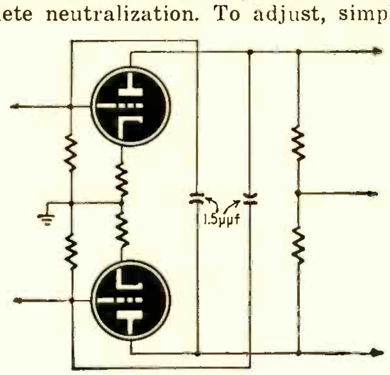


Fig. 2—Cross-neutralization circuit.

There is another way of neutralizing the grid-plate capacitance of tetrodes used as triodes in output stages. This is by employing the *Ultra-Linear* type of operation or a modified form of it. As indicated in Fig. 3, this form of operation connects the screens to taps on the output transformer. For most effective *Ultra-Linear* operation the screen taps should be about 18% of the impedance of the plate taps. However, ratios as low as 2 to 1, though not providing true *Ultra-Linear* operation, will minimize the Miller effect. The portion of the load between screen and plate isolates them so far as the tube capacitances are concerned and the tube behaves as a hybrid between a triode and a tetrode. The reduction in Miller effect is very similar to that of neutralizing — the high-frequency response is improved.

Optimum *Ultra-Linear* operation requires a special transformer. Many output transformers, however, provide two sets of primary taps—10,000 ohms and 5,000 ohms, or 6,600 ohms and 3,300 ohms, for example. Connecting the screens to the half-impedance taps will affect the power output and distortion characteristics very little, but will flatten the h.f. response.

With neutralization, the remaining h.f. losses are a matter of shunting capacitances only. Once more the use of miniatures helps, especially when neutralization is used. *Neutralization, though eliminating the Miller effect, doubles the output capacitance of the tube.* The output capacitance of miniature tubes is half or less that of the standard tubes. So, even after neutralization, the miniatures have a better output-capacitance characteristic than the larger tubes.

Lowering the plate and grid loads improves the h.f. response by improving the ratio of load to shunt reactance. Direct coupling also helps, because circuit and stray capacitance is reduced. Feeding a tube from a low-impedance source also minimizes Miller effect. Thus the 12AX7 second section of the cross-coupled inverter described in Part I, last month, being fed by the very low load of the cathodes of the first section, is affected by the Miller effect only beyond 100 kc. Similarly, in the case of the output tubes direct-coupled to the cathode-follower driver, the Miller effect becomes serious only beyond 50 kc, whereas in the self-bias circuit with a 500,000-ohm grid resistor, it becomes serious shortly after 10 kc. These are approximate frequencies.

Inverse feedback

Use of miniature tubes, neutralization, and the other measures referred to, can extend the response of an amplifier using the direct-coupled front section of Fig. 1 in the September installment and either of the power amplifiers described in this part, to 50 kc or slightly beyond. But this is still about an octave less than the flat response of the best output transformer. One further step can be taken to extend both the low- and the high-frequency response—and that, of course, is inverse feedback.

The conventional amplifier, as exemplified by the Williamson circuit for instance, uses a single feedback loop. Better results can be achieved by using

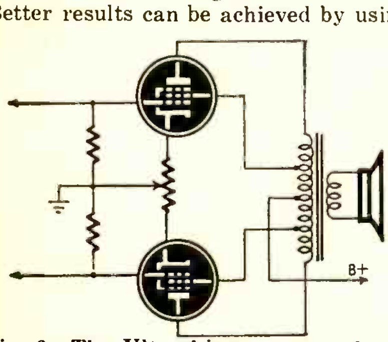


Fig. 3—The Ultra-Linear approach.

two loops. One would be an *internal loop* to flatten the response of the amplifier exclusive of the output transformer, to maintain dynamic and frequency balance, and to cancel part of the distortion. The second would be an *over-all loop* for correcting the response of the output transformer, further reducing distortion, and wiping out any bumps or slopes in the over-all response.

In the virtual direct-coupled amplifier we have been developing here, the internal loop can be very profitably carried from the plates of the output tubes to the cathodes of the voltage amplifier. Because the cathode resistors of the voltage amplifier are 120,000 ohms we can easily keep down the phase shift in the loop, and indeed we can correct the phase shift produced by the single coupling capacitor. For 10% feedback we can use a 1.2-megohm feedback resistor. If we now select a capacitor which gives us the same time-constant as the interstage coupling capacitor-resistor network, we achieve what amounts to neutralization of the interstage coupling capacitance. This is true because the two capacitances produce phase shifts in opposite directions —the interstage capacitor reducing gain, and the feedback capacitor increasing gain at very low frequencies. For exact neutralization the feedback factor should equal the gain between the interstage capacitor and the output tube plates; and by a coincidence, 10% feedback to a pair of 12AU7s produces a feedback factor of 5 which is almost exactly the voltage gain of the big output triodes, or tetrodes used as triodes. Actually, it is not necessary to neutralize precisely, and even a considerable under- or over-neutralization will be satisfactory in practice. So in the case of the amplifier with self-bias we could use a 0.25-μf feedback capacitor, yielding an approximate time-constant of 0.25 second, and in the case of the amplifier with fixed bias, a 0.5-μf capacitor, yielding a time-constant of 0.5 second (Fig. 4). The phase shift in the feedback loops would begin at about the same point, but would go in the opposite direction from the shift caused by the interstage coupling capacitance. The final result would be the extension of the low-frequency response to around 1 cycle in the fixed-bias amplifier, and to 2 cycles in the self-biased amplifier.

With a 12AU7 as the voltage amplifier, 10% feedback will provide 14 db of effective feedback. This is more than enough to extend the high-frequency response at least another octave and probably two octaves. This will make the over-all response from input of the cross-coupled inverter to output-tube plates nearly flat from 1 or 2 cycles to beyond 100,000 cycles. Moreover, since this feedback loop includes the two stages responsible for the largest part of the distortion—the output tubes and the voltage drivers—the 14 db feedback produces an improvement of 5 times in distortion characteristics. Finally, if we match the resistors and capacitors in the feedback loop, we will achieve dynamic and frequency balance. So long as we deliver equal signals to the grids of the 12AU7 voltage amplifier, which we can easily do with the balancing control in the cross-coupled input, the loop will maintain that balance over the dynamic range of the amplifier.

Over-all feedback loop

When we now add an output transformer to the circuit we have just developed we obtain a picture rather different from the one we get when the same transformer is applied to the conventional circuit with its narrow bandwidth. First of all, it is obvious that with so little phase shift in the amplifier proper, the amount of feedback we can introduce from the transformer secondary to the input is limited only by the characteristics of the output transformer itself.

With the best transformers available today, the amount of feedback is actually limited only by the loss in gain we can afford. We have applied as much as 40 db of feedback—in addition to the 14 db of the inner loop—before instability resulted. Actually we need less than 20 db in this loop to correct for phase shifts in the output transformer and decrease the remaining distortion to a negligible level.

The total feedback, as far as the output and driver stages are concerned, would be 30 db or more. This would reduce distortion by a factor of 30 or considerably below 1% at maximum output. 14 db should be sufficient to take care of any remaining imperfections in the response of the best grade of output transformers.

Cheap output transformers

An ordinary public address-type output transformer and about 20 db of over-all feedback in the over-all loop will produce results in this circuit which are about as good or better than those

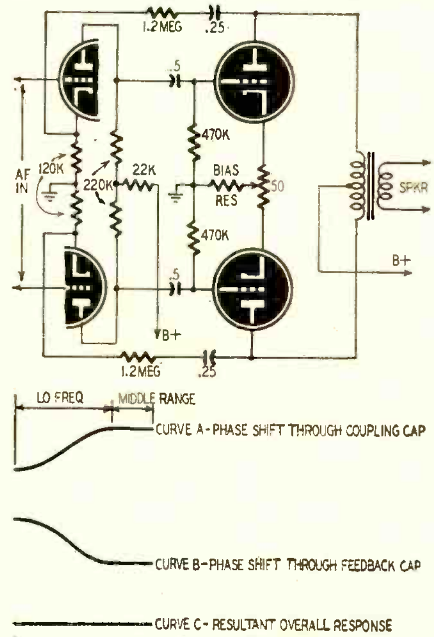


Fig. 4—The phase shift at low frequencies is neutralized in this circuit.

obtained with high-priced transformers attached to conventional narrow-band amplifiers. After all, it doesn't much matter whether the phase shift takes place in the output transformer or in the rest of the amplifier. An amplifier with considerable phase shift in the output transformer but very little in the amplifier itself will have an over-all performance very nearly comparable to that of an amplifier with a wide-range transformer and a narrow-band amplifier. There are other factors, such as core saturation, to be sure; but for many purposes, particularly that of obtaining acceptable high-fidelity reproduction at the lowest cost, an amplifier employing the measures we have discussed here with a public address-type transformer will be practically indistinguishable from the great majority of today's high-grade high-fidelity amplifiers employing high-priced transformers but possessing poor internal bandwidth.

In a very early issue accordingly, we hope to present a practical low-cost version of the *Golden Ear* amplifier, incorporating the various measures discussed in this and previous articles and producing—at a cost of $25 or less—the reproduction which will compare very favorably with that of $100 amplifiers. END

The "goodness" of an amplifier is not shown by its circuit diagram. Circuits have no inherent magic properties, but are merely the tools with which the designer seeks to achieve a certain result, and different designers—provided always that they have the same high standards in view—may achieve the same results by different means.

—D. T. N. Williamson

High-Quality Circuits

Utilization of tone and loudness controls to improve amplifier frequency response.

By JOHN K. FRIEBORN

Tone control

The Bogen model DB20 amplifier uses a tone-control circuit (Fig. 1) which apparently has not yet been used in any

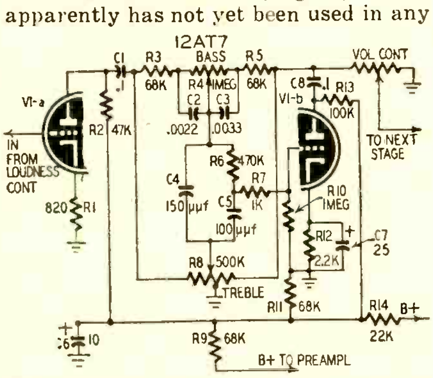


Fig. 1—The Bogen DB20 tone control.

other American amplifier, although it is similar to one published in England[1]. It allows independent bass and treble control, with maximum boost and attenuation as shown in the curves of Fig. 2.

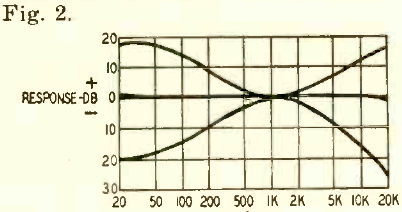


Fig. 2—DB20 control characteristics.

The bass-control section of the circuit includes two signal paths to the grid of V1-b, an input-signal path through R3, C2, and the left-hand section of R4, R6, and R7, and an inverse-feedback path via C8, R5, C3, and the right-hand section of R4. R4 is bypassed for high frequencies by C2 and C3, so that high frequencies are unaffected by the position of the control. When R4 is divided by the arm into two sections whose resistances are in the same ratio as the reactances of C2 and C3, the same ratio of input signal to feedback signal is obtained at all frequencies and the response is flat. When the arm is moved toward R3, low-frequency incoming signals are attenuated less and feedback signals are attenuated more, so the gain at low frequencies increases. Moving the arm toward R5 has the reverse effects.

The treble-control section consists of an incoming-signal circuit and a feedback circuit, each with two paths. One incoming-signal path, through R3, C2, R6, and R7, has an approximately constant impedance at high frequencies. Through the other path, consisting of the left-hand section of R8 and C5, additional input signal at high frequencies can be bypassed around the first path, thus increasing the gain by an amount which depends upon the position of the arm of R8. The treble attenuation is controlled by the two feedback paths. The first, through C8, R5, C3, R6, and R7, has approximately constant impedance at high frequencies. Through the other path, consisting of the right-hand section of R8 and C5, additional feedback can be obtained and the treble can be attenuated by an amount depending upon the position of the arm of R8. When the arm is opposite the grounded tap on R8, no additional input signal or feedback is obtained and the treble response is flat.

Loudness control

Two recent amplifiers present different solutions to the old problem of tone-compensated volume control or, as it is now called, loudness control. Both solutions consist of a tone-compensated "loudness control" used in conjunction with an uncompensated volume control. The loudness control used in the remote-

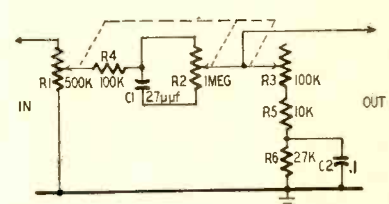


Fig. 3—Loudness control circuit in Stromberg-Carlson AR-25 amplifier.

control unit of the Stromberg-Carlson model AR-425 custom amplifier is a continuously-variable type, as shown in Fig. 3. The three potentiometers are ganged and move together in the direction indicated when the loudness is de-

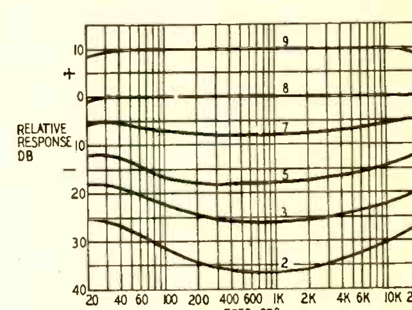


Fig. 4—AR-25 loudness control curves.

creased. The attenuation due to R1 and R2 is increased and the attenuation due to R3 is decreased. C1, shunting R2, provides relative treble boost, and the circuit consisting of C2 and R6 provides bass boost. This circuit is similar to the IRC loudness control[2], except for the addition of R6 and a change in the values of the capacitors. The attenuation characteristic for the circuit of Fig. 3 at several settings is given in Fig. 4.

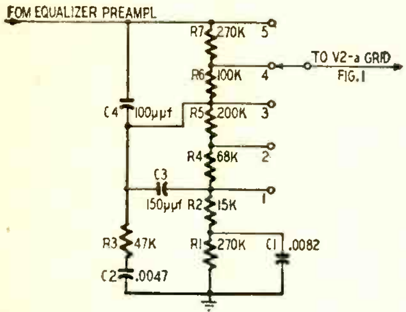


Fig. 5—The loudness control circuit of the Bogen model DB20 amplifier.

The loudness contour selector, as it is called, in the Bogen model DB20 amplifier, is a step-type control. (Fig. 5.) Unlike most previous step-type loudness controls[3], this circuit provides treble as well as bass compensation. As the loudness is reduced, the amplitude of treble signal voltages is reduced more than bass, because of the shunting effect of C1 around R1 and C2 and R3 around all the components between step 3 and ground. Hence, there is a relative bass boost. On the other hand, there is also some treble boost, since C3 and C4 bypass high-frequency signals around R4, R5, R6, and R7, which attenuate the lower-frequency signals. The over-all characteristic is shown in Fig. 6.

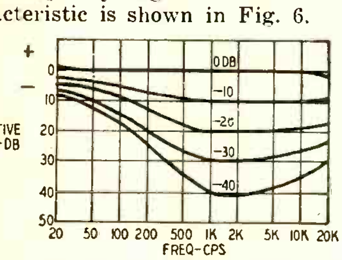


Fig. 6—Frequency characteristics of Bogen DB20 loudness control circuit.

Since there are considerable differences, not only between the actual frequency compensation characteristics of various loudness controls but also between the instructions given by various manufacturers for the use of their controls, it might be useful to sum up briefly the principle involved and a simple method of using any loudness-volume control combination. When any combination of sounds, such as a musical performance, is heard at one volume level and then again at a lower level, if the actual acoustical power of every note is reduced by the same ratio, on the second hearing there will seem to be an extra reduction in the volume of the high-frequency notes and a still greater reduction at low frequencies, compared to frequencies between about 1,000 and 3,000 cycles. If a sound is reproduced at the same loudness level as it originally occurred, no compensation is required, but if it is reproduced at a lower level, there should be some bass and treble boost.

When a program is to be reproduced at its original loudness level, the loudness control should be set so as to give a flat frequency characteristic and the desired loudness of sound obtained by adjusting the uncompensated volume control. If it is desired to reduce the loudness of the reproduced sound compared to the original, this should be done with the compensated loudness control, leaving the volume control at the previous setting. (If we can properly judge from the published frequency characteristics of loudness controls, their designers assume that no one wishes to reproduce sound at a level higher than natural.)

Even if we do not actually know what the original level of the reproduced sound was, we can set the loudness and volume controls properly. Assuming that we have proper equalization for recording characteristic (in record reproduction) or for transmission characteristic (in FM reception) and that our amplifier is otherwise adjusted for a flat frequency response—if all this is true and the loudness control can be turned up or down with no apparent change in the balance between middle, high, and low frequencies, then the volume control is correctly set. (This, of course, assumes also that the loudness control—and the listener's ears—conform to the Fletcher-Munson average curves.

If the sound is deficient in treble and still more deficient in bass, turn the volume control up and the loudness control down. If there is excessive bass, and perhaps slightly excess treble also, compared to the middle register, turn the volume control down and the loudness control up.

Sideband cutting compensation

A few recent FM-AM tuners do not depend upon bandpass tuned circuits in their AM channels to avoid the loss of high audio frequencies. They simply allow the amplitudes of the various sidebands to be attenuated by various amounts in the r.f. and i.f. tuned circuits and then compensate after the detector with an audio filter.

The idea is not new. It was first suggested in the early 1930's[4] and analyzed and tested by several engineers around that time. The Robinson *Stenode*, a receiver with a piezo-electric crystal i.f. filter and an audio amplifier having a gain approximately proportional to frequency, was the extreme extension of the idea.

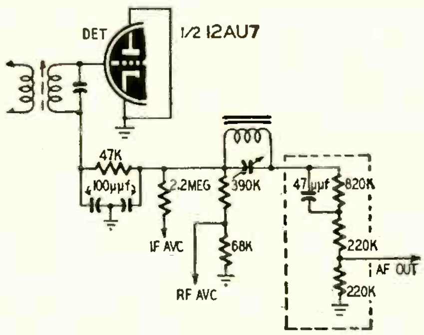


Fig. 7—Sideband compensation circuit, Stromberg-Carlson SR-401 radio tuner.

The circuits described in the reference article used series combinations of resistance and inductance as audio amplifier loads. Current practice is to use resistance-capacitance filters between the detector and first audio amplifier. Stromberg-Carlson model SR-401 radio tuner uses the circuit of Fig. 7. Pilot has used a circuit similar to Fig. 8 in several tuners.

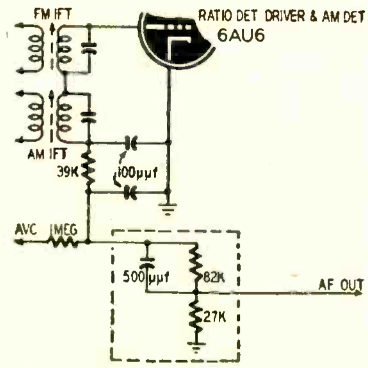


Fig. 8—Sideband compensation circuit in the Pilot model 821 FM-AM tuner.

Various possible defects of the general method were analyzed and disposed of in the article referred to. Presumably Stromberg-Carlson and Pilot find that their particular circuits give satisfactory results.

If the effects of sideband cutting in AM receivers can be counteracted by such a simple method, then why the emphasis all these years on complicated bandpass circuits for high-fidelity receivers?

This article has dealt with interesting circuits and components in current audio equipment. The principles involved and the results achieved are not new in the field of audio design. It is primarily the public interest in high-fidelity equipment that is new; and with this interest the public is willing to pay more to receive this quality. Tone and loudness controls have appeared in a multitude of circuits during the development of radio, but it is only comparatively recently that the more finely engineered circuits have made a widespread appearance. The overall goal is true fidelity of reproduction. What was considered as high fidelity by most manufacturers until recently is now ordinary reproduction. With special compensation networks and high-quality audio components we move continually closer to the ultimate, perfect fidelity.

[1] Baxandall, P. J., "Negative feedback tone control—independent variation of bass and treble without switches," Wireless World, October, 1952, p. 402

[2] Johnson, E. E., "A continuously variable loudness control," Audio Engineering, December, 1950, p. 18

[3] Winslow, J. "Full-range loudness control," Audio Engineering, February, 1949, p. 24

[4] Colebrook, F. M., "A note on the theory and practice of tone correction," Wireless Engineer, January, 1933, p. 4

END

circuit shorts

Voltage regulated screen and bias supplies improve efficiency and fidelity

BY ROBERT F. SCOTT

A WELL-REGULATED screen-voltage source is essential to minimum distortion and maximum output from class-AB push-pull pentode and beam-power audio amplifiers. The screen voltage must be stabilized to hold the plate dissipation at the proper level under all signal conditions. A voltage-regulated bias supply is desirable for good linearity, high output, and high efficiency, particularly in circuits which draw grid current over a part of the input signal cycle.

Fig. 1 shows the signal circuits of the Bogen model HO-125 125-watt booster amplifier. It may be driven by any amplifier that will develop 5 volts across the 500,000-ohm input resistor.

The 6SN7-GT screen-voltage regulator is connected across the 300-volt screen supply lead. When the signal input is low, the screen current decreases. The 6SN7 voltage-regulator grid is connected to the 807 grid-bias line. As the input signal level varies, the 807 grid current and bias change, shifting the bias on the regulator tube so that its plate-current change is equal and opposite to that of the 807 screens. This maintains a constant load on the 300-volt line so that the 807 screen voltage does not change.

Hartley 20-watt amplifier

A series-type voltage regulator (Fig. 2) is used in the Hartley 20-watt amplifier. The plate of the 6J5 voltage regulator connects directly to the 400-volt B plus line. Its grid is tapped onto a B plus voltage divider between the 400-volt line and ground. The divider consists of a 47,000-ohm resistor in series with the plate-to-cathode resistances of a 6J7 voltage amplifier and 6J5 phase inverter in parallel.

Any changes in the supply voltage or load current cause the regulator-tube bias to change. This varies the plate-to-cathode resistance in a direction which tends to stabilize the voltage developed at the 6J5 cathode.

The 10,000-ohm potentiometer in the screen circuit balances the plate currents of the 807's. The tubes are balanced by connecting a 10-ma d.c. meter between the plates and adjusting the potentiometer so that the meter reads zero.

A grid bias regulator

The triode-connected push-pull 1614's in the Fisher model 50-A high-fidelity, 50-watt amplifier are supplied with 42 volts of regulated bias. The driver, output, and bias circuits are shown in Fig. 3. Half of a 12AU7 is used as a shunt-type voltage regulator in the bias supply. Bias voltage is obtained from a tap on the secondary of the power transformer. The 12AU7 control grid is supplied from a variable control in a bias voltage divider network.

This regulator circuit operates somewhat like the one in the Bogen HO-125 shown in Fig. 1. Any changes in the output of the bias rectifier or in the grid bias due to grid current, shift the bias on the 12AU7 so that its plate current varies in a direction which holds the 1614 grids at the proper bias level. When the bias-control potentiometer is properly adjusted, the total 1614 cathode current is 120 ma and the 12AU7 grid and cathode are at minus 43 and 42 volts, respectively.

Altec Lansing voltage regulator

In most circuits using cold-cathode voltage-regulator tubes, the tube (or several in a series) is used as a bleeder to stabilize the voltage at a given point in the circuit. In the Altec Lansing model A-333A amplifier, the voltage regulator tube 0A3 (VR75) is a part of a voltage divider which supplies the preamplifier-equalizer and the screens of the 6L6-G power amplifier tubes. The circuit is shown in Fig. 4. The voltage divider consists of the 0A3 and the 100,000-ohm resistor in series between the 400-volt B plus line and ground. The constant drop across the 0A3 reduces the voltage to 325 at its cathode. The 1,200-ohm and 10,000-ohm series-dropping resistors and the 40- and 20-μf capacitors provide additional filtering and drop the voltage to 320 and 235 for the 6L6 screens and the preamplifier.

Bogen bandwidth control

The Bogen model AM-901 AM tuner and the R-701 FM-AM tuner incorporate a novel switching arrangement for altering the curves of the i.f. and audio output circuits to provide normal 10-kc response for high-fidelity AM reception or a cutoff at about 5 kc for narrow-band reception.

The response-determining portions of the AM-901 tuner are shown in Fig. 5. The 6BE6 is the converter, the 6BA6 is the i.f. amplifier, and the 12AT7 is the diode detector and audio cathode follower. S1 is a 6-circuit, 4-position function selector switch. Position 1 is OFF, 2 is PHONE, 3 is NARROWBAND AM, and 4 is WIDEBAND AM.

Sections S1-a and S1-b vary the response of the i.f. circuit. When set to WIDEBAND AM, the trimmers across the

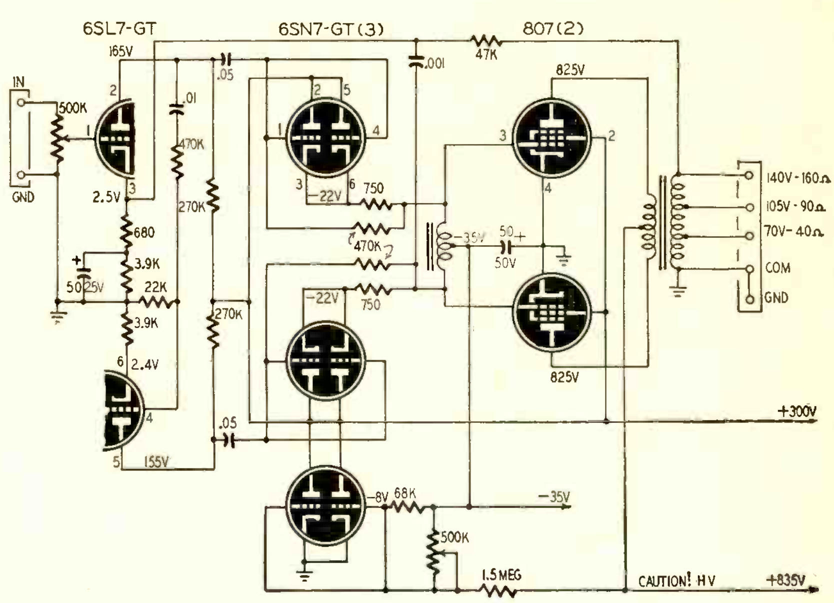


Fig. 1—Diagram of the Bogen HO-125 amplifier. A regulated negative voltage biases the grids of the 807 tubes. It also provides bias for the driver tubes.

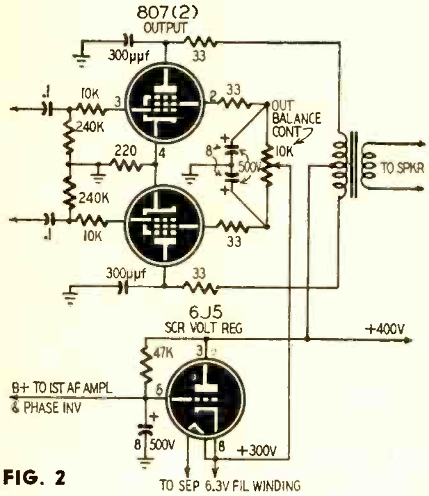


FIG. 2

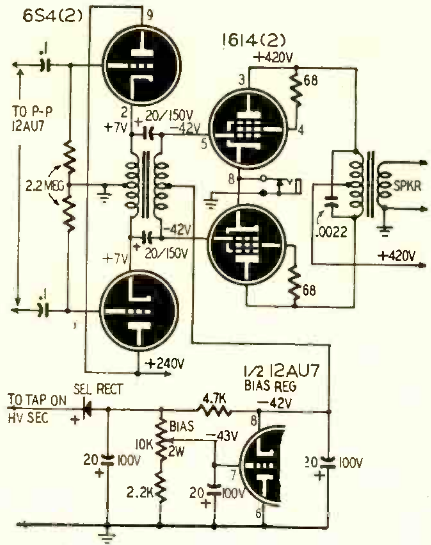


FIG. 3

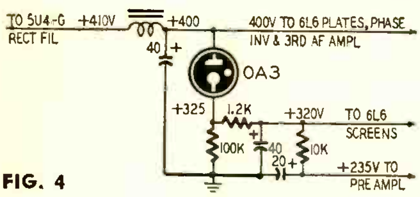


FIG. 4

Fig. 2—Output stage and regulated screen supply in the Hartley amplifier.

Fig. 3—The cathode-follower type driver, Williamson-type output stage, and the grid-bias regulator in the Fisher model 50-A 40-watt amplifier.

Fig. 4—Regulator for 6L6 screen grids.

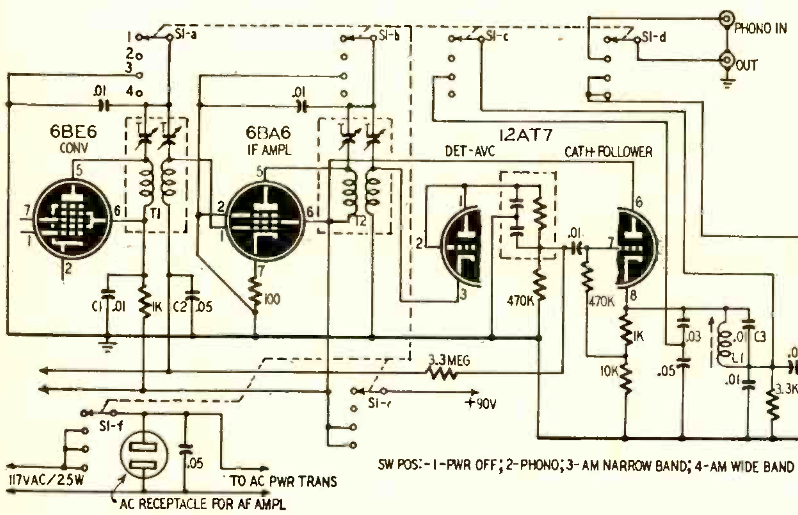


FIG. 5

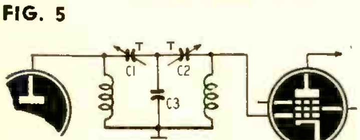


FIG. 6

Fig. 5—Partial schematic of the Bogen model AM-901 high-quality AM tuner.

Fig. 6—Simplified circuit of the overcoupled i.f. stages used in the AM-901.

Fig. 7—Sonocraft's novel tuning eye.

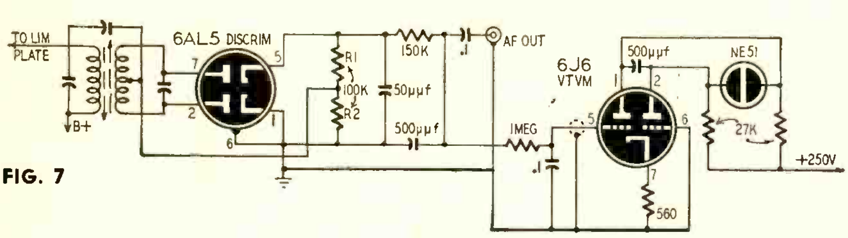


FIG. 7

windings of the i.f. transformers (T1 and T2) are connected to ground through a .01-μf capacitor. The i.f. transformers are now converted to shunt-capacitance type overcoupled circuits which produce a broad, double-humped response curve with sharp skirts.

Fig. 6 is the simplified circuits of one of the i.f. transformers when the selector switch is set for broad response. C1 and C2 represent the trimmers across T1 or T2. C3 corresponds to the .01-μf capacitor in series between C1 and C2 and ground. Note that the cold ends of the transformer windings are shown grounded in Fig. 6 while neither is grounded directly in Fig. 5. This does not affect the performance of the actual circuit because the plate and a.v.c. bypass capacitors (C1 and C2 in Fig. 5) effectively ground the lower ends of the windings for the i.f. signal.

Section S1-c of the selector switch varies the response of the audio signal at the output of the cathode follower. In the WIDEBAND position, L1 and C3 form a parallel-tuned 10-kc heterodyne filter which traps out whistles and interference which occurs when adjacent-channel stations are received simultaneously. Throwing the switch to NARROWBAND AM converts the cathode follower output circuit to a modified M-derived filter which begins to cut off at about 5 kc, thus eliminating a lot of the noise and monkey-chatter which may occur in localities where co-channel interference exists. The i.f. circuits are converted to conventional mutual-inductance types by shorting out the .01-μf capacitor when good selectivity is required.

The Blackout tuning indicator

Sonocraft's new FM tuner uses the novel *Blackout* tuning indicator shown in Fig. 7. The 6J6 operates as a bridge-type v.t.v.m. with a NE51 neon lamp connected between the plates in the place of the usual meter. The input of the 6J6 is direct-coupled to the hot cathode of the 6AL5 discriminator in the tuner.

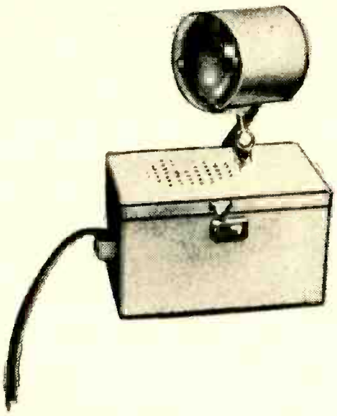
When the tuner is tuned exactly to the carrier frequency, the voltages across discriminator load resistors R1 and R2 are equal with opposite polarities so the net voltage between the discriminator cathodes is zero. When the receiver is detuned, its intermediate frequency shifts above or below the resonant frequency of the discriminator transformer. The voltages across R1 and R2 are now unequal, and the resultant voltage between the cathodes is either negative or positive, depending on the direction of detuning.

Since the most negative electrode of a neon lamp glows when connnected across a d.c. source, it can be used as a tuning indicator across the output of a discriminator.

When a d.c. voltage is applied to the input of the 6J6, the plate currents are unbalanced and one plate swings in a negative direction while the other swings positive, depending on the polarity of the input voltage. Since the NE51 is connected between the plates of the 6J6, the most negative electrode glows. Thus, one plate of the neon lamp glows when the set is tuned above the carrier frequency and the other glows when the set is tuned below the carrier. When the set is tuned exactly on the carrier, the d.c. output from the discriminator is zero and neither plate glows. END

COVER FEATURE

EXPERIMENTAL COMMUNICATION WITH LIGHT BEAMS



Light-beam communication, free from electrical disturbances, is highly applicable for short-range work

By ERIC LESLIE

THE transmitter on our cover this month is one of two distinct types of light-beam communications devices developed by the Yankee inventor Leslie Gould. (Regular readers will remember his *Prismatone* light-operated organ in the April, 1947, issue, and the *Sonicator* ultrasonic radar printed in August, 1946, as well as earlier items on light-electronic music, FM phonograph pickups, and similar devices.)

The more efficient light modulator, says Gould, is the gate type shown in Fig. 1. It uses the motor of a PM speaker, somewhat in the fashion of earlier light-beam transmitters (RADIO-CRAFT, September, 1934). The difference is in the gate. It consists of two crossed triangular Polaroid wafers, as shown in the figure. The upper one is fixed to a frame built up on the speaker; the lower one is cemented to the voice coil. The cone is removed, the voice coil being held by the spider alone. The two pieces of Polaroid are mounted ahead of a lightproof partition, in the center of which a round hole is cut just behind the crossover point of the two Polaroid strips.

The voice coil of this modulator is attached to the output of an ordinary amplifier. Speech or music makes the lower vane move up and down, and the light-stopping action of the crossed Polaroid pieces modulates the light beam projected through the round hole. (As the lower vane moves up, it reduces the amount of light, and increases it as it moves down.)

While it is the most efficient of the transmitters described here, this equipment requires a complete transmitting apparatus, as indicated by Fig. 2. The light has to be concentrated by special lenses for best results. A range of several hundred feet has been attained in daylight, and would be greatly increased in darkness. The other two modulators are not as efficient, but can be used by placing them ahead of an ordinary car headlight or spotlight, a heliograph mirror, or any other source of strong light.

Two light modulators

One of these modulators uses the radiating-vane system shown in the cover photo. One set of vanes is fixed; the other can rotate so as to cover or uncover the openings in the first set. See Fig. 3. An iron rod attached at right angles to the shaft runs down past the edge of the assembly and is terminated in a small iron ball (in some models, a rectangular pole-piece) suspended between the poles of a small permanent horseshoe magnet.

A coil of wire is wound around the rod just above the pole-piece, so that current in one direction will make it an N-, and in the other, an S-pole. A thin strip of spring bronze is adjusted with screws as shown in the figure, to center the pole-piece between the magnet poles and prevent it from striking either pole as it is attached and repelled when audio-frequency current passes through the coil. This attraction and repulsion rocks the moving vanes, increasing or decreasing the apertures and therefore the amount of light transmitted.

The other modulator consists of a number of aluminum slats—plus an iron and a bronze one—which form a square frame. The slats are held together by two aluminum rods which pass through holes in their ends, and are spaced on the rods with fiber washers, making slits through which light can pass.

The center slat is of thin phosphor bronze. It extends beyond the sides of the square and is attached to angle-pieces bolted to the outside ring. The whole frame may now swing or pivot around this center. Fig. 4-a is a drawing of the assembly.

The bottom slat is of iron, and is wound with a coil of insulated wire (200 turns of No. 28 enameled in the one shown). About an inch ahead of its edge is placed a small Alnico magnet, as shown in Fig. 4-b. Several holes are drilled in the slat just beyond the magnet poles, confining most of the magnetic field set up by currents through the coil to the area within the field of the permanent magnet.

As alternating audio currents flow through the coil, the slat is alternately attracted and repelled by the magnet, swinging the bottom of the frame in and out (and the top in the opposite direction). As the angle of the slats change, more or less of the beam of light passes through.

This arrangement has proved more efficient than the rotating one. Signals have been sent with it from a car to a fixed receiving station over a distance of more than 300 feet in daylight.

The receiver

The receiving equipment is simplicity itself. A phototube is mounted in a raintight cylinder, with a simple lens to concentrate the light on it. Its output is connected into any standard phototube amplifier circuit and then goes through a conventional audio amplifier. The first stage of a high-gain amplifier may be hooked up to take the phototube signal directly.

Construction

The original features of all these pieces of equipment are covered by patent applications, so no commercial use may be made of them, as yet. However, the experimenter may wish to imitate the apparatus in one of its forms, either to study light-beam transmission or for his own amusement. He will find construction simple. The modulator units have been built in several sizes and with individual variations. No dimensions or characteristics are particularly critical. Two of the units can be attached ahead of an ordinary automobile headlight and need no further light source. Any good audio amplifier will operate them.

Applications

Equipment of this type might find many uses. They are short-range communications units which require no license and can be used over longer distances than "phono-oscillator" equipment. They are highly directional (though his can be a disadvantage at times.) They can be used in areas where electrical disturbances make radio impractical, or where noise makes a loudspeaker system (straight sound transmission) useless. There are obvious military applications. The equipment is highly interesting to the experimenter, in any event. END

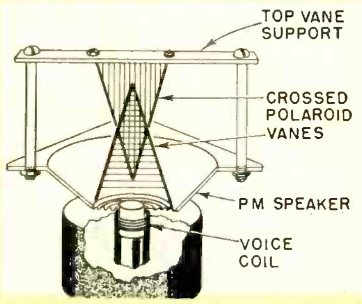
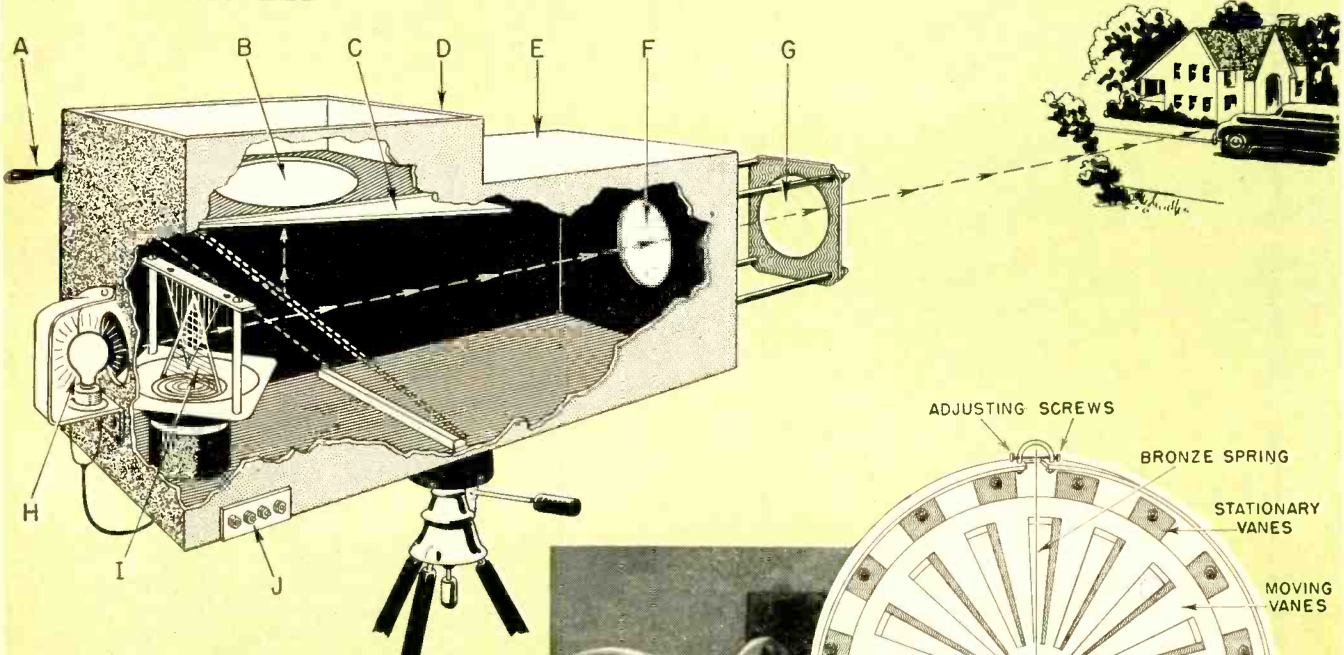
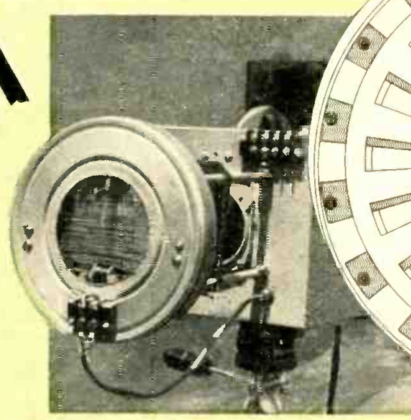
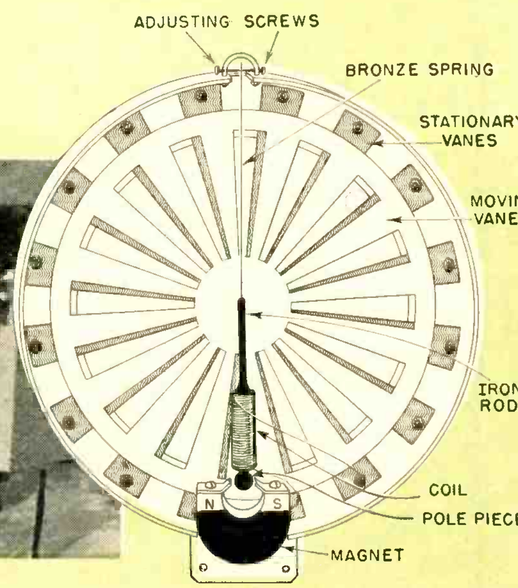


Fig. 1, left—The gate-type modulator. As the voice coil moves the lower vane, it "crosses" a larger or smaller area of the upper one, cutting off light proportionately. Modulation is "negative." Fig. 2, below—The transmitter with light-gate modulator. A is the handle which moves mirror C down into the dotted-line position for sighting an image on ground glass B, or up out of the way for transmitting, D the hood around the ground glass, E the main lightproof case of the instrument, F a 3-inch aperture, G a 4½-inch lens with 20-inch focus, H the lamp in its housing, and I the modulator. A lens system may be made by adding a lens at F and means to vary the distance between it and lens G.







Photograph at right is the shutter-type modulator. It is mounted on the standard transmitter as a convenient light source.

Fig. 3, extreme right—The turning-vane type of light modulator shown on cover.

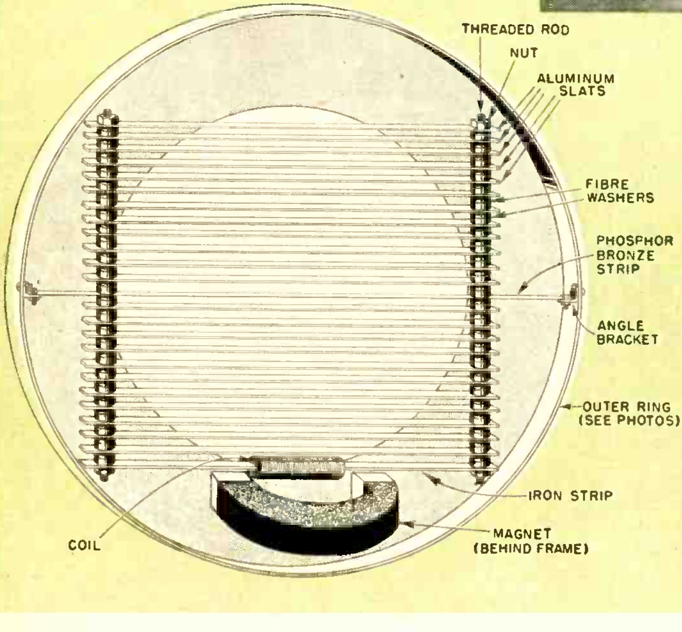
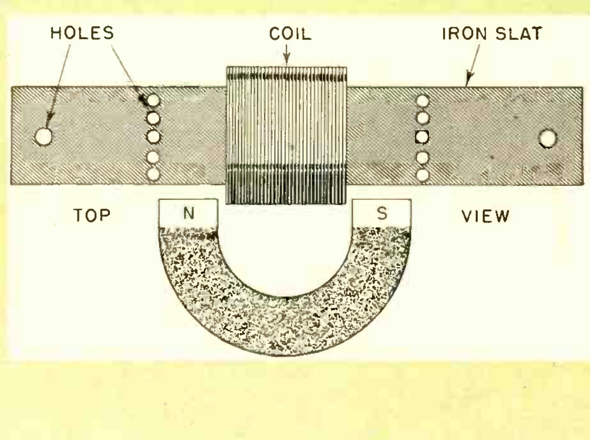


Fig. 4-a, left—Modulator assembly using aluminum slats plus an iron and bronze one. 4-b, below—Detail of the driver slat.



TV SIGNAL TRACING

Fig. 1—Signal tracing with crystal probe shows dead stage as a horizontal line.

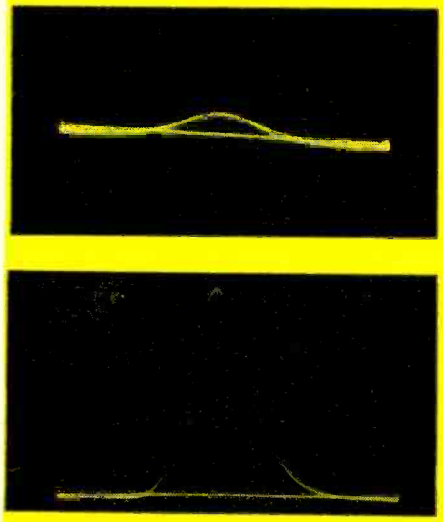


Fig. 2—Gain of 10 through a stage of i.f. Input is shown above, output below.

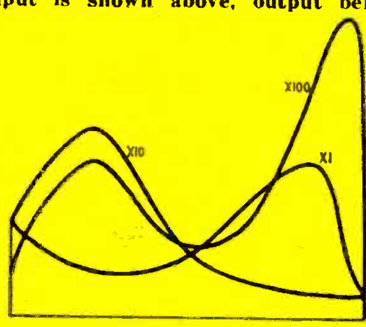


Fig. 3—Example of attenuator resonances and partial rectification of r.f. signal by vertical amplifier of oscilloscope.

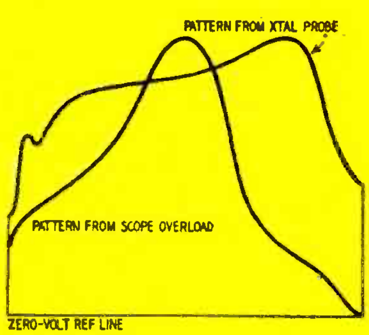


Fig. 4—Patterns obtained from crystal probe and from overloaded oscilloscope.

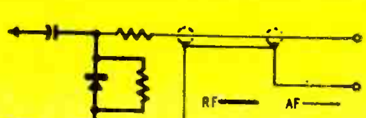


Fig. 5—Diagram of probe signal circuits.

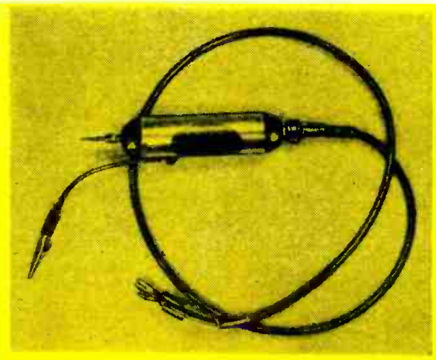


Fig. 6—Probe with moderately long ground lead is unsatisfactory at high frequencies.

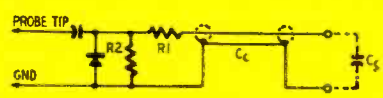


Fig. 7—Probe circuit RC time constants.

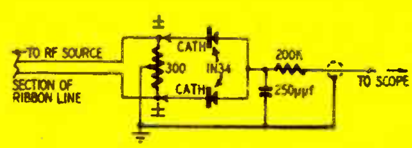


Fig. 8—Schematic of balanced probe.

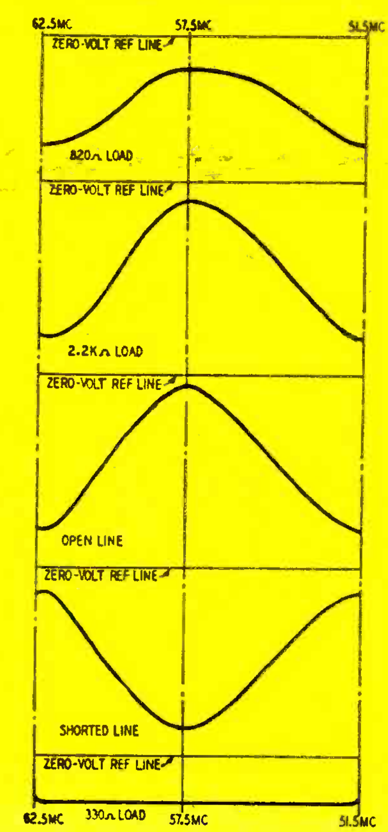


Fig. 9—Margin by which standing wave pattern fails to contact the zero reference line measures the loss in twin lead.

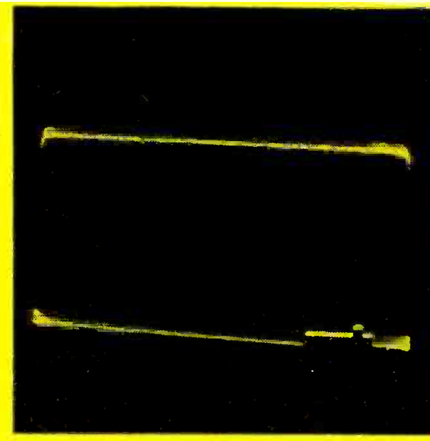


Fig. 10—Crystal probe may rectify signal when testing near local TV station.

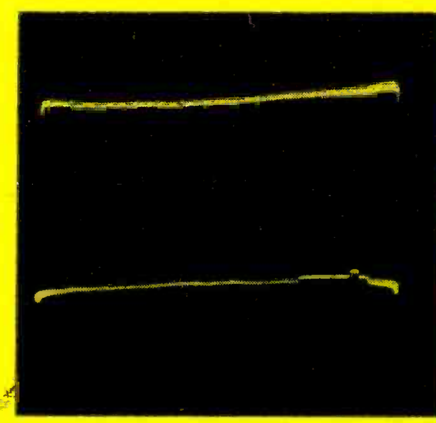


Fig. 11—Curvature of reference line due to 60 cycle pickup in crystal probe.

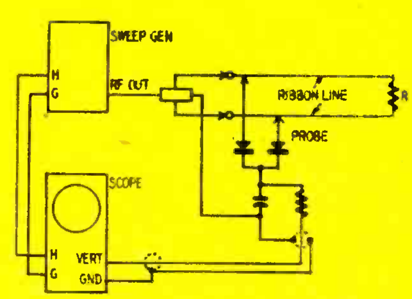


Fig. 12—Horizontal sweep leads shortened. Scope at generator end of line.

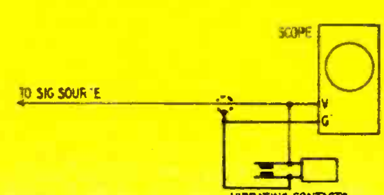


Fig. 13—Vibrating contacts short and un-short the vertical input of scope.

Use of crystal probe gives excellent results in video testing

By Engineering Staff, Scala Radio Co.

MANY technicians find it necessary to use a sweep signal when signal-tracing an i.f. amplifier in a TV receiver, because the available station signal is not strong enough to obtain sufficient vertical deflection on the scope screen when the early stages are under test.

Fig. 1 shows the pattern that is obtained on the scope screen when the i.f. stage under test is dead. A normally operating stage will usually show a gain of approximately 10, as illustrated in Fig. 2.

Technician should take care to keep r.f. voltages out of scope input circuit

Due to unsuitable probes, or to improper modes of testing, the technician is sometimes misled during signal-tracing procedures, due to r.f. voltages entering the scope input circuit. Only demodulated voltages from the probe should be permitted to enter the vertical amplifier of the scope. As shown in Fig. 3, frequency discrimination at r.f. and spurious resonances lead to erratic and unpredictable screen patterns. Partial rectification of the high-frequency voltages which find their way into the vertical amplifier develops a pattern which has no practical value.

When sweep wave envelopes of i.f. signals on the scope screen are viewed by overloading the vertical amplifier with the signal under test, the pattern is highly distorted as compared with the pattern obtained when a suitable crystal probe is used, as illustrated in Fig. 4.

Unnecessary trouble sometime encountered in i.f. signal tracing due to failure to provide good r.f. ground

Suitable ground returns are of great importance in signal-tracing work, and much of the difficulty experienced by beginners is due to this cause alone. Fig. 5 clearly distinguishes between the r.f. and the a.f. circuits which are present in the probe arrangement. The ground lead to the chassis should always be kept very short, and the ground point should be made as near as possible to the signal take-off point in the i.f. amplifier circuit.

This matter is of even greater concern when station frequencies are being tested. It is often necessary to dispense with the short ground lead that is provided with the probe, and to make the ground return directly to the shielded case of the probe.

While a long grounding route would not be of practical concern when a 10-to-1 or a 100-to-1 probe is in use, the long ground route commonly leads to curve distortion, regeneration, or even oscillation when utilized with a crystal probe in i.f. amplifier signal tracing.

The lengths of the ground leads provided with conventional service probes is shown in Fig. 6. Unless high-frequency r.f. circuits are under test, such ground leads can be used satisfactorily.

Ability of crystal probe to display modulation envelope on scope screen depends on time constant of input cable and the isolating resistor

A crystal probe which is to be used for video-amplifier adjustment as well as for signal tracing must be able to display 60-cycle square-wave modulation on the scope screen without appreciable distortion. As seen in Fig. 7, the limiting factor in the ability of a crystal probe to display a modulation envelope on the scope screen is usually determined by the time-constant of the scope-input circuit, $(C_c + C_s)(R1 + R2)$. The total input capacitance $C_c + C_s$ charges through R1 and discharges through R1 + R2. Unless this charging and discharging can take place with sufficient rapidity, there will be negative peak clipping of the waveform displayed on the scope screen. R1 must be large enough to prevent r.f. signal voltage from entering the scope circuits. The time-constant can be reduced by decreasing the value of C_c. The cable capacitance, C_c, is usually much larger than the scope input capacitance C_s. In 1 time-constant interval, the cable can charge up to 63% of the peak value of a square wave, or, having been previously charged, will be able to discharge in 1 time-constant interval to 37% of the peak value of the initial charge.

Balanced crystal probe used to check standing-wave ratio (impedance match) of twin lead to antenna or receiver

A balanced crystal probe, as shown in Fig. 8 (or two single-ended conventional crystal probes), can be used to check a lead-in for flatness or impedance match. Typical patterns and the conditions responsible for the observed standing-wave ratios are shown in Fig. 9. To understand the operation of a doubled-ended probe, note that the two diodes do not conduct simultaneously. As far as the instantaneous lead-in voltages are concerned, when the input signal to one diode is positive, the input signal to the other is negative. These polarities alternate at the carrier frequency, and the diodes conduct alternately.

Standing-wave patterns are sometimes interfered with by TV station signals or 60-cycle hum voltage, as shown in Figs. 10 and 11. Unless the operator recognizes the source of such distortion, he may be at a loss to interpret the pattern which he has obtained on the scope screen.

In Fig. 8, the scope and the sweep generator are located at opposite ends of the transmission line. That is, the sweep generator is located at the left-hand end of the lead, and the scope is connected (through the crystal probe) at the right-hand end of the lead. In this test, a pair of 150-ohm resistors are connected in series to provide a 300-ohm load with a center-tap. The center-tap is required in this test to provide a d.c. return path for the balanced crystal probe.

If the characteristic impedance of the line is 300 ohms, the 300-ohm load will cause a flat trace to appear on the scope screen, as shown in Fig. 10. If the characteristic impedance of the line is not 300 ohms, the 300-ohm load will cause the trace to depart from flatness. Fig. 9 shows the behavior of a section of 300-ohm ribbon line, when swept with various values of load resistance. The operator will understand that a length of lead 25 or 30 feet long should be used in this test, so that appreciable standing waves can be developed at representative TV signal frequencies. Otherwise, the scope must have very high gain to obtain satisfactory deflection.

Several other practical considerations must be observed. Since the scope and the sweep generator are located at opposite ends of the line which is being tested, there may be a problem of obtaining a horizontal sweep voltage from the generator for the scope. Although some service scopes provide a phasable horizontal sweep voltage which is built into the scope, many service scopes do not have this built-in sweep facility, but rely upon the phasable horizontal sweep voltage which is built into the sweep generator. In that case, test leads are run from the generator to the scope to provide a phasable horizontal sweep voltage.

Since these test leads would have to be 25 or 30 feet long to make a test of a 25- or 30-foot length of lead, other test setups may be found more convenient when using a scope without a built-in horizontal phasable sweep. The probe and scope can be connected at the generator end of the line, if desired, as shown in Fig. 12. In this case, the generator has an r.f. output cable which is terminated in a center-tapped load. This center point is connected to the ground system of the test setup, as shown; the load resistor R then does

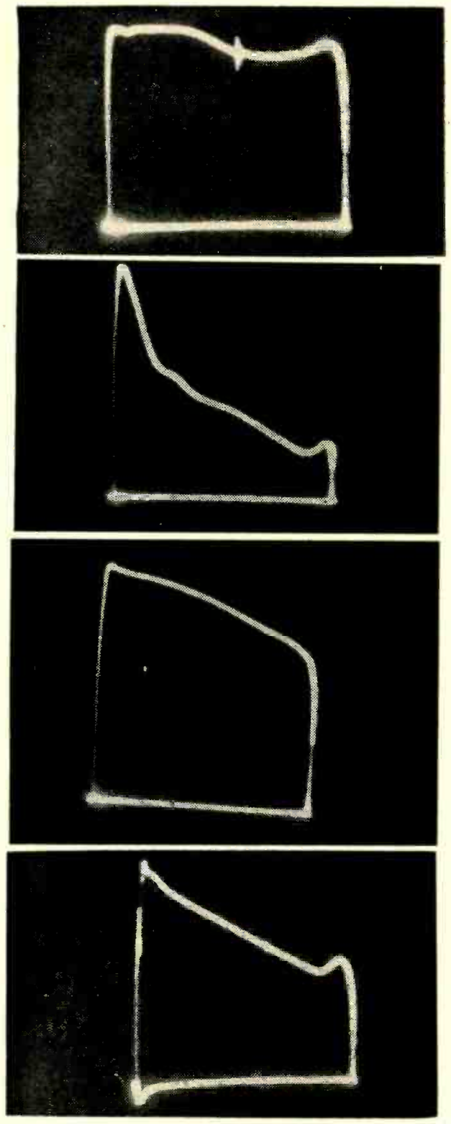


Fig. 14—Result of unsuitable demodulator probe or poor testing conditions.

not need to be center-tapped, and the scope is conveniently swept from the generator, as indicated by the leads between them in Fig. 12. This arrangement can be applied conveniently, especially when the load R may represent a remote point such as an antenna, whose match to the lead-in is to be tested.

These tests mean little unless a zero-volt reference line is available in the pattern. There are two ways of obtaining a zero-volt reference line. The most convenient one is to use a sweep generator in which the return trace is converted automatically into a zero-volt reference. This is done by providing a built-in source of square-wave bias to the swept oscillator in the generator. If the technician must use a sweep generator which does not provide a zero-volt reference line in the pattern, any arrangement which rapidly shorts and unshorts the vertical input terminals of the scope will serve the same purpose, as shown in Fig. 13. The rate of vibration should be considerably greater than 60 cycles, but may be any convenient arbitrary rate. The vibrating contacts operate to make the input signal fall to zero many times during the progress of the trace, thus making the zero-volt reference level apparent as a dashed line. The average constructor will usually have little trouble devising a vibrator, if one is needed.

The generator characteristic may be linear or nonlinear. The technician must first determine this characteristic so he can apply a correction, if one is needed. To make the matter clearer, consider the case in which the length of line shown in Fig. 12 is reduced to zero. No effects of standing waves are then apparent in the pattern, because they are absent. The trace should then be reasonably flat, as seen in Fig. 10. Consider, however, the cases shown in Fig. 14, in which the generator characteristics are not entirely flat. Such instances can arise in practice, due to high harmonics in the generator output combined with probe resonances, for example. In other cases, the fundamental voltage from the generator may vary somewhat. In any case, a correction must be made.

If the technician finds that the display is nonlinear when the lead-in length is reduced to zero, as shown in Fig. 14, the best procedure is to use a grease pencil to indicate the shape of this display on the face of the cathode-ray tube. The penciled curve becomes the reference curve, and is the curve that will then be obtained when a section of lead-in under test is properly terminated. Any deviations in waveshape from the shape of this penciled curve indicate that the section of lead-in is improperly terminated.

If it is desired to use a pair of conventional crystal probes, instead of a special balanced probe, the test setup will appear as shown in Fig. 15. Each of the conventional probes is merely substituting for the diodes shown in Fig. 12. The circuit arrangement used in the dual-probe arrangement is shown in Fig. 16.

Standing-wave pattern may not touch zero-volt reference line when termination is a short or an open

In Fig. 9, although the line termination is a short, or an open circuit, the standing-wave pattern seen on the scope screen when a sweep test is made may not quite touch the zero-volt reference line. The standing-wave pattern will touch the zero-volt reference line only if there are no losses in the line. When the test frequency is increased, the line losses increase, and the standing-wave pattern approaches the zero-volt reference line less closely for an open or a shorted termination. The amount by which the pattern fails to reach the zero-volt reference line is a measure of the loss in the line. END

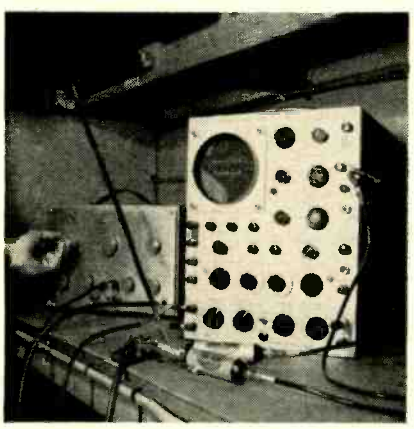


Fig. 15—Testing with dual crystal probes.

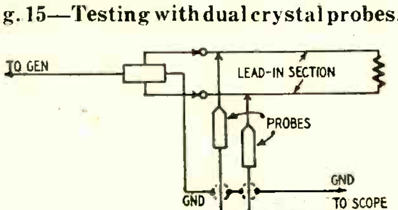


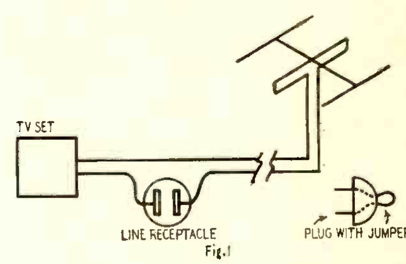
Fig. 16—Diagram of two conventional crystal probes used in balanced tests.

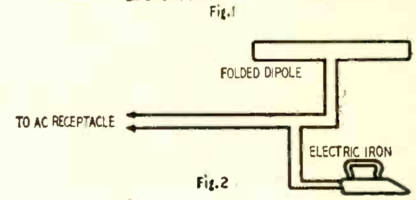
FOLDED DIPOLE TYPE ANTENNAS CAN BE DE-ICED

One of our rural customers had persistent trouble with TV reception each time his TV lead-in became covered with ice. Since this happened too frequently for us to send a technician out to de-ice the transmission line, we made a de-icer for him.

We inserted an a.c. receptacle in series with one side of the 300-ohm lead-in. A plug with its prongs shorted with a jumper is kept in this receptacle to complete the circuit when the antenna is operating properly. See Fig. 1. Note that this method operates only with folded-dipole type antennas.

The instructions we gave were: When reception fades because of ice on the antenna, disconnect the lead-in from the set, remove the shorted plug, and plug in an electric iron in its place; and then poke the lead-in ends into an a.c. receptacle for a few minutes. The current drawn by the iron generates enough heat to melt the ice. The de-icing circuit is shown in Fig. 2. When the ice has melted, disconnect the iron,

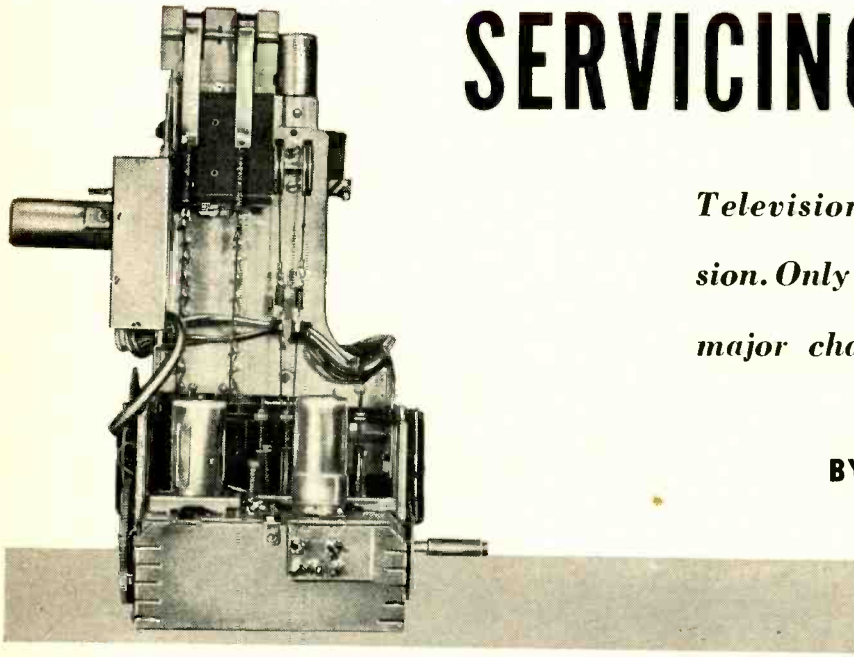




reconnect the lead-in, and return the shorted plug to its normal position.

—*Henry Josephs*

SERVICING UHF TV



A continuous u.h.f. tuner. It is mounted directly over the v.h.f. tuner.

Television is still television. Only tuner undergoes major changes for u.h.f.

BY KEN KLEIDON*

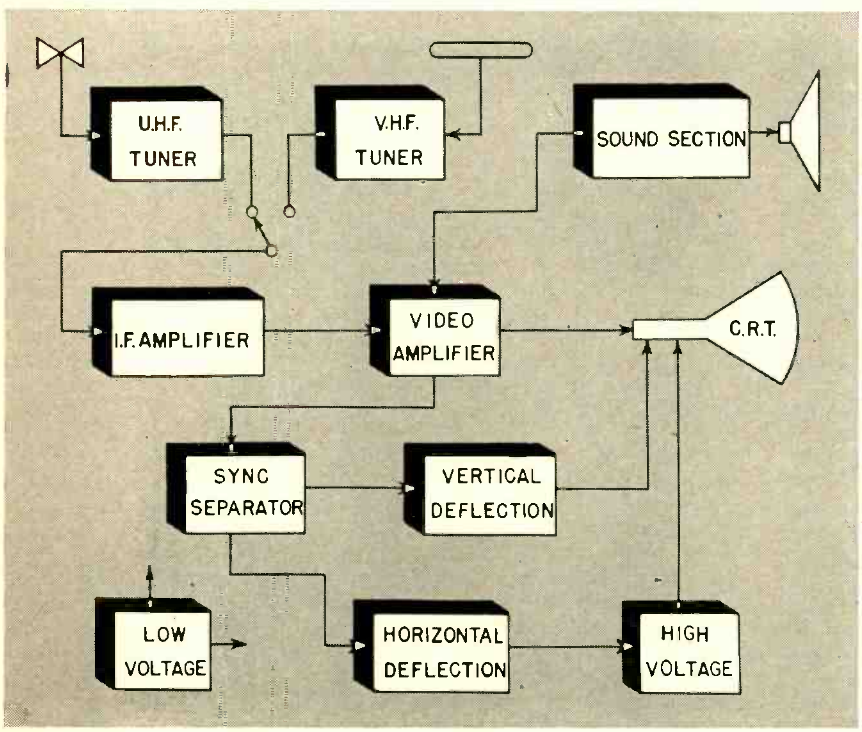


Fig. 1—With the exception of two units, u.h.f. and v.h.f. receivers are identical.

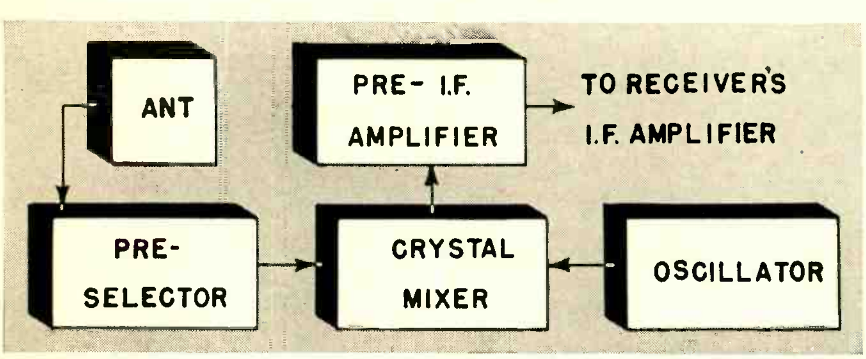


Fig. 2—Breakdown of the component parts of the u.h.f. section of a TV receiver.

SINCE the 70 new television channels have been allocated by the Federal Communications Commission, numerous articles have been published on u.h.f. Many of these articles have confused and in some cases even frightened the average TV technician. U.h.f. is not the monster these publications have led us to believe. It is new and does present different and varied problems not found in v.h.f., but if observed from a practical standpoint, the differences between u.h.f. and v.h.f. are few.

The same transmission standards used for v.h.f. telecasting are also being used for the u.h.f. band. Therefore the only real difference between u.h.f. and v.h.f. is the station's carrier frequency. For this reason, the TV service technician need only observe the different effect caused by the increase in frequency. This increase necessitates new and different tuning methods (u.h.f. strip, converter, or tuner) to receive a u.h.f. station on a v.h.f. receiver. Every u.h.f. television receiver on the market at the present time is nothing more than a v.h.f. receiver with a u.h.f. tuning unit. The majority of circuits in a v.h.f. receiver remain unchanged for reception on u.h.f. Referring to Fig. 1, the low voltage, high voltage, horizontal deflection, vertical deflection, sync separator, video amplifier, sound section, and i.f. amplifier circuits do not change in any way. Even the v.h.f. tuner remains unchanged except for that portion which may be modified to incorporate a u.h.f. tuning device. Because of this, servicing techniques used for v.h.f. will closely parallel u.h.f. servicing.

The function of a u.h.f. tuning device is identical to that of a v.h.f. tuner in that it merely selects and converts the station's sound and picture carriers to an intermediate frequency. Observing the block diagram of Fig. 2, the signal picked up by the antenna is coupled to the preselector which selects the u.h.f. station's sound and picture carriers. The signal is coupled through the preselector to the crystal mixer.

*Raytheon Manufacturing Company, Television and Radio Division, Chicago, Ill.

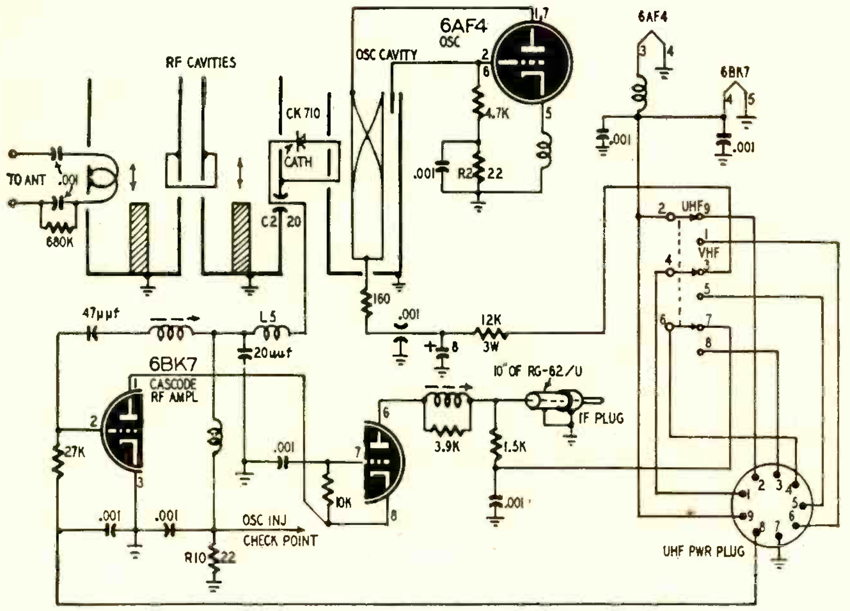


Fig. 3—Complete schematic of the Raytheon UHF-100 continuous u.h.f. tuner.

The signal generated by the oscillator is mixed with the incoming signal and produces the resulting difference frequency falling in the intermediate-frequency range (25 or 40 megacycles). The difference frequency is amplified by the pre-i.f. amplifier before being coupled to the i.f. amplifiers of the receiver. Other u.h.f. tuning devices, such as strips and converters, operate similarly. The only difference is that these methods produce a difference frequency which falls in the v.h.f. frequency range (usually channels 5 or 6), and the signal is then treated exactly like a v.h.f. signal by the v.h.f. tuner.

Since the only difference between u.h.f. and v.h.f. is the carrier frequencies, servicing either a u.h.f. or v.h.f. receiver will be similar except for the tuning units involved. A u.h.f. tuning unit is considerably different mechanically and electrically, due to the new design principles required for the most efficient operation at these ultra-high frequencies. Cavities or tuned lines may be employed in place of coils and capacitors, link coupling is used rather than coupling capacitors, and a crystal mixer is commonly used instead of a vacuum tube, as can be seen by referring to Fig. 3. This is the schematic diagram of Raytheon's single-conversion, continuous u.h.f. tuner. Mechanically, it mounts directly over the v.h.f. tuner in the receiver and is coupled by drive gears which tune both u.h.f. and v.h.f. with the same tuning knob. The tuner obtains its filament and plate-supply voltages from the TV chassis, and a switch selects the desired tuner for operation.

The u.h.f. tuner employs a double coaxial line r.f. cavity preselector. The coaxial line arrangement has the advantages of high selectivity, low insertion losses, uniform bandwidth, and good shielding against oscillator radiation. The coaxial cavity is basically a quarter-wave shorted tuned stub. The electrical length of the cavities is varied by a ribbon attached to the dial cord and pulley arrangement. This is much like varying the length of a tuned stub, which would change the resonant length for various frequencies. The dial cord is of a special material which is not affected by temperature or moisture and is locked to the pulleys to eliminate slippage. Tracking screws are provided in the cavities to obtain uniform bandwidth and sensitivity. The tracking screws vary the capacitance between the ribbon and the cavity wall and thus vary the electrical length of the ribbon.

The oscillator tube is a 6AF4 and the oscillator is tuned with a quarter-wave shorted parallel-wire transmission line arrangement. It differs from the r.f. cavities in that a shorting bar is used to vary the electrical length of the lines. This method provides very stable operation.

Inductive or link coupling transfers the signal between stages. The link coupling arrangement gives maximum selectivity and constant bandwidth over the entire u.h.f. band. The signal from the output coupling link is mixed and detected by a CK-710 crystal detector and then applied to the tuned input of the cascode amplifier. A 6BK7 tube is used as a cascode pre-i.f. amplifier which is tuned to a center frequency of 25 mc and has low noise and broad bandwidth. The signal is amplified by the cascode amplifier and then coupled to the i.f. amplifier section in the receiver through 10 inches of RG-62U coaxial cable.

These new circuit components differ only in application, since they function identically to their v.h.f. counterparts. There is nothing mysterious about their function or operation if they are considered from a practical standpoint.

The mechanical aspects of a u.h.f. tuning device will vary from one unit to another but should not offer a great deal of trouble when service is required. Varied mechanical arrangements have been employed for v.h.f. tuning, dial stringing, control positions, picture tube mounting, etc., and have not proved difficult to the average service technician. Mechanically, servicing should not prove any more difficult than with the average v.h.f. tuner.

Special servicing techniques

The servicing techniques used when working with a v.h.f. tuner must be observed when attempting to service a u.h.f. unit. In dealing with ultra-high frequencies, stray capacitances and inductances have a much greater effect than with v.h.f. Much more care must be observed not to move or rearrange components or mechanical parts, as distributed capacitance or inductance may be changed and thereby offset the alignment. Also, when a part replacement is necessary, the same lead lengths must be maintained and the part must be replaced in the same physical location. Another important factor which sometimes has been overlooked in v.h.f. servicing is to obtain the exact part replacement. This is of the utmost importance in u.h.f. servicing. The manufacturer's replacement parts guide should be consulted and the recommended part obtained if at all possible.

Complete service information is contained in the manufacturers' u.h.f. service manuals. Carefully read and digest this information before attempting adjustments or replacement of components. The manuals usually contain a circuit description for a clearer understanding of the operation and function of the various components. Alignment instructions, or instructions to return the unit to the factory for repair or alignment, are included.

At present, u.h.f. is a relatively new field. Therefore, accurate test equipment necessary for r.f. and oscillator alignment is expensive and not readily available. For this reason, some manufacturers may recommend returning their units to the factory. However, a leading v.h.f. test equipment manufacturer has recently announced that their equipment has proved successful for u.h.f. alignment. This fact has been completely tested and found acceptable. If the v.h.f. sweep and r.f. generators operate on the fundamental throughout the entire range, the generated harmonics may be used as a u.h.f. alignment signal.

Alignment of Raytheon's u.h.f. tuner could not be classified as simple nor could any other u.h.f. tuning unit. However, due to its design and construction, alignment can be performed in the field if necessary. The cascode pre-i.f. amplifier can easily be realigned by connecting a 25-mc unmodulated signal to the junction of L5 and C2 (Fig. 3), connecting a v.t.v.m. at the video detector output of the receiver, and adjusting the cascode plate and grid coils (see Fig. 4) for maximum v.t.v.m. reading. The two r.f. cavities may be aligned with respect to the oscillator by simply loosening the pulley-positioning screw

(Fig. 4) and rotating the r.f. drive pulleys for the sharpest and clearest picture while viewing a u.h.f. program. Complete tracking over the entire u.h.f. band requires accurate test equipment, as well as a detailed alignment procedure (which cannot be presented in this space). Therefore, unless both are available, adjustment of the r.f. tracking screws, oscillator trimmer screw, or shorting bar should not be attempted.

When attempting service of any tuning unit, many technicians fail to explore other circuits or conditions before suspecting the tuning device for trouble. If a "weak picture" condition, as illustrated in Fig. 5, appears on the face of the picture tube, it would be helpful to determine, if possible, if the same condition appears on the v.h.f. frequencies. If the same results are obtained on both u.h.f. and v.h.f., the cause of the trouble will generally be located in either the i.f. amplifier, detector, or video-amplifier circuits. If the condition appears only on u.h.f. and a normal picture is observed on v.h.f., the u.h.f. antenna installation should be checked as the possible source of trouble before suspecting the tuning unit.

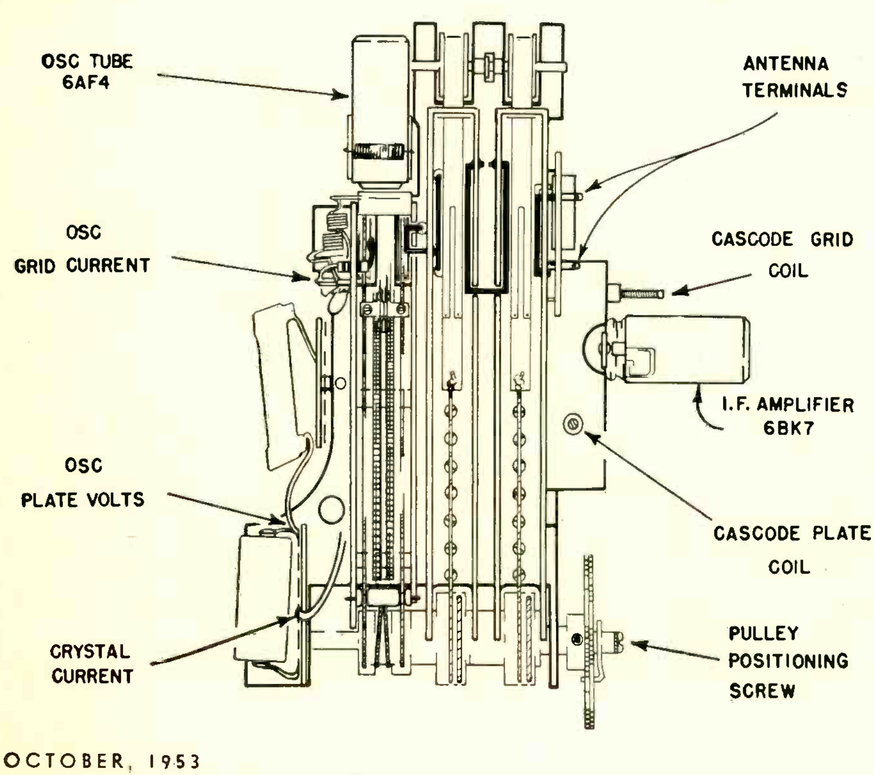
If no picture appears, various circuit failures or external conditions may be the cause. As a fast check to localize the possible cause of the trouble, observe the face of the picture tube at both maximum and minimum contrast or picture-control settings. If no appreciable change is noticed between the two control settings, the trouble is usually in the i.f. or video-amplifier circuits. If at the maximum control setting an increase in snow is noticed, the trouble is most likely in the first i.f. amplifier or in the tuning device; it may be due to station failure; the set may be tuned to an off channel; or the antenna may be disconnected or disabled.

Use of a u.h.f. converter as a method of checking a suspected defective tuning unit may prove very helpful. A u.h.f. converter can easily be substituted for the u.h.f. tuning device, whether it be a tuner, a channel strip, or another converter, to determine if the device is functioning normally. All that is necessary is to connect the u.h.f. antenna transmission line to the terminals provided and connect the output to the v.h.f. antenna terminals of the receiver. If the converter improves picture quality, the u.h.f. tuning device will require servicing.

The design of Raytheon's u.h.f. tuner enables servicing without removing it from the TV chassis. Convenient service check points have been provided, as illustrated in Figs. 3 and 4, for measuring the crystal current, oscillator plate voltage, and oscillator grid current. To determine whether the oscillator is functioning, both the oscillator plate voltage and grid current can be checked. With a voltmeter connected between the point indicated and ground or chassis, a reading of approximately 90 volts should be obtained if there are no defects in the voltage supply source or oscillator plate line. To measure the oscillator grid current, a Simpson model 260 multimeter, or equivalent, in the 100-microampere scale position, should be placed across 22-ohm resistor R2, with the positive meter lead to ground. A reading of 10 to 30 microamperes should be obtained if the oscillator is functioning normally. The crystal current (oscillator injection current) can be measured by placing a meter (type indicated above) on the 100-microampere scale across 22-ohm resistor R10, with the positive lead to ground. A reading of 5 to 40 microamperes should be obtained if the oscillator and crystal are functioning normally.

When attempting to service a u.h.f. tuning unit, it may prove helpful to keep in mind that when trouble occurs in the oscillator section, the picture will generally disappear and when there is a defect in the r.f. or mixer stage a decrease in signal will usually result. When the oscillator section is suspected, the tube should be substituted, grid current, plate, and filament voltages should be checked, and all components in the circuit should be inspected. When the r.f. or mixer section is suspected, the circuits should be inspected, and tracking, alignment, and crystal current should be checked, and the crystal replaced if necessary. A defective crystal may cause varied effects in the picture and should not be overlooked as a possible source of trouble. Crystals are also the greatest source of noise generated in the majority of tuning units. Noise results in undesirable snow appearing in the picture, and crystal substitution to obtain an increase in picture quality may prove beneficial in some cases. Using an ohmmeter to check a crystal detector will prove to be an unreliable method. Direct substitution is the only positive check. The majority of crystal detectors in present u.h.f. tuning units are soldered into place, and overheating may cause damage. So take care when replacing a crystal. One of the most positive ways to avoid overheating of the crystal, is to hold the crystal with a pair of long nose pliers while soldering. The pliers will absorb most of the heat, preventing damage to the crystal.

Since the primary difference encountered in the u.h.f. receiver lies in the tuner, the service technician should thoroughly familiarize himself with the characteristics of u.h.f. There will be new tubes designed for u.h.f. tuners together with improved components. However, whatever we do the signal will not differ from the basic theory of v.h.f. television receivers. END



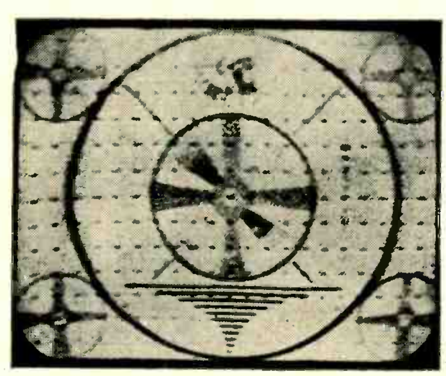


Fig. 4 (Left)—Mechanical detail of the tuner, showing adjustments and check points.

Fig. 5 (Above)—The "weak-picture" condition.

TV SERVICE CLINIC

Conducted by MATTHEW MANDL*

Fig. 1—Picture due to low line supply voltage.

THE large number of new homes built in the past few years have created many line-voltage problems. The power companies are improving their facilities, but the servicing technician will find many areas where the additional evening load drops the line voltage, often to 100 volts or lower. This often results in poor brilliancy, insufficient picture size, and occasionally sync instability because of the change in B voltages which occur. (Rarely these effects may be found in the daytime, as when a room air conditioner is used in an adjacent apartment.)

When a receiver is serviced or installed in the morning or afternoon, the line voltage may be normal. The technician may find that, if he adjusts the picture size to fill the mask at that time, it will shrink during the evening. Sometimes only the top or side of a picture may be affected, depending on the degree of change in sweep amplitude and the idling voltage through the yoke. A change in the latter can cause picture shift as well as general shrinkage.

Fig. 1 shows the appearance of a screen in an area where line voltage dropped to 95. The receiver was adjusted in the afternoon when the line voltage was 115, at which time the controls were set to fill the mask properly. During mornings and afternoons the picture would be perfectly centered and would fill the mask, while during the evening the left and top margins of the picture appeared because of raster shift.

In this particular receiver a readjustment of the controls during the evening when the line voltage was low corrected the condition. The receiver was in an area where only three local stations could be received and signal strength was sufficient to maintain good synchronization. The brilliancy control, however, had to be operated at a higher than normal setting for proper picture illumination.

In weak-signal areas such compensation as adjusting the controls during low line voltage periods rarely solves the problem. Sync instability occurs. This often causes picture pulling and shifting, with occasional loss of both vertical and horizontal synchronization.

In such instances the only solution is to install a transformer to maintain a constant voltage level or boost an abnormally low voltage. A typical one is the Sola model 7202. It is adequate for most 10- to 16-inch receivers and will maintain the voltage to the receiver constant for wide variations in line voltage.

Other devices which can be used are the *Varitran* units. Type V-O is designed for operating a receiver drawing current up to 2 amperes at 230 watts, and the output voltage is variable from 0 to 130. A 570-watt unit is also available, type V-17.

The transformers described above are fairly expensive, ranging from $15 to $35. But they often provide the only means for correcting low line voltages or for preventing picture jitter and pulling during line voltage fluctuations. Where the condition is severe, the power company should be consulted with respect to their plans for improving the service and handling greater loads during peak hours.

Bleached picture

In a Transvision A-4 receiver the light portions of the picture turn white and appear bleached out when the brightness control is advanced. I have checked the control as well as the video i.f., detector, and amplifier tubes as well as resistors and capacitors. I would appreciate any suggestions you have for localizing the trouble. D. F., Welland, Ontario.

You mentioned that the light portions of the picture turn white and appear "bleached out." Since you have checked the parts and tubes of the video detector and amplifier stages, the trouble may be a defective picture tube. A characteristic sign of a defective picture tube is the silvery appearance of white objects when the brilliancy control is advanced.

First, try careful adjustment of the ion trap, to make sure it is positioned for maximum brilliancy. You did not mention whether or not you had sufficient contrast level. This should also be checked. Also make sure the ion trap magnet is not weak and is the correct type for the tube. If these measures do not help, you could have the tube checked with a picture-tube tester, or try a new one.

Cascode tuner

I have installed a new Standard cascode tuner in an Admiral 30A1. I must turn the volume control up higher than I did before to get the same volume as with the old tuner. I do not believe the picture gain is what it should be, and I get what looks like slight r.f. interference in the picture. I do not have 250 volts as called for on the tuner, having used a 22,000-ohm resistor from the 350-volt line. I get the right voltage drop until I make the connection to the tuner, then the voltage drops to 225. What could cause these troubles? I have connected the tuner directly to the grid of the first picture i.f. amplifier. D. G. Bloomfield, Conn.

These faults you described are probably caused by the fact that the sound take-off coil in the original tuner has not been replaced in the new installation. The Standard Coil Products Company has a replacement coil available, part number XM-752. Refer to page 69 of the January, 1953 issue of RADIO-ELECTRONICS for full information on the use of this coil.

The 225 volts is sufficient, though you can obtain more by reducing the size of the series 22,000-ohm resistor. There is always a drop of voltage when the load is applied.

Sweep angle

I have used an RCA 211D2 yoke in the conversion of a Raytheon C1104M receiver. I have changed the original 12LP4A tube to a 19EP4 rectangular type. I evidently have a mismatch because the left side of the picture is expanded and linearity is poor for both the vertical and horizontal sweep. I have been told that since I am using a 70-degree tube and a 70-degree yoke, I also need a 70-degree transformer. Would this give me a better horizontal match and improve results? Please list the matching transformers for the yoke which I already have. L. T., Cicero, Ill.

The rectangular tubes do have a 70-degree deflection, as your friend told

*Author: Mandl's Television Servicing

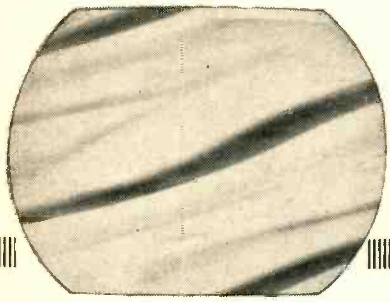


Fig. 2—Screen just at pull-in point.

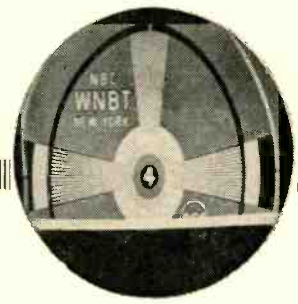


Fig. 3—The foldover trouble here is due to a defective vertical coupling capacitor.

Fig. 4—Rolling the picture slowly as a means of checking vertical linearity.

you. This refers to the angle which the beam must sweep to fill the picture mask properly. When such tubes are used, it is necessary to use a wide-angle yoke and a transformer to match. If this isn't done, poor linearity, insufficient sweep, and other troubles occur.

For the RCA 211D2 yoke, the following represents the matching transformer:

RCA 224T1 (for a 6BQ6 horiz. output tube)
RCA 230T1 6CD6
RCA 231T1 any
RCA 232T1 any

Definition

I have a few problems on a Bendix model 21K3 receiver. There is not appreciable difference in the picture when the focus control is adjusted and the picture does not seem sharp enough. There is also insufficient range in the contrast control. Another trouble I have is elimination of sync buzz when filmed commercials are on or during certain white portions in a movie. I would appreciate your advice regarding these matters. R. C., Chicago, Illinois

Adjust the focus control and watch the horizontal trace lines closely. If the focus control can give you sharply defined trace lines, the control is all right. If the picture detail is still lacking, tuner tracking and video i.f. alignment may be necessary.

Defects such as open peaking coils or off-value components may exist in the video amplifier sections. If the focus control cannot give a sharp line trace, check the resistive network associated with the focus control, and the focus control itself, for off-values.

Lack of sufficient contrast would indicate defective tubes or components from the tuner through the video i.f. stages to the picture tube. First check the tubes. If they are all right, tuner tracking and alignment will be necessary.

Intercarrier buzz should be at a minimum with proper adjustment of the fine tuning control. In some filmed commercials, however, overmodulation occurs at the transmitter and nothing can be done to eliminate the buzz during such intervals.

Synchroguide check

As a television bench technician I find the most annoying service problem is that of horizontal drift. This is particularly the case with pulse width a.f.c. systems. What are some checks and corrective procedures I can make to save time? J. R., Methuen, Mass.

With the pulse width sync system *(Synchroguide)*, good stability is obtained only if the system is aligned properly according to the instructions given in the service notes for the receiver. Procedures include using a scope to make sure the broad and narrow peaks of the waveform at the junction of the coils are of the same amplitude.

A quick check to see whether or not the circuit requires alignment is to turn the horizontal hold control to the extreme counterclockwise position. Turn the station selector off the channel and back again so that sync is lost. Now turn the hold control slowly clockwise and watch the diagonal bars decrease in number. When only two or three bars are left (see Fig. 2) the picture should pull into sync upon a slight additional advance of the hold control in a clockwise direction. The picture should now remain in sync for about 90 degrees of additional rotation in the clockwise direction. If the sync range of the control is narrow, or if more or less bars are present than mentioned in the above check, the system should be completely realigned.

If drift or instability still persist, try several new tubes (some perform better than others). Finally, check voltages and parts. Some parts in the synchroguide circuit are temperature-compensated, and exact replacements should be used or drift will be worse.

Adjacent-channel interference

In a Mercury receiver there is severe adjacent channel interference between channels 3 and 4, as well as between 5 and 6. Is this an alignment problem or is it caused by a defective component? The receiver is used midway between Dallas (channel 4) and Wichita Falls (channel 3). E. C., Decatur, Texas.

When adjacent channel traps are tuned properly and the receiver is correctly aligned, adjacent-channel interference should not be present except from a strong local station when a weak distant station is being received. Use your marker, sweep generator, and scope, and check tuner tracking as well as video i.f. alignment. Follow the step-by-step procedures given in the service notes for this receiver and you will be able to minimize this condition.

Oscillator slug

I have on the bench an RCA 241 with low volume on channels 2 and 4 and no sound on channel 7. When the station selector is turned a little past the place where it clicks in, reception is normal.

If the lead shield is removed from the local oscillator tube the volume also returns to normal. I've replaced all tubes in the tuner and sound section, and as well have taken voltage and resistance checks and found them normal. Any help would be appreciated. F. H., Pontiac, Mich.

Turning the station selector slightly beyond normal changes tuning, while removing the oscillator shield alters the capacitance effects on the circuit. Both indicate off-resonance conditions in the local oscillator which can be corrected by adjustments of the local oscillator slug for the stations giving trouble. If this doesn't help, tuner tracking should be checked.

Bottom foldover

In a 1951 Tele-King receiver there is a foldover at the bottom after warmup. Adjustments of the vertical linearity and size controls do not help. What causes this? N. P., New York

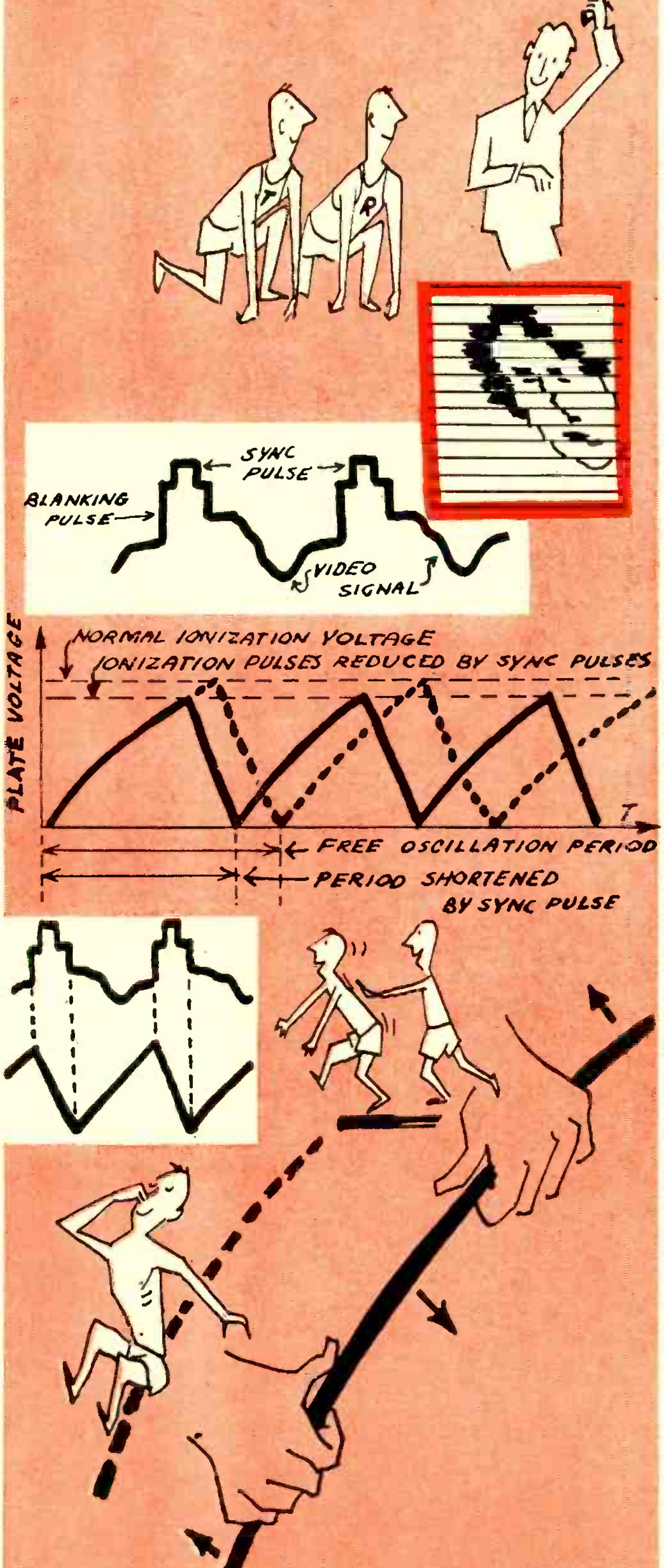
This is usually caused by a defective coupling capacitor between the vertical oscillator and the vertical output tube. Linearity is also affected, as shown in Fig. 3. When the defective part has been replaced, readjust the vertical linearity and height controls when a station pattern is on the air, or with a cross-bar generator. A rough check of vertical linearity can be made by misadjusting the vertical hold control slightly until the picture rolls slowly. The blanking bar across the screen should not change in thickness as it reaches the top or bottom of the screen. (See Fig. 4) END

TELEVISION . . . it's a cinch

By E. AISBERG

From the original "La Télévision? . . . Mais c'est très simple!" Translated from the French by Fred Shunaman. All North American rights reserved. No extract may be printed without the permission of RADIO-ELECTRONICS and the author.

Sixth conversation, second half: Will learns about synchronization.



Hey, you—keep in step!

WILL—And now isn't it about time to take the wraps off that mysterious "synchronization"?

KEN—I think so. You know already that the line and frame sweeps at the receiver have to keep in exact step with those at the transmitter. The beginning of each line (and each frame) have to be *synchronized* rigorously at transmitter and receiver.

WILL—I can see that if they got out of step, you'd get a program something like a piece of music played by an orchestra with every instrument a few seconds behind the one beside it.

KEN—Well, let's not try to develop an optical analogy to your musical program. Actually, the transmitter sends out, along with the video signals, short signals (or pulses) to mark the end of each line, and a longer series of pulses to mark the end of each image.

WILL—And it's these pulses you apply—through capacitor C1—to the thyratron grid? (See last month's installment for figure.)

KEN—Exactly. You have to arrange your circuits so these pulses are *positive* when they reach the grid—so that each one makes the grid *less negative* for a short instant.

WILL—I don't quite see what's going on. Does the tube amplify these pulses?

KEN—No, Will. You're just forgetting the effect of the grid on the anode breakdown voltage.

WILL—Of course! When a positive pulse arrives, the grid becomes less negative, and the ionization voltage drops.

KEN—So the normal period of oscillation of the horizontal oscillator is made just a little *longer* than the time the transmitter takes to make one line (and the vertical oscillator's period a little longer than the time needed to make one field). In other words, the normal frequency is a little lower than the line or image frequency. Then, just before the anode voltage reaches the ionization point, a pulse comes and makes the grid less negative. So the tube discharges prematurely, *triggered* by the synchronizing pulse.

WILL—I think I have it O.K. Say a thyratron has a control ratio of 20 and a grid bias of 15 volts negative. The ionization voltage would then be 300. If the synchronization pulse is 1 volt positive, the ionization voltage will be 280 instead of 300 volts, and the tube will discharge quicker than it would if there were no pulses.

KEN—You have it 100%.

WILL—It wasn't so hard! I had a good example to go by. While I was taking swimming lessons on my vacation, the instructor synchronized the divers.

KEN—Huh??

WILL—When they got out to the end of the board and were ready to jump, most of them would hesitate. Then he'd just expedite them with a firm push on the back. And then they'd make beautiful parabolic curves!

Saturated diodes to pentodes

KEN—Speaking of curves, this business of getting a sawtooth wave by charging and discharging a capacitor is fine, except that the sawtooth we end up with isn't quite linear—it has a curve to it. Now we've got to get back to the job of making that exponential curve as straight as possible.

WILL—Can't we find some method of keeping the current that goes into capacitor C constant? Then the voltage would rise in exact proportion to time, and we'd have a linear sawtooth.

KEN—Maybe you could work out such a scheme. Can you figure out just how you'd limit the current?

WILL—You'd have to replace the charging resistor with something that wouldn't let more than a certain definite amount of current through. How about using a tube—or rather its plate-cathode resistance—for the job?

KEN—That would work, Will. For instance, you could use a diode (preferably a direct-heating type) working at saturation. All the electrons emitted by the filament reach the plate, and so any increase in plate voltage can't increase the current flow. You could regulate the amount of current flow within limits by adjusting the filament voltage.

WILL—But why do you want a direct-heating diode?

KEN—Because a direct heater saturates much more definitely and sharply than an indirectly heated cathode. But if you don't like filament heaters, you can use an ordinary cathode-type pentode.

WILL—Do you work it at saturation, too?

KEN—The term wouldn't be correct, but the result is the same. You know how the plate-voltage/plate-current family of curves of a pentode looks. For any screen voltage, the plate current rises with plate voltage up to a certain point, then changes very little as the plate voltage goes on up. If you work the pentode on that flat part of the curve, it would charge a capacitor at a constant-current rate. Take a look at this schematic. The pentode replaces the charging resistor R. The screen voltage is regulated with a potentiometer P in series with a resistor R4. C3 is a decoupling capacitor.

WILL—These saturated diodes and constant curr.nt pentodes remind me of the bed of that old Greek bandit who used to trim off travelers who were too long for it or stretch them out to size if they were shorter than the bed.

The art of using curves

KEN—You're talking about Procrustes. Yes, it is a sort of inflexible way of doing things. As a matter of fact, it's more common to straighten out the curves *afterward*, in the amplifier tube that we need anyway, to bring our sawtooth waves up to the amplitude we want.

WILL—But how can an amplifier linearize a curved sawtooth wave?

KEN—It's easy. We make it distort a little, so it curves them in the opposite direction! Remember, Will, the most important thing in life is to be able to profit not only from the virtues and good points people or things may have, but also from their very faults and vices! What could be worse than a tube with such a crooked characteristic that it actually deforms the voltage it amplifies? But in this case that very fault becomes an advantage.

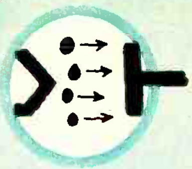
WILL—In other words, we have an amplifier tube with a curved grid-voltage/plate-current characteristic. And this curvature is exactly opposite to the curve of the sawtooth wave itself. If our sawtooth generator produces a wave that has a curve, all we have to do is feed this curved—or nonlinear—sawtooth into an amplifier that will bend the wave in the opposite direction. The result will be a practically straight sawtooth.

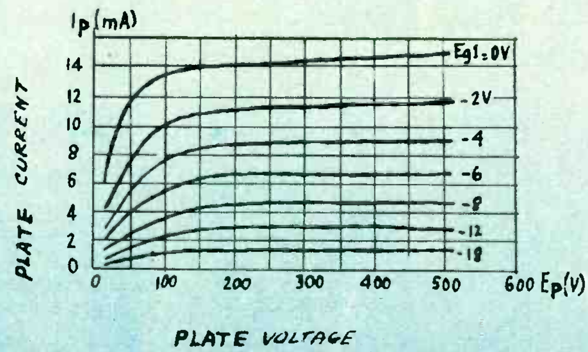
KEN—Here's a little drawing that will show that even better than you can describe it. The curves of the amplifier and those of the sawtooth oscillator may not balance each other exactly, but the compensation is good enough for any practical use.

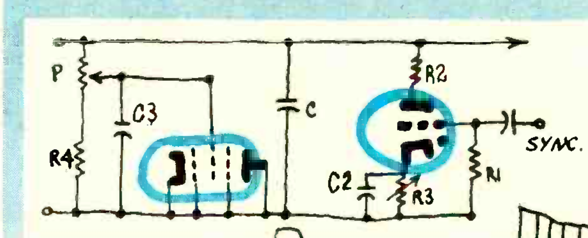
WILL—Well, now that I've got all that down pretty pat, I suppose the moment has come to tell me that neither thyratron time-bases, constant-current tubes, nor linearizing amplifiers were ever used in television?

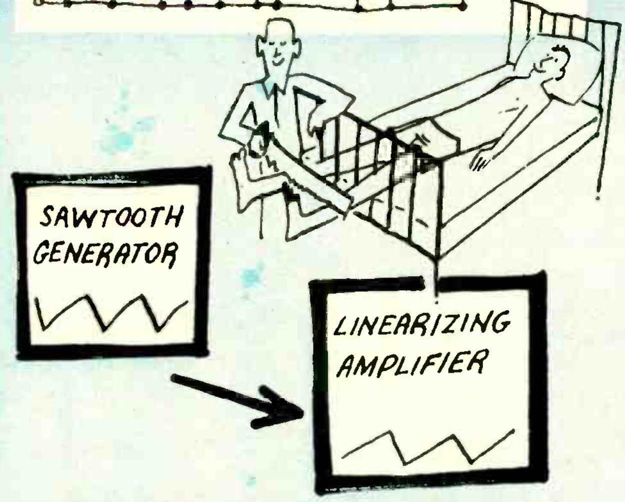
KEN—Not quite, Will. All of them have been used at one time or another, and some are still being used. Even if they weren't, I wouldn't have wasted your time, because the thyratron time-base is almost universal in oscilloscopes, and you'll use them a lot if you expect to do much with television receivers. But I must admit that there is a much more common type of time-base, and I can tell you now that it really is used in most TV sets. But we'll have to put that off till our next conversation.

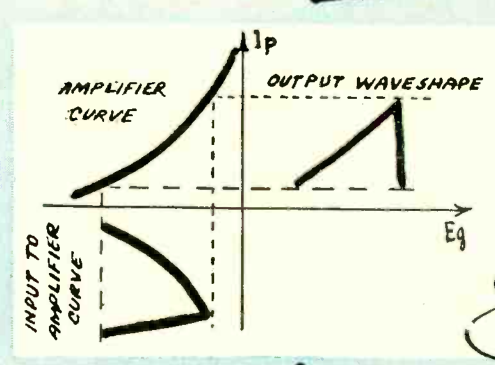
(TO BE CONTINUED)

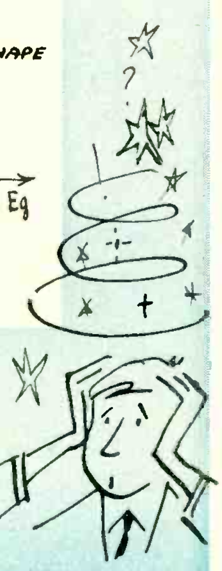








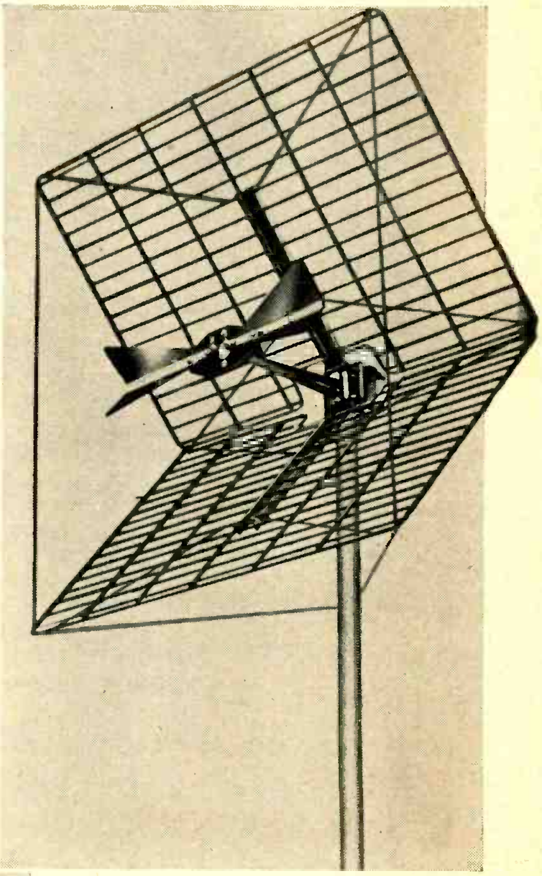




uhf tv ANTENNAS

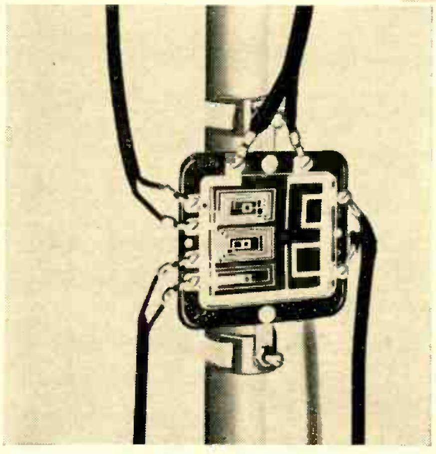
Current u.h.f. antennas combine the old with the new

By ABRAHAM HYMAN and JAMES C. SARAYIOTES*



Right — Bowtie antenna with corner reflector.

Below — Antenna coupler. Single transmission line can be used for wide range of frequencies.



BRINGING forth an antenna for television is much like bringing forth a baby into the world.

This brand new baby is bound to be bigger and bouncier than big brother v.h.f. Now that it no longer needs the warmth of the researchers' bassinette, it is casting off its blankets and starting to flex an unusually large pair of biceps for one so young.

Perhaps because they are still so youthful, u.h.f. signals are weaklings. They're quickly absorbed by trees, hills, and buildings. When u.h.f. waves aren't pulled in by obstructions they're bounced hither and thither. What happens then? Multipath signals are produced. These, in turn, hop aimlessly around town until they're lured in by an antenna. And, when multipathers *are accepted*, they spawn our old black sheep—the ghost.

Very few viewers want ghosts, unless they're watching a TV mish-mash of an old film like "Dracula." [Should they be urban residents, though, they have nothing to fear even if they use the simplest u.h.f. antenna of all—the much-heralded *bowtie*.]

The usefulness of large-area radiators for broad-banding is well known to the art. The triangular dipole is a development of the fundamental dipole for wide coverage in the u.h.f. spectrum.

Very simply constructed of two fanlike, hard-aluminum stampings, they are placed vertex-to-vertex with an included angle of 70°. Element lengths of 16 inches offer maximum gain. This combination results in a peak gain, at 750 mc, of 4 db over a thin dipole. The impedance of the triangular dipole is normally 300 ohms over the u.h.f. band.

A refinement of the simple bowtie dipole antenna is the bowtie backed up by a screen reflector. The change in antenna performance is striking. Gain climbs to well over 8 db at high points in the band, averaging out to about 6 db across the full u.h.f. spectrum. This gain occurs when a single-bay array is used.

The bowtie reflector may be stacked for improved vertical directivity and an additional 3 db gain. This is important for reducing ground reflections and improving fringe-area operation. The use of wire framing for the reflector along with the U-shaped insulator support minimizes weather effects.

Two other members of the u.h.f. family are the stacked-V and the rhombic. The rhombic can be considered as being two V-antennas in series, resistance-terminated at 470 ohms.

The rhombic antenna has a directional characteristic in the vertical plane. At some angle to the horizontal it has maximum pickup. This angle can be varied to some extent by varying its tilt angle, improving the over-all antenna gain. However, the vertical energy pickup may be out of phase with the horizontal pickup and may result in ghosts. The vertical lobe structure varies radically in phase over the frequency spectrum and leads to further difficulty. The vertical effects may be reduced by stacking, which will give an additional increase in gain.

The longer elements not only lead to mechanical problems but also tend to narrow the horizontal pattern excessively. This subjects the installation to erratic signal variations during strong winds. A compromise value of 3 wavelengths at the low end of the band was used for the design figure. The optimum tilt angle for 3 wavelengths is 55°, which equals a length of 55 inches for each element. For lengths greater than 2 wavelengths the tilt angle is not critical over the band. A frequency range of 2 to 1 is feasible with a rhombic.

The rhombic has a narrow-beam horizontal directivity, and gains up to 9 db as its operating frequency climbs. Its elements have an optimum length of 55 inches and are made of ¼-inch outside-diameter hard-aluminum rods.

Both of these antennas are best put to use in regions where the u.h.f. station will be operating in the upper frequencies, since their highest gain is reached in those strata. Both must be considered broadband jobs, since reception on the lower frequencies is more than adequate and improves when the installation is set in a local area.

The single V is not particularly desirable because of its strong pickup in the vertical plane. On stacking, the V array improves immeasurably as far as vertical polarization is concerned.

* JFD Manufacturing Co., Inc.

Its horizontal directivity is not all that may be desired. As has been found with v.h.f. antennas tested on u.h.f., minor lobes in the horizontal plane are numerous and vary with frequency. On

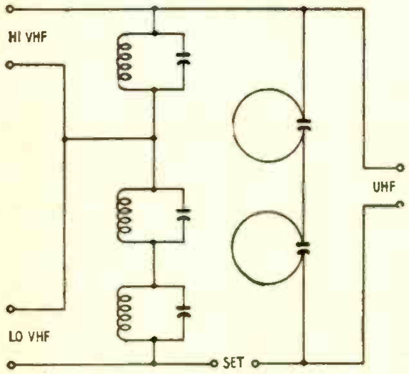
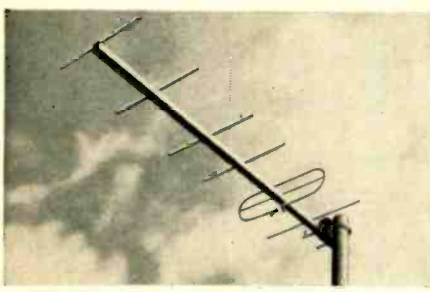


Fig. 1—A simplified coupler circuit for one u.h.f. and two v.h.f. antennas.



Yagi antennas like this receive from six to ten channels on the u.h.f. band.

the high end of the u.h.f. band the lobes are numerous and large enough to make the antenna usable as an omnidirectional job.

Both the rhombic and V antennas have their own particular advantages. The stacked V provides a somewhat higher gain on the lower frequencies of about 6 db and increases fairly well linearly to about 12 db. The rhombic maintains an unvarying impedance over the entire band, making matching with the transmission line remarkably easy.

The opposite of the V antenna as far as lobe structure is concerned is the corner reflector which is most suitable where reflections are caused by objects in the vicinity. Gains of 8 to 12 db can be attained over the band with excellent directivity in both the horizontal and vertical sense.

Two flat reflecting sheets intersecting at an angle form the reflector. Corner angles either greater than or less than 90° can be used, although there are practical disadvantages to angles much smaller than 90°. To reduce the wind resistance of a solid reflector, a grid of closely spaced parallel wires may be used.

In general, the spacing between reflector conductors should be equal to or less than 0.1 wavelength. With a half wavelength driven element the length of the reflector's conductors should be equal to or greater than 0.6 wavelength. If the length is less than .016 wavelength, radiation to the sides and rear tends to increase, and the gain decreases. The triangular dipole was adapted for its broadband characteristics. The dipole was bent parallel to the reflectors, minimizing dipole-to-reflector capacitance and reflector shielding of the collector.

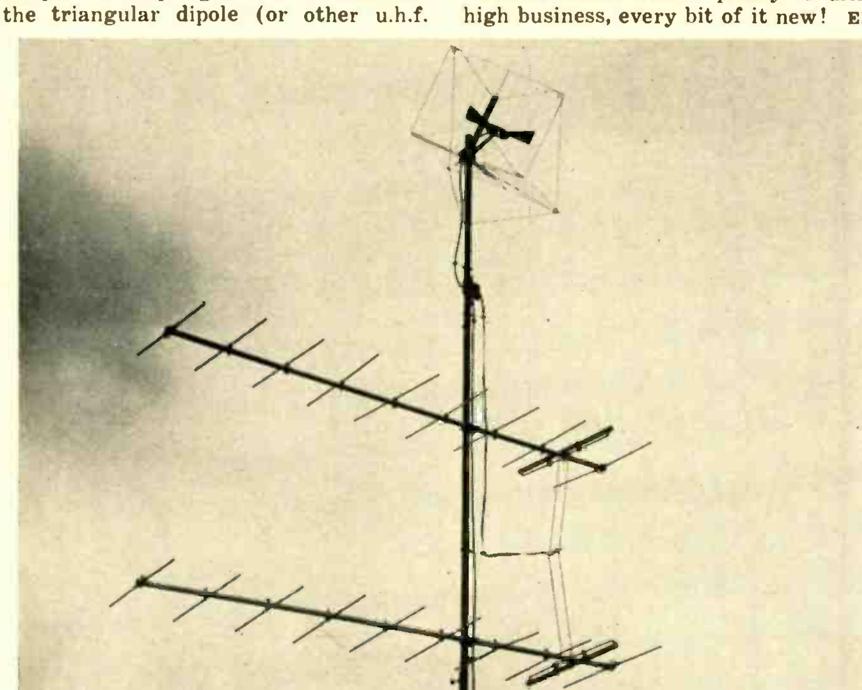
The corner reflector does its job well, reaching and sometimes passing 12 db. This high gain is of great significance because increased radiation on higher frequencies, along with transmission line losses, can weaken signal strength if the gain is not high enough or if the installation is not fairly close to the transmitter.

Our old friend, the Yagi antenna, having become famous as a single-channel antenna in v.h.f., might be expected to be just a single-channel worker on u.h.f. too. Don't you believe it! The Yagi pulls in as many as 15 channels on the ultra-highs. The bandwidth covered at the lower end of the spectrum is 6 channels, while the Yagi cut for the highest frequencies will receive channels 74 through 83. Manufacturing firms are turning out u.h.f. Yagis with six extruded aluminum elements. One is a collector, four are directors, and one is a reflector.

The desirability of a combination u.h.f.-v.h.f. antenna based on the old reliable conical, resulted in further improvements on the conical and the u.h.f. triangular dipole. The new dipole for use with the conical has an angle of 35° and is cut to favor the upper portion of the u.h.f. spectrum. The nominal impedance remains 300 ohms over most of the band. However, the actual impedance is higher rather than lower as compared to that of the 70° triangular dipole. Since the power curve falls off at a much slower rate for higher impedance, a gain advantage is obtained over 80% of the u.h.f. band with this design. To permit coupling of the conical with the triangular dipole (or other u.h.f. antennas), a coupling network was designed to permit connection and use of a single down-lead. It is designed to match a 300-ohm balanced transmission line. High-Q silver-printed circuits minimize any reflections and insertion losses. An improved match is effected with the conical on the low u.h.f channels, which results in an increase in gain of 2 to 3 db. The schematic Fig. 1 is a simplified version of the network. The antenna coupler consists of a group of tuned circuits. Each circuit—being parallel-resonant—will offer a high impedance to the band of frequencies to which it is tuned, while offering an inductive or capacitive shunt to frequencies below or above its band. The Q of the printed circuits enables the antenna coupler to present a constant impedance of 300 ohms to the transmission line over the low u.h.f., high u.h.f., and v.h.f. bands. Since it is hermetically sealed, the antenna coupler maintains stable circuit constants despite constant exposure to the elements.

This design permits the use of two v.h.f. antennas. Therefore, two v.h.f. Yagis may be tied in with any 300-ohm u.h.f. antenna. A second design makes provision for coupling one v.h.f. antenna over the entire band to the 300-ohm u.h.f. antenna. The printed-circuit technique was chosen over lumped-circuit parameters because it lends itself to uniformity in production. The reduction of undesirable stray and distributed capacitances permits the design of desirable inductances and capacitances over the v.h.f-u.h.f. range. The proper composition of the silver compound permits the design of the desired Q for proper bandwidth.

Looking down from the rooftops of America, u.h.f. is looking up! Technicians: There will be plenty of ultra-high business, every bit of it new! END



U.h.f. Bowtie with corner reflector and stacked v.h.f. Yagi, using single downlead.

EUROPEAN STATION LIST

By A. V. J. MARTIN

TELEVISION is expanding rapidly in Europe. Regular daily programs of all kinds are broadcast in Great Britain, France, and Germany. These include kinescope recordings and live pickups of plays, concerts, variety programs, sports, and special events.

Very few, if any, stations have the continuous program schedules found in the United States. In general, European TV schedules call for 20 to 40 hours of program per week, with transmissions only during certain hours in the evenings—and, in some cases, in the mornings and afternoons. For example, France has three regular daily transmissions, at 1:00, 6:30, and 8:30 pm. Except for Great Britain (which has regular afternoon and evening programs, plus morning transmissions on Saturdays and Sundays) and Germany, the stations in most other European countries are on irregular or experimental schedules. This applies to Holland, Switzerland, Denmark, and Italy. Very little is known about Russian TV schedules, aside from the fact that at least three stations are on the air.

The standards in use differ widely, according to the country, and four types are in current use.

405 lines. Old low-definition standard used in Great Britain only—25 frames; positive picture modulation; AM sound; vertical polarization.

441 lines. The old Paris transmitter. Now obsolete; will be working till 1958. Except for number of lines, is identical to British standard.

625 lines. So-called "European" standard—25 frames; otherwise identical with the U.S. Standard.

819 lines. High-definition French standard—25 frames; positive picture modulation; AM sound; vertical polarization.

Several instances of exceptionally good dx have been recorded and certified by photographs. For example, the Paris and London programs have been received in Belgium, Holland, and Italy, and Russian telecasts have been picked up in France. *American TV signals were reported seen on one occasion,* but unfortunately this has not been verified, since it lasted for only a few minutes.

Belgium, as yet, has no stations of its own in operation, but plans to establish separate systems with different standards for the French- and Flemish-speaking sections of the country. Receivers in Belgium that are designed for the French 819-line standard have been experiencing severe co-channel interference between Lille and Paris. These stations were assigned the same frequency in the belief that the distance between the two cities—approximately 150 miles—and the "official" service coverage were enough to prevent any co-channel interference. But many points in Belgium (and France as well) are about the same distance from both cities, and exceptionally good transmission over the flat terrain has created the interference problem. (In the United States the same type of unforeseen co-channel interference was one of the factors that led to the television "freeze" and ensuing changes in several channel assignments.—*Editor*)

The accompanying table lists by countries the European stations now on the air. It includes both sound and picture transmitters, and has been arranged to show the lowest frequency first.

The first column gives the country and the second column gives the actual site of the transmitter. (In many cases this is a suburb of some large city, so the name may not be familiar except to a native.)

The third column gives the transmitter frequency, and the fourth column indicates whether this is the video (V) or sound (S) transmitter. Column five gives the transmitter power when known. (This is *not* the *effective radiated power*, which may be considerably greater through the use of a high-gain antenna system.) The sixth column gives the number of picture lines only, since all European stations have the same 50-field, 25-frame standard.

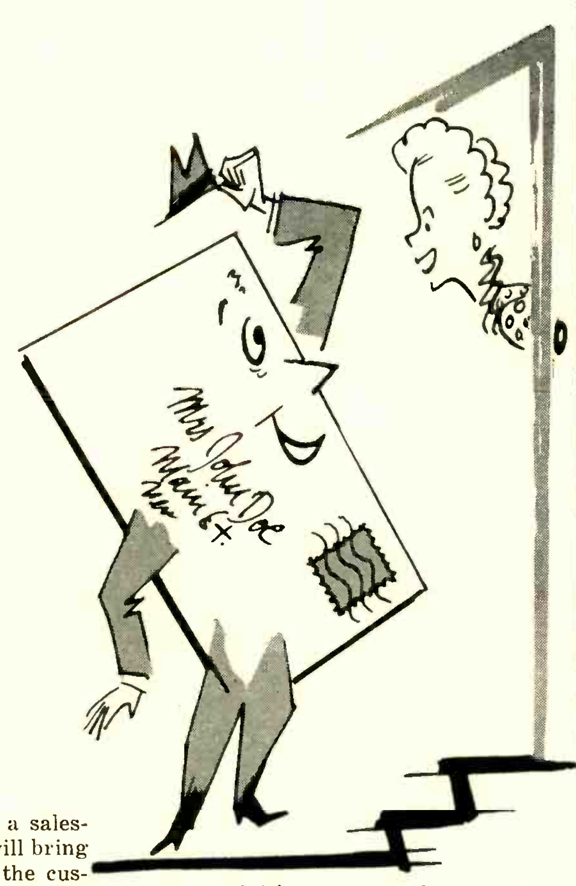
For picture transmitters, column seven indicates whether single- or double-sideband transmission is used, with D for double-sideband, U for upper-sideband, and L for lower-sideband. The eighth column shows whether positive or negative picture-phase modulation is used. As all picture transmitters are amplitude-modulated, + indicates that an increase in carrier amplitude represents an increase in picture brightness, and a minus sign indicates the opposite. For the sound transmitters this column shows whether the modulation is AM or FM.

The ninth column shows the signal polarization: H for horizontal, and V for vertical.

The only city with two regularly scheduled stations is Paris, with the old 441-line picture transmitter on 46 mc (sound on 42 mc), and the new 819-line picture transmitter on 185.25 mc (sound on 174.1 mc). END

Country	Site	Frequency (mc)	Transmitter	Power (kw)	Lines	Sideband	Modulation	Polarization
DENMARK	Copenhagen	63.25	V	0.1	625	D	—	H
		67.25	S	0.1			FM	H
FRANCE	Lille	174.10	S	0.75			AM	H
		185.25	V	3	819	L	+	H
	Paris	42.00	S	5			AM	V
		46.00	V	30	441	D	+	V
	Paris	174.10	S	0.75			AM	H
		185.25	V	3	819	L	+	H
GERMANY	Berlin	182.25	V	1	625	U	—	H
		187.75	S	0.25			FM	H
	Hamburg	182.25	V	10	625	U	—	H
		187.75	S	3			FM	H
	Hanover	196.25	V	1	625	U	—	H
		201.75	S	0.25			FM	H
	Cologne	195.25	V	1	625	U	—	H
		201.75	S	0.25			FM	H
	Langenberg	182.25	V	10	625	U	—	H
		187.75	S	3			FM	H
GREAT BRITAIN	Belfast	41.50	S				AM	V
	(Northern Ireland)	45.00	V	0.4	405	L	+	V
	Brighton	53.25	S				AM	V
		56.75	V	0.4	405	L	+	V
	Holme Moss	48.25	S	12			AM	V
		51.75	V	50	405	L	+	V
	Kirk o'Shotts	53.25	S	12			AM	V
	(Scotland)	56.75	V	50	405	L	+	V
	London	41.50	S	3			AM	V
		45.00	V	17	405	D	+	V
	Newcastle	63.25	S				AM	V
		66.75	V	0.4	405	L	+	V
	Sutton Coldfield	58.25	S	12			AM	V
		61.75	V	50	405	L	+	V
	Wenvoe	63.25	S	12			AM	V
		66.75	V	50	405	L	+	V
THE NETHERLANDS	Eindhoven	47.75	V		625	L		H
		53.75	S				FM	H
	Kootwijk	49.00	S				FM	H
	Lopik	62.25	V		625	U	—	H
		67.75	S				FM	H
ITALY	Turin	83.25	V	5	625	U	—	V
		87.75	S	2.5			FM	H
	Milan	201.25	V	5	625	U		
		206.75	S	2.5				
SWITZERLAND	Lausanne	62.25	V		625	U	—	H
		67.75	S				FM	H
U.S.S.R.	Kiev	77.25	V		625	U	—	H
		83.75	S				FM	H
	Leningrad	59.25	V		625	U	—	H
		65.75	S				FM	H
	Moscow	49.75	V		625	U	—	H
		56.25	S				FM	H
YUGOSLAVIA	Belgrade	42.50	V	1	625			
		47.00	S	1				

MR. POSTAL CARD HAS SELLING POWER



Here is an inexpensive salesman who can cover lots of territory fast. Every door is open to him.

By B. W. WELZ

FOR two cents you can buy a salesman at any postoffice who will bring your sales talk right into the customer's home. Your salesman is *Mr. Postal Card*, and he is allowed through anybody's door, rich or poor. He is BIG BUSINESS in informal dress.

Don't make the mistake of selling him short because of his puny size. He can say a lot if he is properly handled. If you've never written an ad on a postcard, you'll be surprised at how much you can get on one. Mr. Postal Card is an inexpensive operator, too. If you don't want to pay printer's costs, all you need is a typewriter.

He puts your sales talk right under the customer's eyes. He has an unique advantage of his own, too. Ad writers say he can be "individually placed." Since this is what makes him so effective, let's see what it means.

Suppose a shop has a new shipment of 17-inch TV sets. Say the boss has a file of all TV repairs marked with the screen sizes. He goes through the file, picks out the names of those who own 7-, 10-, and 12-inch sets, and he writes an ad on Mr. Postal Card, beginning, "Your small-screen TV is worth money on a trade-in . . ."

See how a postal card can be placed—right into the hands of those who would be *most interested* in buying!

Slanting the story

Now, it doesn't make too much difference whether Mr. Postal Card is printed in flashy colors or merely typewritten. He is only as effective as his words. And it's up to the boss to put those words in the right order. If he wished, the boss could get an ad man to write copy for him.

But let's say the boss wants to write his own ad and save money. How does he go about it? First, let's see what he's got to say. He's got some new 17-inch sets he wants people with small-screen sets to buy. Already he's got one of the hardest problems of his ad licked—he's got *something definite to write about*.

The boss knows that to write a good ad *he has to think like a buyer*, not a seller. He doesn't think, "I have some 17-inch sets for sale . . .", but rather, "A small-screen TV is worth money as a trade-in on a new 17-inch set." When he writes the ad he'll be telling people why they want to buy.

With the first sentence down, he warms up to the subject. He describes the sets in his own words, their sensitivity, their fine finish, their super-sharp focus, etc. It's important that he write it smoothly, naturally and plainly—like he was telling the customer right to his face the advantages of buying his product. He searches the manufacturer's literature to get ideas. Because he can say only so much on a postal card, he makes his sales pitch as short and direct as possible.

Other advantages

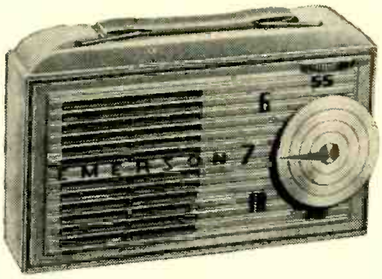
Besides being individually placed, Mr. Postal Card can do general heavy work, too. Some stores keep mailing lists handy and send out postal cards regularly, listing new items or telling of monthly sales. This pays off in two ways: Besides boosting sales, it keeps the name of the business in front of those who buy.

Another advantage of postal cards is *follow-up*. If a product moves slowly you can give it a shove with a series of postal cards—a series that doesn't end until the product is sold. Lots of big businesses today owe their rise to persistent follow-ups. Anyone who was ever on their mailing lists will never forget the stream of postal cards he got.

Mr. Postal Card can sell your services, too. Let him tell why people should bring their repairs *to you* instead of to the next guy. Remember to make your best selling point very clear, whatever it is—experience, low cost, reputation—make an impression with it. And remember—*keep the buyer's view in mind*, like the boss did with his TV sets. Convince people that your selling point is an advantage to *them*.

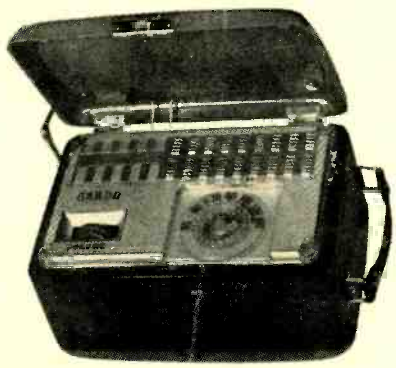
A postal card has lots of other uses. It can announce store openings or enlargements, renew ties with old customers, sell slow-moving appliances, remind past-due accounts, etc.

Once again, write him right: have something to say; say it in your own words, but *with the buyer's benefit in mind*. And next time you plan to sell your services or anything else, get in a good two cents' worth: Let Mr. Postal Card do the selling for you. END



Emerson model 747, the "Pocket Radio."

midget portables and their PROBLEMS



Garod "Starlet," 4 tube superheterodyne

The care and feeding of midget receivers. Standard routine makes servicing easy

By PAUL BOLLER

THE standard midget portable has some inherent limitations in sensitivity and tone quality due to its low cost, its compactness, and the materials used in its construction. It's biggest handicap, though, is *service*. The little thing gets the most abuse and the least attention. Only rental PA systems get worse treatment. Here are some of the hazards a midget has to meet:

Rough and improper handling. Few midgets survive more than one season without a cracked cabinet, loose hinges, or a missing handle. Where the set has no lid-operated shutoff, the owner often forgets about the set and leaves it on until the batteries are exhausted.

Corrosion. Few owners realize that a leaky battery is the midget's worst enemy. Corrosion damage is usually permanent. The tuning capacitor is the most common victim of the leaking chemicals. Steel-sealed A batteries offer some protection against leakage, but this doesn't solve the problem completely.

Elements. A midget is used around the house, in the backyard, at the beach, on trips—under every conceivable physical condition. Near pools and on the beach, it is often splashed, operated by people with water dripping from their bodies. Sand also gets inside. Between water and sand, the set really takes a beating, especially the loudspeaker and the controls. The hot sun heats up black and other dark cabinets to a point where they get soft and distorted. After such an ordeal, the lid often can no longer be shut. In many cases insects crawl inside through the speaker grille and cause rattles.

Servicing midgets is a problem all right. The customer—especially in resorts—wants fast, if not immediate, service. There are at least twenty brands of midgets currently on the market, and it is remarkable how few parts are standardized. Surprisingly few parts are obtainable at local jobbers. Many have to be ordered from the distributor, often from out of town. This makes immediate service almost impossible in some cases.

Most midgets are designed for maximum compactness, and servicing convenience is completely forgotten by the manufacturer. So, to remove a bug that's established itself in front of the speaker cone—a simple matter as the customer thinks—you often have to remove a cabinet, unsolder a loop, then remove some almost inaccessible screws (almost invariably with special heads). All that just to lift off the front panel! The mere pulling of a knob can be a headache when you find out that the genius who serviced the set last glued

Philco personal radio, model 650.

Motorola portable midget receiver.

Motorola model 61L is very compact.

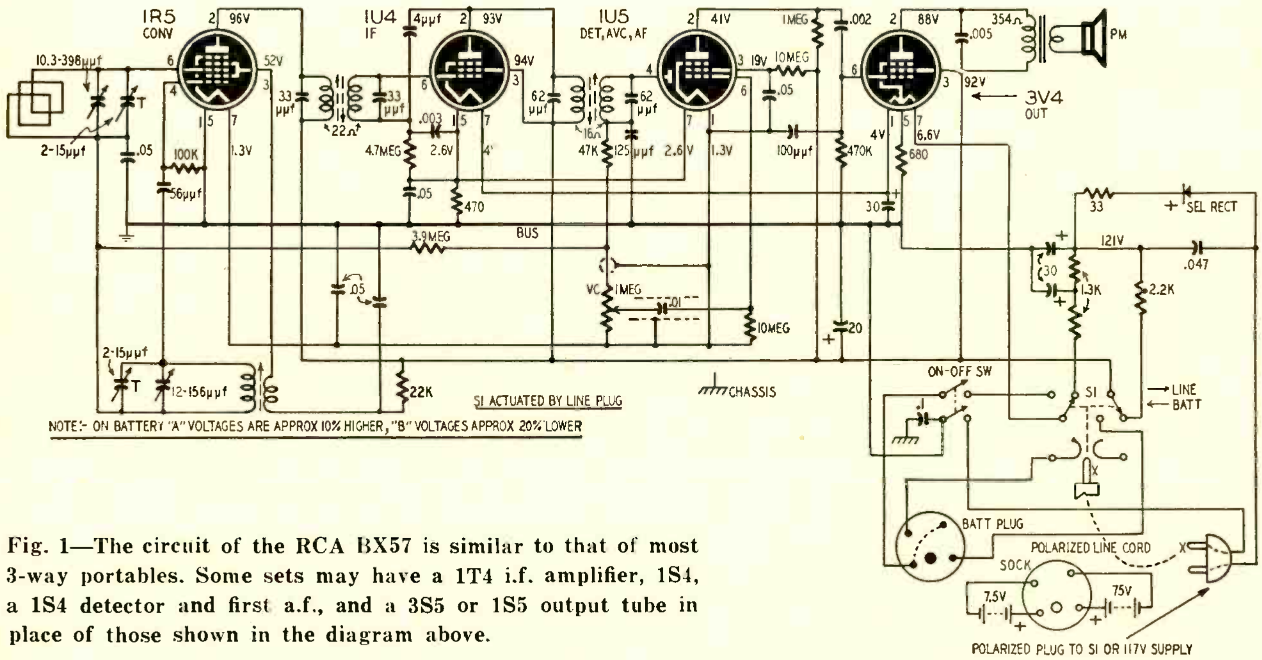


Fig. 1—The circuit of the RCA BX57 is similar to that of most 3-way portables. Some sets may have a 1T4 i.f. amplifier, 1S4, a 1S4 detector and first a.f., and a 3S5 or 1S5 output tube in place of those shown in the diagram above.

the knob to the shaft. It is almost impossible to clip a standard alligator clip to a tube-socket pin without shorting out something and blowing a couple of dollars worth of tubes. Not even the new types of clips—Klipzon for instance—are safe in this respect, although they are many times superior to alligators.

Comparing the cost of replacement parts with the initial cost of the equipment, we find that it is pretty high. Plastic cabinets seldom run below $3.50, i.f.'s around $1.75, tuning capacitors from $2.75 up. Most midget tubes have higher list prices than the equivalent a.c.-d.c. types. But shop overhead and hourly wage is about the same whether the technician works on a $500 TV set or a $19.95 midget. This is hard to get across to some customers who think that midget knowledge is cheaper than other radio knowledge because the midget radio cost only half as much as a conventional table model. Any repair involving more than a mere tube or battery replacement will certainly present a higher ratio of service cost to original cost than a conventional a.c.-d.c. set. But it *is possible* to get money out of midget service through rationalized service and a sound approach, although volume is essential.

The RCA "Yachtsman" 3-way portable.

Estimates

It is often difficult to make an accurate estimate on repair jobs in the case of a TV set or a good table-model radio-phonograph, but in the case of a midget radio a fair estimate can usually be made while the customer is waiting. This presents two advantages. For one thing, it is possible to call the customer's attention to a broken cabinet, a mushy speaker or the like, and it may well be that he is willing to pay the cost of replacing them. There is normally a fair profit on parts, and this sales possibility should not be overlooked. Especially if you're doing a large-volume business in midgets, profit per set can be considerably higher than in the case of straight servicing, where only the least possible is done to get the radio back in operation. The other advantage of an estimate is that it may save the customer embarrassment when he comes to pick up his set, as he won't have to discover that he is short a few cents. The majority of midget owners are young people, students and teen-agers who seldom carry much money with them.

Service procedure

Once the set is taken to the service bench, open it up and shake it to make sure there are no loose parts and hardware (not over the trash can). It is good to have compressed air available at the bench for removing dust, insects, sand, etc. I have built several compressed-air installations in my spare time, each for less than $25.00, including compressor, air tank, hose, gauge, relief valve, etc. I was able to do this by using the motor and compressor assemblies of old refrigerators which I obtained for around $5.00 apiece.

Done on a clean bench, *blowing* dirt out does a better job than sucking it out with a vacuum cleaner, because you don't have to empty a messy dust bag to hunt for some little special screw that may have disappeared up the hose.

The next things to check are the battery connectors. They often have only a single strand of wire left on them. Proper resoldering insures a good job. Corrosion on any part of the chassis should be brushed or scraped off. The bare metal should be coated with a thin film of *Lubriplate* or the like to prevent further damage. After this give the tuning capacitor a few more squirts of air to make sure no metal dust or bristles from the brush are left in it.

Circuit trouble-shooting and repair are usually routine, and after having serviced a few dozen sets a remarkable regularity of troubles is noticeable. With *three-way* portables (Fig. 1) a common trouble is leakage between sections of multiple electrolytic capacitors. This trouble can have many different symptoms, from varying filament voltages to squeals. Another problem is sudden loss of sensitivity due to poor soldering of Litz wire in the antenna circuit. Also most temperature- and humidity-induced troubles can be quite perturbing.

Once the set is playing again, but before checking the alignment, make the following tests:

Three-way sets. Make sure the selenium rectifier (or tube rectifier in bigger sets) delivers a healthy B+ even at low line voltages. Measure the filament voltage across the heater of the converter tube, maintaining a line voltage of around 100 to 105. This filament voltage should be not less than 1.1 volts or the oscillator section may fail. A more conclusive test is to adjust the line to 105 volts, tune the set to a station around 600 kc, and let it play for about 15 minutes. If it does not cut out or stop playing altogether, you can assume that the rectifier and converter tube are all right.

Battery-only sets. Make the same filament-voltage and drop-out tests by using a nearly used-up A battery. A poor oscillator tube or changed oscillator grid resistor will show up in these tests. Abnormal filament voltages across one or more tubes in series hookups can stop you in your tracks if you are unfamiliar with the fact that some tubes change their filament resistance as they get old. Try a whole new set of tubes. Naturally there are many other causes of incorrect voltages at the filaments.

Rubber bands tied around microphonic tubes will greatly reduce the tendency to howl.

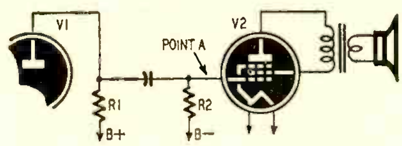


Fig. 2—Audio amplifier check point.

After the set has been on for a while, check the voltage at the grid of the second audio amplifier (point A in Fig. 2). A leaky coupling capacitor can completely upset the bias (measured from grid to filament) because of the high-value grid resistors usually found in midgets. First-audio plate-load resistors range from 470,000 ohms to over 1 megohm, and grid-return resistors in the audio output stage from 1 to 10 megohms. It is clear that even a small leakage will raise havoc in these circuits.

Alignment

Because of the necessarily small antenna, signal pickup is generally poor. This increases the importance of proper

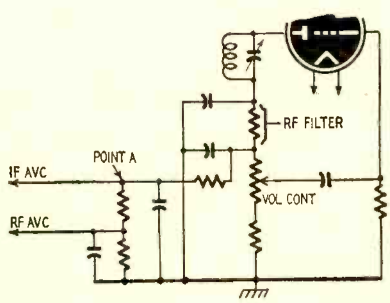


Fig. 3—Point A measures a.v.c. voltage.

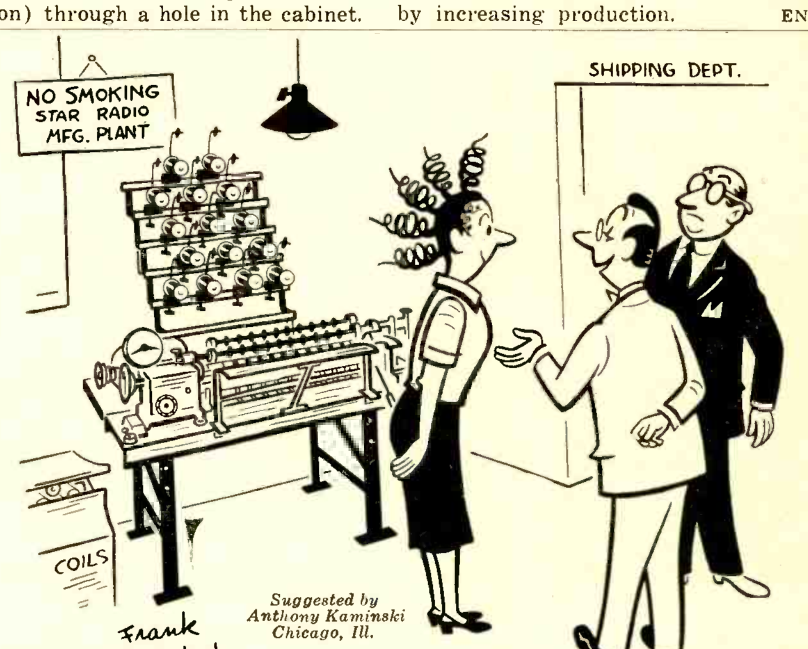
alignment. The i.f. alignment can be done before the chassis is installed in the cabinet. Many i.f. slugs and trimmers cannot be reached with any conventional alignment tool, once the chassis is in place. A v.t.v.m. across the a.v.c. bus will give a much better indication of gain variations than will the human ear which has built-in a.v.c. The conventional method of connecting an output meter across the voice coil or the output transformer primary is almost useless, unless a very sensitive meter is used. This is because the a.v.c. has tendency to compensate for any gain increase obtained during alignment, unless the aligning signal is too weak to produce any a.v.c. voltage. In normal use, the set is seldom tuned to such a weak signal, and a.v.c. bias does influence the response curve of a tuned amplifier. So by tuning the i.f.'s with a nearly normal signal input we do a better job because we have proper response at normal bias. A.v.c. voltages of minus 1.5 to minus 3 volts are normally found at point A in Fig. 3 with a 500-microvolt signal applied to the converter grid. This is about the same reading as you would get when the set is tuned to a local medium-power station. This method of indication has another advantage: It can be silent. No more wide-open volume controls, with earsplitting 80-percent modulation filling the room. An unmodulated signal can be used with just the same effect.

Once the set is back in the cabinet, give it an r.f. alignment. On three-way sets do this with batteries in place (whether or not the customer will purchase a set of batteries) and using battery power. Working with line power will only introduce errors due to the line pickup. Besides, in many sets the capacitance of the batteries affects the loop tuning. Plugged in an outlet a couple of blocks from a 25-kw station, any midget will play—even one that's way out of alignment—but out in the sticks, 60 miles from the nearest 1-kw transmitter—that's real playing. The kind of performance we will try to attain is the kind that advertises.

A good method of signal injection is to couple the r.f. to the set with a loop of about two turns of heavy wire, the loop around six inches in diameter, placed near the receiver. As the oscillator-trimmer setting is not usually affected by the position of the batteries and the antenna loop, special precautions are seldom needed when adjusting it. But the r.f. trimmer is very critical. The ideal way to adjust it is (with the batteries and receiver loop in normal position) through a hole in the cabinet. Some sets have them. Naturally the ear will have to be used as the output indicator, as it's almost impossible to make connections to the speaker with the cabinet shut. In spite of the handicaps, an accurate adjustment can be made if a weak r.f. signal with low modulation is used. Listen to the hash, rather than to the modulation; it increases as the modulation decreases. Never place a hand or object very close to the receiver loop, nor should the latter be placed on a metal bench top. The r.f. alignment affects tracking, and thus selectivity and gain. All adjustments should be made at the frequencies recommended by the manufacturer.

The oscillator trimmer is usually set at frequencies from 1,500 kc to 1,650 kc; some sets (RCA) have a padder which is set around 600 kc; the r.f. trimmer is generally peaked somewhere from 1,200 kc to 1,550 kc. Going back and forth between these adjustments and rocking the tuning capacitor on the r.f.-trimmer settings will give a very fine job of alignment.

Most of the precautions and practices described become routine after a certain amount of midget work, and many of the above tests take less time than the decision of whether or not to make them. It is good to stop and think, but stoppage because of indecision is nonproductive. It is possible to repair and align almost any midget portable (except intermittents) in 30 to 45 minutes, provided replacement parts are at a finger's reach. Any set taking more than an hour of a good technician's time can be considered a bad deal, a lemon. Routine is the most important part in productive and reliable midget service. Routine is possible because midget circuits are more or less conventional and standardized. Only a few different tube types are used, and in a short time one knows most of the base connections. Routine reduces cost by increasing production. END



"Miss Spaget, here, is in charge of our Coil Winding Department."

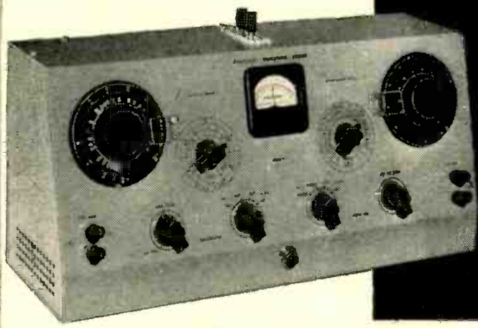
Heathkit

IMPEDANCE BRIDGE KIT

MODEL IB-2

$59.50

SHIPPING WT. 15 LBS.



Features

- Simpson 100-0-100 microampere meter.
- Completely AC operated.
- Built-in phase shift generator and amplifier.
- Battery type tubes, no warm-up required.
- Newly designed two section CRL dial.
- Single knob D, Q, and DQ functions.
- Special impedance matching transformer.
- New modern cabinet styling.
- ½% precision resistors and silver mica condensers.

Another new, outstanding instrument design so typically characteristic of Heathkit operation in producing high quality instrument kits at the lowest possible price. A new, improved model Impedance Bridge kit featuring modern cabinet styling, with slanted panel for convenience of operation and interpretation of scales at a $10.00 price reduction over the preceding model. Built-in adjustable phase shift oscillator and amplifier with all tubes of the battery operated type completely eliminates warm-up time. The instrument is entirely AC line operated. No bothersome battery replacements.

The Heathkit IB-2 Impedance Bridge Kit actually represents four instruments in one compact unit. The Wheatstone Bridge for resistance measurements, the Capacity Comparison Bridge for capacity measurements, Maxwell Bridge for low Q, and Hay Bridge for high Q inductance measurements. Read Q, D, DQ all on one dial thereby eliminating possible confusion due to the incorrect dial reference or adjustment. Only one set of instrument terminals necessary for any measurement function. Panel provisions provided for external generator use.

A newly designed two section CRL dial provides ten separate "units" switch settings with an accuracy of .5%. Fractions of units are read on a continuously variable calibrated wire-wound control. A special minimum capacity, shielded, balanced impedance matching transformer between the generator and the bridge. The correct impedance match is automatically switch selected to provide constant load operation of the generator circuit. The instrument uses ½% precision resistors and condensers in all measurement circuits.

The new Heathkit IB-2 provides outstanding design features not found in any other kit instrument. The single low price includes the power supply, generator, and amplifier stages. No need to purchase separate instrument accessories in order to obtain the type of operation desired.

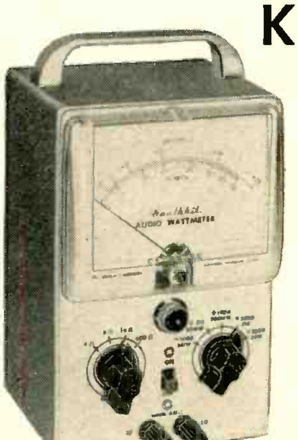
Heathkit

AUDIO WATTMETER KIT

MODEL AW-1

$29.50

SHIPPING WT. 6 LBS.



A new Heathkit design for the audio engineer, serious hi fi enthusiast, recording studio, or broadcast station; the Heathkit Audio Wattmeter Kit. This specialized instrument instantly indicates the output level of the equipment under test without requiring the use of external load resistors. All readings are taken directly from the calibrated scales of a 4½" 200 microampere Simpson meter.

The Heathkit Audio Wattmeter features five full scale power measurement ranges from 5 milliwatts up to 50 watts with db ranges of −15 db to +48 db. The instrument has a power measurement rating of 25 watts continuous and 50 watts maximum for intermittent operation. Non-inductive resistance load impedances of 4, 8, 16, and 600 ohms are provided through a panel impedance selector switch. Frequency effect is negligible from 10 cycles to 250 kc. A conventional VTVM circuit utilizes a 12AU7 twin triode tube. The meter bridge circuit uses four germanium diodes for good linearity.

With the Heathkit AW-1 desired information can be obtained instantly and conveniently without bothering with the irksome setups and calculations usually required. Useful for power curve measurements, frequency response checks, monitoring indicator, etc. Convenient calibration directly from 110 volt AC line source. This new instrument will help to supply the answers to your audio operating or power output problems.

Heathkit

LABORATORY GENERATOR KIT

MODEL LG-1

$39.50

SHIP. WT. 16 LBS.

Another welcome new addition to the popular line of Heathkit instruments, the Heathkit Laboratory Generator. Specifically designed for flexibility of operation, accuracy and versatility beyond the performance level provided by the conventional service type generator. Frequency coverage of the Colpitts oscillator is 150kc to 30mc in five convenient ranges with provisions for internal or external modulation up to 50%, and .1 volt RF output throughout the frequency range. Panel mounted 200 microampere Simpson meter for RF "set reference level" to provide relative indication of RF output. Individually shielded oscillator and shielded variable and step attenuator provide flexible control of RF output.

The circuit features a 6AF4 high frequency oscillator, a 6AV5 amplifier with grid modulation, 12AU7 400 cycle oscillator and modulator, OB2 voltage regulator tube, and a selenium rectifier for the transformer operated power supply. The smart professional instrument appearance and over-all flexibility of operation will prove a decided asset to any industrial or educational laboratory. The Heathkit Laboratory Generator sets a new level of operation, far superior to any instrument in this price classification.

HEATH COMPANY • Benton Harbor 20, Mich.

NEW 5" *Heathkit*

OSCILLOSCOPE KIT

MODEL O-9

$59.50

SHIPPING WT. 28 LBS.

CHECK THESE *Features*

- New 5UP1 CR tube
- Re-trace blanking
- Voltage regulation
- Extended band width
- Peak-to-peak calibrating provisions
- Good square wave response
- Astigmatism control
- New heavy duty shielded power transformer

Announcing the latest addition to a brilliant series of Heathkit Oscilloscopes, the new Model O-9. This outstanding instrument incorporates all of the features developed and proven in the production of well over 50,000 kits, in addition to a host of many new design features for truly outstanding performance. This new scope features a brand new (no surplus) commercially available 5UP1 cathode ray tube for fine focusing, high intensity, and freedom from halation. The 5" CR tube is the standard size for design and industrial laboratories, development engineers, and service men. The only size CR tube offering a wide range of types, colors, phosphors, and persistence. The answer to good oscilloscope performance lies in improved basic design and operating characteristics, and not in the use of larger CR tubes.

VERTICAL AMPLIFIER — New extended band width vertical amplifier with sensitivity of .025 volts per inch, down 3 db at 2 mc. down only 5½ db at 3 mc. Three step vertical input attenuator, quality ceramic variable capacitors for proper input compensation, provisions for calibrated 1 volt peak-to-peak reference, with calibrated screen for direct reading of TV pulses.

HORIZONTAL AMPLIFIER — New input selector switch provides choice of horizontal input, 60 cycle sweep input, line sync, internal sync, and external sync. Expanded horizontal sweep produces sweep width several times the cathode ray tube diameter. New blanking amplifier for complete retrace blanking and new phasing control.

POWER SUPPLY — New high voltage power supply and filtering circuit for really fine hairline focusing. New heavy duty power transformer with adequate operating reserve. Voltage regulated supply for both vertical and horizontal amplifiers for absolutely rock steady traces and complete freedom from bounce and jitter due to line variations.

The acid test of any oscilloscope operation is the ability to reproduce high frequency square waves and the new Heathkit O-9 will faithfully reproduce square waves up to 500 kc. This is the ideal all around, general purpose oscilloscope for educational and industrial use, radio and TV servicing, and any other type of work requiring the instantaneous reproduction and observation of actual wave forms and other electrical phenomena.

Heathkit LOW CAPACITY PROBE KIT

NO. 342

$3.50 SHIP. WT. 1 LB.

Oscilloscope investigation of high frequency, high impedance, or broad bandwidth circuits encountered in television work requires the use of a low capacity probe to prevent loss of gain, distortion, or false service information. The Heathkit Low Capacity Probe features a variable capacitor to provide the necessary degree of instrument impedance matching. New probe styling with bright polished aluminum housing and polystyrene probe ends.

Heathkit SCOPE DEMODULATOR PROBE KIT

NO. 337-B

$3.50

SHIP. WT. 1 LB.

In applications such as trouble shooting or aligning TV, RF, IF, and video stages, the frequency ranges encountered require demodulation of signals before oscilloscope presentation. The newly-styled Heathkit Demodulator Probe in polished aluminum housing will fulfill this function and readily prove its value as an oscilloscope service accessory. Detailed assembly sheet provided, including instructions for probe operation.

Heathkit VOLTAGE CALIBRATOR KIT

The Heathkit Voltage Calibrator provides a convenient method of making peak-to-peak voltage measurements with an oscilloscope by establishing a relationship on a comparison basis between the amplitude of an unknown wave shape and the known output of the voltage calibrator. Peak-to-peak voltage values are read directly on the calibrated panel scales. To offset line voltage supply irregularities, the instrument features a voltage regulator tube.

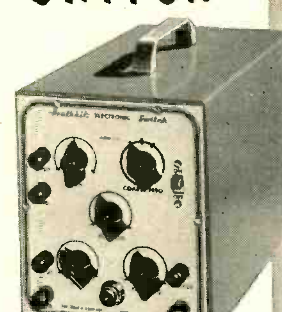
With the Heathkit Voltage Calibrator, it is possible to measure all types of complex wave forms within a voltage range of .01 to 100 volts peak-to-peak. A convenient "signal" position on the panel switch by-passes the calibrator completely and the signal is applied to the oscilloscope input thereby eliminating the necessity for transferring test leads.

MODEL VC-2

$11.50

SHIPPING WT. 4 LBS.

Heathkit ELECTRONIC SWITCH KIT



The basic function of the Heathkit S-2 Electronic Switch Kit is to permit simultaneous oscilloscope observation of two separate traces which can be either separated or superimposed for individual study. A typical example would be observation of a signal as it appears at both the input and output stages of an amplifier. It will also serve as a square wave generator over the range of switching frequencies, often providing the necessary wave form response information without incurring the expense of an additional instrument.

Continuously variable switching rates in three ranges from less than 10 cps to over 2,000 cps. Individual controls for each input channel and a positioning control. The five tube transformer operated circuit utilizes two 6SJ7, two 6SN7, and one 6X5 tubes. Buy this kit and enjoy increased versatility of operation from your oscilloscope.

MODEL S-2

$23.50

SHIP. WT. 11 LBS.

HEATH COMPANY • Benton Harbor 20, Mich.

New *Heathkit* 12 Volt
BATTERY ELIMINATOR KIT

MODEL BE-4

$31.50

SHIPPING WT. 18 LBS.

CHECK THESE *Features*

- Either 6 or 12 volt operation
- Continuously variable voltage output
- Constant ammeter and voltmeter monitoring
- Automatic overload relay — self-resetting
- Two 10,000 mf condensers
- New 18 disc split type heavy duty rectifier unit
- Fuse protection

Here is the new Heathkit Battery Eliminator necessary for modern, up-to-date operation of your service shop. The Heathkit Model BE-4 furnishes either 6 volts or 12 volts output which can be selected at the flick of a panel switch. Use the BE-4 to service the new 12 volt car radios in addition to the conventional 6 volt radios.

This new Battery Eliminator provides two continuously variable output ranges, 0-8 volts DC at 10 amperes continuously, or 15 amperes maximum intermittent; 0-16 volts DC at 5 amperes continuously or 7.5 amperes maximum intermittent. The output voltage is clean and well filtered as the circuit uses two 10,000 mf condensers. The continuously variable voltage output feature is a definite aid in determining the starting point of vibrators, the voltage operating range of oscillator circuits, etc. Panel mounted meters constantly monitor voltage and current output and will quickly indicate the presence of a major circuit fault in the equipment under test. The power transformer primary winding is fuse protected and for additional safety an automatic relay of the self-resetting type is incorporated in the DC output circuit. The heavy duty rectifier is a split type 18 plate magnesium copper sulfide unit used either as a full wave rectifier or voltage doubler according to the position of the panel range switch.

Here is the ideal battery eliminator for all of your service problems and as an additional feature, it can also be used as a battery charger. Another new application for the Heathkit Battery Eliminator is a variable source of DC filament supply in audio development and research. More than adequate variable voltage and current range for normal applications.

Heathkit VIBRATOR TESTER KIT

Your repair time is valuable, and service use of the Heathkit Vibrator Tester will save you many hours of work. This tester will instantly tell you the condition of the vibrator being checked. Checks vibrators for proper starting and the easy to read meter indicates quality of output on a large Bad-?-Good scale. The Heathkit VT-1 checks both interrupter and self rectifier types of vibrators. Five different sockets for checking hundreds of vibrator types.

The Heathkit Vibrator Tester operates from any battery eliminator capable of delivering continuously variable voltage from 4 to 6 volts DC at 4 amperes. The new Heathkit Model BE-4 Battery Eliminator would be an ideal source of supply.

MODEL VT-1

$14.50

SHIPPING WT. 6 LBS.

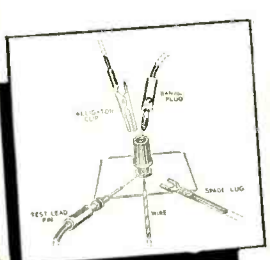
NEW *Heathkit* VARIABLE VOLTAGE ISOLATION TRANSFORMER KIT

The new Heathkit Isolation Transformer Kit provides line isolation for AC-DC radios (not an auto transformer), thereby eliminating shock hazard, hum problems, alignment difficulties, etc. The output voltage is variable from 90 to 130 volts AC and is constantly monitored by a panel mounted AC volt meter. Use it to increase AC supply voltage in order to induce breakdown of faulty components in circuits thereby saving service time. Use it also to simulate varying line voltage conditions and to determine the line voltage level at which oscillator circuits cease functioning, particularly in three-way portable radios. Rated at 100 watts continuous operation and up to 200 watts maximum intermittent operation. A useful radio and TV service tool.

MODEL IT-1

$16.50

SHIP. WT. 9 LBS.



Heathkit BINDING POST

Binding post kit now available so that standardization of all instrument connectors is possible. This new, five-way binding post will accommodate an alligator clip, banana plug, test lead pin, spade lug, or hook-up wire. Sold in units of 20 binding post assemblies. Each assembly includes binding post, flat and shoulder fiber washers, solder lug, and nut. 120 pieces in all. Kit 362, $4.00.

Heathkit TECHNICAL APPLICATION BULLETINS

An exclusive Heathkit service. Technical application bulletins prepared by recognized instrument authorities outlining various combinations of instrument applications. Available now with 40 four-page illustrated bulletins and an attractive flexible loose-leaf binder. Only $2.00. (No c.o.d. on this item, please.)

HEATH COMPANY • Benton Harbor 20, Mich.

CHECK THESE *Features*

- INCREDUCTOR controllable inductor sweep
- TV and IF sweep deviation 12-30 mc
- 4 mc- 220 mc continuous frequency coverage
- Oscillator operation entirely on fundamentals
- Output in excess of 100,000 microvolts
- Automatic amplitude circuit
- Voltage regulation
- Simplified operation

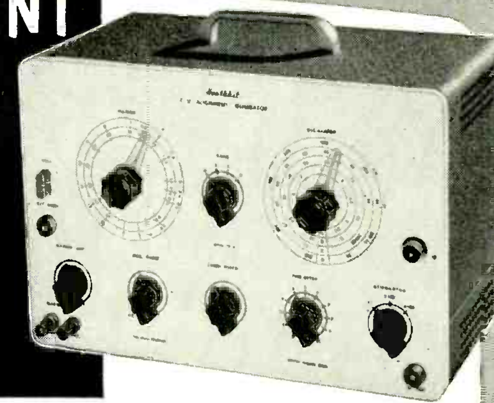
NEW *Heathkit*

TV ALIGNMENT GENERATOR KIT

MODEL TS-3

$44.50

SHIPPING WEIGHT 18 POUNDS



Proudly announcing an entirely new, advanced model TV and FM Sweep Generator, the Heathkit Model TS-3. This new design provides features and combinations of functions not found in any other service type instrument. Every design consideration has been given to the requirements of the TV service man to provide a flexible, variable sweep source with more than adequate RF output and complete frequency coverage throughout the TV and FM spectrum.

The frequency range of the TS-3 is from 4 mc to 220 mc in four switch selected ranges. All frequency ranges are overlapping for complete coverage. A particularly important feature of the instrument is that the oscillator operates entirely on fundamentals, thereby providing complete freedom from spurious oscillation and parasitics normally encountered in beat frequency type oscillators. This circuity assures a much higher total RF output level and simplifies attenuation problems.

The new TS-3 features an entirely new principle of sweep operation. Sweep action is entirely electronic with no moving parts or electro-mechanical devices so commonly used. The heart of the sweep system is a newly-developed INCREDUCTOR controllable inductor. With this system, the value of inductance of each oscillator coil is electrically varied with an AC control current, and the inductance variation is achieved by a change in the magnetic state of the core on which the oscillator coils are wound. This system provides a sweep deviation of not less than 12 mc on all TV frequencies, and up to a maximum of 30 mc on TV IF frequencies. The high RF output level throughout the instrument frequency range overcomes the most common complaint of the older type sweep generators. A new, automatic amplitude control circuit maintains the output level flat to ± 2 db throughout the instrument range. For convenience of operation a low impedance 50 ohm output is used.

Operation of the instrument has been simplified through the reduction of panel controls and separate panel terminals provide for external synchronization if desired. The circuit uses a voltage regulator tube to maintain stable instrument operation. A built-in variable oscillator marker further adds to flexibility of instrument operation. Provisions are also made for the use of an external marker, such as your service type signal generator, if desired. Use the Heathkit TS-3 for rapid, accurate TV alignment work, and let it help you solve those time consuming, irksome problems so frequently encountered.

NEW *Heathkit*

SIGNAL GENERATOR KIT

MODEL SG-8

$19.50

SHIPPING WEIGHT 8 POUNDS

Announcing the new Heathkit Model SG-8 service type Signal Generator, incorporating many design features not usually found in an instrument in this price range. The RF output is from 160 kc to 100 mc in five ranges, all on fundamentals, with useful harmonics up to 200 mc. The RF output level is in excess of 100,000 microvolts throughout the frequency range.

The oscillator circuit consists of a 12AT7 twin triode tube. One half is used as a Colpitts oscillator, and the other half as a cathode follower output which acts as a buffer between the oscillator and external load. This circuity eliminates oscillator frequency shift usually caused by external circuit loading.

All coils are factory wound and adjusted, thereby completely eliminating the need for calibration and the use of additional calibrating equipment. The stable low impedance output features a step and variable attenuator for complete control of RF level. A 6C4 triode acts as a 400 cycle sine wave oscillator and a panel switching system permits a choice of either external or internal modulation.

The transformer operated circuit is easy to assemble, requires no calibration, and meets every service requirement for an adjustable level variable frequency signal source, either modulated or un-modulated.

NEW *Heathkit*

BAR GENERATOR KIT

MODEL BG-1

$14.50

SHIPPING WEIGHT 6 POUNDS

The Heathkit BG-1 Bar Generator represents another welcome addition to the fast growing line of popular Heathkits. The station transmitted test pattern is rapidly disappearing, and the bar generator is the logical answer to the TV service man's problem in obtaining quick, accurate adjustment information without waiting for test patterns.

The Heathkit BG-1 produces a series of horizontal or vertical bars on a TV screen. Since these bars are equally spaced, they will quickly indicate picture linearity of the receiver under test. Panel switch provides "stand-by position" — "horizontal position" — "vertical position." The oscillator unit utilizes a 12AT7 twin triode for the RF oscillator and video carrier frequencies. A neon relaxation oscillator provides low frequency for vertical linearity tests. The instrument will not only produce bar patterns but will also provide an indication of horizontal and vertical sync circuit stability, as well as overall picture size.

Instrument operation is extremely simple, and merely requires connection to the TV receiver antenna terminal. The unit is transformer operated for safety when used in conjunction with universal or transformerless type TV circuits.

HEATH COMPANY • Benton Harbor 20, Mich.

NEW *Heathkit*

TUBE CHECKER KIT

MODEL TC-2

$29.50

SHIP. WT. 12 LBS.

CHECK THESE NEW *Features*

- Simplified harness wiring
- Improved, smooth, anti-backlash roll chart action
- Optional roll chart illumination
- Individual element switches
- Portable or counter style cabinet
- Spare blank socket
- Contact type pilot light test socket
- Simplified test set-up procedure
- Line adjust control
- 4½" three-color meter

The new Model TC-2 Heathkit Tube Checker features many circuit improvements, simplified wiring, new roll chart drive and illumination of roll chart. The instrument is primarily designed for the convenience of the radio and TV service man and will check the operating quality of tubes commonly encountered in this type of work. Test set-up procedure is simplified, rapid, and flexible. Panel sockets accommodate 4, 5, 6, and 7 pin tubes, octal and loctal, 7 and 9 pin miniatures, 5 pin Hytron and a blank socket for new tubes. Built-in neon short indicator, individual three-position lever switch for each tube element, spring return test switch, 14 filament voltage ranges, and line set control to compensate for supply voltage variations, all represent important design features of the TC-2. Results of tube tests are read directly from a large 4½" Simpson three-color meter, calibrated in terms of Bad-?-Good. Information that your customer can readily understand. Checks emission, shorted elements, open elements, and continuity.

The use of closer tolerance resistors in critical circuits assures correct test information and eliminates the possibility of inaccurate test interpretation. Improvement has been made in the mechanical roll chart drive system, completely eliminating diagonal running, erratic operation, and backlash. The thumb wheel gear driven action is smooth, positive, and free running. As an additional feature, the roll chart is illuminated for easier reading, particularly when the tube checker is used on radio or TV home service calls.

Wiring procedure has been simplified through the extended use of multicable, color coded wires, providing a harness type installation between tube sockets and lever switches. This procedure insures standard assembly and imparts that "factory built" appearance to instrument construction. Completely detailed information is furnished in the new step-by-step construction manual, regarding the set-up procedure for testing of new or unlisted tube types. No delay necessary for release of factory data.

The new Heathkit Tube Checker will prove its value in building service prestige through usefulness — simplified operation — attractive professional appearance. Don't overlook the fact that the kit price represents a savings of $40.00 to $50.00 over the price of a comparable commercially built instrument. At this low price, no service man need be without the advantages offered by the Heathkit Tube Checker.

New

HEATHKIT

PORTABLE TUBE CHECKER KIT

MODEL TC-2P

$34.50

SHIP. WT. 14 LBS.

The portable model is supplied with a strikingly attractive two-tone cabinet finished in rich maroon, proxylin impregnated, fabric covering with a contrasting gray on the inside cover. Detachable cover, brass-plated hardware, sturdy plastic handle help to impart a truly professional appearance to the instrument.

PORTABLE TUBE CHECKER CABINET as described above will fit all earlier Heathkit TC-1 Tube Checkers. Shipping weight 7 lbs. Cabinet only, 91-8, $7.50.

Heathkit TV PICTURE TUBE TEST ADAPTER

No. 355 Ship. Wt. 1 Lb. **$4.50**

The Heathkit TV Picture Tube Test Adapter used with the Heathkit Tube Checker will quickly check for emission, shorts, etc., and determine picture tube quality. Consists of standard 12 pin TV tube socket, four feet of cable, octal socket connector, and data sheet.

Heathkit POWER SUPPLY KIT

MODEL PS-2

$33.50

SHIPPING WT. 17 LBS.

The Heathkit Laboratory Power Supply features continuously variable, regulated voltage output with good stability under wide load variations. A 4½" Simpson plastic enclosed panel mounted meter provides accurate meter output information of voltage or current. All panel terminals completely isolated from the cabinet. Separate 6.3 volt AC supply at 4 amperes for filament requirements. Ripple component exceptionally low, stand-by switch provided to eliminate warm-up time of the five tube circuit.

LABORATORY AND SERVICE SHOP BOOKLETS

"Planning Your Service Business" by John T. Frye, and "Establishing the Industrial Electronics Laboratory" by Louis B. Garner, Jr., are booklets available to Heathkit customers at no charge. These booklets, written by nationally recognized authorities, outline the various requirements and considerations for establishing your own service business or for setting up an industrial electronics laboratory. Full attention is given to various details that are frequently overlooked when projects of this nature are undertaken. Just write in to the Heath Company requesting your free copy, or attach a memo to your next order.

HEATH COMPANY · Benton Harbor 20, Mich.

CHECK THESE *Features*

- Visual and aural signal tracing
- Two channel input
- High RF sensitivity
- Unique noise locater circuit
- Calibrated wattmeter
- Substitution test speaker
- Utility amplifier
- RF, audio probes and test leads included

Heathkit VISUAL-AURAL

SIGNAL TRACER KIT

MODEL T-3

$23.50

SHIPPING WEIGHT 10 POUNDS

An entirely new type of signal tracer incorporating a combination of features not found in any other instrument. Designed expressly for the radio and TV service man, particularly for the servicing of AM, FM, and TV circuits. Here in a five tube, transformer operated instrument are all of the useful functions so necessary for speedy, accurate isolation of service difficulty.

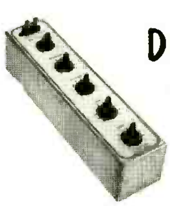
This new signal tracer features a special high gain RF input channel, used in conjunction with a newly-designed wide frequency range demodulator probe. High RF sensitivity permits signal tracing at the receiver antenna input. A separate low gain channel and probe available for audio circuit exploration. Both input channels are constantly monitored by an electron ray beam indicator, so that visual as well as aural signal indications may be observed. The instrument can also be used for comparative estimation of gain per stage.

A decidedly unusual feature is a noise localizer circuit in conjunction with the audio probe. With this system, a DC potential is applied to a suspected circuit component and the action of the voltage in the component can be seen as well as heard. Invaluable for ferreting out noisy or intermittent condensers, noisy resistors, controls, coils, IF and power transformers, etc. A built-in calibrated wattmeter circuit is very useful for a quick preliminary check of the total wattage consumption of the equipment under test. Separate panel terminals provide external use of the speaker or output transformer for substitution purposes. Saves valuable service time by eliminating the necessity for speaker removal on every service job. The terminals also permit the utilization of other shop equipment, such as your oscilloscope or VTVM. The T-3 Signal Tracer can be used as a high gain amplifier for checking tuners, record changers, microphones, phono crystals, etc.

Don't overlook the interesting service possibilities provided through the use of this new instrument and let it work for you by saving time and money. The kit is supplied complete with all tubes, circuit components, demodulator probe, audio probe, and additional test leads.

Heathkit

DECADE RESISTANCE KIT



MODEL DR-1

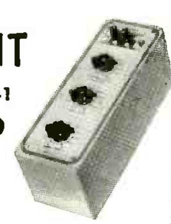
$19.50

SHIP. WT. 4 LBS.

The Decade Resistance Kit provides individual switch selection of resistance values using twenty 1% resistors providing a choice of 1 to 99,999 ohms in 1 ohm steps. Ceramic wafer switches, silver-plated contacts, smooth, positive detent action, baked enamel panel, and handsome, polished birch cabinet.

Heathkit

DECADE CONDENSER KIT



MODEL DC-1

$16.50

SHIP WT 4 LBS.

The Heathkit Decade Condenser Kit features silver mica, precision condensers with a rated accuracy of ± 1%. Capacity values are arranged in three decades from 100 mmf to .111 mf in steps of 100 mmf. Ceramic wafer switches with silver-plated contacts and smooth detent action. Useful in laboratory work, for circuit development.

Heathkit RESISTANCE

SUBSTITUTION BOX KIT

MODEL RS-1

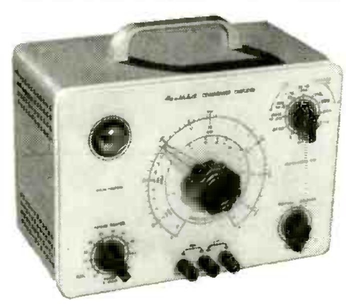
$5.50

SHIP. WT. 2 LBS.

The Heathkit Resistance Substitution Box provides individual switch selection of any one of 36 RTMA 1 watt 10% standard value resistors, ranging from 15 ohms to 10 meghoms. Many applications in circuit development work, and also in radio and TV service work. Ideal for experimentally determining resistance values and for quickly altering circuit operating characteristics. Entire unit housed in attractive Bakelite cabinet, featuring the new universal type Heathkit binding posts to simplify circuit connections.

Heathkit

CONDENSER CHECKER KIT



MODEL C-3

$19.50

SHIPPING WT. 8 POUNDS

Use the Heathkit C-3 Condenser Checker to quickly and accurately measure those unknown condenser and resistor values. All readings are taken directly from the calibrated panel scales without requiring any involved calculation. Capacity measurements in four ranges from .00001 mf to 1,000 mf. Checks paper, mica, ceramic, and electrolytic condensers. A power factor control is available for accurate indication of electrolytic condenser measurements. A leakage test switch with switch selection of five polarizing voltages, 25 volts to 450 volts DC, will indicate condenser operating quality under actual load condition. The spring return leakage test switch automatically discharges the condenser under test and eliminates shock hazard to the operator.

Resistance measurements can be made in the range from 100 ohms to 5 megohms. Here again all values are read directly on the calibrated scale. Increased circuit sensitivity coupled with an electron beam null indicator increases overall instrument usefulness.

For safety of operation the circuit is entirely transformer operated and the instrument is housed in the attractive, newly-styled Heathkit cabinet, featuring rounded corners, and drawn aluminum panel. The outstanding low kit price for this surprisingly accurate instrument includes necessary test leads. Good service shop operation requires the use of this specialized instrument, designed for the express purpose of determining unknown condenser values and operating characteristics.

HEATH COMPANY • Benton Harbor 20, Mich.

Heathkit AMATEUR TRANSMITTER KIT

MODEL AT-1

$29.50

SHIPPING WEIGHT 16 POUNDS

CHECK THESE NEW *Features*

- Single knob band switching
- Pre-wound coils
- Metered operation
- 52 ohm coaxial output
- Crystal or VFO excitation
- Built-in power supply
- Rugged, clean construction

Here is the latest Heathkit addition to the ham radio field, the AT-1 Transmitter Kit, incorporating many desirable design features at the lowest possible dollar-per-watts price. Panel mounted crystal socket, stand-by switch, key click filter, AC line filtering, good shielding, etc. VFO or crystal excitation — up to 35 watts input. Built-in power supply provides 425 volts at 100 ma.

This kit features pre-wound coils, single knob band switching, 52 ohm coaxial output, plug in chassis provisions for VFO or modulator and rugged clean construction. Frequency range 80, 40, 20, 15, 11, and 10 meters. Tube line-up 6AG7 oscillator-multiplier, 6L6 amplifier-doubler, 5U4G rectifier. Physical dimensions 8⅛" high x 13⅛" wide x 7" deep.

This amazingly low kit price includes all circuit components, tubes, cabinet, punched chassis, and detailed construction manual. The ideal kit for the novice just breaking into ham radio. It can be used later on as a stand-by rig or an all band exciter for higher powered transmitter.

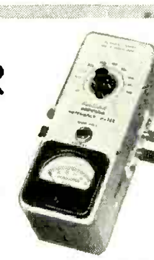
NEW *Heathkit* ANTENNA COUPLER KIT

New Heathkit Antenna Coupler, specially designed for the Heathkit AT-1 Transmitter. The Antenna Coupler can be used with any 52 ohm coaxial input — up to 75 watts power. Low pass filter with cut-off frequency of approximately 36 mc — L section tuning network — neon tuning indicator — rugged, compact construction — transmitter type variable condenser, and high Q coil are all outstanding features. The AC-1 has both inductance and capacity tuning for maximum operating versatility. Dimensions 8⅛" wide x 4⅜" high x 4⅞" deep.

MODEL AC-1

$14.50 SHIP. WT. 3 LBS.

Heathkit ANTENNA IMPEDANCE METER



Use the Heathkit Antenna Impedance Meter for measuring antenna impedance for line matching purposes — adjustment of beam antennas — phone monitor, etc. It will determine antenna resistance at resonance, match transmission line for minimum SWR, determine receiver input impedance, and provide a rough indication of SWR. Precision resistors, germanium diode, 100 microampere Simpson meter. Dial calibrated from 0-500 ohms. Shielded aluminum cabinet. 7" long x 2½" wide x 3¼" deep.

$14.50 SHIP. WT. 3 LBS.

MODEL AM-1

Heathkit COMMUNICATIONS RECEIVER KIT

MODEL AR-2

$25.50 SHIP. WT. 12 LBS.

Here is the new receiver kit you have repeatedly asked for, the Heathkit Communications Receiver. The perfect companion piece for the AT-1 Transmitter kit. Many outstandingly desirable features have been incorporated in the design of the AR-2; such as, electrical bandspread for logging and tuning convenience — high gain miniature tubes — IF transformers for high sensitivity and good signal to noise ratio — separate RF gain control with optional automatic volume control or manual volume control, in addition to the conventional audio gain control. Noise limiter — stand-by switch — stable BFO oscillator circuit — headphone jack — transformer operation, etc., all contribute to a high performance standard.

Frequency coverage is continuous from 535 kc to 35 mc in four ranges. For added convenience, various ham bands have been separately identified in respect to their relative placement on the slide rule tuning scale. A chassis mounted, 5½" PM speaker is included with this kit. Tube line up 12BE6 mixer oscillator, 12BA6 IF amplifier, 12AV6 detector AVC audio, 12BA6 BFO oscillator, 12A6 beam power output, 5Y3GT rectifier.

RECEIVER CABINET

Proxylin impregnated, fabric covered, plywood cabinet with aluminum panel designed expressly for the AR-2 Receiver. Part 91-10, shipping weight 5 lbs., $4.50.

IMPROVED *Heathkit* GRID DIP METER KIT

$19.50 SHIP. WT. 4 LBS.

MODEL GD-1B

The invaluable instrument for service men, hams, and experimenters. Useful in TV service work for alignment of traps, filters, IF stages, peaking compensation networks, etc. Locates spurious oscillation, provides a relative indication of power in transmitter stages, use it for neutralization, locating parasitics, correcting TVI, measuring C, L, and Q of components, and determining RF circuit resonant frequencies. With oscillator energized, useful for finding resonant frequency of tuned circuits. With the oscillator not energized, the instrument acts as an absorption wave meter. Variable meter sensitivity control, head phone jack, 500 microampere Simpson meter. Continuous frequency coverage from 2 mc. to 250 mc. Pre-wound coil kit and rack, new three prong coil mounting, 6AF4 high frequency triode.

Two additional plug-in coils are available and provide continuous extension of low frequency coverage down to 355 kc. Dial correlation curves included. Shipping weight 1 lb., kit 341, $3.00.

HEATH COMPANY • Benton Harbor 20, Mich.

CHECK THESE *Features*

- First popular priced Q Meter
- Reads Q directly on calibrated scale
- Oscillator supplies RF frequencies of 150 kc to 18 mc
- Calibrate capacitor with range of 40 mmf to 450 mmf with vernier of ± 3 mmf
- Measures Q of condensers, RF resistance, and distributed capacity of coils
- Many applications in design and development work
- Useful in TV service work for checking deflection yokes, coils, chokes, etc.

Heathkit "Q" METER KIT

MODEL QM-1

$44.50

SHIPPING WT. 14 POUNDS

Another outstanding example of successful Heathkit engineering effort in producing a Q Meter Kit within the price range of TV service men, schools, laboratories, and experimenters. This Q Meter meets RF design requirements for rapid, accurate measurement of capacity, inductance, and Q at the operating frequency and all indications of value can be read directly on the meter calibrated scales. Oscillator section supplies RF frequencies of 150 kc to 18 mc. Calibrate capacitor with range of 40 mmf to 450 mmf, with vernier of ± 3 mmf.

Particularly useful in TV service work for checking peaking coils, wave traps, chokes, deflection coils, width and linearity coils, etc. At this low kit price research laboratory facilities are within the range of service shops, schools, and experimenters.

Heathkit INTERMODULATION ANALYZER KIT

MODEL IM-1

$39.50

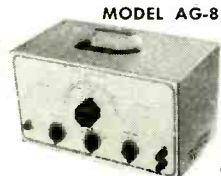
SHIPPING WT. 17 POUNDS

The Heathkit IM-1 is an extremely versatile instrument specifically designed for measuring the degree of inter-action between two signals in any portion of an audio chain. It is primarily intended for making tests of audio amplifiers, but may be used in other applications, such as checking microphones, records, recording equipment, phonograph pick-ups, and loud-speakers. High and low test frequency source, intermodulation unit, power supply, and AC vacuum tube volt meter all in one complete instrument. Per cent intermodulation is directly read on the calibrated scales, 30%, 10%, and 3% full scale. Both 4:1 and 1:1 ratios of low to high frequency easily set up. With this instrument the performance level of present equipment, or newly developed equipment can be easily and accurately checked. At this low price, you can now enjoy the benefits of intermodulation analysis for accurate audio interpretation.

Heathkit AUDIO GENERATOR KIT

MODEL AG-8

A Heathkit Audio Generator with frequency coverage from 20 cycles to 1 mc. Response flat ± 1 db from 20 cycles to 400 kc, down 3 db at 600 kc, and down only 8 db at 1 mc. Calibrated, continuously variable, and step attenuator output controls provide convenient reference output level. Distortion is less than .4% from 100 cps through the audible range. The ideal controllable extended frequency sine wave source for audio circuit investigation and development.



$29.50

SHIP. WT. 11 LBS.

Heathkit AUDIO OSCILLATOR KIT

Sine or square wave coverage from 20 to 20,000 cycles in three ranges at a controllable output level up to 10 volts. Low distortion, 1% precision resistors in multiplier circuits, high level output across entire frequency range, etc., readily qualify this instrument for audio experimentation and development work. Special circuit design consideration features thermistor operation for good control of linearity.

MODEL AO-1

$24.50

SHIP. WT. 11 LBS.

Heathkit AUDIO FREQUENCY METER KIT

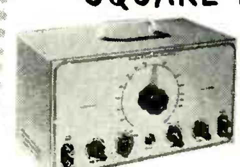
MODEL AF-1

$34.50

SHIP. WT. 12 LBS.

The Heathkit Audio Frequency Meter provides a simple and convenient means of checking unknown audio frequencies from 10 cycles to 100 kc at any voltage level between 3 and 300 volts rms with any non-critical wave shape. Instrument operation is entirely electronic. Just set the range switch, feed an unknown frequency into the instrument, and read the frequency directly on the calibrated scale of the Simpson 4½" meter.

Heathkit SQUARE WAVE GENERATOR KIT



MODEL SQ-1

$29.50

SHIP. WT. 12 LBS.

The Heathkit Square Wave Generator provides an excellent square wave frequency source with completely variable coverage from 10 cycles to 100 kc. This generator features low output impedance of 600 ohms and the output voltage is continuously variable between 0 and 20 volts, thereby providing the necessary degree of operating flexibility. An invaluable instrument for those specialized circuit investigations requiring a good, stable, variable square wave source.

HEATH COMPANY • Benton Harbor 20, Mich.

Heathkit
WILLIAMSON TYPE
AMPLIFIER KIT

MODEL W-2

Particularly designed for custom installations, featuring separate cable connected units for simplicity of installation. Sheet metal work finished in attractive gray hammertone for smart appearance. All control shafts of the adjustable length break-off type.

$69.50

PRICES OF COMBINATIONS

W-2 Amplifier Kit including main amplifier, power supply, and WA-P1 Preamplifier Kit. Shipping Weight 37 lbs. Shipped Express only. **$69.50**

W-2M Amplifier Kit includes main amplifier and power supply. Shipping Weight 29 lbs. Shipped Express only. **$49.75**

WA-P1 Preamplifier Kit only. Shipping Weight 6 lbs. Shipped Express or Parcel Post. **$19.75**

When selecting an amplifier for the heart of your high fidelity audio system, investigate the outstanding advantages offered by the Heathkit Williamson Type Amplifier. Meets every high fidelity audio requirement and makes listening to recorded music a thrilling new experience.

This outstanding amplifier is offered with optional output transformer operation, providing either the conventional triode output circuit or the new extended power circuity in which the screen supply voltage is obtained from separate transformer primary taps. Frequency response within ± 1 db from 10 cycles to 100 kc. Tube complement — 6SN7 cascade amplifier and phase splitter, 6SN7 push pull driver, two 5881 push pull power amplifiers, one 5V4G cathode type rectifier.

Matching preamplifier available providing three switch selected inputs, correct compensation, and individual bass and treble tone controls. Uses 12AY7 (or 12AX7) preamplifier — 12AU7 tone control amplifier.

Particularly designed for the novice kit builder and requires no specialized knowledge or equipment for successful assembly and operation.

NEW *Heathkit* 20 WATT
High Fidelity AMPLIFIER KIT

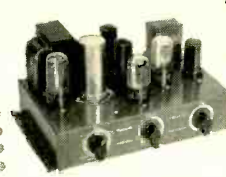
MODEL A-9A

$35.50
SHIP. WT. 18 LBS.

A new 20 watt high fidelity amplifier, designed especially for custom audio installations demanding clean reproduction, adequate power, and flexibility to meet individual requirements. Separate treble and bass tone controls provide up to 15 db boost or cut. Four switch selected inputs, each with the necessary compensation for the service desired. Output transformer impedances of 4, 8, and 16 ohms.

Preamplifier, tone control, and phase splitter circuits utilize 9 pin twin triode miniature tubes for low hum and noise level. Two 6L6 push pull power output tubes provide full 20 watts power. Frequency response ± 1 db, 20-20,000 cycles. Total harmonic distortion 1% (at 3 db below rated output). Tube line-up: 12AX7 preamplifier, 12AU7 voltage amplifier and tone control, 12AU7 voltage amplifier and phase splitter, two 6L6 push pull pentode power output, 5U4G rectifier. Truly outstanding amplifier performance coupled with low cost.

Heathkit ECONOMY 6 WATT
AMPLIFIER KIT



MODEL A-7B
$15.50
SHIP. WT. 10 LBS.

The new Heathkit Model A-7B Amplifier offers many unusually fine features not normally expected in this low price range. Either of the two input circuits may be individually switch selected for phono or tuner operation. Separate bass and treble tone controls. Output impedances of 4, 8, and 15 ohms. Push pull beam power output stage for balanced reproduction. Excellent voltage gain characteristics, good frequency response, and full 6 watts power output. 12J5 amplifier, 12SL7 second amplifier and phase splitter, two 12A6 beam power output, one 5Y5 GT rectifier.

A-7C incorporates preamplifier stage with special compensated network to provide necessary gain for operation with variable reluctance or low output level phono cartridge. Circuit is properly compensated for microphone operation. $17.50.

NEW *Heathkit*
BROADCAST BAND
RECEIVER KIT

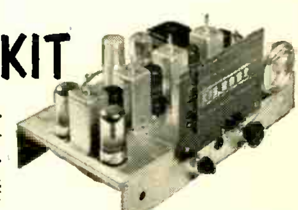
Another new Heathkit for the student, beginner, or hobbyist. If you have ever had the urge to build your own radio receiver, this kit warrants your attention.

New high gain miniature tubes and IF transformers provide excellent sensitivity and good signal to noise ratio. A built-in ferrite core rod type antenna has been provided. A chassis mounted 5½" PM speaker provides excellent tone and volume. Convenient phono input. Can be operated either as a receiver or tuner. Simplified construction manual outlines circuit theory. Ideal for students. Tube line-up: 12BE6 mixer oscillator, 12BA6 IF amplifier, 12AV6 detector-AVC-first audio, 12A6 beam power output, 5Y3GT rectifier.

MODEL BR-2
$17.50 SHIP. WT. 11 LBS.

CABINET — Proxylin impregnated fabric covered plywood cabinet. Shipping weight 5 lbs. Part number 91-9, $4.50.

Heathkit
FM TUNER KIT



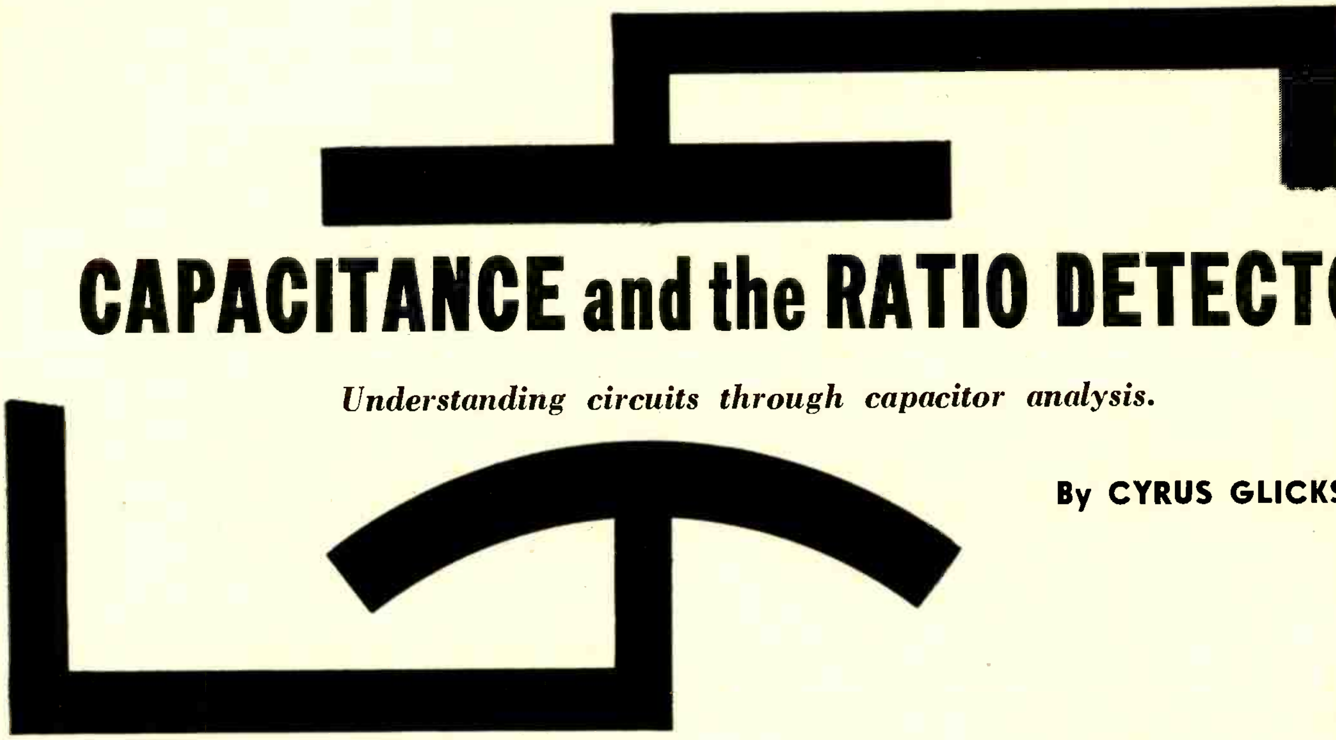
The Heathkit FM-2 Tuner was specifically designed for simplified kit construction. Can be operated through the "phono" portion of your radio or with a separate amplifier. The kit features a pre-assembled and adjusted tuning unit, three double tuned IF transformers, and a discriminator transformer in an 8 tube AC operated circuit. Frequency coverage 88 to 108 mc. Experience the thrill of building your own FM tuner and at the same time enjoy all of the advantages of true FM reception.

MODEL FM-2
$22.50
SHIP. WT. 9 LBS.

Free CATALOG

Write for free catalog containing latest price information, schematics, specifications, and descriptions of all Heathkits.

HEATH COMPANY • Benton Harbor 20, Mich.



CAPACITANCE and the RATIO DETECTOR

Understanding circuits through capacitor analysis.

By CYRUS GLICKSTEIN

ONE of the handiest tools in analyzing circuits is an exact knowledge of how capacitors work. When a new circuit seems hard to understand, I've usually found I haven't fully analyzed the capacitor action. Once that is completely clear, the over-all circuit operation becomes simple to follow.

Most of the facts on how capacitors work are well known. But every so often a circuit is developed where capacitors act in a way not described in the textbooks. A popular circuit found in many FM and TV receivers bears out this point.

The unbalanced ratio detector is shown in Fig. 1. Very little detailed analysis of this circuit has appeared in print. Most of the published explanations have not fully described the operation because of an incomplete analysis of capacitor action.

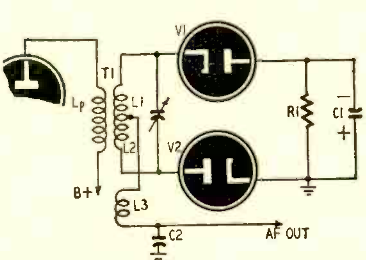


Fig. 1—The unbalanced ratio detector.

The ratio detector circuit in Fig. 1 acts as a combined limiter and detector for FM sound signals. Transformer T1 is an i.f. transformer with a primary Lp, a secondary which is center-tapped and consists of two equal halves (L1 and L2), and a third or tertiary winding (L3). An i.f. signal from the primary is inductively coupled into the secondary and tertiary windings.

At the resting frequency, the voltages across the secondary and the voltage across the third winding (L3) are 90 degrees out of phase. The diodes conduct as usual only when the plates are positive compared to the cathodes. Conduction occurs when the polarity across the secondary is such that the cathode of V1 (top diode) is negative and the plate of V2 (bottom diode) is positive. The diodes therefore do not conduct on the positive half of the incoming signal. Also, the large time-constant of R1-C1 makes this section of the circuit act as a limiter. The peak value of the voltage across the secondary is rectified and developed across R1-C1.

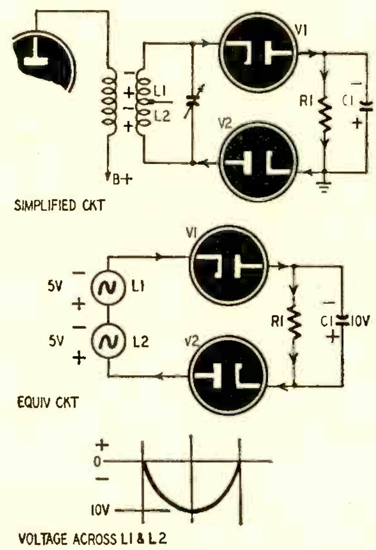


Fig. 2—Simplified and equivalent circuits showing the voltage across R1-C1.

Specific voltage values will be used to clarify circuit operation. At the resting frequency, assume the peak voltage across *each* half of the secondary is 5 and the voltage across the third winding (L3) is also 5. Two actions take place: First, the entire secondary—L1 and L2 in series—acts as a generator during the entire negative half-cycle. The total secondary voltage of 10 is across the diodes and R1-C1. The diodes conduct and practically all of the source voltage (10 volts) can be considered across R1-C1, since the voltage drop across the diodes is negligible. This action is shown in Fig. 2.

In addition to this action, a second action is taking place simultaneously during the first quarter-cycle (first half of the negative alternation). One-half of the secondary, L2, is in series with L3 across the bottom diode and C2. The two windings act as out-of-phase generators in series. The voltage polarity is such that current flows through the bottom diode V2 and charges C2 as shown in the simplified circuit of Fig. 3. The rectified voltage across C2 will have the polarity shown—negative with respect to ground—and will be -7 (the vector sum of 5 volts across L2 and 5 volts across L3; the two voltages are 90 degrees out of phase). Now in the next quarter-cycle (second half of the negative alternation), the entire secondary is still across R1-C1 as in Fig. 2. Simultaneously, the polarity across L3 reverses and L3 is now in series with L1. L1 and L3 now act as two out-of-phase generators in series and the voltage polarity is such that current flows through the top diode V1. The current path is through V1, R1-C1, and C2 as shown in Fig. 4. Note that

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*Trade Mark — Printed Electronic Circuit there is 10 volts across R1-C1 and 7 across C2 as a result of the action in the first quarter-cycle. In this second quarter-cycle, therefore, the voltage in C2 is in series-aiding with the voltages across L3 and L1 but this combined total is bucking the voltage across R1-C1. This is illustrated in the simplified schematic of Fig. 5. This means that 7 volts (vector sum of the voltages

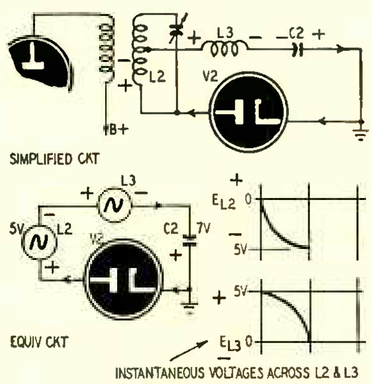

Fig. 3—Peak voltages across L2 and L3 are rectified and developed across C2.

across L1 and L3) plus the 7 volts across C2 (total –14 volts) is bucking the 10 volts across R1-C1. As a result, *there is a difference of 4 volts* and C2 discharges 4 volts worth. Since it had –7 volts to start with, this leaves –3 volts across C2. As long as the incoming signal remains at the resting frequency, then, the voltage across C2 will be –7 volts on the first quarter-cycle and –3 volts on the next quarter-cycle for each half-cycle when the diodes conduct. *The average d-c voltage across C2 is –5 volts.* That is, a d.c. meter placed across C2 cannot measure the instantaneous changes at each quarter-cycle but measures the average level of voltage.

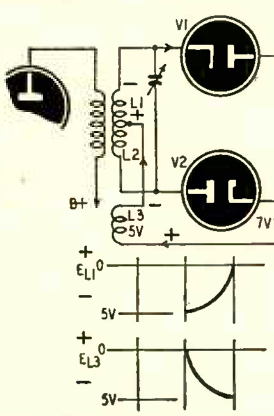

Fig. 4—Diagram showing current flow during second quarter cycle of signal.

It is interesting to note that the average d.c. voltage across C2 (–5 v) is exactly half the voltage across R1-C1 (–10 v). This is true in every ratio detector at the resting frequency. In fact, when aligning a ratio detector, two equal resistors (R2 and R3) in series are temporarily soldered across R1-C1, to divide the voltage in half. A d-c meter is then placed at the junction of the two resistors (Fig. 6) and the top of C2. The secondary circuit of T1 is then tuned, while applying a signal at the resting frequency, until the meter reads zero—that is, until the voltage across C2 is exactly equal to one-half the voltage across R1-C1.

When the signal frequency deviates to one side of the resting frequency, the following occurs: The rectified vector sum of the voltages across L2 and L3 becomes greater across C2 (let us say 8 volts). C2 therefore charges to this value. On the next quarter-cycle, the vector sum of the voltages across L1 and L3 is less. This value (assume it is 6 volts) is in series with the 8 volts across C2 and bucks the 10 volts of R1-C1. Therefore 14 volts bucks 10 volts and C2 discharges 4 volts or down to –4 volts (subtracting 4 volts from the original 8 leaves 4 volts). The average value across C2 for the two quarter-cycles is –6 volts (Fig. 7-b). Assuming still further deviation, C2 charges up to –9 volts, discharges down to –5 volts, leaving an average now of –7 volts (Fig. 7-c).

When the deviation returns to zero, the charge across C2 goes to –5 volts. With deviation on the other side of the resting frequency, the average voltage across C2 goes to –4 volts then to –3 volts, returning to –4 volts and –5 volts. As a result, a pulsating negative d.c. voltage is produced across C2 which gives 1 cycle of audio for each complete frequency swing of the incoming signal.

One further point on how limiter action is effected in this circuit. Any instantaneous increase of signal voltage across the secondary will not cause C1 to charge up immediately because of the large capacitance of C1. Therefore, even with a noise pulse coming through, R1 and C1 have the same voltage.

To illustrate the action at the resting frequency with figures: Assume R1-C1 have 10 volts across them when an instantaneous noise pulse increases the voltage across the secondary to 14 volts (7 volts across each half) and the voltage across L3 to 7 volts. The vector sum of the two voltages is 10 volts, and C2 charges up to this value. Then the 10 volts across C2 is in series with the 10 volts across L1 and L3 bucking the 10 volts across R1-C1. The difference is 10 volts, so C2 discharges to zero. The average voltage across C2 is

$$\frac{-10 + 0}{2}$$

or –5 volts as before. It is interesting to note that, no matter what values are chosen, and throughout the change of values due to deviation, any instantaneous increase of voltage across the secondary and across L3 will not change the voltage output across C2 compared with the no-noise condition, provided R1-C1 remain at the original voltage value.

A point which is basic to understanding capacitor action is how r.f. and d.c. voltage add together. The voltages across each half of the secondary and across L3 are r.f. voltages. The voltages across R1-C1 and C2 are rectified r.f., therefore d.c. voltages. It is entirely possible for an r.f. voltage to be in series-aiding (or series-bucking) with a d.c. voltage. It is further possible for a combined r.f. voltage in series-aiding with a d.c. voltage to be applied in opposition to a bucking d.c. voltage. The *direction* of current flow in the circuit then depends on the *difference* between the two sets of voltages—*on which is larger at a given instant.*

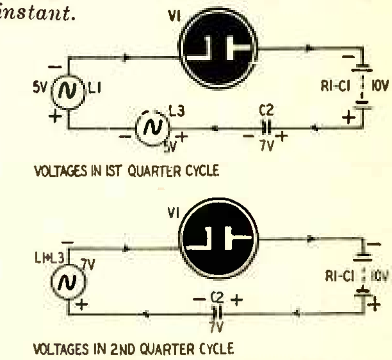

Fig. 5—Simplified circuit of Fig. 4.

Some previous explanations of the action in this circuit are based on the assumption that on one quarter-cycle, C2 (Fig. 1) charges through the lower diode, but on the next quarter-cycle C2 charges equally in the opposite direction through the upper diode. It is maintained that at the resting frequency the voltage across C2 is zero. It is further assumed that C2 can charge equally through the upper diode because

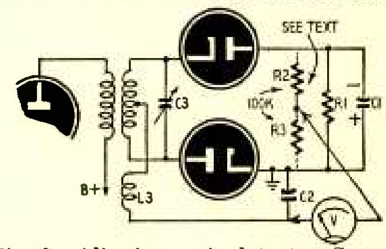

Fig. 6—Aligning ratio detector. Secondary is tuned for zero output on meter.

C1 has practically zero impedance for r.f. This explanation is defective on at least three counts. (1) Rectified r.f. is no longer r.f. but d.c.; therefore it is incorrect to state that C1 has zero impedance to r.f., since the diodes rectify the r.f. (2) There is a definite d.c. voltage across R1-C1 which cannot be ignored in the explanation of how voltages are developed across C2. (3) The average d.c. voltage across C2 at the resting frequency is not zero but one-half the voltage across R1-C1. The detailed explanation of the circuit in this article takes each of these points into consideration. END

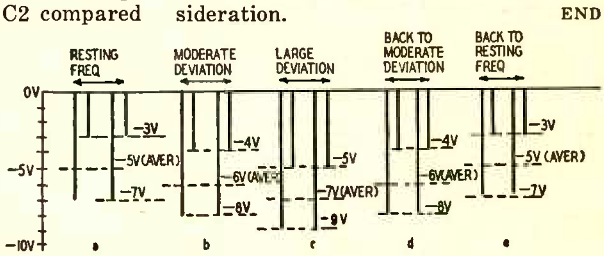

Fig. 7—Voltage across C2 during deviation to one side of resting frequency.

Shortcut Service on Radios

By FAIRBANKS TRYON

NO ONE can proceed to fix any radio simply by reading "how-to-do-it" books. But he *can* learn enough about specific troubles from an article by an experienced technician so that he may service a set that has similar troubles.

I have used this method in tackling a.c.-d.c. sets in my shop for about 15 years. It has saved lots of time—and a lot of radios. Many service technicians make the mistake of plugging in the set before they even look at it. If the filter capacitors are leaky or shorted this is just about the worst thing you can do. Always check for shorts *first*!

When handling a.c.-d.c. sets with tube rectifiers (this *does not* include 3-way portables), make the following tests before plugging in the set or even before taking it out of the cabinet:

1. Set the ohmmeter on its highest range; then short the leads and zero the pointer.

2. Don't plug in the set, but turn the switch *off*, and hook the meter test prods across the prongs of the line plug. See Fig. 1. The meter should read anywhere from several hundred megohms to *infinite resistance*. Anything less than this indicates a short or leak in the line cord, the line-filter capacitor, or the switch. (In many cases carbon granules wear off the volume-control resistance element and get into the switch mechanism.) A high-resistance leak here would not stop the set from operating, but could make it very noisy.

3. If this test shows everything normal, switch the ohmmeter to its 2,000-ohm range (or thereabouts) and turn the set *on*. The meter should now read between 100 and 150 ohms. (If the set has a 110-volt pilot light, this reading may be as low as 50 ohms.) If the meter reads less than 95 ohms, take a look at the pilot light; if it's a 110-volt type remove it and repeat the test.

4. If this test shows an *open circuit*, hold the test prods firmly on the plug prongs and bend the line cord back and forth—especially near the plug, and where the cord enters the chassis. Should the meter kick over when you bend the cord, it means the cord is broken somewhere between the plug and the chassis.

5. If the meter still shows an open circuit, remove one tube at a time and touch the test prods to the tube heater pins. (Check the tube-base diagrams to make sure you get all the heater pins, as there are 3 on some tubes.) No-reading across any two heater pins indicates the tube is open, and replacing it with a new one may be all you have to do to fix the set.

There is always the possibility that more than one tube is open, or that one is open and another is intermittent. The reading at the line plug will tell. Of course an open reading with all tubes good (and in the right sockets), and the line cord good, would leave only the switch or a series resistor (if there is one in the circuit), which might be open; or a broken connection or cold-solder joint in the heater wiring.

6. Suppose the meter reads about 400 ohms at first; then drops back slowly to 150 or 200. (A 110-volt pilot lamp will fool you here unless you remove it.) This clearly indicates an *intermittent* filament or a high-resistance contact, which is reduced by the voltage of the ohmmeter.

7. I have found that the output tube is the one that's most often intermittent. Test it first, and then the 12SA7, 12SK7, 12SQ7, and 35Z5 (or their equivalents), in that order. The resistance reading across the filament of an intermittent tube will generally be abnormally high at the instant the test is applied. (Good filaments should read 10 to 15 ohms on 12-volt tubes, and 20 to 50 ohms on 35- and 50-volt types.) A reading of 100 to 300 ohms on any tube filament indicates a *probable* intermittent. If the complaint is an intermittent set, or you are in doubt about the results of the resistance test, try the tube in the tube tester. *Bad*- or *weak-tube* indications, and excessive warmup periods before any reading shows on the tester are all indications of an intermittent heater.

8. Any reading of much less than about 100 ohms across the line plug with the switch *on* probably indicates a leak or a short, and the set *should not be plugged in* until the trouble has been cleared and normal reading restored across the plug. Start by removing the rectifier tube from its socket; turn the switch *on*; and, with the meter on its 2,000-ohm range, hook one test prod to the switch side of the line plug and touch the other test prod to the two outside heater contacts of the rectifier socket in turn. One of these positions should read *open*; the other should read the combined series resistance of the remaining tube heaters (between 75 and 120 ohms). Then repeat this test with the power-output tube and each of the remaining tubes in the heater string.

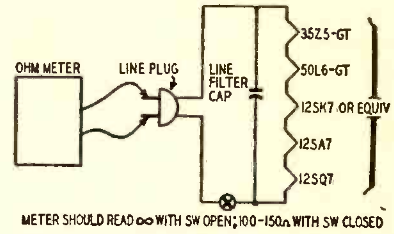

Fig. 1—Checking for shorts in the input circuits of a.c.-d.c. receivers. Proportional readings should be obtained between the individual tube-socket heater terminals and the switch side of the line plug if all is well.

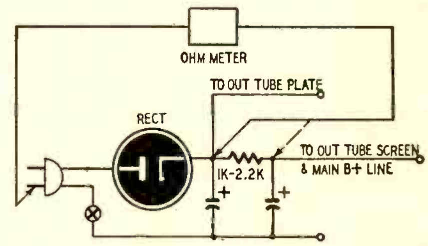

Fig. 2—Isolating leaky or shorted filter and bypass capacitors by comparing resistance readings to switch side of line plug at rectifier cathode terminal and output screen terminal. Lowest reading shows which side of filter resistor defective capacitor is on.

9. Now set the meter on the 20,000-ohm range and check from the rectifier-socket *cathode* terminal to the switch side of the line plug. Any reading under 20,000 ohms at this point indicates a short or a leak on the B plus line (except that at the instant of contact the meter pointer may kick all the way over and then swing back slowly—this is the initial discharge and slow recharge of the filter capacitors from the ohmmeter battery, and is perfectly normal).

Readings which indicate leakage on this test also include any paper, mica, or ceramic bypass capacitors across the B plus line as well as the electrolytic filters. To isolate the trouble, you will have to pull the chassis and disconnect at least one side of each electrolytic.

(Sometimes it may be possible to isolate the bad capacitor without pulling the chassis. In most a.c.-d.c. sets the B plus for the plate of the output tube is taken directly from the rectifier cathode, while the output screen voltage and the B supply for the other tubes are taken off the end of a 1,000- to 2,200-ohm filter resistor. See Fig. 2. Measure the resistance to the switch from the rectifier cathode terminal and from the output screen terminal. If the first reading is lower, it shows the input filter is the defective unit. If the second reading is lower, it indicates the output filter—or a bypass capacitor —is bad.—*Editor*)

Any technician who tries these tests will find he can restore over 50% of all a.c.-d.c. sets to operating condition by this method. END

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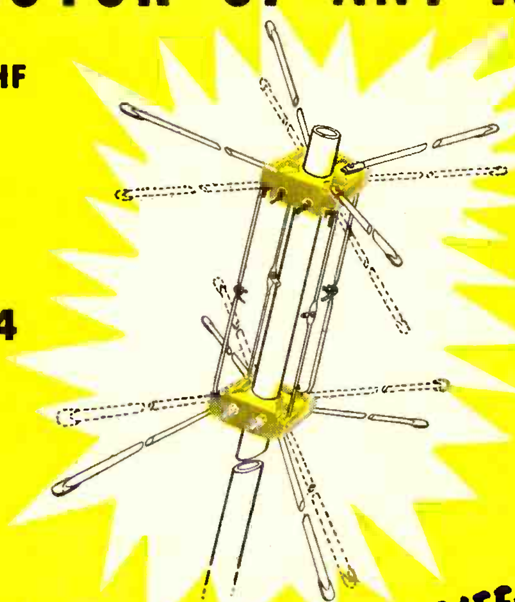

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ATTENUATION PROBLEM

An unusual trouble-shooting problem came up a few years ago during a production run of BA289 band-rejection audio filters for the CAA. These filters had to attenuate a narrow band of frequencies around 1,020 cycles *more than 100 db*, while their insertion loss at all other frequencies had to be held to *less than 10 db*.

The exceptionally steep filter characteristic called for setting each of several adjustable inductors to the right value with a high degree of accuracy.

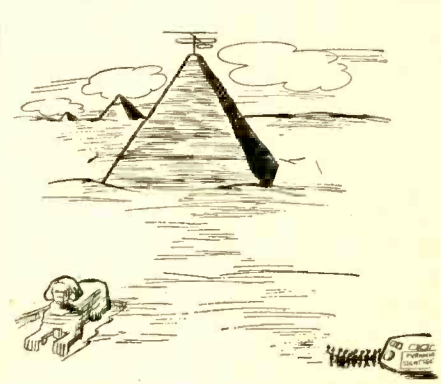
Physically, the filters were multisection coil-and-capacitor devices assembled in riveted aluminum-alloy cases. Since the aluminum case was in close proximity to the coils, the pattern of the eddy currents induced in the case had considerable influence on the settings.

After adjusting the filters for the required electrical characteristics, the cases were filled with a molten mixture of beeswax and rosin. Then the cover was put on and fastened with self-tapping screws.

This was the trouble: Tests made on the units after they were filled with wax and sealed showed that they had lost their 100 db attenuation; in fact, most of them had lost as much as 50 to 60 db. After a good deal of study, during which rejected filters were piling up in great quantities, it was definitely established that the hot wax was not causing the coils and capacitors to drift, but that the trouble was caused solely by the *riveted* aluminum-alloy case.

When the hot wax was poured into the box, the rapid heating caused a substantial increase in the contact resistance at the riveted joints. This altered the eddy-current distribution and changed the highly critical inductance values. The tuning in a 100-db device is so sharp that the slightest change in inductance is sufficient to destroy the attenuation characteristics. To obtain an attenuation so great over so narrow a band of frequencies it is necessary to use coils of very high Q. The slightest changes in magnetic fields caused by eddy currents lowered the Q.

The solution to the problem was to replace the *riveted* aluminum box with a drawn, seamless enclosure. This was immune to changes in eddy-current distribution under the heat of the wax, and the filters remained perfectly stable after potting.—*Sidney Wald* END

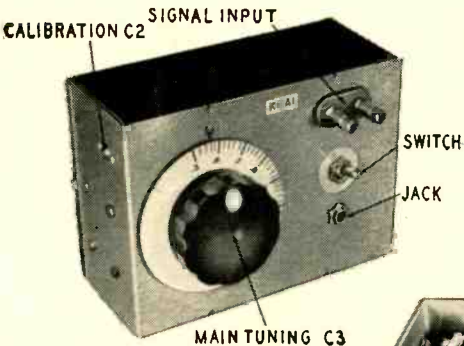


Suggested by Arthur Henrikson, Chicago, Ill.

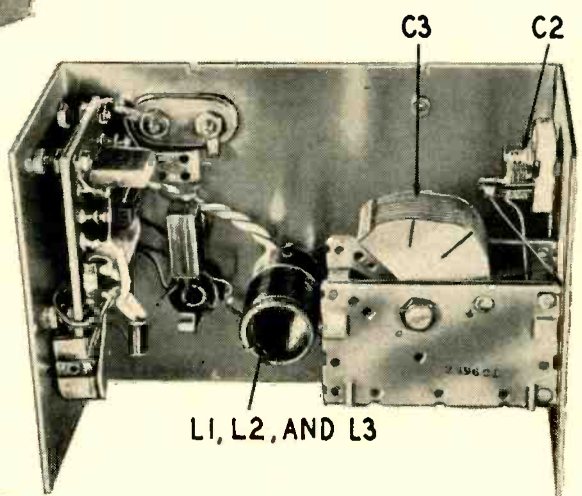
Heterodyne Frequency Meter uses pair of Transistors

Portable test instruments offer an excellent opportunity for transistors to do their stuff. Small size and light weight make them ideal.

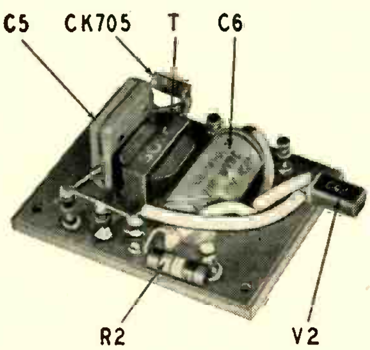
By RUFUS P. TURNER



Front view of the transistorized frequency meter in its compact metal case.



The meter with rear cover removed. All parts are visible except R1, C1, and V1.



Photograph of the mixer and audio components mounted on a terminal board.

WITHIN its frequency and power limitations, the junction transistor offers interesting possibilities of application in portable test instruments. In our fervor to transistorize amplifiers, receivers, transmitters, and control devices, we should not overlook the heterodyne frequency meter. It is one instrument which can be transistorized readily, and its operation is not handicapped by the limited high-frequency response of the type CK722 transistor now easily obtained.

Battery operation of the heterodyne frequency meter always has been desirable in the interest of complete isolation from power lines, of portability, instant operation, and low heat generation. But battery operation usually has not been feasible because of the cost, weight, and size of the A and B batteries required; comparatively short battery life, especially if the instrument is left running by mistake; and annoying microphonics in battery-type tubes.

A frequency meter using junction transistors has none of those disadvantages and has the following desirable advantages: (1) Complete isolation and portability. (2) Small size. (3) Light weight. (4) Practically zero heat generation. (5) Low-current operation *from a single battery*. (6) Instant operation. (7) No microphonics. (8) Long battery life with small loss during accidental left-on periods. (9) Infrequent "tube" replacements, since the transistors are believed to have a life of tens of thousands of hours. (10) Ability of the instrument to take rough handling without damage.

The basic instrument

The heterodyne frequency meter is well known to commercial radio operators who use it frequently to measure transmitter carrier frequency. Hams use this instrument supplementarily as a c.w. monitor and receiver calibrator. The heterodyne frequency meter is a common instrument in radio-frequency laboratories where it is used to check the frequency of r.f. oscillators and signal generators and as a comparator.

The block diagram in Fig. 1 shows the basic arrangement of a heterodyne frequency meter. The r.f. oscillator uses an inherently stable circuit tunable over a single frequency band. Its output is fed into an aperiodic detector or mixer together with the test signal to be measured. The oscillator and test signals (or some harmonics of one or both) produce a beat note which then is amplified by the audio amplifier and monitored with headphones or a visual indicator. The r.f. oscillator is tuned to zero-beat with the signal and the frequency is read off the oscillator dial. The dial may be directly calibrated.

The test-signal frequency may be lower than the fundamental frequency range of the oscillator. Its harmonics then beat with the oscillator. Or the signal frequency may be higher than that of the oscillator, in which case an oscillator harmonic will beat with the signal. In this way, we use the instrument over a wide frequency range extending from f/n to nf, where f is the oscillator fundamental frequency at some suitable setting, and n is a multiplier or divisor representing the most remote useful harmonic or subharmonic which will give a sufficiently strong beat note. Thus, in one commercial heterodyne frequency meter, the oscillator is tunable from 100 to 200 mc, and the useful measurement range (from f/n to nf) is 10 to 2,000 mc. (In this instance, the factor n is 10.)

Transistorized meter

When using a junction transistor in the r.f. oscillator section of a heterodyne frequency meter, the designer is limited by the fact that this type of transistor ordinarily will not oscillate beyond the top of the standard broadcast band. However, by tuning the transistor oscillator from 500 to 1,000 kc., the practical

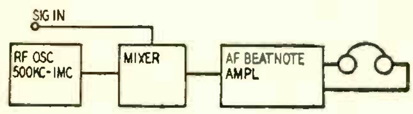


Fig. 1—Block diagram of the meter.

measurement range is found to be 50 kc or less to 30 mc. Response at the high frequencies is dependent to a great extent upon the strength of the test signal.

Fig. 2 shows the complete circuit of the transistorized heterodyne frequency meter. Type CK722 transistors are used in the r.f. oscillator and a.f. amplifier stages, and a CK705 germanium diode is used in the mixer stage. The r.f. oscillator is a high-gain grounded-emitter amplifier provided with inductive feedback through the tickler coil L1. The r.f. output from the oscillator is coupled to the diode mixer circuit through pickup coil L3. Coil L2 is a Miller type 20-A antenna coil (113 turns of No. 32 wire closewound on a 1-inch-diameter form) with the slip-over primary removed. L1 consists of 40 turns of No. 26 enameled wire closewound on top of L2 and wound in the same direction as L2. L3 is 15 turns of insulated hookup wire jumble-wound and cemented inside the form on which L2 is wound. So that the reader may phase these coils properly for oscillation, the tops of L1 and L2 have been labeled X and Y respectively in Fig. 2. X and Y are the beginnings or ends of each coil. It is immaterial which is chosen as long as they correspond.

The test signal is applied to the mixer through coupling capacitor C4. Audio output from the mixer is coupled through transformer T (a UTC type SO-2) to the grounded-emitter a.f. amplifier. Note that the interstage transformer is connected backward to match the low input impedance of transistor V2.

The entire instrument is powered by a miniature 15-volt battery. The 15-volt potential is necessary for high-frequency oscillation because with 1.5 to 10 volts, not all CK722 transistors will operate up to and including the broadcast band. While for size considerations, a hearing-aid-type battery is shown here, a larger-sized battery can be used and may be more desirable, from a life standpoint, to individual builders. Total measured current drain is 440 microamperes d.c. in this instrument, but this may be expected to vary in each direction with individual transistors.

(CONTINUED ON PAGE 90)

Construction

The photographs show construction details of the heterodyne frequency meter. The entire instrument is built into an aluminum utility box 7 inches long, 5 inches high, and 3 inches deep. Considerable reduction in size is possible by the use of smaller components.

Tuning capacitor C3, calibration trimmer C2, and the r.f. coil assembly are mounted directly to the box (see rear-view photo). The mixer and a.f. amplifier components are mounted between the turret terminals of a Useco 2½ x 2 inch terminal board. Placement of these parts will be seen in the photo of the audio subchassis. Oscillator transistor V1, capacitor C1, and resistor R1 are mounted on a small bakelite terminal strip attached to the front of the main tuning capacitor C3, and are not visible in the rear-view photo.

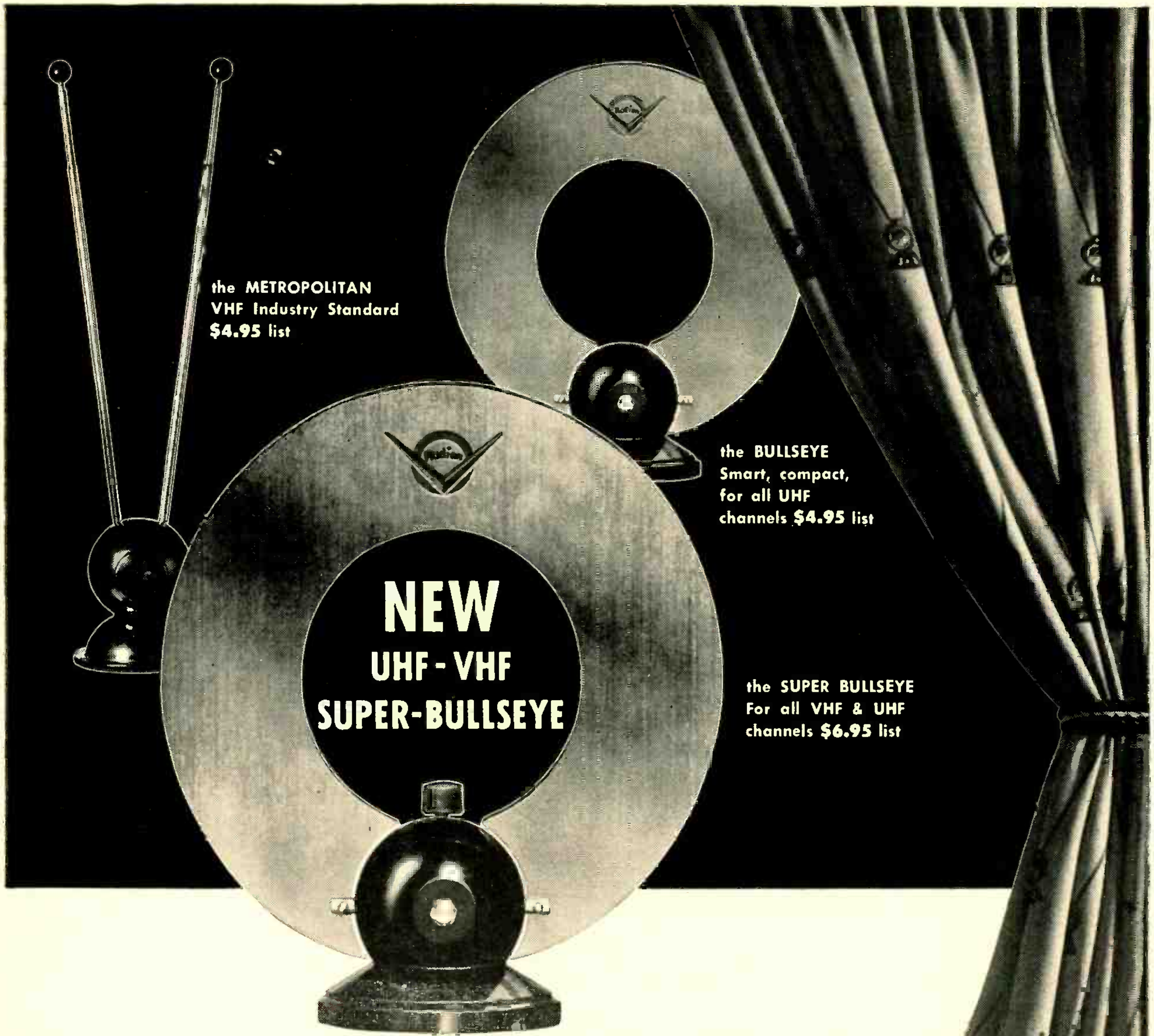
Base resistors R1 and R2 are the only critical components. Their values vary with individual transistors and must be selected for the particular transistors used. The resistance values given in Fig. 2 worked satisfactorily in the author's instrument and will be good starting values from which to begin tests. Resistor R1 should be selected for lowest collector current which will permit strong oscillation over the entire range of the tuning capacitor. For this test, connect a multirange d.c. milliammeter temporarily in the lead from L1 to the negative terminal of the battery. Note the indicated collector current for each experimental value of R1. To test for oscillation, touch the collector lead of the transistor with the finger. The milliammeter should change reading vigorously. A slight change shows weak oscillation. After each change of R1, make this check at each setting of C3.

To adjust R2, insert a pair of 2,000–3,000-ohm headphones into the jack. Feed in an r.f. test oscillator signal (500 to 1000 kc) at the SIGNAL INPUT terminals, and obtain a beat note by tuning C3. Using this beat note, adjust the value of R2 for loudest undistorted signal. Remove the headphones and plug a d.c. milliammeter into the jack. The current reading ordinarily should not exceed 1 ma. Choose R2 for the lowest current which gives a loud signal with low background noise.

Calibration

The best final calibration will be obtained with a 100-kc frequency standard. However, follow these steps for the initial calibration: (1) Feed a 500-kc signal to the SIGNAL INPUT terminals. (2) Set the main tuning capacitor to its full-capacitance position. (3) Plug headphones into the jack and adjust the CALIBRATION trimmer C2 for zero beat. The C3 dial now may be marked 500 kc at this point. (4) Substitute a 100-kc frequency standard for the signal generator. (5) Reset C2, if necessary, to establish a more accurate zero-beat with the standard. (6) Tune C3 slowly from this setting until another standard frequency point is brought in on zero-beat.

(*Continued on page* 94)



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Mark this point 600 kc on the dial. (7) Repeat at each standard spot frequency, marking the dial 700, 800, 900, and 1000 kc accordingly. If the frequency standard is equipped also with a 10-kc multivibrator, 10-kc points may be located and marked between adjacent 100-kc graduations on the dial.

It is advisable to check against a standard-frequency source before beginning use of the heterodyne frequency meter at any subsequent time. A single spot check will suffice. A rapid method is to set the dial to 1000 kc (1 mc) and, with the 100-kc standard feeding into the SIGNAL INPUT terminals, adjust trimmer C2, if necessary, to re-establish exact zero-beat. This compensates for any frequency shift due to transistor temperature characteristics or to battery variation.

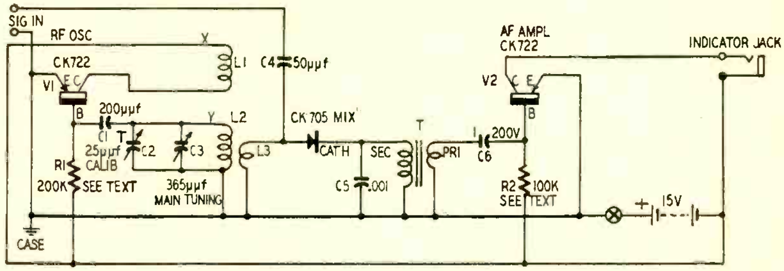


Fig. 2—Circuit of the transistorized 50-kc to 30-mc heterodyne freqmeter.

Materials for frequency meter

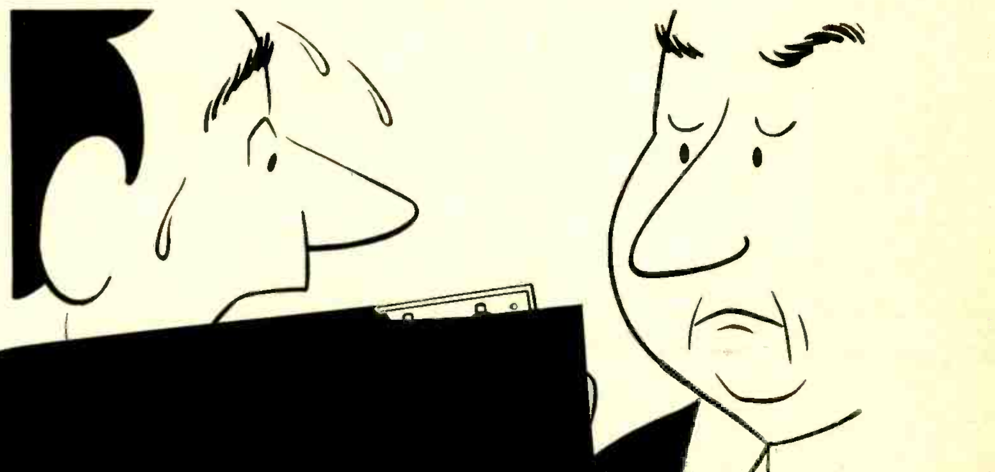
Capacitors: 1—25 μμf, air trimmer; 1—365 μμf, single-section tuning capacitor; 1—50, 1—200 μμf, midget mica or ceramic; 1—.001 μf, mica or ceramic; 1—1.0 μf, 200 volts, metalized paper.
Miscellaneous: 2—CK722 transistors; 1—CK705 germanium diode; 1—s.p.s.t. toggle switch; 2—resistors (see text); 1—3:1 interstage a.f. transformer (U.T.C. type SO-2 or equivalent); 1—J. W. Miller broadcast antenna coil type 20A; 1—miniature 15-volt battery (Burgess U10 or equivalent); 1—aluminum utility box 7 x 5 x 3 inches; 1—insulated open-circuit phone jack; 1—2 x 2½-inch terminal board with 10 posts (USECO or equivalent); 1—tuning dial; hookup wire, hardware.

Application

Always use high-resistance magnetic headphones (minimum 2,000 ohms). Crystal phones will not work, because transistor V2 relies upon the d.c. path through the phones for its collector current. When using a visual zero-beat indicator, such as an oscilloscope or meter, complete the d.c. collector path by connecting a 2,000-ohm resistor in parallel with the jack.

When checking a transmitter (and some oscillators), satisfactory coupling into the frequency meter is obtained by using 1 or 2 feet of stiff wire. Longer ones may cause interference on nearby broadcast receivers. Ordinarily, such interference is not created because of the low power output of the transistor oscillator stage.

Remember that a relatively low input impedance appears at the SIGNAL INPUT terminals. This is an important factor when the frequency meter is used to calibrate an r.f. oscillator or signal generator connected to those terminals. Usually, the only mischief is the requirement of a stiffer signal from the oscillator under test. But the situation is not much worse than feeding a signal generator into the antenna coil of a receiver. END



INDUCTANCE METER USES HETERODYNE PRINCIPLE

There are a number of ways of measuring the inductance of a coil. The most common of these are:

1. Shunt the unknown inductance with a capacitor and then use a grid-dip meter to measure the resonant frequency of the combination. Calculate the inductance from the formula for resonance.

2. Use an inductance bridge.

3. Measure the reactance at a known frequency, then calculate the inductance from the reactance formula.

This can be done by connecting the inductance in series with a resistor across a signal generator. The voltage drop across the resistor gives the circuit current. By measuring the voltage drop across L, and knowing the resistance of L, its reactance can be computed.

4. Insert the inductance in the circuit of a L-C oscillator. Measure the operating frequency, then calculate the inductance from the resonance formula.

A novel adaptation of the fourth method uses the heterodyne principle. The unknown inductance is connected in parallel with a standard capacitor in a transitron oscillator. The frequency of the transitron is measured by heterodyning it with the signal from a calibrated signal generator. The inductance of the coil in henries is then calculated from the formula:

$$L = \frac{1}{(6.28 \times f)^2 \, C}$$

where L is in henries, C in farads, and f in cycles per second.

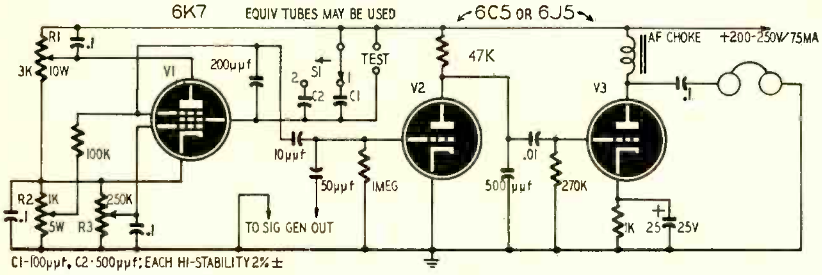
The circuit of the transitron inductance meter—reprinted from *Radio Constructor* (London, England)—is shown in the diagram. The transitron oscillator V1 may be a 6K7 of any similar r.f. pentode with a separate pin connection for the suppressor grid. A part of the signal from the oscillator V1 is fed through a 10-$\mu\mu$f capacitor to the grid of mixer tube V2 which operates as a grid-leak detector. A low-level signal from an accurate signal generator is fed to the grid of V2 through a 50-$\mu\mu$f capacitor. The beat note generated by the two r.f. signals is fed to the input of V3, an audio amplifier which drives a pair of headphones used as the null indicator. A null indicates that the frequencies of the internal oscillator and signal generator are the same. Use the inductance formula or a reactance slide-rule to determine the inductance of the coil.

When constructing the unit, be sure to keep the oscillator leads short to minimize stray capacitance and to increase efficiency at high frequencies. To set up the tester, set R3 (the oscillator output control) to maximum, R1 about one-third the way up, and then adjust R2 so the suppressor is slightly negative with respect to the cathode. V1 should now oscillate when a coil is connected across the test terminals and the selector switch is thrown to position 1.

Connect an external signal generator and tune it through its range until a beat note is heard in the phones. If a beat is not heard, vary the setting of R2 (and R1 if necessary) until the tester starts to oscillate. After obtaining a beat note, readjust R1 and R2 for the strongest signal. Adjust R3 until the signal is barely audible and then repeat the procedure. The sliders of R1 and R2 may now be locked in position.

For extreme accuracy, use a capacitance bridge. Measure the internal stray capacitance across the test terminals with the power off, S1 in position 1, and C1 temporarily disconnected from the circuit. Add the measured internal capacitance to the capacitance of C1 and C2 when computing the inductance of the coil. C1 and C2 should be high-stability type capacitors having a tolerance of 2% or better.

The inductance meter is an extremely accurate method of determining L. The inductance being measured is allowed to operate at its natural frequency. The accuracy of the signal generator limits accuracy of the final result. END



Schematic of inductance meter. 6K7 tube is used in transitron oscillator circuit.

Materials for inductance meter

Resistors: 1—1 megohm, 1—270,000, 1—100,000, 1—47,000, 1—1,000 ohms, 1/2 watt; 1—1,000 ohms, 5 watts with semiadjustable slider, 1—3,000 ohms, 10 watts with semiadjustable slider; 1—250,000 ohms, potentiometer.

Capacitors: 1—10, 1—50, 1—200, 1—500 μμf mica or ceramic; 1—100, 1—500 μμf, silver mica with tolerance of 2% or better; 1—.01, 4—0.1 μf, 400 volts, paper; 1—25 μf, 25 volts, electrolytic.
Miscellaneous: Tubes (see text), sockets, hardware, hookup wire.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AUTOMATIC HEADLIGHT DIMMER

Electronic headlight dimmer installed. Oncoming headlights actuate dimmer.

By JACK MARLEY

THE automatic headlight dimmer has always intrigued me, and I decided to build one, planning to use low-cost parts. It cost even less than I had expected, and provided interesting instruction over several pleasant hours.

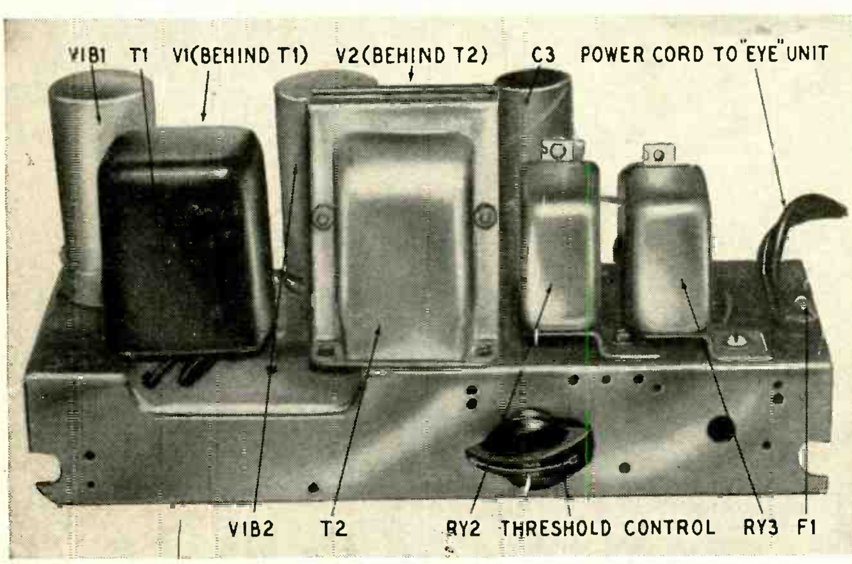
All parts used were stock items, except the 931-A phototube and the resistor network. The 931-A can be obtained from any radio supplier and the resistor network may either be purchased from a United Motors radio parts distributor or made up of 220,000-ohm ½-watt resistors. The network is very compact and costs only $2.25.

Several tries with other tubes showed me that a multiplier type is the best phototube to use. Another unit built around an 868 gas phototube lacked sufficient sensitivity. The gas type, being a single-stage unit, does not have sufficient current flow. The 931-A takes a submagnal 11-pin socket. If one isn't available, use an Amphenol 77-MIP11.

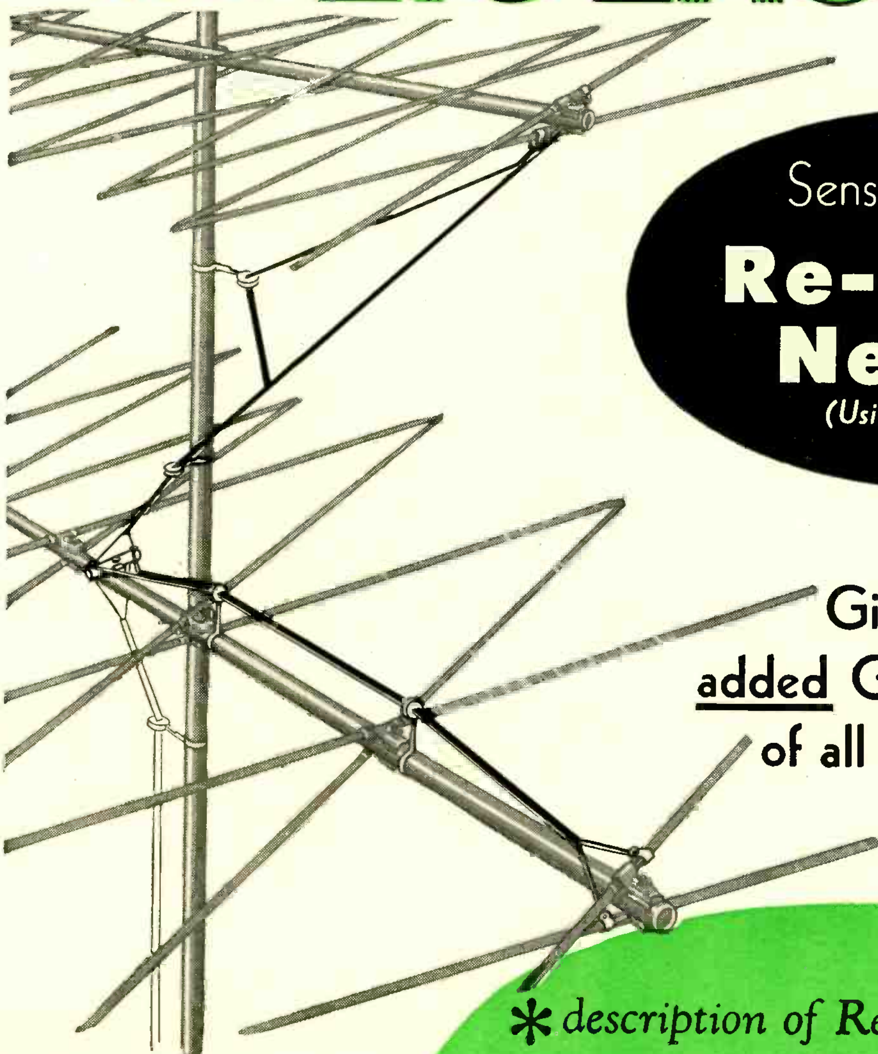
The phototube operates with approximately –520 volts on the cathode, which gives ample sensitivity at all times. The tube may be covered with light yellow cellophane as an aid in filtering out moonlight. Care must be taken not to use too many layers or the sensitivity will decrease.

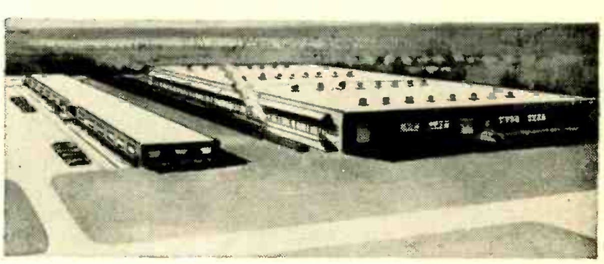
The –520 volts on the phototube cathode and the 220 volts on the 6C4 plate are obtained from separate vibrator power supplies. In building this

(CONTINUED ON PAGE 102)



Front view of dimmer. The power cord to the 931-A is located at extreme right.





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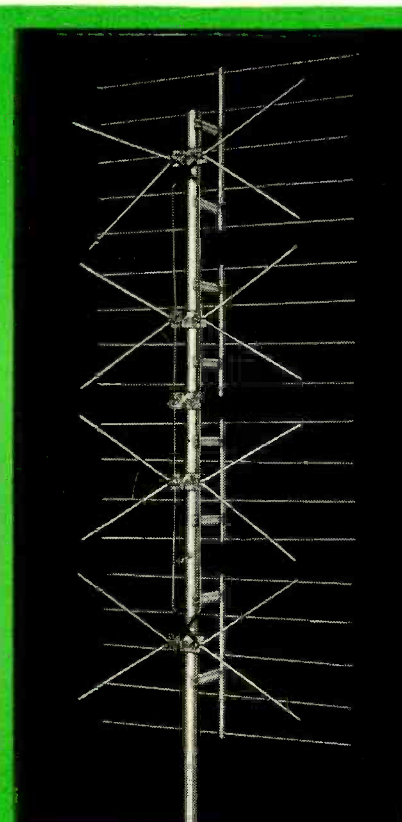
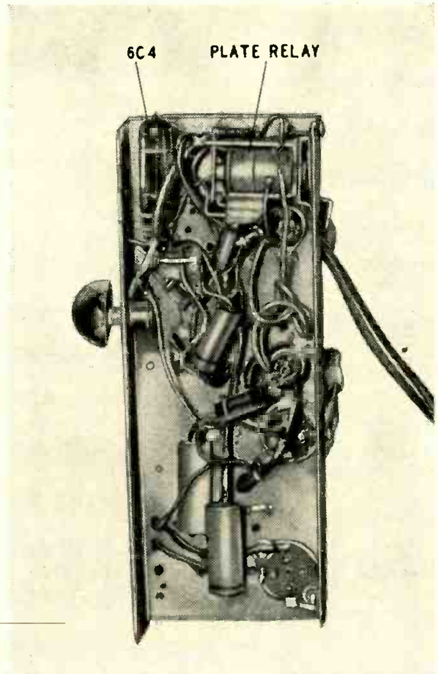
TRIO bow-ties offer high forward gain without sacrificing excellent front-to-back ratio and good line match. Adoption of reflectors using individual horizontal elements eliminates vertically polarized noise pickup so often encountered with grid, mesh and solid type reflectors.

TRIO bow-ties are also available in 2-stack and single stack models. The 4-stack and two stack come assembled on 4 foot and 3 foot aluminum masts respectively, with phasing harness installed. The single bay model is furnished assembled on a 2 foot aluminum mast.



TRIO Manufacturing Co.

GRIGGSVILLE, ILLINOIS



Note horizontal mounting of plate relay.

electronic dimmer, old auto radio transformers were used as an economy measure. All returns are made to the 6-volt bus so that the unit will work with either polarity-type battery system. New vibrators should be used, since a variation in voltage will affect the sensitivity to light. Select the buffers with the aid of a scope to insure long vibrator life. The Radiart vibrator manual lists procedures for checking buffer capacitors. C1 and C2 should be matched to T1 and T2 with an oscilloscope.

The 10,000-ohm s.p.d.t. plate relay used in the 6C4 plate circuit is not too critical. However, it is well to be sure that the relay used can be closed by the 6C4 plate current. The builder should be sure to ground the relay armature.

Ordinary horn relays handle the full headlight current. These may be purchased from any auto-parts store.

The mounting for the main unit and the eye unit may be placed at any convenient location in the car. The plate relay must be horizontal in order to keep car vibrations from affecting it, and the eye unit must be so placed that little extraneous light will strike it.

The phototube itself was mounted in a metal container found in the shop junk box. The container was grounded to eliminate shock.

Operation

The cathode of the multiplier type phototube emits electrons when light strikes it. The resultant current flows through the 6C4 grid resistor, developing a negative voltage at the grid of the 6C4, causing the tube to be cut off. The plate relay is de-energized, which in turn de-energizes the high-beam power relay and energizes the low-beam power relay to dim the lights.

When an oncoming car has passed, or when the car leaves a lighted area, current flow from the 931-A drops to a value which will no longer keep the 6C4 cut off. When this happens the plate relay armature is pulled down and the high-beam power relay is re-energized. The voltage drop across the 6C4 grid resistor was 60, with the 931-A under light. All voltages were measured with a v.t.v.m. The 2-megohm potentiometer is a high-voltage threshold control which is adjusted so that the phototube will just recover to high beam after passing an oncoming car. This control also compensates for bright moonlight nights.

Connecting the unit to the original car wiring as shown in Fig. 1 permits the driver to signal an oncoming car with a flick of the floorboard dimmer switch.

Fig. 2 is the diagram of a hold cir-

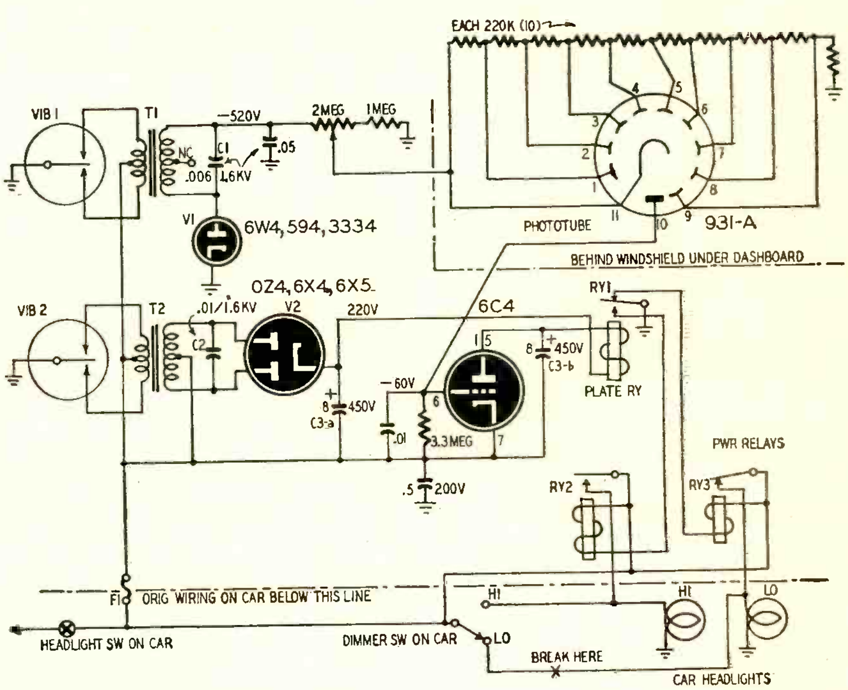


Fig. 1—Schematic of dimmer. The 931-A circuit is mounted on separate chassis.

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cuit later added to the original unit to increase its sensitivity when the lights are on low beam. This keeps them from flicking up and down frequently during twilight hours. By adding another relay as shown, you can now speed the return to high beam by pressing the dimmer switch to high beam and then back to automatic (low) position.

The author has used this unit for approximately four months with success and no component failures. No bugs were encountered in building this unit other than the usual ones you run into in everyday servicing.

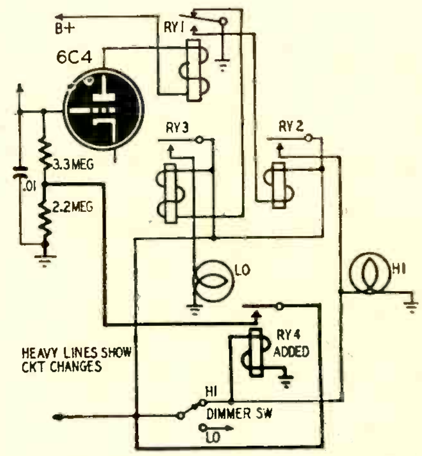


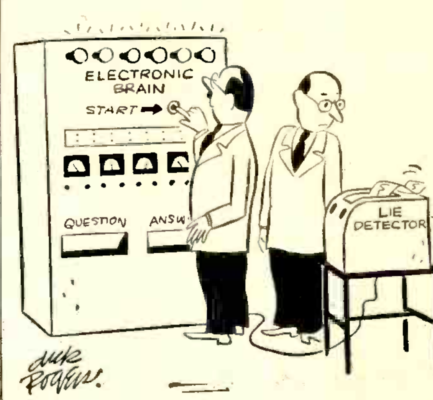
Fig. 2—Additions for more sensitivity.

Materials for electronic dimmer

Resistors: 10—220,000 ohms, $\frac{1}{4}$ watt, or use General Motors printed network assembly No. 5943524; 1—3.3 megohm, $\frac{1}{4}$ watt; 1—1 megohm, $\frac{1}{2}$ watt; 1—2 megohm potentiometer.
Capacitors: (Paper) 2—buffer capacitors, 1,600 volts, matched to power transformers with scope; 1—.01 µf 600 volts; 1—.05 µf, 1,600 volts; 1—0.5 µf, 200 volts. (Electrolytic) 1—8-8 µf, 450 volts.
Miscellaneous: 2—auto radio power transformers; 2—4-prong nonsynchronous vibrators; 1—10,000 ohm s.p.d.t. plate relay; 2—automotive-type horn relays; 1—6W4 or GM 5943334; 1—0Z4 or 6X4 or 6X5; 1—931A multiplier-type phototube; 1—SFE 9 fuse; sockets; wire; assorted hardware.

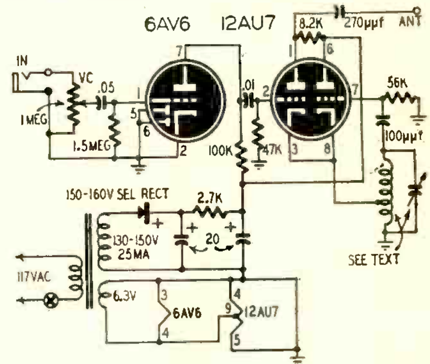
Building this electronic dimmer gives its constructor valuable experience in and information on the principles of servicing automatic headlight dimmers which may prove to be very useful in their repair as the units become more common. The General Motors *Autronic Eye* is a model now in popular use.

We may see the day when all cars will have an electronic dimmer as standard equipment. END



PHONO OSCILLATOR

The simple phono oscillator shown in the diagram is the best I have ever used. It has comparatively few parts and is capable of high-quality reproduction with a high percentage of modulation. The quality of reproduction of the over-all system is limited by the receiver.



Materials for phono oscillator

Resistors: 1—1.5 megohms; 1—100,000, 1—56,000, 1—47,000, 1—8,200, ohms, ½ watt; 1—2,700 ohms, 2 watts; 1—1-megohm potentiometer, audio taper.
Capacitors: 1—.05, 1—.01 μf, 400 volts, paper; 1—270, 1—100 μμf, mica or ceramic; 2—20 μf, 250 volts, electrolytic; 1—380-μμf mica trimmer.
Miscellaneous: 1—broadcast oscillator coil; 1—selenium rectifier, 150-160 volts r.m.s.; 1—half-wave power transformer, 130-150 volts at 25 ma, 6.3 volts at 0.6 amp; 1—phono input jack; 1—6AV6, 1—12AU7. Sockets, chassis, hookup wire, hardware.

The circuit consists of a 12AU7 oscillator and buffer and a 6AV6 speech amplifier. The buffer is essentially a grounded-grid r.f. amplifier with the audio signal applied across the 47,000-ohm resistor between grid and ground. The r.f. signal is fed into the cathode of the buffer by tying it directly to the cathode of the oscillator. With an 8-foot antenna, the oscillator produces a good noise-free signal at 50 feet. The coil and capacitor combination may be any which tunes to the broadcast band. A standard tapped broadcast oscillator coil and trimmer is used. The oscillator is of the Hartley type and will operate well in the broadcast band. The buffer serves not only as a mixer of the audio with the local r.f. oscillator, but as its name implies, it will act as a buffer between the antenna and the oscillator, otherwise, changes in the antenna location would reflect impedance into the oscillator circuit and change its operating frequency, causing drift.—*James R. Kaness*

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With his wife made a bet
He could fix his own set
And they both went TV-less that night

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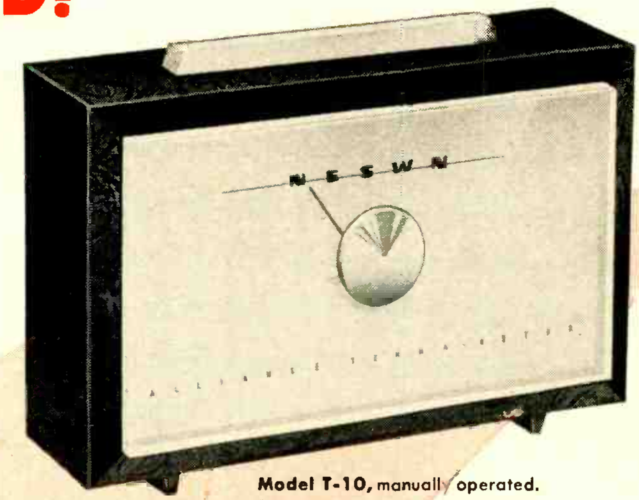
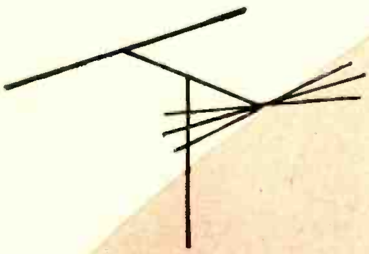
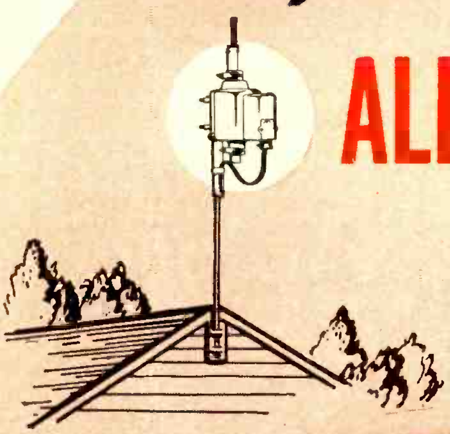


Model T-10, manually operated. Pointer shows right where antenna is aimed. Highly accurate!



Stay on the beam with



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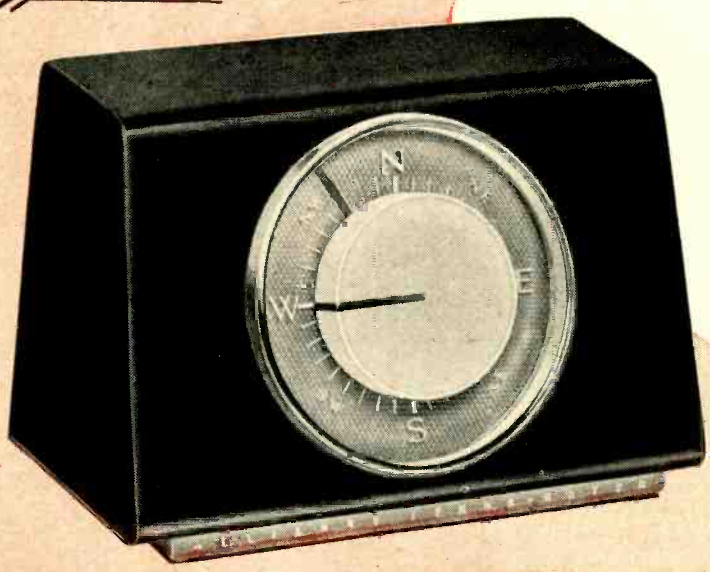

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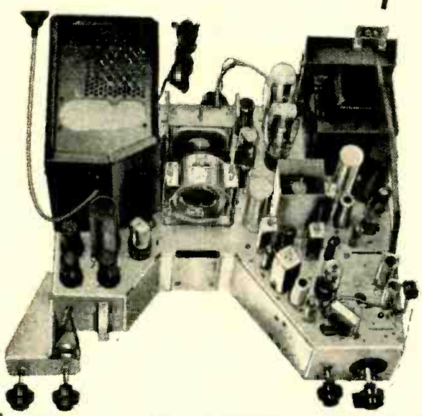

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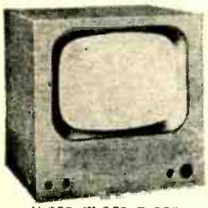

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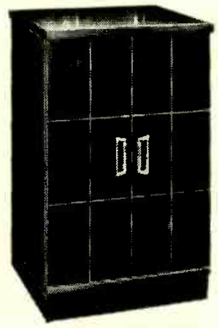

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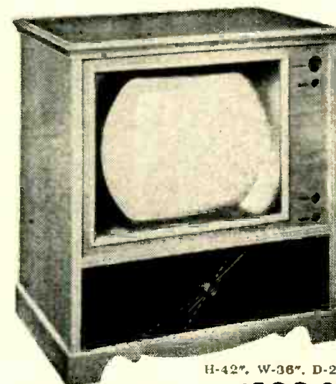

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For better all around performance

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STANDARD CASCODE TUNER, incl. tubes		$22.49
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COMPLETE SET OF KNOBS, incl. decals		1.34
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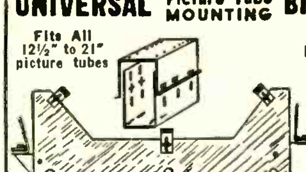

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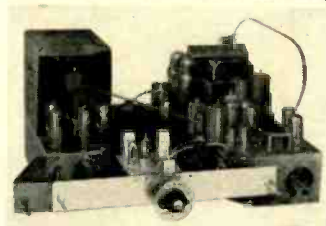

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limit 8 to a customer
$3.42 each

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2000 in stock
first come, first served
29¢ each

5" PM SPEAKER (Alnico #5)

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case of 30 .... 99¢ each
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TV TYPE 5300/2—500 ohms 20/2/2W
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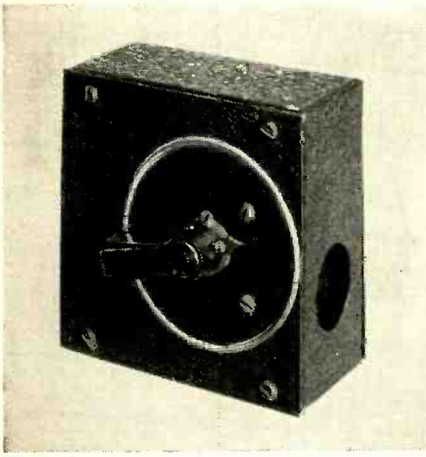
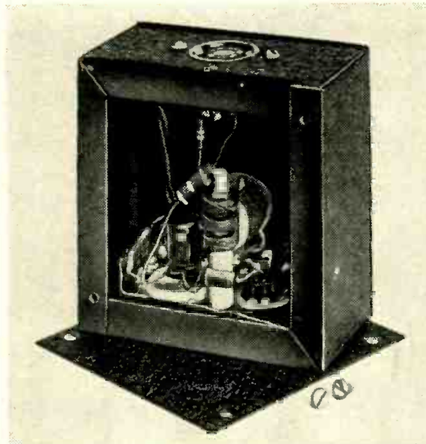


Front view of probe shows calibration. Coil socket is in the recess at right.



Interior of grid-dip probe. Coil socket is extremely close to variable capacitor.

VERSATILE GRID-DIP PROBE

BY I. QUEEN

FEW technicians recognize the close relationship between a grid-dip meter and a v.t.v.m. Both instruments are also useful around a ham shack and experimenter's lab. Often both are used on the same construction or repair project—one to measure frequency, the other to measure voltage. The two instruments are physically similar. Each requires a relatively low B supply (about 150 volts), a sensitive d.c. meter, and a probe. It seems wise therefore to combine them into a single unit with separate probes for each function. The same power supply and microammeter can be used for both.

Fig. 1 shows a grid-dip probe made to plug into a home-made v.t.v.m. The probe is housed in a 4 x 4 x 2-inch metal box into which a 7-lead cable can be plugged. The other end of the cable plugs into the voltmeter proper. When a.f. or r.f. voltage is to be measured, a voltmeter probe is substituted for the Fig. 1 probe.

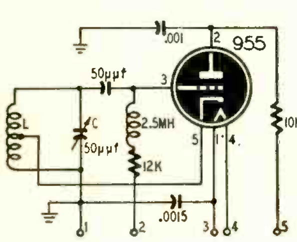


Fig. 1—Schematic of a grid-dip probe for use with a v.t.v.m.

The grid-dip circuit shown here is simple and effective. It consists of oscillating circuit L-C with plug-in coil. Power for the 955 acorn tube is supplied through the cable. Since the tube oscillates at all times, grid current flows out of lead 2. This lead connects to the microammeter in the v.t.v.m. as shown in Fig. 2. When the grid-dip probe is used, an auxiliary switch removes the meter from the voltmeter circuits so it can measure the grid dip. A meter shunt is also used. This adjusts the meter to full scale.

The probe is simple to use. First the meter is adjusted to full scale as mentioned. Then coil L is brought near an external circuit being measured. This may be a wave-meter, an r.f. amplifier tank, an antenna (through a coupling coil), etc. When the external tank resonates with L-C, power is absorbed from it. This causes a dip in the grid current. At maximum dip the unknown frequency is read off from the grid-dip calibration.

Of course the grid-dip instrument is also an excellent signal generator. Simply couple L near an r.f. receiver and listen for zero-beat. Plenty of harmonics are available. This makes it easy to calibrate the grid-dip meter. At higher frequencies, a TV receiver helps a calibration.

Fig. 3 shows a common type of voltmeter probe which can be used as companion to the grid-dip probe. The same lead numbers are used for the ground and filaments as in Fig. 1. The other two, leads 6 and 7, connect to the v.t.-v.m. tube grids.

Construction is straight-forward, but two points need explanation. The bottom of an acorn tube extends below its socket. Therefore the latter cannot mount directly on the metal box. I

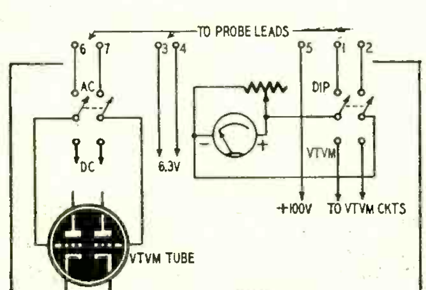


Fig. 2—V.t.v.m. adaptions for use with probe.

added a metal shelf one-half inch below the top of the box. It holds the sockets for coil L and the 955 tube. The shelf may be mounted either with spacers or brackets.

For high frequencies, a ¾-inch diameter polystyrene coil is convenient. Be careful in soldering to the pins. More often than not the heat softens the polystyrene and ruins the coil form. I found the following procedure good: Saw the base off an Amphenol type 24 form (no prongs). This form fits neatly

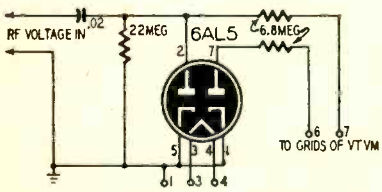


Fig. 3—Voltmeter probe which can be used in conjunction with the probe.

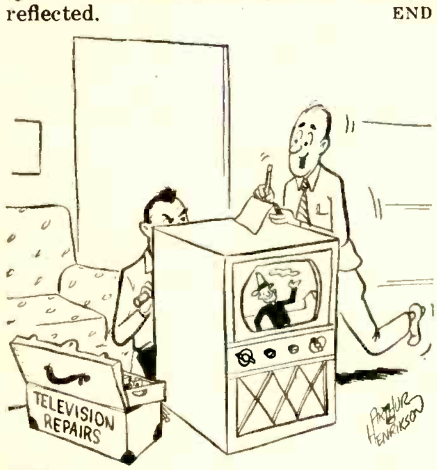
Materials for probe

Resistors: 1—9,100, 1—12,000, ½ watt.
Capacitors: 1—50 μμf, mica; 1—1,000 μμf, mica; 1,500 μμf, ceramic; 1—50 μμf, variable.
Miscellaneous: 1—2.5-mh r.f. choke; 1—955 tube and socket; 1—4-prong socket (Amphenol 78-S4S); 2—coil forms (Amphenol type 24); 2—4-prong plugs (Amphenol 71-4S); 1—metal box 4 x 4 x 2 inches; 1—7-prong socket.

into a 4-prong miniature chassis plug (type 71-4S). The two are cemented together or they may be held together by screws. This makes a plug-in coil form with a bakelite base so there is no soldering problem. The chassis plug mates with Amphenol socket type 78-S4S.

Two coils are used with this probe. One has 8 turns occupying about ½ inch. This tunes over 10 and 15 meters. The other has 4 turns and oscillates on 6 meters. Other ranges may be determined experimentally; it is difficult to specify exactly at high frequencies.

The grid-dip instrument tunes much more sharply than an absorption meter. A circuit does not have to oscillate to have its frequency measured by the grid-dip method. This offers a decided advantage. Not only must an absorption type meter depend upon an oscillator circuit to operate, but in the process a small amount of power is taken from that circuit. In cases of low-power high-Q circuits, noticeable impedance may be reflected. END



"What's the number of that tube? If the set acts that way again, I won't have to call you!"

CHARACTRON TUBE HAS MANY COMMERCIAL APPLICATIONS

By S. M. MILANOWSKI

DESPITE the "human inertia" that often delays the development and use of new inventions for periods of many years, Joseph T. McNaney's *Charactron* tube has found a variety of commercial applications since its development was first announced by Consolidated Vultee Aircraft Corporation at San Diego, Calif., back in 1949. (See RADIO-ELECTRONICS, December, 1949.)

The Charactron is a special cathode-ray tube which is distinguished from its predecessors to the extent that it has a beam-forming matrix situated between its electron gun and fluorescent screen. The matrix has a sequence of stencil-like openings with different configurations (for letters, numerals, or other characters), through which the electron beam must pass before it reaches the screen. These apertures alter the cross-sectional shape of the beam so that it forms images of a predetermined character. After leaving the matrix, the beam passes through a second set of deflecting plates which position the image at any desired point on the screen.

Because it can produce as many as 10,000 separate characters in a period of only one second, and these can be positioned on the screen in any arrangement desired, the Charactron is a tube of particular importance in the development of equipment for the transmission, storage, reproduction, and interpretation of data requiring the visual use of words, symbols, and statistics. For example:

One version of the Charactron is currently being used with electronic computers to convert electronic answer-impulses into visual figures which can be easily read and recorded by engineering personnel.

Charactrons with standard alphabetical and numerical matrices are being used in Xerographic high-speed printing machines. Here their purpose is to reproduce visual images on light-sensitive surfaces, so that words and figures can be permanently developed and transferred to paper. Messages and data thus printed may come directly from a remote transmitter or from an automatic filing system wherein various types of information have been recorded on magnetic tape.

As shown in Fig. 1, the Charactron starts with a more or less conventional electron gun and a set of electrostatic deflecting plates called *selectors*. These are followed by the beam-forming matrix and a second deflecting-plate assembly. The latter may be varied in many ways to meet special requirements. The matrix is located about three inches ahead of the gun-selector assembly.

Focusing voltage for the Charactron

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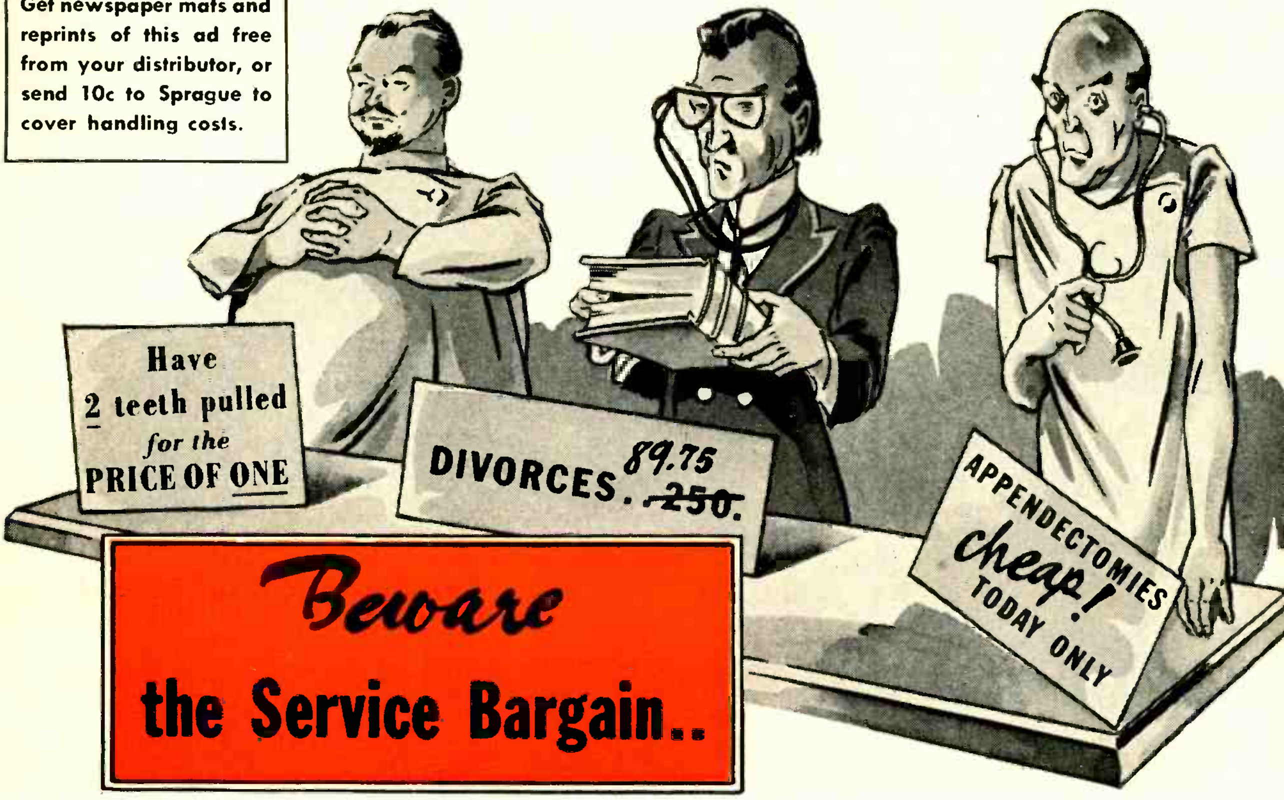

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Unfortunately, as in any business, there will always be a few fly-by-night operators. But patients, clients, and TV set owners who recognize that you get only what you pay for, will never get gypped. "There just ARE no service bargains"...but there is GOOD SERVICE awaiting you at FAIR PRICES!

Harry Kalker
PRESIDENT

SPRAGUE PRODUCTS COMPANY
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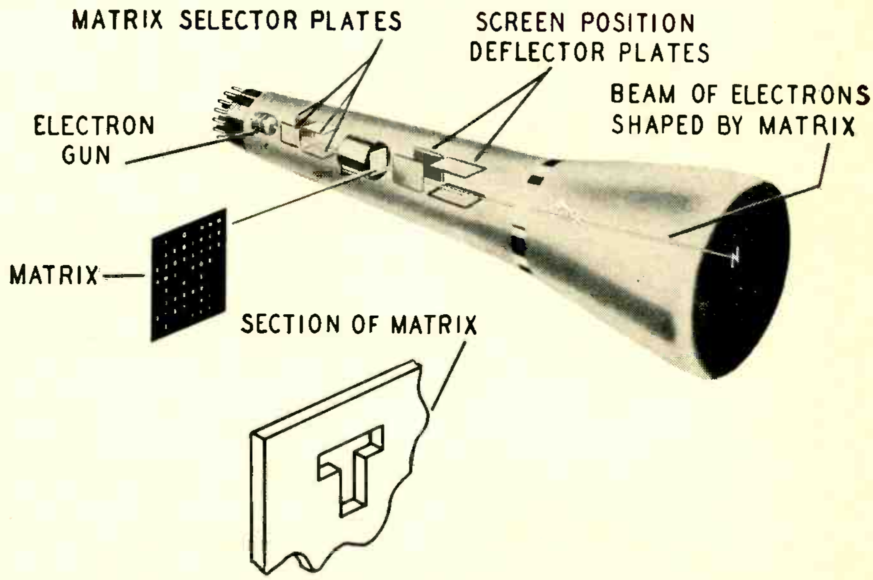

Fig. 1—Elements of the Charactron. Selector plates next to electron gun guide beam through desired opening in matrix, which shapes beam outline to produce letters, numerals, or special symbols on screen. Deflector plates following matrix shift image to any position desired over screen area.

is adjusted so that the undeflected electron beam will produce a relatively large spot of light, since the diameter of the beam must be large enough to cover each matrix aperture. Accelerating voltage adjustments, effective beyond the matrix position in the tube, make it possible to create a screen image of exceptional sharpness with a minimum number of control elements.

Control voltages applied to the *selector* plates determine which opening in the matrix the beam passes through. When it has been shaped by a matrix opening, the beam may be deflected to an appropriate area of the screen by the second set of electrostatic deflecting plates or electromagnetic forces (or a combination of both), depending on the nature of the images that must be produced or reproduced. As many as 100 different letters or figures may be provided on the matrix of a single Charactron, and the position of each on the screen is determined by its sequence or the selective voltage with which it is transmitted.

Many different types of viewing screens have been used experimentally in constructing Charactron tubes, but only the phospor types are now considered satisfactory. P-4 screens are used for direct viewing just as in TV picture tubes, while short-persistence P-11 types are used principally for photographic purposes.

Virtually all types of photographic materials and equipment can be used to reproduce the images that appear on the face of a Charactron; but Xerog-

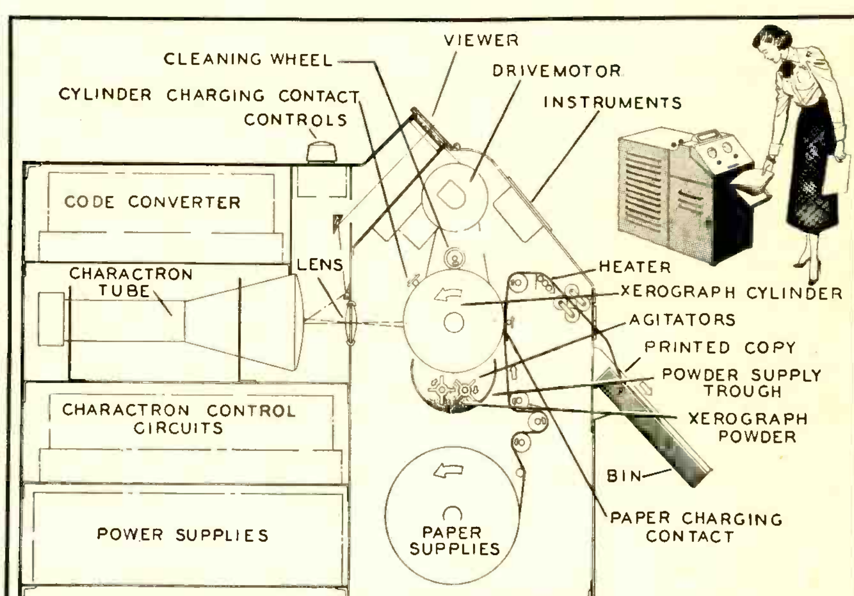

Fig. 2—The Charactron in high-speed Xerographic ("dry") printing transforms coded signals directly into light images of letters, figures, punctuation, etc. These are focused on photosensitive drum, which picks up colored printing powder in direct proportion to degree of exposure. Charged paper picks up powder pattern, which chemicals and heat make into permanent impression.

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1B5	.29
1H5GT	.59
1J6GT	69c
1L4	
1L6	1.29
1LA4	1.19
1LA6	1.19
1LC5	.69
1LC6	1.19
1LD5	
1LE3	1.19
1LH4	1.19
1LN5	1.19
1N5GT	
1P5GT	79c
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1R5	
1S4	.99
1S5	69c
1T4	
1U4	
1U5	.59
1V	89c
1X2A	
2A6	89c
2A7	
2B3	.89
2B7	.89
2C34	.60
2E5	.89
2X2/879	.74
3LP4	1.25
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3S4	.69
3V4	.95
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5U4G	.59
5V4G	.87
5W4	59c
5W4GT	
5Y3GT	.45
5Y4G	.54
5X4G	81c
5Z3	
6A3	1.68
6A7	89c
6A8GT	69c
6AB4	
6AB7	1.15
6AC5GT	.89
6AC7	1.45
6AG5	1.05
6AG7	1.49
6AH6	1.89
6AK5	.89
6AK6	1.08
6AL5	69c
6AQ5	
6AQ6	.81
6AQ7	1.19
6AR5	.79
6AT6	.59
6AS5	.90
6AU5GT	1.29
6AU6	.59
6AV5GT	.89
6AV6	.59
6AX4	.69
6AX5	.79
6AX6	.69
6AY5GT	.89
6B4G	1.44
6B8GT	1.15
6BA6	.59
6BA7	.89
6BC5	.69
6BC7	1.05
6BD5GT	.89
6BE6	.59
6BF5	69c
6BF6	
6BG6	1.89
6BG6G	
6BH6	69c
6BJ6	
6BK7	1.19
6BL7	.79
6BN6	1.19
6BQ6G	1.19
6BQ6GT	1.19
6BQ7	1.29
6BZ7	
6C4	.59
6C5GT	69c
6C6	
6CB6	
6C8	1.29
6CD6	2.09
6CD6G	1.69
6D6/78	1.10
6D8G	1.15
6E5	.69
6F5GT	59c
6F6GT	
6F7	1.59
6F8G	1.54
6G6G	.95
6H6GT	.89
6J5GT	.59
6J6	.79
6J7G	.69
6J8G	1.15
6K5GT	.69
6K6GT	.59
6K7GT	.69
6K8GT	1.19
6L5G	.95
6L6G	95c
6L6GA	
6L7	1.19
6N6G	1.40
6N7GT	1.19
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6SH7	
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6SJ7GT	59c
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6SL7GT	.69
6SN7GT	.69
6SQ7	59c
6SQ7GT	
6SR7GT	
6SS7	.99
6T7G	1.15
6T8	.89
6U5	69c
6U6GT	
6U7G	
6U8	.89
6V3	1.29
6V6GT	.69
6W4GT	.59
6W6	.69
6X4	59c
6X5GT	
6X8	1.29
6Y6G	.69
6Z4/84	.72
7A4	.95
7A5	1.19
7A6	.89
7A7	79c
7A8	
7B4	.89
7B5	.89
7B6	.89
7B7	89c
7B8	
7C4	1.30
7C5	.89
7C6	79c
7C7	
7E5	
7E6	79c
7E7	
7F7	.89
7F8	1.47
7G7	1.19
7H7	1.05
7J7	1.19
7K7	
7L7	.79
7N7	.69
7Q7	.79
7R7	1.19
7S7	1.19
7V7	.79
7W7	1.19
7X6	1.05
7X7	79c
7Y4	
7Z4	.89
12A7	1.59
12A8	.69
12AH7	1.38
12AL5	.54
12AT6	.59
12AT7	.89
12AU6	.69
12AU7	.79
12AV6	.59
12AV7	.89
12AW6	1.19
12AX4	.69
12AX7	.69
12AY7	1.95
12BA6	.59
12BA7	1.19
12BE6	69c
12BF6	
12BH7	.89
12BY7	.89
12BZ7	1.19
12F5GT	.65
12H6	.89
12J5GT	.75
12K7GT	.69
12K8	.89
12Q7GT	.89
12S8	.89
12SA7GT	.69
12SC7	1.05
12SF5GT	.69
12SF7	.99
12SG7	.89
12SH7GT	69
12SJ7GT	
12SK7GT	
12SL7GT	
12SN7GT	.89
12SQ7	69c
12SQ7GT	
12SR7GT	
12Z3	.95
14A7	1.05
14AF7	.93
14B6	89c
14B8	
14C5	1.25
14C7	1.12
14F7	1.05
14F8	1.45
14H7	1.12
14Q7	1.05
14W7	1.19
14X7	1.19
19BG6	1.89
19BG6G	
19T8	.89
20	1.40
24A	.69
25AC5GT	1.04
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25BQ6GT	
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25Z5	.69
25Z6GT	.69
32L7GT	1.15
26	59c
27	
35A5	.99
35B5	69c
35C5	
35L6	
35W4	.59
35Y4	99c
35Z3	
35Z4	.75
35Z5	.55
35/51	.79
36	1.06
37	.93
38	88c
39/44	
41	.72
42	.69
43	72c
45	
45Z5	.69
46	89c
47	
50A5	1.05
50B5	69c
50C5	
50C6G	1.39
50L6	.69
50X6	.69
50Y6	.99
57	79c
58	
70L7	1.49
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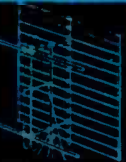

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.1			11c	.5 mfd . . . ea.	18c

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3237 West North Avenue, Chicago 47, Illinois • ARmitage 6-5550 raphy appears to have the greatest advantages in this connection. As it has been developed by the Haloid Company of Rochester, N. Y., Xerography involves:

1. Exposing a photosensitive surface such as selenium to a high-voltage electric field, which builds up a light-sensitive electrostatic charge on it.
2. Exposure of the electrostatically charged photosensitive surface to light, much the same as conventional photographic films are exposed. The light changes the charge at any point on the surface in proportion to its intensity at that point.
3. Development of the exposed surface with multicolored powders, which are attracted to the surface in accordance with the respective intensities of the remaining electrostatic charges.
4. The use of heat, pressure, and adhesives for transferring the powder images to paper and other surfaces.

This is an inexpensive and rapid method of reproducing high-contrast images because the photosensitive printing plates can be recharged and re-used indefinitely.

Fig. 2 shows how a Charactron tube has been used in conjunction with Xerographic equipment for high-speed reproduction of printed matter on paper. Operated at top speed, this setup is capable of decoding numerous types of input signals and translating them directly into words and figures that can be printed continuously in small type at a rate of 20 square inches of paper per second.

In this setup images on the face of the Charactron are focused by the lens on the surface of a selenium-coated cylinder. The section of the cylinder to be exposed is charged with high voltage immediately before exposure to light coming through the lens. The cylinder is rotated by a small motor synchronized with the Charactron control circuits, and exposed surfaces are developed immediately after they pass beyond the range of the lens by means of mechanically agitated powders in a trough beneath the cylinder.

The developed surfaces next come in contact with the chemically treated surfaces of a continuous roll of paper, which is electrically charged to facilitate the final transfer of powder images. A heater unit "fixes" the powder-printed copy, and makes the image permanent. Research is daily opening new fields for use of the Charactron. A field in which it should prove virtually indispensable is that of guided missiles. Data could be telemetered from a guided missile in high-speed flight and photographically recorded by means of the Charactron tube. Needless to say, such flight instrument data would be very difficult to obtain by other means. Fundamentally, the system would operate with the guided missiles signaling to special radio receiving equipment. This signal could then be passed through a commutating system to a Charactron commutator, then to an analog-to-digital converter. From there to a Charactron commutator, then to Charactron control circuits, and finally to the tube. END

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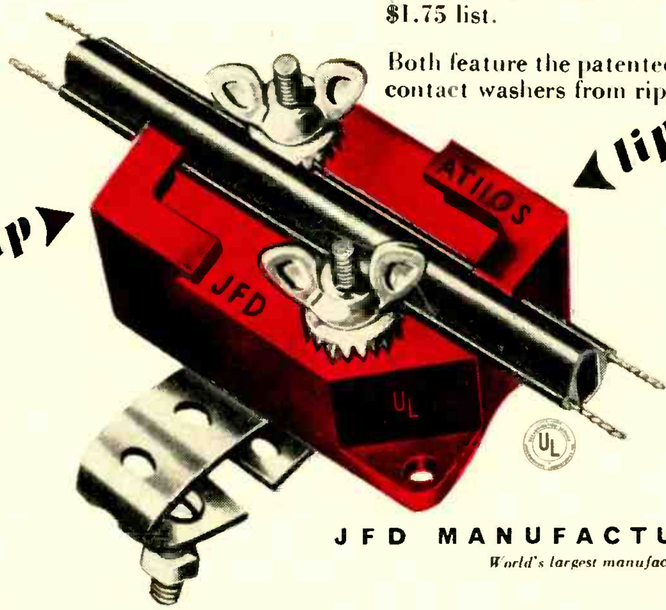

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understanding MECHANICAL FILTERS

Superior filtering and selectivity is obtainable by use of mechanical filters

By LESLIE L. BURNS, JR.

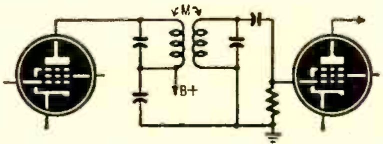


Fig. 1—Conventional i.f. transformer.

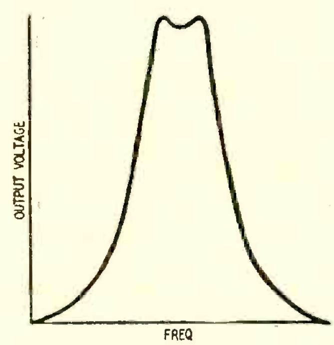


Fig. 2—Typical response curve For Fig. 1.

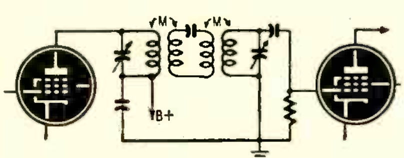


Fig. 3—Coupling with third tuned circuit.

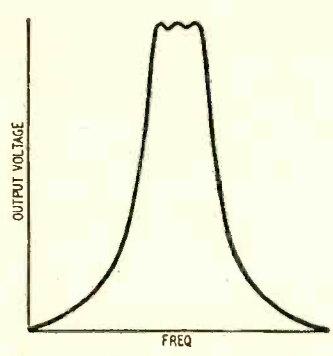


Fig. 4—Typical response curve for Fig. 3.

OBTAINING adequate selectivity is an always-present problem in radio receiver design. Most receivers get the necessary selectivity by cascading a number of i.f. stages. This method does not result in ideal selectivity; it gives us a rounded selectivity curve with broad skirts. The ideal curve would have a flat top and steep sides.

Special commercial receivers for point-to-point communication sometimes use crystal filters of the type used to a great extent in telephone work. These are expensive and not suitable for use in communications receivers for ordinary use. A new answer to this problem is provided by mechanical filters which are becoming increasingly important in radio communications. Several radio sets manufactured for the Armed Forces have mechanical filters. One company markets such a filter for amateur or experimental use and also sells a communications receiver with this filter installed.

By a mechanical filter we mean a filter that employs mechanically coupled mechanical resonators as distinguished from one that employs mechanical resonators coupled electrically (as in the case in crystal filters). This definition becomes clearer as a mechanical filter is better understood.

These filters make it possible to obtain a lot of filtering in a small space and to maintain the flat top and steep sides so desirable in selectivity considerations. These filters are stable with respect to temperature and humidity. Field maintenance is eliminated, since—once a filter is manufactured—no adjustment is either necessary or possible.

Principles of Operation

The basic idea behind mechanical filters is very simple and can be easily understood. Consider Fig. 1 which shows a conventional i.f. transformer coupling the plate of one i.f. amplifier to the grid of the next i.f. amplifier. The two tuned circuits are coupled by a mutual inductance. The amount of this mutual coupling determines the bandwidth of this particular transformer. Fig. 2 is a typical response curve for this type of circuit. To obtain more selectivity with this arrangement we might put a third tuned circuit between the two already shown, as illustrated by Fig. 3. Fig. 4 illustrates the response from this arrangement. Now we might continue this procedure until we get a response approaching the ideal, which would be a flat-topped curve with steep sides.

These additional electrical circuits would have losses due to the resistance of the coils, and these losses would prevent the selectivity curve from being as steep as might be desired. Also the problem of aligning additional circuits during maintenance operations in the field would be acute. However, these interior electrical circuits can be replaced by permanently tuned mechanical circuits. Fig. 5 shows an arrangement similar to Fig. 3 wherein the middle electrical circuit has been replaced by a single *mechanical* resonator. This mechanical resonator is exactly equivalent to the middle electrical circuit of Fig. 3, with the additional feature of being of very low loss.

Magnetostrictive conversion

The radio-frequency signals must be converted to mechanical vibrations in

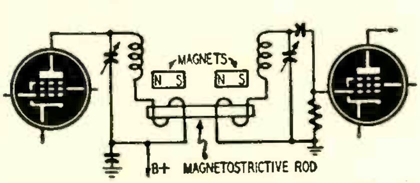


Fig. 5—Mechanical resonator circuit.

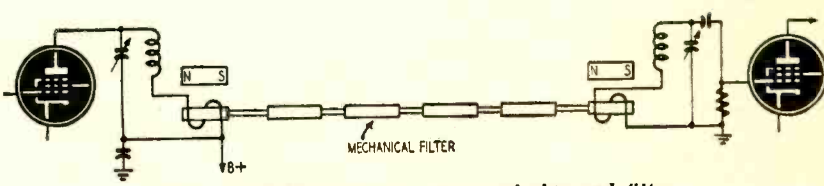


Fig. 6—Multisection magnetostrictive rod filter.

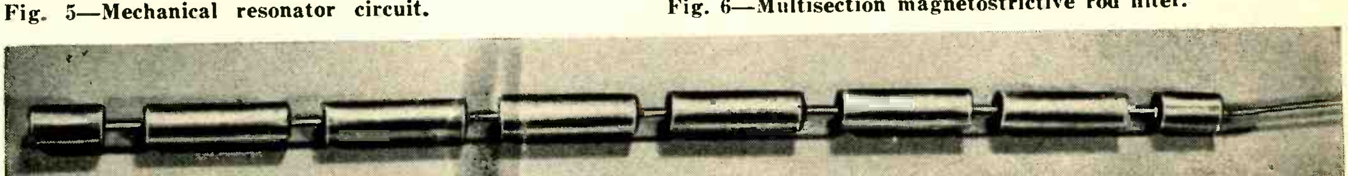


Fig. 7—8-circuit mechanical filter designed for 455 kc with bandwidth of 6 kc. Small necks couple circuits together.

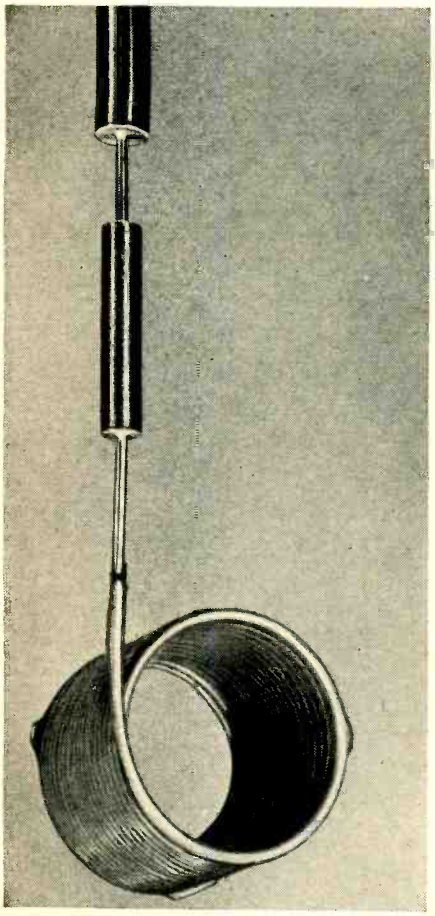


Fig. 8—End circuit has narrow diameter.

an intermediate amplifier so that they may be filtered by a mechanical filter. This is done with the help of a phenomenom known as *magnetostriction.* When certain materials are placed in a magnetic field they expand or contract, depending on the nature of the particular material. Nickel contracts when placed in a magnetic field. Thus a small rod of nickel becomes slightly shorter when magnetized. Now if the magnetic field is made to alternately increase and decrease, the nickel rod will alternately become shorter and longer. If the frequency of the alternating magnetic field coincides with the resonant frequency of the rod, the motion will be relatively large. Efficient electrical-to-mechanical conversion of energy is thus obtained.

Conversely, a rod of nickel that is alternately expanding and contracting generates a magnetic field that can produce a voltage in a coil surrounding the rod. In both cases a permanent magnetic field is supplied to prevent double frequency operation.

With these two effects in mind it is easy to see that the electrical energy is converted to mechanical energy at the filter input coil by magnetostriction; at the output the reverse phenomenon converts the mechanical energy back into electrical energy.

Instead of nickel, most mechanical filters are made of an iron-and-nickel alloy called Ni-span C, which is very stable with respect to temperature.

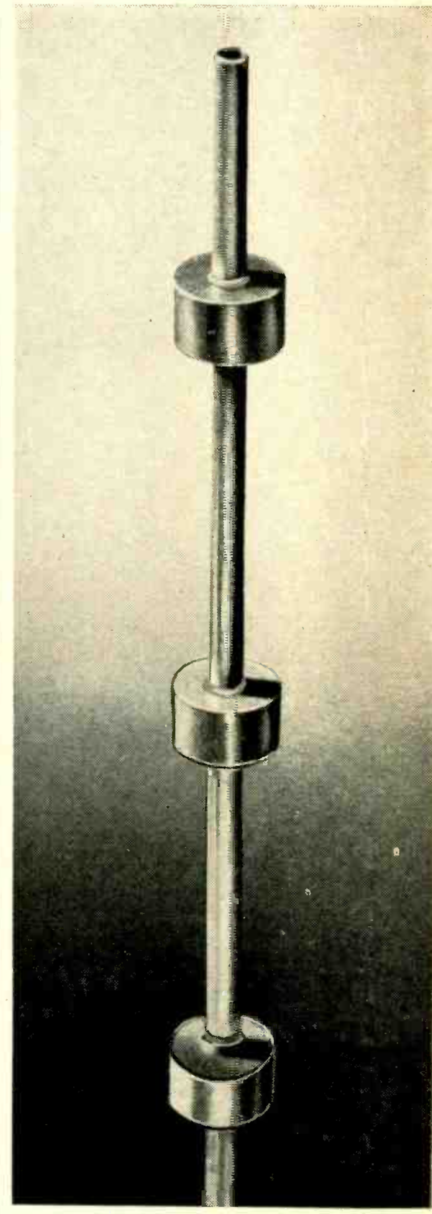
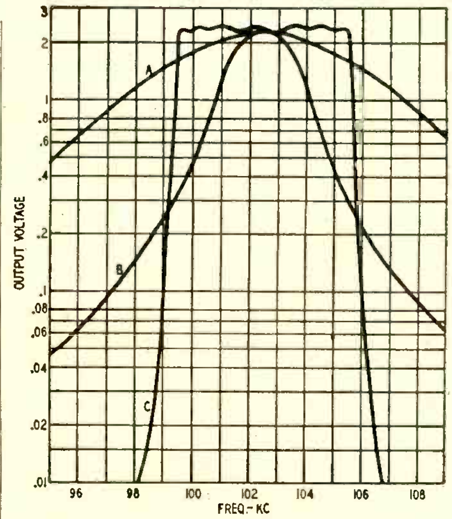


Fig. 9—Heavy slugs couple resonators.

By continuing the process of adding more mechanical circuits we have the arrangement shown in Fig. 6. Here we have six mechanical circuits and two electrical circuits for a total of eight circuits. This arrangement will provide a selectivity curve with a flat top and steep sides suitable for most communications receivers designed for general use.

The bandwidth of this type of arrangement is determined by the relative size of the mechanical resonators to the small coupling necks. The small neck corresponds to weak coupling and produces a narrow band, whereas a larger-diameter neck produces a wider band. To keep the functions of a mechanical filter clearly in mind, imagine each resonator—that is, each large portion of the rod—to be a tuned circuit, and imagine each small neck portion to be like a small amount of mutual coupling. Fig. 7 is an enlarged photograph of an 8-circuit mechanical filter designed for 455 kc with a bandwidth of 6 kc. The small necks coupling the mechanical



A-SELECTIVITY WITHOUT FILTER; B-SELECTIVITY WITH XTAL FILTER; C-WITH MECHANICAL FILTER

Fig. 10—Selectivity of various filters.

circuits together can be easily seen. The interior resonators of this filter are actually 0.4 inch long.

Further design considerations

The resonant frequency of a magnetostrictive rod is determined by its length. A rod of nickel about 1 inch long will be resonant at 100 kc. The relation is:

$$\text{Length} = \frac{\text{velocity of sound}}{\text{frequency} \times 2}$$

The velocity of sound is different in different materials. In nickel it is 1.95×10^5 inches per second, while in Ni-span C the velocity is 1.89×10^5 inches per second. Each of the resonators in a mechanical filter is made exactly this length or some multiple of this length so that they all will be resonant at the center frequency of the pass-band. In some designs the interior resonators are made just twice as long as the end resonators, but they are still resonant at the center of the pass-band.

Also, other forms than the rod-shaped resonator can be used in mechanical filters. Disc or spherical resonators can be used. Each of these different shapes has advantages that make it suitable for certain frequencies and bandwidths.

The bandwidth of the simple rod-type filter that has been illustrated is determined by the relative size of the coupling neck to the resonator. The relation is:

$$\frac{\text{bandwidth}}{\text{center freq.}} = \frac{\text{area of neck}}{\text{area of resonator}}$$

where the area is the cross-sectional area of the neck or resonator.

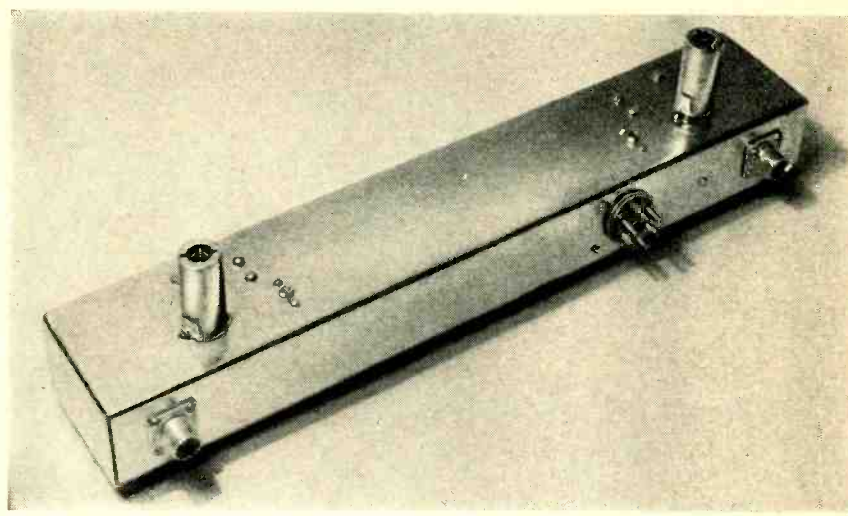


Fig. 11—A top-side view of a typical mounting for a mechanical filter.

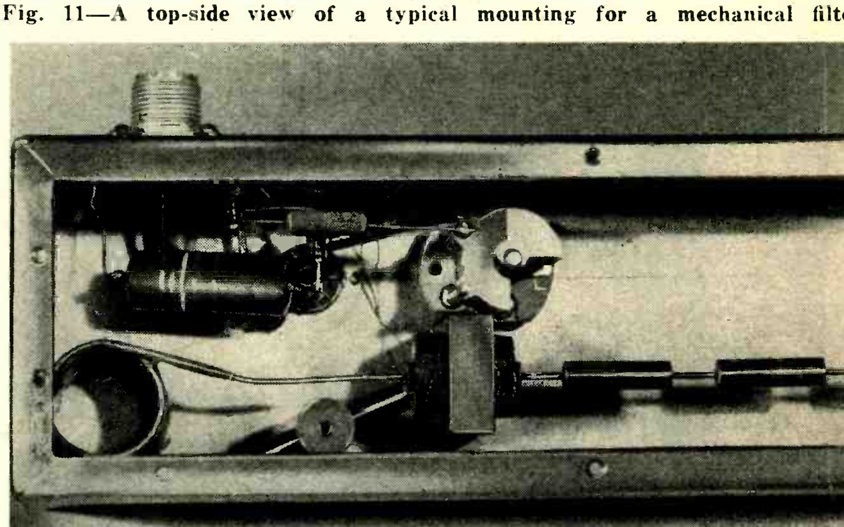


Fig. 12—The drive coil and permanent magnet can be seen in this bottom view.

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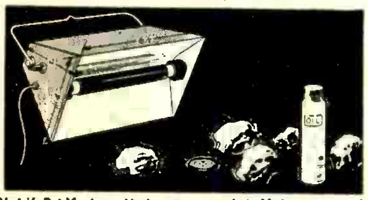

BLAK-RAY 4-watt lamp, model X-4, complete with U-V tube. This lamp gives long-wave ultra-violet radiation having a wave-length of 3654 to 4000 angstrom units. Some of the substances made to fluoresce visibly when illuminated by U-V light are certain woods, oils, minerals, milkstone, cloth, paints, plastics, yarn, drugs, crayons, etc. This lamp is self-filtering and the invisible U-V rays are harmless to the eyes and skin. Equipped with spectral-finish aluminum reflector. Consumes only 4 watts and can be plugged into any 110 volt 50-60 cycle A.C. outlet. Will give 2000 to 3000 hours of service. It weighs but 1¾ lbs. Approved by the Underwriters Laboratories and has a built-in transformer so that it may be safely used for long periods when necessary. Extra U-V tubes are available.
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Mechanical filters, like electrical filters, must be terminated for minimum ripple in the pass-band. Termination of a filter for minimum ripple is analogous to terminating a television transmission line for minimum reflections in the picture. Mechanical resistance in the form of mechanical lossy material is attached to the end resonators. (A mechanical lossy material might for example be a small piece of rubber glued to the end resonator.) Another method of producing the required mechanical resistance is to attach a long piece of wire coated with some lossy material to absorb the vibrations. With this method it is easy to get exactly the proper amount of mechanical resistance since the diameter of the wire determines the amount of the losses. Fig. 8 shows the end portion of a mechanical filter with a coiled lossy line attached.

Sometimes, when the bandwidth of the filter is not too great, no mechanical resistance in the form of lossy material is necessary, since all the resistance needed to properly terminate the filter is provided by the electrical circuit coupled to the end resonator.

Another consideration in mechanical filter design is that, to obtain the flattest pass-band response, the end resonators must contain half the energy of the interior resonators. This is evident in Fig. 7 where it can be seen that the end resonators are half as long as the others and in Fig. 8 where the end resonator has a smaller diameter than the interior resonators.

The circuits of an electrical filter can be coupled by either a mutual capacitance or a mutual inductance. This is true also of the mechanical case. One form of mechanical filter uses heavy slugs to couple the resonators instead of the small necks as has been previously shown. Fig. 9 illustrates this type of filter. Here the small tubes are the resonators, while the slugs form the couplers. The slugs are about 0.2 inch long, while the interior resonators are about 0.6 inch long. Again on this filter the half-energy end resonators can be seen clearly. A filter of this type is fully equivalent to the other form shown, and the choice between the two is purely a matter of the ease of fabrication for the frequency desired.

Applications

A typical selectivity curve is illustrated in Fig. 10, which also shows for comparison the curves obtained in a high-quality communications receiver with and without the crystal filter. The crystal filter here referred to is the type usually found in communications receivers and is designed to provide a single sharply peaked response and not a flat-topped response such as is provided by a mechanical filter or a band-pass crystal filter employing several crystals.

The electrical circuit diagram for a mechanical filter is given by Fig. 6. A typical mounting for a mechanical filter is illustrated by Figs. 11 and 12 for a 100-kc filter with a 6-kc band-pass. The drive coil and permanent magnet are evident in the underchassis view. Filters for higher frequencies will have much smaller housings.

The application of mechanical filters to high-quality receivers will increase as improved designs and better fabrication techniques are developed. It seems unlikely that they will ever be used in the cheap table-model broadcast receivers because the selectivity of these receivers is now satisfactory. However, the better-quality broadcast receivers will use mechanical filters. The big field for the application of mechanical filters is in communications receivers and in military equipment where the stringent selectivity requirements cannot be met by any other type of filter.

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"Compact Electromechanical Filter," R. Adler. **Electronics**, April, 1947, page 100.

"Mechanical Filters for Radio Frequencies," W. van B. Roberts and L. L. Burns, Jr. **RCA Review**, September, 1949, page 348.

"A Bandpass Mechanical Filter for 100 Kc," Leslie L. Burns, Jr. **RCA Review**, March, 1952, page 34.

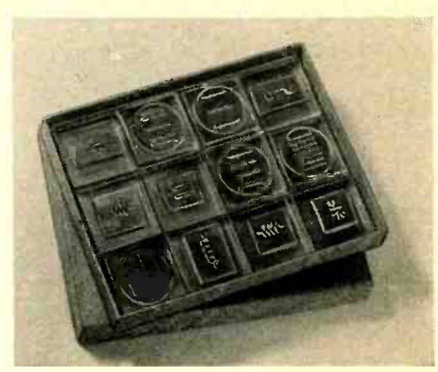
"Mechanical Bandpass Filters for I.F. Ranges," Ben Roberts, **QST**, February, 1953.

"How to Use Mechanical I.F. Filters," M. L. Doelz and J. C. Hathaway, **Electronics**, March, 1953, page 138.

END

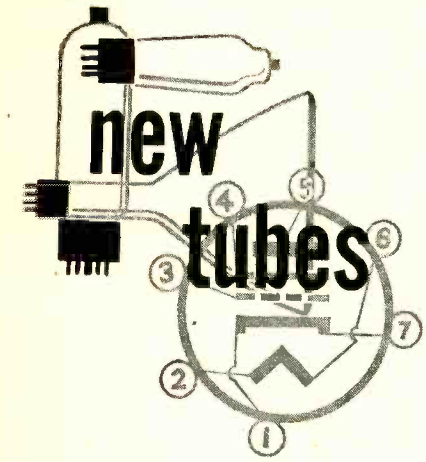
CIRCUIT-SYMBOL STAMPS

Here's an unusually handy gadget for the technician, engineer, or hobbyist who isn't an expert draftsman but who wants to draw neat schematics. It's a set of 12 1¼ x 1¼-inch clear-plastic blocks engraved with the basic component symbols that make up practically all electronic circuit diagrams. All you have to do is ink them lightly on an ordinary stamp pad and press them on the paper to produce perfect tube diagrams, resistors, or other common circuit elements.



The set has five tube stamps, covering standard types from diode to pentagrid converter; a fixed resistor and a potentiometer; fixed and variable capacitors; a basic inductor stamp which can be repeated and inverted as required for transformers or coupled circuits; a contact-rectifier symbol; and a stamp for headphones. [This latter one will probably get relatively little use, and possibly the manufacturer (Precise Measurements Co.) should substitute a more common symbol such as a speaker, line plug, or a transistor.]

END



new tubes (and Transistors)

THE transistor continues to make news. As mentioned last month, Sylvania Electric Products has developed two new types of point-contact transistors.

One is a tetrode transistor 3N21 that was scheduled to be commercially available about August 15, and the other is a pentode transistor that is expected to become commercially available later this year. Sylvania is the first company to announce that its development work

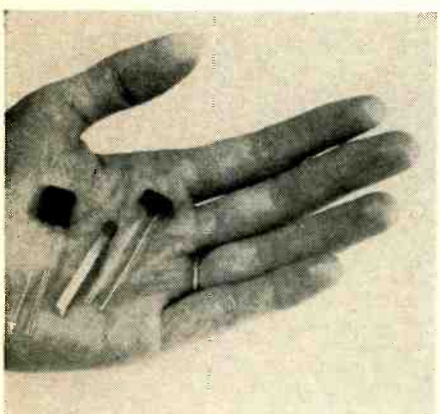


Photo shows compactness of transistors.

in tetrodes and pentodes has progressed to the point of commercial production. Where the triode transistor has two catwhiskers in contact with the germanium crystal, the tetrode has three wires making contact, and will do the work of two triode transistors in all applications where the two outputs could be paralleled.

The type 3N21 tetrode is designed primarily for use in switching and small signal applications. Recommended small-signal applications include modulation, signal translation apparatus, and audio or low r.f. mixer. The maximum ratings of the 3N21 are: collector voltage d.c. –60; collector dissipation 100 mw; emitter voltage d.c. –50 volts; emitter output (either emitter) 30 mw; ambient temperature 50°C. Voltages are with respect to base.

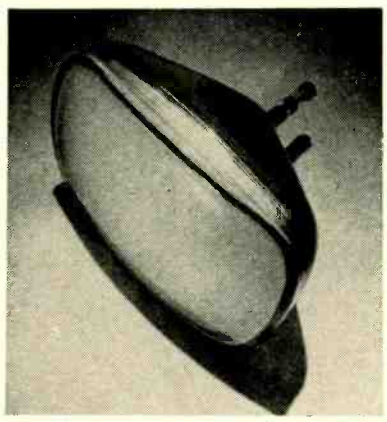
New Tubes

With virtually simultaneous announcements, General Electric and the Rauland Corp., have heralded two new 24-inch rectangular glass cathode-ray tubes for television application, the 24CP4 and its aluminized counterpart, the 24CP4A.

The new tubes have a deflection angle of 90 degrees, a major factor in making them shorter than 21-inch glass rectangular tubes. They measure only 21⅛ inches in over-all length.

The new types are glass, magnetic-focus and magnetic-deflection, direct-view picture tubes. They boast an electron gun which is used with an external single-field ion trap magnet and an external conductive coating that acts as a filter capacitor when grounded. Another feature of the two new types is a gray, filter-glass face-plate to improve contrast in the presence of ambient light.

The aluminized version, the 24CP4A, gives additional light output because of its metal-backed screen.

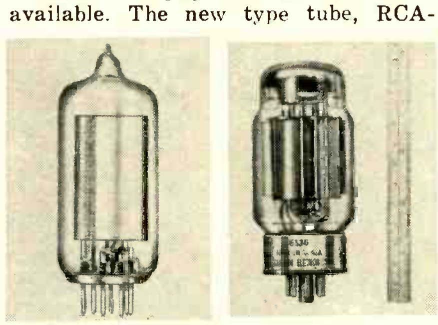


24CP4 has deflection angle of 90 degrees.

Recommended operating conditions for the 24CP4 and 24CP4A:

Anode voltage, 16,000; grid 2 voltage, 300; grid 1 voltage, –33 to –77; focusing coil current, 119 ma; ion trap intensity, 40 gausses. Base-pin connections are for a standard small-shell, 5-pin duodecal socket.

A new RCA electron tube specially engineered to shake off the "shakes" of airborne and mobile electronic communications equipment has been made available. The new type tube, RCA-6101, is designed specifically for use as a class-A amplifier and control tube in applications where dependable equipment performance hinges on the ability of electron tubes to take abnormal shock and vibration.

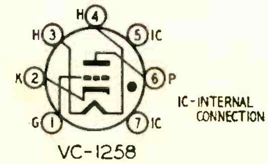


VC-1258 thyratron; 6336 twin power triode.

The 6101 is a medium-mu twin triode which couples the characteristics of the 6J6 with the ability to withstand punishing physical operating conditions.

The new tube has a pure tungsten heater to provide long life under frequent on-off switching operations. Additional insulating material has been applied to the heater to give protection against short-circuits between the heater and cathode under conditions of extreme vibration. Base connections are the same as the 6J6.

Chatham Electronics Corp. has announced the production of two new tubes. The first, type 6336, is a high-perveance, high-plate-dissipation twin-power triode for voltage regulation. Used as a series tube, it will pass 150 ma per section at 40 volts d.c. with minimum bias, and the same current at 200 volts d.c. with a grid bias of −60 volts. The tube features a hard glass envelope and an 8-pin butt stem. Pin connections are the same as those of the 6AS7-G. The filament voltage is 6.3, and it draws 5 amp. Forced ventilation is not necessary at ambient room temperature. Mu is 2.7, gm is 11,000 micromhos, Rp is 250 ohms. Its life expectancy is 1,000 hours minimum. The second tube, type VC-1258, is a miniature hydrogen thyratron for pulse generating applications. It is capable of handling peak power up to 10 kw. This tube will fit a standard miniature socket. (See base diagram below.) It is rated at 1,000 peak anode volts, 20 amperes peak anode current, and 40 ma average anode current. Repetition rates in excess of 10,000 pulses per second are possible at reduced ratings.



Tube fits standard miniature socket.

The VC-1258 will withstand all shock and vibration tests required of a ruggedized electronic tube.

RCA has announced the production of a tube type 6CF6. The 6CF6 is a sharp-cutoff pentode of the miniature type especially designed for use in gain-controlled video if stages operation at frequencies in the order of 40 mc. It is also well suited for use as an r.f. amplifier in v.h.f. television tuners.

The 6CF6 features controlled plate-current cutoff and very high transconductance (6.200 micromhos) combined with low capacitance values. It is provided with separate base pins for grid No. 3 and the cathode.

The heater operates at 6.3 volts and draws 300 ma. The tube may be mounted in any position. The base is of the small-button miniature 7-pin type. In typical operation, the 6CF6 has a plate voltage of 200, the suppressor grid is connected to the cathode at socket, the screen grid voltage is 150, and the grid bias for a plate current of 35 μa is −6.5 volts. Except for its sharper cutoff, the 6CF6 is identical to the 6CB6. END

NATESA'S FOURTH MEET

Fourth annual convention of the National Alliance of Television and Electronic Service Associations will be held at the Morrison Hotel in Chicago, on October 9, 10 and 11, reports Frank J. Moch, national president.

More than one thousand members of the thirty-five affiliated state groups are expected to accompany the seventy delegates, with an additional five hundred persons representing Chicago area companies, John Cecich, convention chairman, estimated.

This year's plans call for both an industry convention and product display and an open forum, to which the public is invited, and where leading authorities on television maintenance and repair will give set owners an opportunity to air their comments on TV repair service.

The Convention entertainment program will be in charge of Phil Levant, with a gala industry banquet scheduled for Saturday night, Oct. 10th. The educational program will feature Donn Mason, nationally known sales training consultant, and Dr. J. H. Hazlehurst, prominent business consultant and psychologist, both of Chicago.

PENNSYLVANIA LICENSE BILL

Paul V. Forte, executive secretary of the Television Contractors Association, has struck out against Pennsylvania House Bill, HR 839, a law to license television technicians, as "an innocuous piece of legislation." He said it will not accomplish the purpose for which it is intended, to protect the service technician and the customer.

Mr. Forte attacked the bill as unsound and asserted that there is no need for television licensing.

One section of the bill says that just complaints would be recognized and investigated. Mr. Forte said that this was a naive statement, and that there are so many complaints about television service that a fantastically large staff would be needed just to read them, much less determine which complaints are just and which are unjust.

PENNSYLVANIA PARLEY

The Federation of Radio Service Men's Associations of Pennsylvania plans to hold an Eastern Conference in Philadelphia in January, 1954, to discuss television-radio servicing and related industry problems. L. J. Helk, spokesman for the FRSMAP, said that representatives of similar servicing organizations from Maine to Florida are expected to attend.

MIDDLETON ILL

Tom Middleton, former active member in the Philadelphia and Pennsylvania service organizations, has suffered a complete breakdown in health. Tom left Philadelphia for Miami some time ago, with the hope that the climate would improve his condition.

Though his health was poor when he arrived in Florida, Tom became an active influence in the Miami service technicians' organization. His wife has informed us that it will be necessary for him to have complete rest, and that they expected to return to Philadelphia in August. Meanwhile the service technicians of Miami were helping to liquidate his business in that city.

NEW TRADE ASSOCIATION

The formation of the Utah Association of Radio and Television Servicemen has been announced by D. Pieper, general manager. The association was incorporated as a nonprofit, educational unit, with the basic purpose of promoting the welfare, progress, and well-being of the radio and television service industry in the State of Utah.

The aims and objectives of the association include the following: Establishment of suggested minimum rates and charges, assuring all members of fair and equitable returns for work and services performed; protection of the industry through voluntary beneficial policies and regulations; promotion of legislation that is affirmative and responsive to the growth and progress of the industry as a whole; and initiation of a broad, comprehensive public relations campaign, to better acquaint the public with the industry.

PHILLY LAUNCHES CAMPAIGN

The Television Service Dealers Association of Philadelphia have announced a series of 18 newspaper advertisements promoting TSDA's members' facilities. A sum of $1,200 was voted unanimously by the association to cover the costs of the campaign.

TSDA has set up offices at 6021 Ogontz Avenue, with a central telephone system to channel requests for service to the nearest member shop.

A grievance committee has been appointed to investigate all customer complaints. Industrial and Public Relations Committees have also been set up, with Dave Krantz as chairman of the former and Edward Strychowski of the latter.

THE "SERVICE-SAVER"

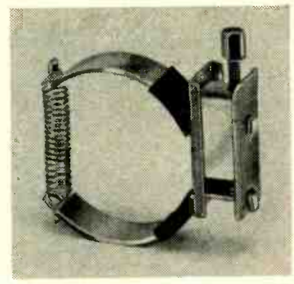
A new and unique method of helping television technicians diagnose and repair troubles in a television set was described recently by Carroll W. Hoshour, director of Raytheon Sales Engineering.

The new device, which means "more efficient and economical service" for television set owners, consists of a booklet containing photographs of 40 possible troubles that could occur with a TV set's picture. Each picture is numbered for easy identification. When something goes wrong with the set, the owner calls his service technician and tells him, "My picture looks like number seven, or ten, or twenty-four."

In the Raytheon Service manual that is distributed to all television technicians, there is also a "Service Saver" section that shows the same numbered 40 conditions, and gives schematic diagrams of the circuits and what causes the trouble, plus a complete list of parts and tubes that might be involved. It also contains hints and kinks for quick repair—what to test, and what component might be causing the difficulty. END

ADJUSTABLE ION TRAP

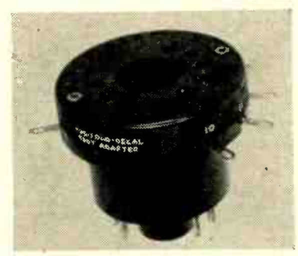
J. W. Miller Co., 5917 S. Main St., Los Angeles, Calif., has developed the new type 6285 single-field adjustable ion trap having a variable gauss range of 32 to 55. The strength of the magnetic



field is varied by turning a small screw which moves a slug back and forth in the field of the ion-trap magnet.

TEST SOCKET ADAPTER

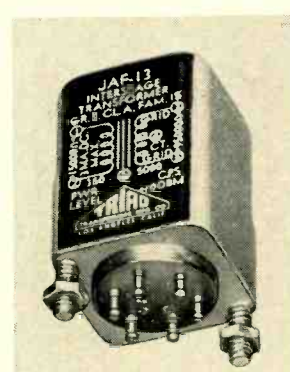
Pomona Electronics Co., 524 W. Fifth Ave., Pomona, Calif., has announced the Peco TVS-1 Duo-Decal test socket adapter. The unit permits operating tests on all circuits going into the television tube socket while the set is in operation.



The TVS-1 is inserted between the C-R tube base and its socket to complete the circuit and make all connections accessible to meter test leads. Measurements can be made without tracing circuit wiring to test points below chassis.

AUDIO TRANSFORMERS

Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif., has added the JAF series of miniature audio transformers to their line. For use with transistor or tube amplifying equipment, these magnetically shielded, hermetically sealed units cover the audio-frequency range.

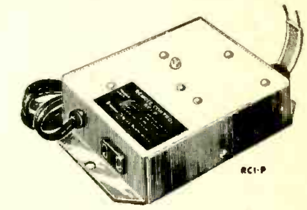


The JAF line is available in standard MIL cases with mounting studs so arranged that transformers may be mounted in closest possible proximity to each other. Information for each transformer is carried on a permanently attached decal.

TV REMOTE CONTROL

Blonder-Tongue Laboratories, Inc., 526-536 North Avenue, Westfield, N. J., is distributing the new RCI remote-control unit for controlling TV boosters, u.h.f. converters, distribution units, and many other remote electrical accessories from a single on-off switch.

The control unit consists of the RCI-P power unit and the RCI-R remote unit. The RCI-P plugs into any 117-volt a.c. outlet and receives the line cord of the TV receiver, audio preamplifier, or other device containing the a.c. line switch. It contains a thermal relay, indicator light, and fuses. The RCI-R, located at the unit to be controlled, is connected to the power unit through a single heavy-duty 300-ohm line. This line carries a.c. to the remote apparatus and serves as a transmission line for TV signals coming



down from the antenna. Both sides of the slave unit are fused to comply with the code of the National Board of Fire Underwriters. Any unit drawing 100 watts at 117 volts can be operated at distances up to 1,000 feet or more with this control system.

UHF CONVERTER

Walsco Electronics Corp., 3225 Exposition Place, Los Angeles, Calif., is introducing the new Walsco Imperial all-channel u.h.f. converter which features the new *Turretune* tuning system—a turret-type bandspread tuning unit with a double-tuned preselector.

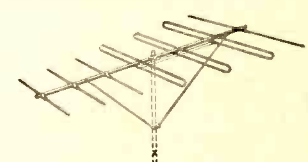
The tuned circuits have a constant L-C ratio throughout its range. The oscillator uses a balanced-line circuit for minimum frequency drift. Input terminals are provided for separate

u.h.f. and v.h.f. antennas. The cabinet is available in a wide variety of colors to blend with modern interiors.

VHF YAGI

Technical Appliance Corp., Sherburne, N. Y., has announced a broad-band, triple-driven v.h.f. Yagi for channels 2–6. The antenna consists of three directors and three driven elements, plus reflector. Gain is of the order of 7 db throughout the low band.

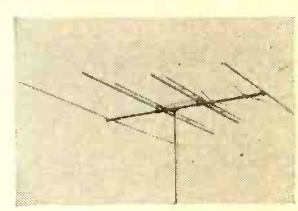
Primarily designed for fringe areas receiving two or more low-band channels, the No. 1840 antenna is also recommended for areas in which a channel change is contemplated. This new antenna eliminates the need for



multiantenna installations for low-band reception and the ensuing mutitransmission lines and switching devices otherwise employed.

V.H.F. ANTENNA

Wells & Winegard, Burlington, Iowa has introduced the model CP-1 *Clipper* v.h.f. antenna for fringe areas. Manufacturer claims high uniform gain and good front-to-back ratio.



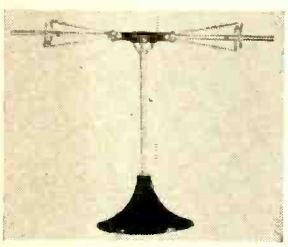
CRYSTAL MICROPHONE

Shure Brothers, Inc., 225 W. Huron St., Chicago 10, Ill. has announced an all-purpose crystal microphone, the model 777. This unit can be used on desk or floor stand, in the hand, or around the neck.

The model 777 has a frequency response of 60-10,000 c.p.s., is 4½-inches long x 1-inch wide, and is finished in chrome.

INDOOR U.H.F. ANTENNA

The Hi-Lo Antenna Corp., 3540 N. Ravenswood Ave., Chicago 13, Ill., has announced their model 303 *Twin Arrow* indoor antenna for u.h.f. The twin arrows may be adjusted for local areas. The upright and crossbar are gold-colored, and the base is of light-weight brown plastic.



HOME MUSIC ASSEMBLY

Radio Craftsmen, Inc., 4401 N. Ravenswood Ave., Chicago 40, Ill., has announced a home music assembly for the high-fidelity enthusiast.

All the units for a complete home-music system are provided in a single carton, complete with a changer mounting board, all necessary connecting cables, mounting hardware, detailed yet simple connecting instructions, and drawings of typical cabinets, including a horn-loaded corner speaker cabinet.

Included in the assembly, known as the Craftsmen CA1 are the C10 FM-AM tuner, a C400 10-watt amplifier, a 3-speed automatic record changer, and a 12-inch speaker system with a range of 40 to 16,000 c.p.s.

SIGNAL GENERATOR

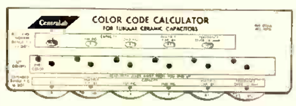
Hickok Electrical Instrument Co., 10514 Dupont Avenue, Cleveland 8, Ohio, has announced the model 292XAL air-line microvolt signal generator, which provides continuous coverage from 125 kc to 165 mc on fundamentals.

The generator covers the aircraft band, including all the necessary intermediate frequencies and covers all radio frequencies with calibrated output. It can be externally modulated from 15 to 10,000 c.p.s., and measures both input and output of units under test.

COLOR CODE UNIT

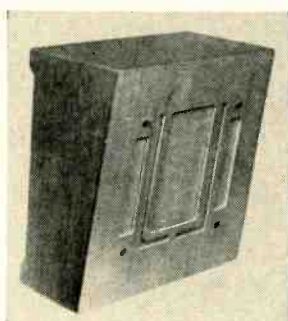
Centralab, Division of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis., is producing a color code calculator covering both capacitors and resistors.

The calculator is printed in full color. By setting seven rotating wheels, capacitance or resistance, tolerance, and temperature coefficient can be read directly. The calculator covers RETMA color code specifications on normal- and extended-range tubular ceramic capacitors and radial- or axial-lead resistors.



WALL BAFFLES

Utah Radio Products Co., Inc., Huntington, Ind., has announced the Utone line of wall baffles. They are obtainable in 6-, 8-, 10-, and 12-inch sizes in brown, red mahogany, limed oak, and unfinished.

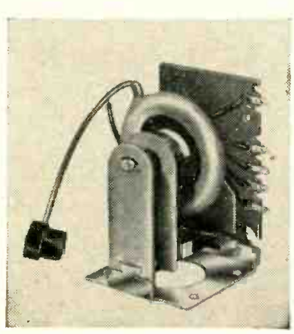


REPLACEMENT UNITS

The Standard Division of the Chicago Standard Transformer Corp., has added five TV replacement components to the Stancor line.

They include a new exact replacement flyback transformer, A-8137, exact duplicate of Hoffman No.5035, used in 25 Hoffman models and chassis, and A-8126, universal Philco replacement vertical blocking oscillator transformer. A-8126 can be used in all Philco TV models and chassis built up to the spring of 1953.

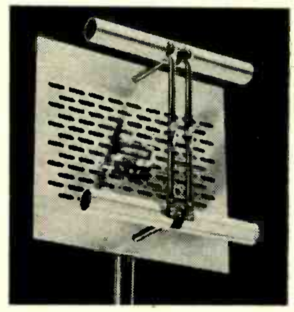
Two width controls, WC-1 and WC-4, and a tapped linearity coil, WC-2, also have been added.



U.H.F. ANTENNA

General Antenna Manufacturing Co., 1652 Rockwell Ave., Cleveland 14, Ohio, is producing an outdoor u.h.f. antenna reported effective up to 50 miles, depending on local conditions.

The 500-U has a low vertical radiation angle, low standing wave ratio, and 300-ohm terminal impedance.



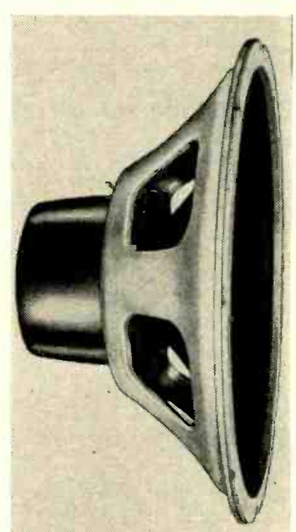
VOLTAGE REGULATOR

Perma-Power Co., 4727 N. Damen Ave., Chicago 25, Ill., has announced a TV voltage regulator, which returns full height and width of picture when it is distorted by low line voltage.

The unit has a 300-watt rating. A selector switch permits boosting or lowering of voltage.

HIGH-FIDELITY SPEAKER

Oxford Electric Corp., 3911 South Michigan Ave., Chicago 15, Ill., has announced a 15-inch speaker, No. HF15LN. The unit has a frequency range of 50 to 10,000 c.p.s., a 14-ounce Alnico V magnet, 25 watts power rating, an input impedance of 8 ohms and a 1½-inch-diameter voice coil.

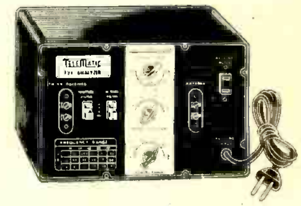


TVI ANALYZER

Tele-Matic Industries, Inc., 1 Joralemon St., Brooklyn 1, N. Y., is producing a TVI analyzer to identify TV interfering signals.

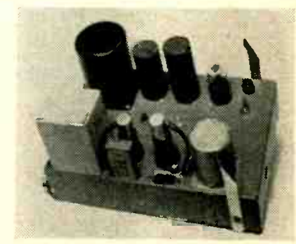
A cross-index scale indicates what wave trap or filter is needed to eliminate interference. The analyzer contains a high-pass and ignition filter section, an a.c. line filter section, and a full range of calibrated wave traps.

The unit is housed in a compact steel case with carrying handle measuring 5½ x 7-inches, and can be carried in a service technician's kit.



AUDIO ITEMS

RCA Victor Division of RCA, Camden, N.J., has announced three audio equipment items for AM-FM and TV stations. These are the type BA-12A utility amplifier, the LC-6A speaker mechanism and associated wall housing, and a microphone boom stand.



The BA-12A amplifier can serve as a microphone preamplifier, a turntable booster amplifier, a line amplifier, or an isolation amplifier. The 2-stage unit has a frequency response of ± 1 db 30 to 15,000 cycles.

LEARNER'S KIT

Progressive Electronics Co., 497 Union Ave., Brooklyn 11, N. Y., has announced its 1954 *Edu-Kit*, which features a new instruction book and a newly designed tester and manual. Circuits of a signal tracer, code oscillator, receivers and transmitters are included.

NEW CAPACITOR

Cornell-Dubilier Electric Corp., South Plainfield, N. J., has developed a molded tubular capacitor, the *CUB*, for general replacement service.

The unit is molded in mica-base bakelite. The 200- and 400-volt series are impregnated with HT compound, and the 600-volt and up series with Dykanol "C" oil. It is dry-assembly processed and sealed immediately after impregnation.

NEW OSCILLOGRAPH

The Instrument Division, Allen B. Du-Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J., has announced that an electrical equivalent of the well-known Du Mont type 304-A cathode-ray oscillograph is now available as a rack-mounted unit. The rack-mounted version is designated as the type 304-AR, and features the same built-in voltage calibration as the type 304-A. The illuminated screen is specially calibrated for reading any portion of the signal directly in volts. The screen is calibrated by a push-button control on the operating panel which applies a standardizing potential to the screen.

The type 304-AR incorporates a flat-faced, tight-tolerance cathode-ray tube, type 5ADP-, to increase accuracy of measurement. Voltage-reading range on a 4-inch scale is from 0.10 volt to 1,000 volts, full scale. Frequency response is flat at d.c. and extends to 300 kc, 50% down.

END

All specifications given on these pages are from manufacturers' data.

BIG!

the V-O-M with the BIG dial

SIMPSON'S NEW MODEL 269 VOLT-OHM-MICROAMMETER!

100,000 OHMS PER VOLT

Never before available commercially a Volt-Ohm-Microammeter with this sensitivity · 7 inch dial in 7 inch case · Read 33 Ranges direct on the dial · The biggest dial in the smallest possible case · It is ideal for voltage measurements in high resistance circuits · May be used in place of Vacuum Tube Volt Meter for many voltage and resistance measurements · Complete with Operator's Manual, pair of test leads with removable alligator clips, 4000 volt DC probe extension . . . only $88.00

RANGES FOR MODEL 269

DC Voltage

0-1.6 volts	100,000 ohms per volt sensitivity
0-8 volts	
0-40 volts	
0-160 volts	
0-400 volts	
0-1600 volts	
0-4000 volts	

AC Voltage

0-3 volts	5,000 ohms per volt sensitivity
0-8 volts	
0-40 volts	
0-160 volts	
0-800 volts	

AF Output Voltage

0-3 volts	0.1 microfarad internal series capacitor
0-8 volts	
0-40 volts	
0-160 volts	

Volume Level in Decibels

− 12 to +11 decibels	Zero DB Power Level .001 watt in 600 ohms
− 3.5 to +19.5 decibels	
+10.5 to +33.5 decibels	
+22.5 to +45.5 decibels	

DC Resistance

0-2,000 ohms (18 ohms center)
0-20,000 ohms (180 ohms center)
0-200,000 ohms (1800 ohms center)
0-2 megohms (18.000 ohms center)
0-20 megohms (180,000 ohms center)
0-200 megohms (1.8 megohms center)

DC Current

0-16 microamperes	267 millivolts maximum drop
0-160 microamperes	
0-1.6 milliamperes	
0-16 milliamperes	
0-160 milliamperes	
0-1.6 amperes	
0-16 amperes	

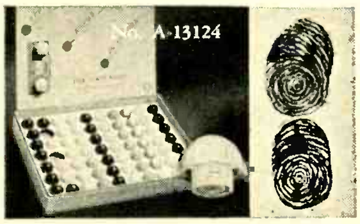
ALSO, SIMPSON'S NEW MODEL 262 VOLT-OHM-MILLIAMMETER!

20,000 OHMS PER VOLT SENSITIVITY $68.00!

SIMPSON ELECTRIC COMPANY 5200 W. Kinzie Street Chicago 44, Illinois EStebrook 9-1121

In Canada: Bach-Simpson, Ltd., London, Ontario

WANTED



By DEALERS, SERVICEMEN and others.

Suspected of willfully aiding and abetting them in saving time and satisfying customers.

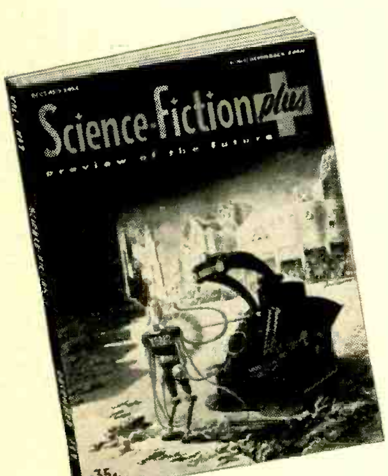
Name . . . **WALDOM'S AUTO KNOB ASSORTMENT**

Description . . . 70 CRONAME tenite knobs in assorted colors. Knobs are 7/8″ in diameter and will fit 3/16″ flatted shaft. Set screws included. Housed in attractive display box. Answers to No. A-13124

SPECIAL BULLETIN

Knob Assortments answering to above charge and description have been apprehended by your local parts distributor, assisted by **Woldom Electronics Inc.**, 911 N. Larabee St., Chicago 10, Illinois.

For the very best yet in



- science fiction stories
- articles
- features
- illustrations

READ SCIENCE-FICTION PLUS

December issue on sale October 9

Read the exciting and stimulating stories of science-fiction masters like Harry Bates, Murray Leinster, Eric Frank Russell and many, many others. Ponder over the challenging article "Extra-Terrestrial Communication" by Leslie R. Shepherd. See the finest science illustrations published anywhere, by such top flight artists as Frank R. Paul, Virgil Finlay and Lawrence.

On sale at all better newsstands, 35¢.

BUILD 15 RADIOS AT HOME

ONLY $19.95

With the New Improved 1954 Progressive Radio "EDU-KIT"

NOW INCLUDES SIGNAL TRACER and CODE OSCILLATOR

- FREE TOOLS WITH KIT
- ABSOLUTELY NO KNOWLEDGE OF RADIO NECESSARY
- NO ADDITIONAL PARTS NEEDED
- EXCELLENT BACKGROUND FOR TV
- 10 DAY MONEY-BACK GUARANTEE

WHAT THE PROGRESSIVE RADIO "EDU-KIT" OFFERS YOU

The Progressive Radio "Edu-Kit" offers you a home study course at a rock bottom price. Our Kit is designed to train Radio Technicians, with the basic facts of Radio Theory and Construction Practice expressed simply and clearly. You will gain a knowledge of basic Radio Principles involved in Radio Reception, Radio Transmission and Audio Amplification.

You will learn how to identify Radio Symbols and Diagrams; how to build radios, using regular radio circuit schematics; how to mount various radio parts; how to wire and solder in a professional manner. You will learn how to operate Receivers, Transmitters, and Audio Amplifiers. You will learn how to service and trouble-shoot radios. You will learn code. You will receive training for F.C.C. license.

In brief, you will receive a basic education in Radio exactly like the kind you would expect to receive in a Radio Course costing several hundreds of dollars.

THE KIT FOR EVERYONE

The Progressive Radio "Edu-Kit" was specifically prepared for any person who has a desire to learn Radio. The Kit has been used successfully by young and old in all parts of the world. It is not necessary that you have even the slightest background in science or radio.

The Progressive Radio "Edu-Kit" is used by many Radio Schools and Clubs in this country and abroad. It is used by the Veterans Administration for Vocational Guidance and Training.

The Progressive Radio "Edu-Kit" requires no instructor. All instructions are included. All parts are individually boxed, and identified by name, photograph and diagram. Every step involved in building these sets is carefully explained. You cannot make a mistake.

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" comes complete with instructions. These instructions are arranged in a clear, simple and progressive manner. The theory of Radio Transmission, Radio Reception, Audio Amplification and servicing by Signal Tracing is clearly explained. Every part is identified by photograph and diagram. You will learn the function and theory of every part used.

The Progressive Radio "Edu-Kit" uses the principle of "Learn by Doing". Therefore you will build radios to illustrate the principles which you learn. These radios are designed in a modern manner, according to the best principles of present-day educational practice. You begin by building a simple radio. The next set that you build is slightly more advanced. Gradually, in a progressive manner, you will find yourself constructing still more advanced radio sets, and doing work like a professional Radio Technician. Altogether you will build fifteen radios, including Receivers, Transmitters, Amplifiers, Code Oscillator and Signal Tracer. These sets operate on 105-125 V. AC/DC.

THE PROGRESSIVE RADIO "EDU-KIT" IS COMPLETE

You will receive every part necessary to build 15 different radio sets. Our kits contain tubes, tube sockets, chassis, variable condensers, electrolytic condensers, mica condensers, paper condensers, resistors, line cords, selenium rectifiers, tie strips, coils, hardware, tubing, hook-up wire, solder, etc.

Every part that you need is included. These parts are individually packaged, so that you can easily identify every item. Tools are included, as well as an Electrical and Radio Tester. Complete, easy-to-follow instructions are provided.

In addition, the "Edu-Kit" now contains lessons for servicing with the Progressive Signal Tracer, F.C.C. instructions, quizzes. The "Edu-Kit" is a complete radio course, down to the smallest detail.

TROUBLE-SHOOTING LESSONS

Trouble-shooting and servicing are included. You will be taught to recognize and repair troubles. You will build and learn to operate a professional Signal Tracer. You receive an Electrical and Radio Tester, and learn to use it for radio repairs. While you are learning in this practical way, you will be able to do many a repair job for your neighbors and friends, and charge fees which will far exceed the cost of the "Edu-Kit". Here is your opportunity to learn radio quickly and easily, and have others pay for it. Our Consultation Service will help you with any technical problems which you may have.

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PROGRESSIVE ELECTRONICS CO.

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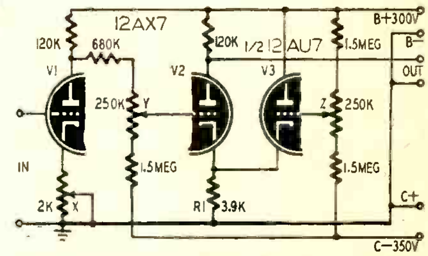
STABLE D.C. AMPLIFIER

Patent No. 2,620,406
Robert P. Nelson, Southbridge, Mass.
(Assigned to Philco Corp., Philadelphia, Pa.)

Direct-coupled circuits must be used for amplifying d.c. or very low frequencies, but unfortunately the gain of any circuit that responds to slow signal variations is also affected by even minor fluctuations in supply voltages. These changes in gain can be minimized by using carefully balanced push-pull stages throughout, large amounts of inverse feedback, and closely regulated power supplies, all of which call for very complex circuit arrangements.

This invention is a *single-ended* direct-coupled amplifier that is compensated against the effects of changes in supply voltages. The first two triodes (12AX7) are the d.c. amplifier. The third triode (one half of a 12AU7) draws considerably more plate current than the output section of the 12AX7, and determines the voltage drop across R1.



The bias on V2 is the sum of the drop across R1 and the negative voltage from the C supply at the slider of potentiometer Y. If the C supply voltage increases, the grid of V2 goes more negative. At the same time the V3 grid also receives a more negative bias. This reduces the current through R1. At the correct setting of potentiometer Z, the change in V3 current will restore the bias on V2 to normal.

V1 is especially sensitive to changes in the B supply because these variations are amplified by the following stage. Assume an increase in the supply voltage. This increases the V1 cathode current and raises the bias on its grid. The increase in bias *reduces* the cathode current again—but not necessarily to the original level, unless the cathode resistor has a certain critical value. By making the cathode resistor adjustable, a setting can be found that will hold the V1 plate current constant regardless of changes in the B supply voltage.

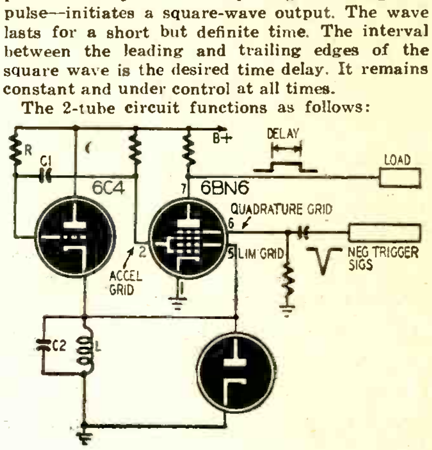
According to the inventor, circuit adjustments should be made in the following order: First set Y for desired output. Then adjust Z to compensate for drift in the bias supply. Finally, set X to neutralize variations in B voltage.

DELAY CIRCUIT

Patent No. 2,635,185
Robert F. Casey, Pompton Plains, N. J.
(Assigned to Allen B. Du Mont Laboratories, Inc., Clifton, N. J.)

Delay circuits are sometimes troubled by time-jitter. Hum modulation, thermal agitation, voltage drift, and other circuit variations may affect the delay interval and cause erratic operation. The circuit shown here has been engineered to prevent time-jitter. The input signal—a negative pulse—initiates a square-wave output. The wave lasts for a short but definite time. The interval between the leading and trailing edges of the square wave is the desired time delay. It remains constant and under control at all times.

The 2-tube circuit functions as follows:



1. A negative pulse applied to the quadrature grid of the 6BN6 reduces the plate current very little, but "partition action" increases the accelerator-grid current considerably. The voltage on the accelerator drops and feeds a negative pulse through C1 to the grid of the 6C4.

2. The triode blocks, and the sudden disappearance of cathode current permits C2 to discharge through L. The time required for C2 to discharge depends on the natural resonant frequency of the tank circuit. The discharge places a negative voltage on the limiter grid of the 6BN6.

3. This blocks the gated-beam tube and its plate voltage rises abruptly to the B+ value. This starts the square-wave output. It lasts until the voltage across C2 reverses polarity—that is, becomes positive. The diode now damps out the oscillation and removes the bias from the limiter grid. The 6BN6 conducts, its plate voltage drops to the original value and there is no further output till the next signal pulse arrives.

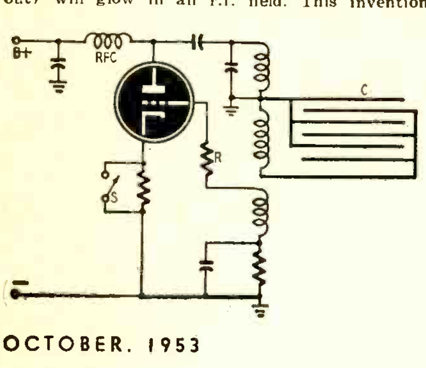
The delay interval depends only upon the natural resonant frequency of L and C2. It cannot be changed by other components or supply voltages.

FLUORESCENT DISPLAY

Patent No. 2,635,215

Frank M. Shoemaker, Pittsburgh, Pa.

A fluorescent lamp (even one that's burned out) will glow in an r.f. field. This invention uses this principle for display purposes. Fluorescent tubes are shaped to form characters and are placed in an r.f. field. If the r.f. oscillator is keyed on and off periodically, the characters or letters will blink.



The schematic shows a triode r.f. oscillator tuned to a relatively low frequency, (for example 120 kc) to reduce harmonic interference to broadcasting. Harmonic radiation is reduced still further by inductive coupling between circuits and by designing them for high Q. An anti-parasitic resistor R is connected in the grid lead. The switch S is opened and closed automatically to flash the sign.

The load capacitance C is made up of strips of metal foil. The r.f. field exists between them. The fluorescent characters are placed on shelves where they rest within the field. Unlike a neon sign, these letters are not connected to each other or to any source of voltage, so they may be moved about as required as long as they remain within the r.f. field.

ARC SUPPRESSION

Patent No. 2,637,769

(Assigned to Westinghouse Brake & Signal Co., Ltd., London, England)

When an inductive circuit is interrupted suddenly, the energy stored in the magnetic field induces a e.m.f. which may be many times greater than the original voltage. This induced voltage may force an arc discharge across the opened contacts. Repeated arcs will ruin relay or switch contacts and every effort should be made to avoid them. This patent discloses a simple method to suppress arcing.

Fig. 1 applies to d.c. circuits. L may be the winding of a relay or electromagnet. The rectifier is connected so that it cannot conduct while the switch is closed. When the switch opens, the d.c.-input circuit is broken and a counter-e.m.f. is induced in the winding L. This induced voltage appears across L with the opposite polarity to the original input voltage but in the right polarity for the rectifier to conduct.

If the rectifier alone were connected across L, it would have to be large enough to dissipate all the energy stored in the winding almost instantly. But by connecting the bias battery in series with the rectifier, L cannot discharge until the induced e.m.f. is greater than the bias voltage. This limits the discharge current through the rectifier, so

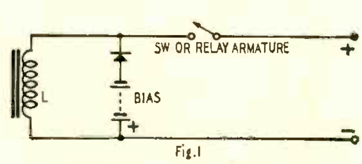


Fig. 1—Rectifier and bias across L.

that a relatively small unit can be used, and the stored energy is dissipated not in the rectifier, but in the battery.

Fig. 2 is a bridge-type arc suppressor for an a.c. circuit. Here the energy represented by the

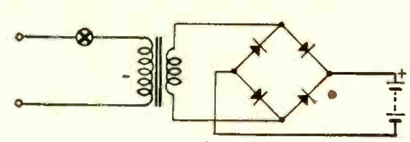


Fig. 2—Bridge rectifier for a.c. circuits.

e.m.f. across L is induced in a secondary winding. As before, the energy is dissipated within the biasing battery, and does not go back into the a.c. circuit.

The voltage induced by a rapidly falling magnetic field, such as that occurring when a circuit is opened, is often dangerous to life, especially in a heavily inductive circuit. For circuits of this type, the rectifiers should be of sufficient size to dissipate the heat created by a large current flow. This is true even in circuits which use a capacitor across the circuit switch to absorb much of the surge. When used in circuits with electric motors, values should be carefully computed. END

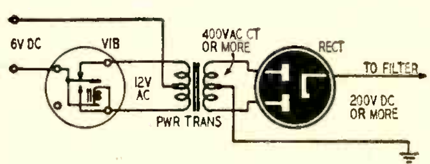
CHEVROLET 985793 RADIO

Several of these sets have been brought in with complaints of distortion and intermittent operation. In each case, the fault was traced to the spark plate connection which bypasses the 6SQ7 plate. This section of the spark plate develops a high-resistance to ground and causes the trouble. When we eliminated this connection from the circuit the trouble cleared up with no noticeable effect on reception.—*Geo. R. Anglado*

DEAD AUTO RADIOS

When servicing dead auto radios, I have a procedure for checking the power supply quickly so I will have more time to track down the trouble if it is in some other part of the set. The circuit of a typical vibrator supply is shown in the diagram. This is the procedure:

1. Check for 6 volts d.c. across the input to the supply. Measure the voltage at a point between the set and the fuse. Low voltage at this point when the 6-volt supply is perfect indicates excessive voltage drop in the supply line. Check the fuse holder for high resistance. If the fuse is blown, check the vibrator and make a resistance check to make sure that there are no



shorts in the transformer or filter.

2. Measure the voltage across the primary of the transformer. There should be 6 volts a.c. across each half and 12 volts a.c. across the full primary. No voltage is a symptom of a defective vibrator.

3. Measure the voltage between the rectifier plates. Average a.c. voltage measurements show 400 volts or more between the plates and 200 volts or more from each plate to ground. No voltage is indicative of a defective transformer. If a buffer capacitor is connected between the rectifier plates, it should be checked for a short or leakage.

4. Measure the voltage between the rectifier cathode and ground. It should be 200 volts d.c. or more. Low voltage is probably caused by a weak or burned-out rectifier tube.

Loss of signal or d.c. voltage at other points in the set may be caused by defective spark plates. Check the schematic for the location of spark plates and check each one for a short.—*A. von Zook*

RCA KCS66 TV CHASSIS

When the set was first turned on, sound came in normally for a few seconds and then dropped out when the raster appeared. There was no evidence of video modulation on the raster. The a.g.c. bias was normal (about 0) until the raster appeared and then falls to 35 volts negative.

This trouble was caused by an open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BIGGER MOTOR — (with ¾" lamination) develops 40 ft. lbs. torque at antenna mast . . . drives heaviest arrays!
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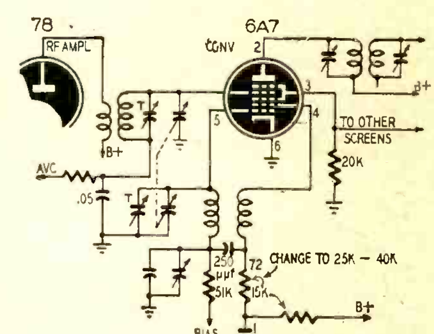
circuit in resistor R131 (the 2,500-ohm, 10-watt wirewound resistor between the 265- and 143-volt B plus lines). This is a voltage-dropping resistor which supplies reduced B plus voltage to the sync and a.g.c. circuits and holds the cathode of the 6CB6 a.g.c. amplifier at 100 volts positive. The grid of the 6CB6 is supplied with 80 volts positive from another source. When R131 opens, the 6CB6 cathode voltage drops below the grid. This renders the 6CB6 highly conductive to pulses from the horizontal sweep circuit and causes the development of excess a.g.c. bias. Excess bias cuts off the i.f. amplifier and blocks the sound and picture signals.

Replace the resistor to clear up the difficulty.—*George DeLaMater*

OSCILLATIONS IN PHILCO 645

Squeals and birdies on the high end of the 3–6-mc band are usually caused by oscillations in the 6A7 converter. This can sometimes be eliminated by trying several 6A7's until you find one which does not oscillate.

If the trouble cannot be eliminated by substituting 6A7's, try replacing the 15,000-ohm oscillator plate-dropping resistor (part 72 on the Philco schematic) with a 1-watt resistor of 25,000 to 40,000 ohms. The schematic shows the



position of this resistor in the circuit. Use the lowest value which results in an oscillator anode voltage of 70 to 85. If the converter performance drops off, increase the capacitance of the oscillator injection gimmick which is mounted on top of the tuning capacitor.

This type of trouble may also occur in other makes and models of old sets when a 6A7 is replaced with a new one.—*G. P. Oberto*

SEARS, ROEBUCK TV SETS

When one of these sets comes in with no high voltage and no obvious defect in the sweep and high-voltage circuits, take a look at the 1B3-GT high-voltage rectifier. In many instances, you will find that someone has installed a G-E 1B3-GT.

G-E 1B3's will not work in many Sears receivers because pins 1, 2, 3, 5, and 8 are connected internally. The socket is wired so that the high voltage is automatically grounded out when this type of 1B3-GT is used.

Substituting a 1B3 of a different brand will usually eliminate the trouble.—*Raymond W. Calvert* END

tv dx IN OCTOBER

OCTOBER, like September, will produce very little in the way of ionospheric dx. The early fall is one of the low spots of the year for sporadic-E skip. October will provide interest to the observer who likes to check the effects of weather variations on TV reception. Tropospheric dx will not equal the summertime skip in miles spanned, but it often provides steady or nearly steady signals from far beyond the normal range at this season of the year.

The best tropospheric propagation is usually associated with the changing seasons, so it will have passed its peak in the more northerly parts of the country in September. Below the Mason-Dixon Line, October may be at least as good as its predecessor. Worth watching in the North will be the effect of diminishing foliage, particularly where u.h.f. reception was begun during the green-leaf months. The removing of foliar screening may more than make up for the drop in signal levels that will accompany the arrival of cooler weather in the northern states and Canada, particularly in hilly terrain, or in sites where antennas aim directly into dense growths of deciduous trees.

Dx on u.h.f. continues to lag behind v.h.f., due primarily to the relatively poor performance of the majority of u.h.f. receivers. The summer of 1953 brought numerous instances of communication by amateurs using the 420-mc. band over distances exceeding 300 miles. This was done with power levels that are but a small fraction of those employed in u.h.f. TV transmission on only slightly higher frequencies. The hams have vastly superior receivers and antenna systems, so it seems only a question of time before u.h.f. TV receiving techniques will catch up. When this happens, tropospheric dx of 300 miles or more may be observed on u.h.f.

What the limit of u.h.f. dx will be is anybody's guess, but strong signals on the 420-to-450-mc band exchanged by hams over distances in excess of 400 miles will give some inclination of the possibilities.

CORRECTION

There is a discrepancy between the diagram and the text of the article "Tube-Filament Checker" on page 90 of the June, 1953, issue. The text specifies a 5-ma meter and the diagram specifies 500 ma. The value of 500 milliamperes on the diagram is correct.

We thank Mr. Allan W. Seely, of Danvers, Mass., for calling this to our attention.

PHOTOGRAPHS

RADIO-ELECTRONICS can use good photographs of service benches, service shops, high-fidelity audio layouts, and any other interesting and original radio-electronic devices.

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The Editor, RADIO-ELECTRONICS
25 West Broadway, New York 7, N. Y.

THE FUND REACHES $10,807.59

HELP-FREDDIE-WALK FUND

Herschel Thomason, radio technician of Magnolia, Arkansas, and father of five-year-old Freddie Thomason, writes the HELP-FREDDIE-WALK FUND as follows:

". . . Freddie is really looking forward to getting some arms. Almost every time we sit down to eat, he will tell us that Dr. Kessler is going to make him some

Freddie Thomason and young brother.

hands and that he will be able to feed himself. We are very anxious for next spring to come, for that is when they will start on his arms."

By this time, most of our readers are acquainted with little Freddie, the youngster who was born without arms or legs, and for whom life has meant a series of adjustments such as few of us can comprehend. Quite some time ago, he was fitted with artificial legs at the Kessler Institute for Rehabilitation, West Orange, N. J., and he is now learning to walk by himself. Each step forward is a new accomplishment requiring courage and faith, but these are qualities in which Freddie and his family have never been found lacking.

They and we have been encouraged not only by the welcome contributions to the Fund, but by the many expressions of affection and good will that often accompany donations. Typical of such messages are the following:

Received from Patricia L. Nield, Sec'y-Treasurer of The Sunshine Circle of Sacramento, Calif., along with their donation of $10.00: "We, The Sunshine Circle, are thankful that this case has been brought to our attention and that we are privileged to help Freddie attain health and happiness . . . We seek to reach out and give a touch of warmth, so necessary for the well being of those in need of help. Therefore, along with our gift for Freddie, we send our most sincere and heartfelt thoughts."

And from Frank Gabinowitz, of Long Branch, N. J., comes a donation of $2.00 accompanied by this note: ". . . It is good to hear that he is making progress at Kessler Institute with his legs . . . Every now and then I'll be only too happy to make a contribution to his progress. I believe in strong legs to work so weak legs can someday walk."

Won't you join our family of friends of Freddie? No donation is too small to receive our sincere thanks and acknowledgement, as well as the heartfelt appreciation of the Thomasons. *Make all checks, money orders, etc., payable to Herschel Thomason.*

Address letters to:

HELP-FREDDIE-WALK FUND
c/o RADIO-ELECTRONICS Magazine
25 West Broadway
New York 7, N. Y.

FAMILY CIRCLE CONTRIBUTIONS

Balance as of July 17, 1953	$ 602.50
FAMILY CIRCLE Contributions as of August 18, 1953	$ 602.50

RADIO-ELECTRONICS CONTRIBUTIONS

Balance as of July 17, 1953	$10,166.09
Anonymous, New York, N.Y.	1.00
A/IC E. J. Dupuis, Eglin A.F.B., Fla.	20.00
Frank Gabinowitz, Long Branch, N.J.	2.00
G. Leonard, Gouverneur, N.Y.	1.00
Edward J. Schnepf, Forest Hills, N.Y.	5.00
The Sunshine Circle, Sacramento, Calif.	10.00
RADIO-ELECTRONICS Contributions as of August 18, 1953	$10,205.09
FAMILY CIRCLE Contributions as of August 18, 1953	602.50
TOTAL Contributions as of August 18, 1953	$10,807.59

Radio Thirty-Five 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 of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

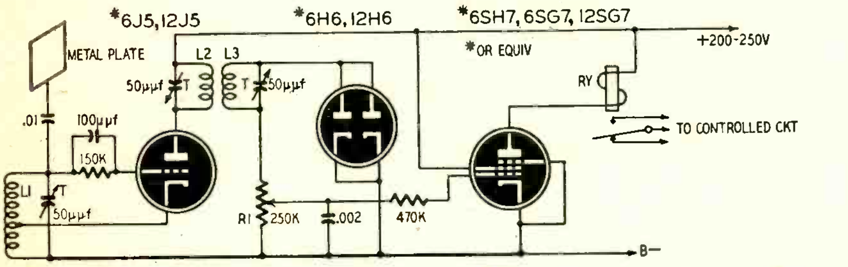
OCTOBER 1919 ELECTRICAL EXPERIMENTER

"My Inventions–
The Art of Telautomatics,"
by Nikola Tesla.
"Submarine's Under-water Radio."
"The Wireless Ukulele."
"Unique Radiophone Helmet."
"Government Radio Control—Once More," by H. Gernsback.
"Radio Problems in Aviation," by Edward Rice Doyle.
"Efficient Radio Crystal Detector," by Robert F. Gowen, R.E.
"Can Radio Ignite Balloons?" by Nikola Tesla and others.

END

SENSITIVE CAPACITANCE RELAY CIRCUIT

In the most common types of capacitance relay circuits, the relay tube is controlled by the cathode bias of the oscillator tube. In this circuit described by D. H. Sullivan in *Radio Constructor* (London, England), control bias is obtained from a rectifier coupled to the oscillator plate circuit.



L1, L2, and L3 may be tuned to any convenient frequency as long as it is not too low and is not in the broadcast band. L1 consists of 250 turns of No. 28 wire wound on a ⅜-inch form and tapped 50 turns from the ground end. L2 and L3 are each 200 turns of No. 28 wire wound side-by-side or one over the other on a ⅜-inch form.

The unit is simple to adjust. Set the sensitivity control R1 so the grid of the relay tube is grounded. Connect a high-resistance voltmeter or v.t.v.m. across R1 and adjust the trimmers across L2 and L3 for maximum indication on the meter. Advance R1 slowly until the relay just opens. When any comparatively large body approaches the metal pickup plate, the added capacitance appears across L1 and causes the oscillator frequency to shift. This reduces the r.f. voltage developed across L2 and L3. The rectified bias voltage across R1 drops and causes the relay to operate.

Materials for capacitance relay
Resistors: 1—470,000, 1—150,000 ohms, ½ watt; 1—250,000 ohms potentiometer.
Capacitors: 1—.002, 1—.01 μf, 1—100 μμf mica or ceramic. 3—50-μμf air or ceramic variable trimmers.
Miscellaneous: Chassis, ⅜-inch rod or tubing for coil forms, sockets, tubes; 1—plate-circuit relay with coil resistance of 2,000 ohms or more; hookup wire, and hardware.

PICTURE TUBE CHECKER

TV service technicians have developed various short-cuts for quickly determining whether the more common picture-tube complaints are caused by defects in the kinescope or in the receiver circuits. A recent issue of *Current Flashes* (Stromberg-Carlson TV service bulletin) shows how a 6AF6-G or similar twin-beam electron-ray tuning indicator can be used to check the voltages at the picture-tube socket. The diagram is shown in Fig. 1-a. The 6AF6-G socket is wired to a plug which fits the picture tube socket.

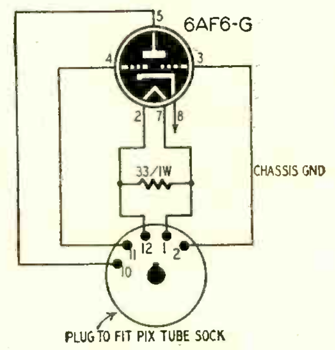


Fig. 1-a—6AF6-G is wired to plug.

The performance of the kinescope and associated receiver circuits can be checked by inserting the checker into the socket on the receiver. Indications are as follows: (1) A glowing heater indicates the presence of heater voltage on the C-R tube socket. (2) A bright green glow on the target indicates the presence of first anode voltage. (3) One of the shadows will have sharp areas as in the lower half of Fig 1-b. A properly functioning brightness control will cause the shadow area to vary as the control is rotated. (4) One-half of the target area will have fuzzy or blurred edges as in the upper half of Fig. 1-b. The blurred edge indicates the presence of video or sync information, or both. A properly operating contrast control causes the shadow area to vary as it is turned.

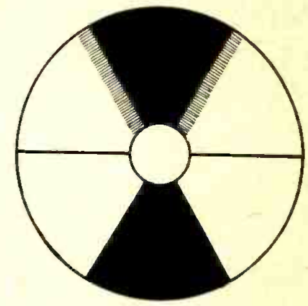
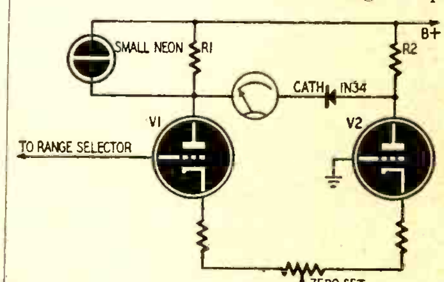


Fig. 1-b—Upper half has blurred edges.

On the Stromberg-Carlson models 24 and 119, the eye will overlap, but this does not prevent the contrast and brightness circuits from being checked as described above. On the model 317 series, the brightness and contrast controls affect the voltage on the cathode of the kinescope so the operation of both of these controls will be observed on the same half of the target.

PROTECTING V.T.V.M.

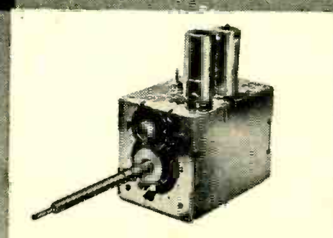
This circuit shows how a conventional bridge-type v.t.v.m. may be protected against overloading and possible burnouts. Resistor R1, the plate load of V1, is shunted with a small neon lamp. When the input voltage is zero, the voltage across R1 is just below the firing point of the neon lamp. Excessive input to the v.t.v.m. will cause V1 to conduct heavily and the voltage drop



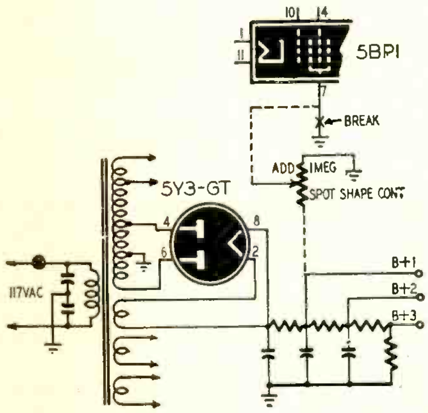
across R1 exceeds the firing voltage of the lamp. The lamp fires and practically short-circuits R1 so the full supply voltage is applied to the plate of V1. Ordinarily, the needle would tend to fly off scale in the reverse direction. However, this does not happen because the most positive voltage is now applied to the cathode of the 1N34 so that it does not pass current through the meter. The neon lamp may be mounted on the front panel of the meter to provide an immediate indication of meter overload.—*D. Sachs*

OSCILLOSCOPE MODIFICATION

My Eico model 425K scope performed well, but its trace was not as sharp as I desired. The spot was oval instead of round. I incorporated a spot-shape control which improved the trace. A 1-megohm potentiometer is the only component required for the modification. Pin 7 of the 5BP1 is normally



grounded. I lifted it off ground and connected it to the arm of the 1-megohm potentiometer connected between the first B plus lead and ground as shown by the dashed lines in the diagram. I mounted the potentiometer on the chassis, since readjustment is not

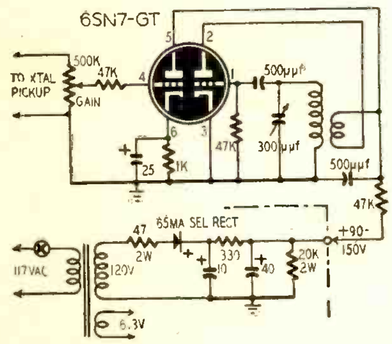


required until the C-R tube is replaced.

To adjust the control, turn the vertical and horizontal gain controls fully clockwise. Set the horizontal input switch to EXTERNAL and turn down the brightness to prevent burning the screen. Adjust the spot-shape control to produce a spot which is as round as possible while keeping the spot diameter at minimum with the focus control.—*Milton Herman*

NOVEL PHONO OSCILLATOR

The phono oscillator shown in the diagram will probably provide better quality than those in which the pickup works directly into one of the grids of a pentode or a multigrid converter tube. Since one half of the tube is used as an audio amplifier and plate modulator, it will provide a greater depth of modulation with less distortion.



The oscillator uses a standard Hartley-type broadcast oscillator coil tuned by a 300-μμf trimmer capacitor. The designer, writing in *Radio-Gen* (New Zealand), claims that the output is sufficient to cover a small home.

Power input should be the lowest value that will provide a usable signal at the receiver. Power-supply requirements are slight. Any supply delivering 90 volts or more at a few milliamperes will suffice. A suitable supply is shown below the main diagram. To vary the output, use a semivariable resistor in place of the bleeder. Connect B plus line from oscillator to the slider on the resistor and vary as desired. END

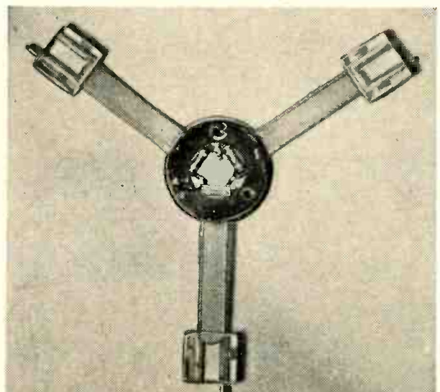
DEMAGNETIZING GUN

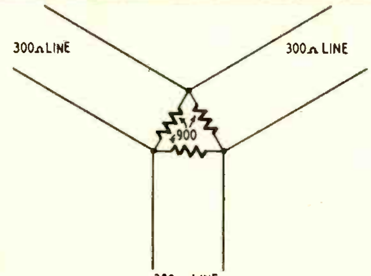
The magnetic field surrounding the tip of a Weller-type gun is useful for demagnetizing wrist watches and pocket watches. A special technique is needed for best results. Turn on the gun and place the watch between the tip electrodes or as nearly so as possible. Then slowly withdraw the watch, taking three or four seconds to get it a foot or two away from the gun (*which is left on*). Repeat this for each axis of orientation of the watch, and if it happens to be a large one, for each side. *Take care to avoid touching plastic crystals with the gun tip while it is hot.*

Of course, it is better to take precautions to keep from magnetizing the watches. They should not be brought closer than two or three times the largest dimension to modern magnetic structures, even momentarily. Multimeters, photographic exposure meters, and speakers are among common offenders. Both wrist and pocket watches should be removed before handling large PM speakers, even when speakers are inside their shipping containers.—*Gray C. Trembly*

ANTENNA COUPLER

You may sometimes want to couple two TV sets to a single antenna for a demonstration or a comparison.





Simply take three 2½-inch lengths of 300-ohm lead and connect them together as shown above, with a 900-ohm, ½-watt carbon resistor (standard 910-ohm units will serve nicely) soldered across each lead at the junction. Then rivet suitable fiber washers together so that the assembly is held between them.

When a 300-ohm TV-antenna lead is connected to any one of the legs and 300-ohm receiver inputs are connected to the other two, each of the receivers and the antenna "look into" 300 ohms. At the same time the signal from the antenna is divided equally.—*John T. Frye*

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If we receive this information before the 20th of the month, you will continue getting the magazine without interruption.

Your cooperation will be most helpful and greatly appreciated.

FINDING V.H.F.–U.H.F. BANDS

Harmonics from the oscillator of an accurately calibrated communications receiver can be a valuable aid in calibrating other receivers and converters designed for use on v.h.f. and u.h.f. bands. First, you must know the receiver's i.f. and whether its oscillator is on the low or high side of the signal frequency. With these facts, the set's oscillator can be used as an accurate signal generator. If the oscillator is above the signal, add the i.f. to the dial reading to get the oscillator frequency. Subtract the i.f. from the dial reading when the oscillator operates on the low side.

This is how a receiver using a high beat might be used to locate the 220-225-mc band which was opened to technicians: Set the receiver dial to 27.045 mc. Add the i.f. (455 kc in this case) to get the oscillator frequency (27.5 mc). The 8th harmonic (27.5 X 8) is 220 mc, the low end of the band. Similarly, tune the receiver to 27.67 mc to find the high end of the band at 225 mc.

Tune to frequencies between 27.05 and 27.67 mc to establish other points in the band. Although we have used the 8th harmonic in this example, other harmonics may be used to calibrate this and other v.h.f. and u.h.f. bands.

We must emphasize that the equipment to be calibrated must first be roughly calibrated with a grid-dip meter, Lecher wires, or a wavemeter to establish the approximate tuning range before attempting spot calibration with the communications receiver.

No direct connection is needed between the two receivers. Laying two short antennas side-by-side should provide sufficient coupling.—*S. H. Beverage, W1MGP*

FILAMENT WIRING HINT

In building sets where large filament currents are required, it is often considered necessary to parallel smaller filament transformers to get the required current. However, in such cases it is best to divide the filaments into groups and feed each group from a separate transformer. If the transformers are paralleled and their output voltages are not identical under all load conditions, circulating currents flow through the transformers and cause power wastage and possible transformer overload. You also get the advantage of isolation. Frequently undesirable coupling results from common filament supplies.—*Charles Erwin Cohn*

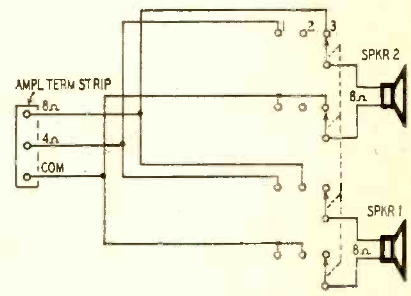
HANDY GROUND CLIPS

Someday when your wife isn't around, snitch one of her wave-set clips. They make good clamps to ground chassis during tests. I used a *Goody* clip which is nearly 4 inches long. It grips a large area of the chassis, thus assuring a good ground. There are holes in the clips, so all you have to do is attach a soldering lug and a length of ground wire.—*B. W. Welz*

SPEAKER MATCHING CONTROL

When two 8-ohm speakers are used with an amplifier, one in the cabinet and one at a remote point such as a rumpus room, it is often desirable to energize either one separately or both simultaneously.

For maximum output quality and volume a proper impedance match must be maintained. This is easily done by using a 4-deck, 3-position switch such as a Centralab type 1427. The schematic shows a hookup which can be made in

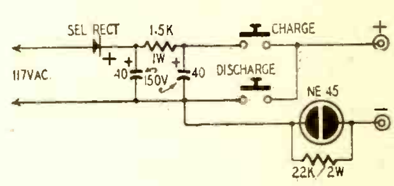


a matter of minutes. Most amplifiers have both 4- and 8-ohm taps. Both of these are used. Placing the switch in position 1 connects speakers 1 and 2 in parallel across the 4-ohm tap. Position 2 connects only speaker 1 to the 8-ohm tap and position 3 connects only speaker 2 to the 8-ohm tap. Thus we have properly matched impedance in all three positions.

This switching circuit can be used with speaker impedances different from those mentioned. The output taps on the amplifier and the speakers used are your guide. Just keep in mind that two 8-ohm speakers in parallel become one 4-ohm unit, and two 16-ohm speakers in parallel become 8-ohms. It's the law of parallel resistances, remember?—This system is of course not limited to 2 speakers. If sufficient power is available, you can hook up as many speakers as you wish. Always be sure that the total impedance of the sqeakers equals that of the transformer.—*John E. Howlett*

MODIFIED CAPACITOR CHECKER

The capacitor checker in the February issue (bottom diagram on page 115) worked fine but I was not satisfied. It had one feature I did not like. Sometimes we want to check a capacitor for its ability to hold a charge. I could not do this with the original checker because the capacitor automatically dis-



charged when the switch was released.

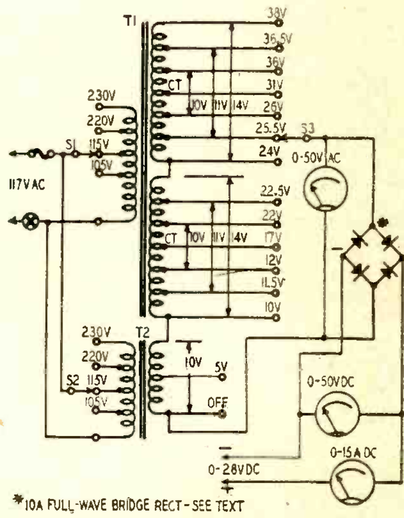
After some experimenting, I came up with a satisfactory circuit. See diagram. Two s.p.s.t push-buttons are used instead of the d.p.d.t. switch in the original model.—*Harold L. Wilkerson*

END

BATTERY CHARGER-ELIMINATOR

? *Please prepare a diagram of an a.c. operated power supply for charging storage batteries and operating dynamotors requiring 6 to 28 volts d.c. at a maximum of 10 amp.—O. H. M., Brentwood, N. Y.*

A. Here is the circuit of a power supply which will do the job for you. Transformers for high-current, low-voltage d.c. supplies are usually special items which are not generally available to the consumer. Of course, a suitable transformer can be obtained on special order but its cost alone is likely to be greater than that of a complete commercial supply having the same ratings The transformer should have a large number of taps on the primary and secondary windings to permit adjusting the voltage input to the rectifier to the required value for various d.c. loads and voltages.



*10A FULL-WAVE BRIDGE RECT - SEE TEXT

To avoid specifying a transformer which would have to be wound to order, we have designed the supply around 10-amp filament transformers having tapped primaries and secondaries. The secondaries are connected in series aiding. The sum of the secondary voltages should not exceed the maximum input to the rectifier. You can use any number of 10-amp transformers as long as you get the required a.c. voltage out of them. Since some UTC series CG filament transformers have dual multivoltage secondaries and multivoltage primaries, the large number of taps available makes them ideal for obtaining the desired a.c. output. Type CG-124 and CG-126 transformers or close equivalents are recommended for CT and T1 respectively. The positions of S1 and S2 can be changed independently.

You have a choice of copper oxide, magnesium-cupric sulphide, or selenium rectifiers. The maximum a.c. input voltage for each type depends on the make and type. Manufacturers' data gives the maximum a.c. input to each type when working into inductive, resistive, and capacitive loads. The a.c. voltage rises when the rectifier is not working into a load, so take care that the no-load a.c. input voltage does not exceed the maximum rating.

The output is not filtered. If a filter is required, try connecting several 500-µf, 50-volt electrolytics in parallel across the d.c. supply between the rectifier and the ammeter. Connecting old storage batteries in series across the output of the supply is an excellent way of obtaining smooth filtering and good regulation. Of course, with variable voltage output, you will have to change the battery connections so that their total terminal voltage ratings equal the output of the supply.

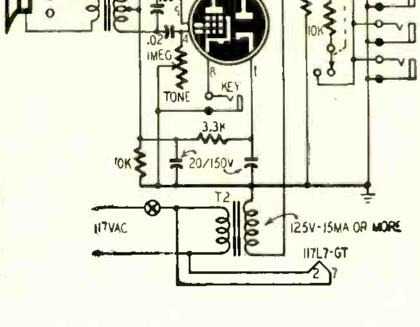
Readers desiring supplies of this type with different voltage ratings can use this circuit as the basis for their design. The current ratings of the transformers and rectifier should equal or be greater than the maximum current which will be drawn by the load. The maximum a.c. voltage required depends on the type and make of rectifier. Power rectifiers and data on them is rather difficult to obtain in many locations. You can obtain catalogs and information on sources of supply from: Sarkes Tarzian Inc., Rectifier Division, Bloomington, Ind.; Radio Receptor Co., Inc., 251 W. 19th St., New York, N. Y.; P. R. Mallory & Co., Indianapolis, Ind; and others.

Select a rectifier which will deliver somewhat more than the maximum voltage that you require. Note the a.c. input which it needs for the specified d.c. output, then select your transformer or transformers accordingly. Remember that the transformer should have as many taps as possible so that the rectifier input can be adjusted to meet actual operating conditions.

CODE OSCILLATOR

? *Several years ago I constructed a code oscillator from a diagram which appeared in Radio-Craft. The oscillator and its diagram were given away when I entered the service. I would like to duplicate this oscillator for a group of Boy Scouts. The unit used a 117-volt rectifier-amplifier tube and was designed to feed a speaker and several pairs of phones connected in parallel. Please reprint the original diagram or one similar.—A. E. T., St. Louis, Mo.*

A. We believe that this is the diagram that you used. T1 is a push-pull output transformer. A 1-megohm variable grid



resistor varies the pitch and a 50,000-ohm control varies the headphone volume. The half-wave power transformer T2 isolates the unit from the power line and minimizes the shock hazard. The transformer may be a Stancor type PS8415 or equivalent. Note particularly that the tube heater is connected across the a.c. line rather than across the secondary of T2.

OSCILLATOR SWITCHING

? *I am constructing a small signal generator which provides four spot frequencies for checking superhet alignment. The circuit (see Fig. 1) requires*

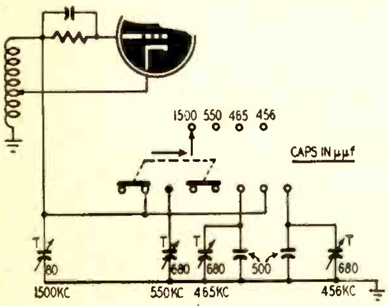


Fig. 1

a special slide switch which I cannot obtain. Please modify the circuit so that I can use a switch which is readily available.—J. W. S., Hartford, Conn.

A. The diagram in Fig. 2 shows how the circuit can be wired with a standard

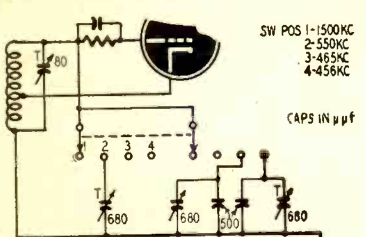


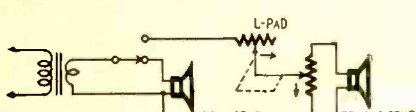
Fig. 2

double-pole (two-circuit) rotary switch having four or more positions.

EXTENSION LOUDSPEAKER

? *I plan to add an extension speaker and separate volume control to my audio system. Please show how the switch and volume control may be added without disturbing the impedance of the output circuit.—H. W. K., Hagerstown, Md.*

A. The diagram shows the circuit you requested. The L-pad and remote speak-



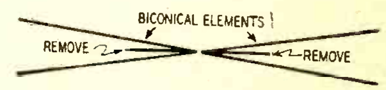
er should have the same impedance as the secondary impedance of the output transformer.

CONICAL ON U.H.F.

? *Is it true that conical antennas designed for the regular v.h.f. channels can also be used on u.h.f.? The particular one I have in mind has an "X"* *type reflector and the fed element has two short "high-frequency" bars.—E. T., Gaston, Ind.*

A. Most present-day television antennas will work on u.h.f. because they act as *long-wire* antennas on the higher frequencies. Losses are greater, however, and the antenna should be well spaced from tin roofs, shade trees, or other possible reflecting or absorbing surfaces. The transmission line should also be spaced from the mast, rain pipes, and other metal objects by 6 inches or more.

Because of the small dimensions necessary for u.h.f., a more efficient antenna could be used. The corner reflector type, rhombic, collinear, and others are most popular on these frequencies. Because half-wavelength spacings are smaller, multiple stacking



can also be utilized to increase gain.

(Incidentally, research has disclosed that the two small center arms of the biconical you mentioned actually load down the antenna and decrease instead of improve performance on both the high and low channels. Removing them will give you better signal strength.)

COAXIAL LINES

? *I got fairly good results using a home-made v.h.f. antenna in conjunction with a 300-ohm ribbon type transmission line. Since installing a commercial antenna plus an RB-59/U coaxial line, results are inferior to those of the old antenna. The new antenna is several feet higher than the old homemade affair. What is causing the poorer reception?—J. C., United, Pa.*

A. You are probably getting a mismatch with the coaxial cable at both the antenna and the receiver. A certain amount of mismatching is permissible when the antenna is connected to the transmission line. However, too great a mismatch results in serious loss of signal, and reflections are set up all along the line. Reflections in a transmission line may cause double images to appear on the picture tube screen just as readily as reflected signals at the antenna itself. Besides this, coaxial-cable transmission lines have higher losses than most 300-ohm ribbon types. Coaxial lines are most useful for their self-shielding properties where local noise levels are extremely high and the losses in the coaxial cable can be [illegible]. Type RG-11/U should be used [illegible]ssible, for it has lower losses than [illegible]G-[illegible]/U. The following table gives relative losses per 100-foot length:

Frequency	300-ohm ribbon	RG-11/U	RG-59/U
100 mc	1.25 db	1.88 db	3.66 db
200 mc	1.82 db	2.85 db	5.50 db

If you install 300-ohm line with the commercial antenna, your reception will probably improve. You should also make sure the new antenna is properly oriented. END

$3.00 FOR CARTOON IDEAS

RADIO-ELECTRONICS prints several radio cartoons every month. Readers are invited to contribute humorous radio ideas which can be used in cartoon form. It is not necessary that you draw a sketch, unless you wish.

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Les Wildberg, president of Leader Electronics, Inc., Cleveland, announced that his firm, which has been producing special industrial switches, would enter into the manufacture and sale of TV equipment for consumer use. Mr. Wildberg has been in the electronics field for over 30 years. He was the founder and former president of Radiart Corp. Other executives in the Leader organization include George J. Feiss, Jr., vice-president in charge of sales, and Ralph Blauvelt, chief engineer.

L. Wildberg

Vinton K. Ulrich joined David Bogen Co., New York City, as general sales manager replacing W. Walter Jablon, who resigned as vice-president in charge of sales. Ulrich was formerly renewal sales manager of National Union Radio. Mortimer Sumberg of the Bogen jobber sales staff has been upped to the position of distributor sales manager.

V. K. Ulrich

Edward P. Atcherley was appointed merchandising manager for renewal tube sales of Sylvania Electric Products, New York City. He was formerly regional sales manager for renewal sales in the Midwest district. Sylvania also announced the appointment of W. T. Buschmann to the new position of product sales manager of radio receiving tubes. He was formerly production requirements and service coordinator for the Radio Tube and TV picture Tube Divisions.

E. P. Atcherley

Douglas Carpenter and **Jim Hall** were appointed chief antenna development engineer and associate antenna test engineer, respectively, for JFD Manufacturing Co., Brooklyn, N. Y. Carpenter was at one time with La Pointe Electronics and Hall with the Civil Aeronautics Administration.

D. Carpenter

J. Hall

Karl W. Jensen, vice-president of Jensen Industries, Inc., Chicago, was elected chairman of the Electronic Parts & Equipment Manufacturers Association. Theodore Rossman, general manager of Pentron Corp., Chicago, was elected vice-chairman, and Helen

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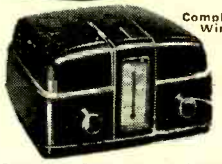

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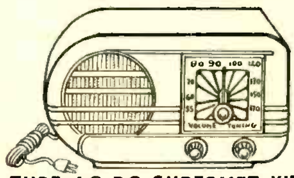

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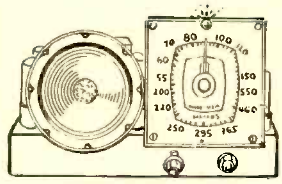

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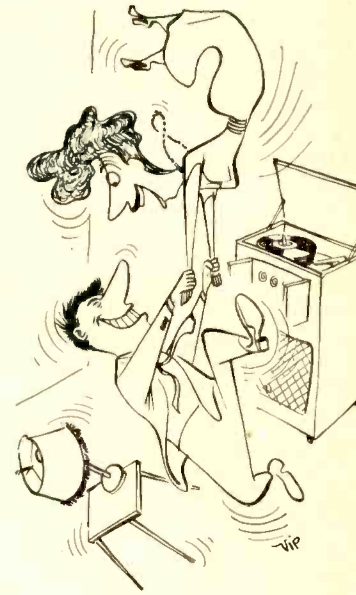

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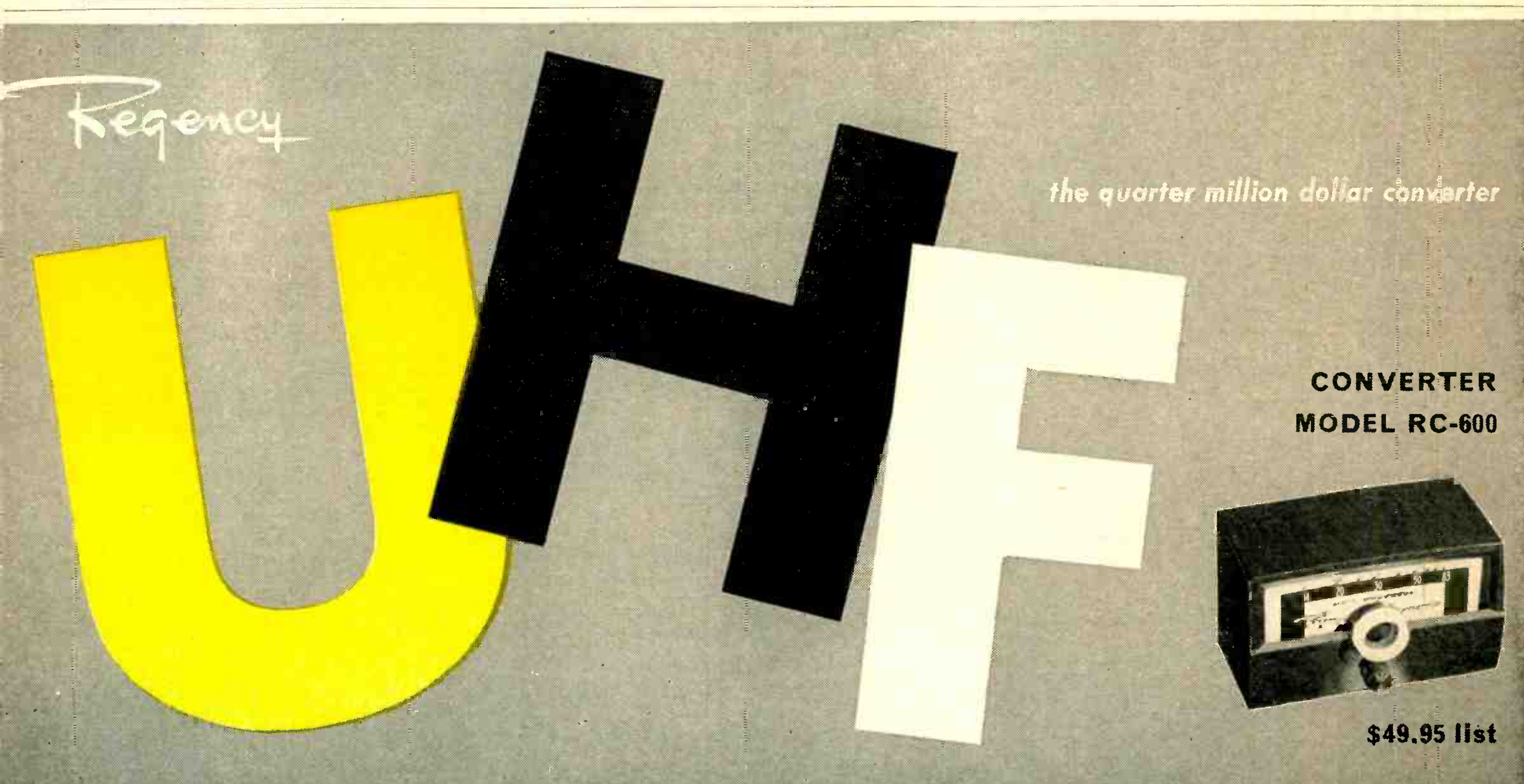

R. W. Jensen

Staniland Quam, distributor sales manager of Quam-Nichols Co., Chicago, was re-elected treasurer of the association for her 16th annual term. Kenneth C. Prince was re-named executive secretary.

Edwin A. Freed was named manager of operations of the General Instrument Corp. headquarters plant in Elizabeth, N. J. He was formerly sales manager. Robert L. Klabin, controller of General Instrument, was elected to manage the company's Sickles Division plant at Danielson, Conn. C. F. Sullivan, assistant controller, was named acting controller during Klabin's absence. General Instrument also announced the election of Malcolm C. Hutchison as a director of the company. Hutchison is a former vice-president of Irving Trust Co.

E. A. Freed

Jacob H. Ruiter, Jr. was appointed to the newly created post of public relations manager for the Allen B. Du Mont Laboratories, Clifton, N. J. He was formerly technical advertising manager.

Obituary

Fred R. Ellinger, president of Waldom Electronics, Chicago, and Ellinger Sales Corp., Chicago representative firm, died recently in Chicago after a short illness.

Personnel Notes

. . . **Jerome J. Kahn**, founder and president of Standard Transformer Corp. until its recent merger with Chicago Transformer Corp., withdrew from active management in the newly formed Chicago Standard Transformer Corp.

. . . **Robert C. Sprague**, chairman of the Board of Sprague Electric Co., North Adams, Mass., was elected a director of the Massachusetts Business Development Corp., a state agency created to attract industry to Massachusetts.

. . . **Harry C. Hagerty**, financial vice-president and director of the Metropolitan Life Insurance Co., was elected a director of the Radio Corporation of America.

. . . **Carl E. Smith** resigned as vice-president in charge of engineering of United Broadcasting Co., Cleveland, to devote full time to expanding his consulting engineering operation, that of Carl E. Smith Consulting Radio Engineers, Cleveland. He also continues as president of Cleveland Institute of Radio Electronics.

. . . **George A. Hinckley** was appointed sales engineer in the Equipment Sales Division of Raytheon Manufacturing Co., Waltham, Mass. He was formerly chief engineer of station WLAW

PEOPLE

. . . **Carolyn Chorlton** joined Aerovox Corp., New Bedford, Mass., as a physical chemist in the Research Department. She is a graduate of Seton Hall University and of Smith College.

. . . **Harry Goostein**, senior engineer with Clarostat Manufacturing Co., Dover, N. H., was promoted to manager of the Precision Control Division.

. . . **Roy E. Nelson** was promoted to the newly created post of manager of semiconductor equipment sales for the RCA Tube Department, Harrison, N. J. He was formerly with the Department's Government Equipment Sales as a sales engineer handling the development and sales of new products.

. . . **Martin W. Krenske** joined Edwin I. Guthman Co., Chicago, as assistant sales manager. He was formerly with Standard Transformer Corp.

. . . **Ross H. Reynolds** was appointed sales manager for commerical products, Government equipment, marketing in the General Electric Commercial and Government Equipment Department. He was formerly a project manager in the Army Equipment Section of Government Marketing.

. . . **Joseph J. Peterson**, formerly with Lee Electric & Manufacturing Co., was named to head the West Coast office of the RETMA Engineering Department. Jean A. Caffiaux, ex-Sylvania, was named assistant to Ralph R. Batcher, RETMA chief engineer, with headquarters in New York City.

. . . **John B. Swan, Jr.**, Philco Corp., and **William L. Fogelson**, P. R. Mallory & Co., were reappointed chairman and vice-chairman, respectively, of the RETMA Traffic Committee. Leslie F. Muter, Muter Co., was reappointed chairman of the Annual Awards Committee.

. . . **Robert C. Cheek** was promoted to the newly created post of assistant manager of engineering for the Westinghouse Electric Corp. Electronics Division. He was formerly assistant division sales manager.

. . . **Thomas M. Fitzgerald, Jr.**, joined P. R. Mallory & Co., Inc., as sales manager of the Capacitor Division. He had previously been with Stewart-Warner.

. . . **G. W. Moler** was appointed general sales manager of Potter & Brumfield, Princeton, Ind.

. . . **Rufus P. Turner**, independent consulting engineer and radio writer, was awarded the honorary degree of Doctor of Science by the College of Engineering of the Golden State University, Hollywood, California. Dr. Turner, who is well known to readers of this magazine for his many articles, was given the degree in recognition of his contributions to radio literature, simplification of test instruments, and popularizing of semiconductor devices.

. . . **Frank W. Mansfield**, Sylvania Electric Products, was reappointed chairman of the Industry Statistics Committee of RETMA, and Leslie E. Woods, Raytheon Manufacturing Co., was reappointed chairman of the Association's Industrial Relations Committee. END

HORIZONTAL HARMONICS

Dear Editor:

I have just read, with interest, the letter under the heading "Community TV Troubles" in the May, 1953, issue. This letter brings to mind another radiation problem caused by TV receivers—radiation of harmonics of the horizontal oscillator. This radiation is at its worst in the 80-meter amateur band and is detectable and often objectionable throughout the high-frequency communications bands.

About six months ago a neighbor of mine bought a 1953-model 21-inch TV receiver built by a prominent manufacturer. Harmonic radiation from the receiver's horizontal oscillator almost completely blocked the 80-meter band. A phone signal had to be from 30 to 40 db above S9 to be intelligible.

Why is it that hams are required to keep spurious radiations within the limits of good engineering practice and yet television manufacturers are allowed to produce equipment which radiates high-order harmonics with such terrific field strength?

J. N. PHILLIPS, W4SUF
Anniston, Alabama

REMOTE TOOTHACHE

Dear Editor:

Your editorial, "Radar Hazards," in the August issue of RADIO-ELECTRONICS, was of particular interest to me. It cleared up a mystery which has plagued me since 1943.

While studying 10-centimeter airborne radar gear as part of my training in the R.C.A.F., I noticed that soon after the sets were switched on, I would get a toothache. When the sets were turned off, the toothache would stop. None of the other boys in our group were similarly affected, but then none of them had such a large silver filling as I had. It was inevitable that someone would remark that I had a "resonant cavity." By reading your article, it became evident to me that the heat effect was the cause of my discomfort. In closing, let me say that I'm out to anyone who phones or calls me on the day the postman brings my copy of RADIO-ELECTRONICS.

JACK V. MILTON
Toronto, Ont.

COMMUNITY ANTENNA SYSTEMS

Dear Editor:

I wish to take exception to the conclusions drawn by Mr. E. D. Lucas in his articles on Community Antenna Systems. Unfortunately, his conclusions, as drawn from his own information, do not take into consideration the established facts.

Mr. Lucas, on page 40 of your August issue, recommends the use of broadband amplifier systems over individual channel-strip amplifier systems despite the fact that to date there are no commercially successful multi-channel broad-band amplifier systems in operation anywhere that compare favorably with individual strip amplifier systems.

RADIO-ELECTRONICS is paying good rates on *acceptance* for original and unusual articles on audio, television, FM and AM servicing, as well as articles on industrial electronic equipment and applications. Send for a copy of our Authors' Guide. Address:

THE EDITOR, RADIO-ELECTRONICS
25 West Broadway, New York 7, N. Y.

The use of individual channel-strip amplifiers is a far superior method of solving the problems found in Community Antenna Systems.

In making this statement, consideration has been given to the many interrelated problems inherent in the successful installation and operation of a Community Antenna System. These problems include:

1. *Control of Signal Levels*

   With broad-band amplifiers there is no control over individual channels. Even if a broad-band system starts out with individual strips and employs automatic gain con- at the antenna site, it is impossible to maintain proper signal level relationships through the miles of cable and the quantity of cascaded broad-band amplifiers that are involved. Cable attenuation is not linear with frequency. Different makes of cable have different temperature variations, which in turn are seldom linear with frequency. In addition, the effects of cable deterioration are not linear.

   Thus, the larger the system and the longer it has been installed—the greater the variations; the greater the need for individual control of each channel signal level in order to prevent the twin evils of snow and cross-modulation. Only individual strip amplifiers can do the job properly and keep each channel at the proper level.

2. *Broad-band Systems Use More Equipment*

   Broad-band amplifiers cannot be made with the gain or the high output that can be achieved with strip amplifiers. The gains of the broad-bands are generally about 20 db (40 db by stacking two amplifiers together). These amplifiers are spaced about 4 or 5 to a mile (at maximum rated output). To get 20 db, twelve tubes are used; for 40 db, twenty-four tubes are used.

   Jerrold "W" strip amplifiers use only five tubes per channel and have gains of 54 db, outputs of 1.0 volt and are spaced 2,600 feet apart (about two to a mile). Because of the higher output, much greater lengths of feeder lines can be run, further reducing the number of amplifiers to cover any given *area*.

   It can be proven by blueprint layout comparisons that in almost every case, strip amplifier systems will use less than ¼ the number of amplifiers that will be needed in broad-band systems.

3. *Less Maintenance with Strip Amplifier Systems*

   Because less equipment is used in strip amplifier systems, there will be less maintenance. If one strip goes out in the strip amplifier system, it only affects one channel; when a broad-band amplifier goes out, all channels are gone.

   Much is being made of the fact that in "chain" broad-band amplifiers, the failure of a tube does not affect operation because it only changes the gain of an amplifier by 1.5 db. This claim is based on theory, not practice.

(a) The channel level balance in a system using these amplifiers is often so critical that failure of tubes in this manner definitely does affect operation and can throw the system into either snow or cross-modulation or both.

(b) A large percentage of 6AK5 tube failures are inter-element shorts. This type of failure stops the entire broad-band system. Furthermore, the vastly greater number of tubes in a broad-band system over a strip amplifier system means that there can be more system-stopping shorts, than the combined total of all tube failures which occur in a strip amplifier system.

(c) Maintenance becomes more complex. Even if it is assumed that the 1.5 db supposition is true, the failure of a tube leaves the subscriber with a useless connection. These tubes are not easily located, and meanwhile the entire system, all channels, are out of operation.

What is true in both theory and fact is that with individual strip amplifiers it is possible to maintain constant gain, even with tubes that are aging. By applying AGC to at least every third amplifier in a system, as tubes age, the AGC takes control. Periodic preventive maintenance checks catch the weakening tubes and the system does not fail (it does not drop the picture into the snow level; it does not cause cross-modulation). Maintenance is reduced tremendously using strip amplifiers, and the customers have better, more constant pictures.

As for shorts, Jerrold is now using the 5654 Military-Industrial version of 6AK5. This tube is ruggedized and pre-selected. Troubles of all sorts are considerably reduced over the use of 6AK5 tubes. But even if a short does occur, it affects only one channel and not the whole system. Customers still have service on the other channels, and the tube failure is easy to locate.

4. *Broad-band Systems Cost More*
(a) Initial cost using broad-bands is much higher because of the greater amount of equipment.
(b) Operation cost is higher because maintenance is higher.

I think it is important for these facts to be brought to the attention of your readers.

JERROLD ELECTRONICS CORP.
MILTON J. SHAPP
Pres.
Philadelphia, Penna.

SERVICE TECHNICIANS

What was your most unusual service case? Not necessarily the most difficult one, but the one you will remember longest, either because of the problem itself or because of other conditions surrounding the job. If the experience was interesting to you, it probably will be to other readers of RADIO-ELECTRONICS. We will pay $10 for each "My Most Unusual Service Job" item we consider outstanding enough to publish in this magazine. If the item is striking enough or carries sufficient technical information to be worth more than $10 in our opinion, it will be paid for at our regular space rates. Address your stories to

Unusual Service Job
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25 West Broadway New York 7, N. Y.

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. All literature offers void after six months.

PICTURE TUBE COMPONENTS

Sylvania has issued a 4-page booklet describing tungsten and chemical components for TV picture tubes. Among the components described are screen phosphors, potassium silicate for screen settling, tungsten wire for cathode heaters, and triple carbonate cathode coatings.

Free on request from the Tungsten and Chemical Division, Sylvania Electric Products Inc., Towanda, Pa.

RADIO-TV CERAMICS

Stupakoff's latest 4-page brochure includes photographs and descriptive details on glass-to-metal seals, Steatite and other ceramics, printed circuits and ceramic-metal assemblies. A section is also devoted to the characteristics of Kovar glass-sealing alloy.

Request Bulletin No. 653 from the Stupakoff's & Ceramic Manufacturing Co., Latrobe, Pa.

PICTURE TUBE DATA

Federal's 8-page, 2-color *Picture Tube Data Book* gives interchangeability considerations, basing diagrams, bulb outlines, and dimensions and electrical characteristics of picture tubes of most manufacturers.

Available free on request to the Vacuum Tube Department, Federal Telephone & Radio Corp., 100 Kingsland Rd., Clifton, N.J.

TRANSFORMER CATALOGS

Stancor's 24-page transformer catalog carries complete electrical and physical specifications on almost 500 transformers for radio, TV, hi-fi, amateur, and other electronic applications. Featured are 25 new units, including 13 TV components and 5 transistor transformers, an increased TV section, and an expanded hi-fi section including miniature audio transformers and more detailed information on the Stancor-Williamson amplifier.

The company's 32-page 1953 TV transformer replacement guide lists replacement information on over 5,600 TV models and chassis. It covers 101 brands in alphabetical order, by model and chassis number.

Both available without charge from the Chicago Standard Transformer Corp., Standard Division, Addison & Elston, Chicago 18, Ill.

NON-LINEAR RESISTORS

Bulletin SR-3, *IRC Varistors* (nonlinear resistors) gives comprehensive data on voltage-current characteristics, current ratings, temperature characteristics, dimensions, and typical applications. The 6-page booklet is illustrated with charts and graphs.

Free from International Resistance Co., Special Products Div., 401 N. Broad St., Philadelphia 8, Pa.

KNOB CATALOG

Gee-Lar's 16-page well-illustrated catalog shows and describes hundreds of molded knobs for radio and television equipment. Switches, TV antenna mounts, connectors and other hardware products are also listed.

Ask for Catalog No. 55 from Gee-Lar Mfg. Co., 1330 10th Ave., Rockford, Ill.

A.C. ERASURE

Sound-Talk Bulletin No. 24 discusses a.c. erasure of magnetic tape. The 2-page technical bulletin describes the theory and practice of a.c. erasure, and covers such points as orientation, speed, and number of passes required.

Free from Minnesota Mining and Manufacturing Co., 900 Fauquier St., St. Paul 6, Minn.

LINE AND SLIDE SWITCHES

Stackpole's line and slide switches for radios, TV sets, appliances, small motors, toys, instruments and similar equipment are described in a 16-page bulletin, RC-9B.

Included are specifications, dimensions, and application data for seven new line switches recently developed for use with Stackpole variable composition resistors.

Available on letterhead request to Stackpole Carbon Co., Electronic Components Div., St. Marys, Pa.

SELENIUM RECTIFIER

Westinghouse's new type K *Magamp* selenium rectifier is described in a new 8-page booklet. Although developed for magnetic amplifier circuits and sensing devices this rectifier may be used wherever improved rectifier characteristics are needed.

The booklet includes the definition of selenium rectifier terms and electrical characteristics; graphs showing reverse current leakage limits and forward current-voltage drop under various conditions.

Request Booklet TD-52-650 from the Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

ELECTROLYTIC CAPACITORS

Astron has issued a new catalog supplement for its expanded line of twist-prong electrolytic capacitors. Included are catalog numbers, capacitance and voltage ratings, case sizes, and list prices of all standard twist-prong capacitors for radio and TV replacement needs.

Copies of Supplement AC-3A obtainable from Astron Corp., 255 Grant Ave., E. Newark, N. J.

DECIMAL EQUIVALENTS

Meyercord has printed a time-saving decal showing decimal equivalents in 64ths. Designed for application to slide rules, T-squares, drawing boards, desk tops and other similar equipment, the decal measures 6 x 1¼ inches. The figures are printed in sharp black and red type on a white background.

Free on request to the Mayercord Co., 5323 W. Lake St., Chicago 44, Ill.

TELEVISION AND RADIO REPAIRING, by John Markus. Published by McGraw-Hill Book Company, Inc., New York, N. Y. 6 x 9 inches, 556 pages. Price $7.95.

This repair manual differs basically from any we have read. It is prepared for persons who know *absolutely nothing* about radio or the use of tools. In simple language and with the aid of clear illustrations, it teaches how to solder, test tubes, read meters, and some of the fundamentals of business. It emphasizes the test, removal and replacement of parts, batteries and tubes. The latter come in for special attention. The author points out that they are responsible for about half of all troubles. This book does not cover trouble-shooting or trouble-localizing as most books do.

Interesting and practical chapters also include pickups and needles, antennas, tuning devices, and service-call suggestions.

The author of this book is highly optimistic. He states that any person who reads the manual becomes qualified to repair 75% of all radio-TV sets. Also, he feels that the life of an independent radioman is a happy one. He notes that the service technician can smoke, relax, listen to music while working, take a day off at will, and even write his own pay-check.

Unlike most books that are purportedly written for the novice, this text very scrupulously maintains an even elementary level. The author defends his position, that of preparing the reader to handle 75% of all service troubles, by very carefully covering the rudiments of day in and day out radio routine. Since the majority of receiver breakdowns are the result of tube failures and obvious defects such as resistors that have burned, the ability to test tubes and check for shorted or open capacitors should enable the beginner to handle most routine problems.

The book is recommended to technician's helpers who want to know something about radio. Radio-TV owners may also find it useful and practical. *—IQ*

TV TROUBLE TRACER, Volume 2. Published by Harry G. Cisin, 200 Clinton Street, Brooklyn, N. Y. 5½ x 8½ inches, 46 pages. Price 50¢.

This booklet can be helpful to TV owners and can save time for service technicians. It lists 40 typical TV troubles. They include vertical roll, insufficient width, ghosts, foldover, ion spot, etc. Each symptom is followed by probable causes and remedies.

The author has devised a novel time-saving method for localizing troubles due to defective tubes. He lists over 500 different models from more than 40 manufacturers. A tube lineup is given for each model, and each tube is associated with a significant letter, such as H for horizontal, B for brightness, S for sound. Thus if tube trouble is suspected, it is easy to locate the one that is responsible. *—IQ*

BASIC THEORY AND APPLICATION OF ELECTRON TUBES Published by the U. S. Government Printing Office, Washington, D.C. (TM 11-662/TO 16-1-255) 8 x 10 inches, 215 pages. Price $1.00.

This book will help beginners, students and applicants for radio licenses. It is an orderly presentation of facts relating to tubes of all types. Tube construction, calculation of constants, examples of applications are clearly shown. Large graphs show how to calculate amplification factor, plate resistance and mutual characteristics. The last few chapters cover transmitting and special types. One chapter describes how to use a tube manual effectively.

Each of the 12 chapters is divided into paragraphs which are numbered. This makes it easy to remember or note material which a reader may want to review or remember. Also it is easier to find information in the index.

Each chapter ends with review questions.—*IQ*

ALIGNMENT TECHNIQUES by Art Liebscher. Published by John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N.Y. 5½ x 8½ inches, 123 pages. Price $2.10.

This book is devoted entirely to the sweep alignment method of testing and adjusting TV receivers. It discusses markers and illustrates many sweep curves. Separate chapters show how to align video and sound i.f. amplifiers, discriminators and video amplifiers. The author suggests testing the video channel in two steps: square-wave methods for the i.f.; sweep technique for the h.f. He shows how to do this effectively. The last chapter is a brief presentation of u.h.f. alignment. The entire subject is well covered, but there are no schematics or block diagrams to show how test equipment is set up.

The author introduces a novel and efficient method for oscillator alignment. He applies a standard i.f. signal to the first detector along with the local oscillator signal. The beat generates a "supermark" near the carrier frequency. By varying the frequency of the oscillator, the *supermark* will approach the *carrier* marker along the sweep curve. When the oscillator is correctly set, the *supermark* and *carrier* markers will coincide. Alignment is quickly done since the same i.f. may be used on each channel.—*IQ*

DATA AND CIRCUITS OF MODERN RECEIVING AND AMPLIFYING VALVES (supplement 2) Published by Philips Technical Library. Distributed by Elsevier Press, Inc., 300 Park Ave., New York, N.Y. 6 x 9 inches, 487 pages. Price $6.50.

Tubes or "valves" give best results when used in appropriate circuits. Therefore circuit information is as important as tube data. This book gives both. All Philips tubes designed between 1945 and 1950 are included. Equivalent American types exist for practically any Philips tube, so the reader may convert and utilize the data.

The tube information includes all necessary average and maximum values, warm-up time for rectifiers, coupling between diode plates, microphony, etc. Circuit information includes coil design, recommended schematics (with component values), how to eliminate hum, shielding, etc. Large tube graphs are drawn on each type of tube.

The last 40 pages offer a description of Philips test instruments.—*IQ*

THE FLIGHT OF THUNDERBOLTS, by F. J. Schonland. Published by Oxford University Press, Amen House, E.C. 4, London, England. 5½ x 8¾ inches, 152 pages. Price $3.00.

Man has learned how to generate, distribute and utilize electricity, but has made little headway with nature's own brand, lightning. However, much of the hazard of lightning has been minimized. We know how to protect ships, buildings and power lines to a great extent. This book gives a full account of our present knowledge of lightning, its causes and effects.

Beginning with early times, the book describes the superstitions and fears connected with thunderbolts. It lists important fires and explosions caused by them. The invention of the lightning rod by Franklin changed all this. The interesting experiments which led up to this invention are given in some detail.

The book describes the safest spots inside a building and out-of-doors when lightning strikes. It details the latest methods for protecting livestock, telephone lines, ships and aircraft. Equipment used to record and investigate lightning is described.—*IQ*

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1N34A	.75	6G6G	.85	35T (Eimac)	2.75
1N48	.50	6H6	.52	35Z5GT	.53
1N54	.79	6J4	5.75	50A5	.77
1N54A	1.05	6J5GT	.50	50B5	.55
1N69	.60	6J6	.62	50C5	.60
1N70	1.25	6J7M	.75	50L6GT	.65
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6AK5	.65	12BA6	.60	5691	7.60
6AK6	.95	12BD6	.75	5693	6.25
6AJ5	1.30	12BE6	.60	5800(Vict)	6.50
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6AK6	.98	12BY7	1.03	8020	1.98
6AL5	.53	12SA7	.69	9002	.85
6AN4	1.50	12SF5	.70	9003	1.25
6AQ5	.55	12SG7	.80	9004	.35
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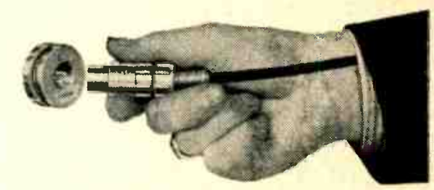
ADVERTISING INDEX

RADIO SCHOOL DIRECTORY PAGE 171

The XL series —available through radio parts distributors and electrical wholesalers everywhere

CANNON PLUGS



Cannon's famous XL Connector Series for audio applications is available in 14 shell designs through Radio Parts Distributors and Electrical Wholesalers. These lightweight, compact connectors embody many desirable features: adaptable either to cord end or wall mounting applications...convenient latchlock coupling device...cable entry with compression gland and relief spring or integral clamp...tapped metal for insert retaining screw...provision for special grounding contact or grounding to shell. Accessories include dust caps and adapter shunts, receptacles for integral mounting on microphones and other audio components. Watch for the colorful Cannon counter display carton at your Radio Parts Distributor.

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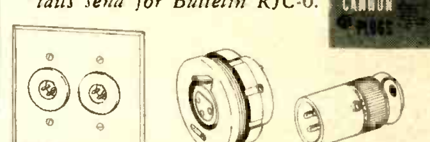

XL Connectors are available in 14 shell designs shown here.

Watch for this Cannon XL counter display carton.

CANNON ELECTRIC

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Radio-Electronics does not assume responsibility for any errors appearing in above index.

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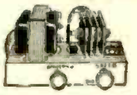

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1AMP	1.35	2.15	3.70	7.50
2AMP	2.20	3.60	5.40	10.50
4AMP	4.25	7.95	12.95	29.25
6AMP	4.75	9.00	13.50	33.00
10AMP	6.75	12.75	20.00	40.00
12AMP	8.50	16.25	25.50	45.00
20AMP	13.25	25.50	39.00	79.50
24AMP	16.25	32.50	45.00	90.00

Full-Wave Selen Rect & Trans. in Kit Form. All 115V/60 cy inputs
up to 14VDC at 12 amps $23.98
up to 28VDC at 12 amps 31.98
up to 28VDC at 48 amps 129.00

"TAB" THAT'S A BUY

★ ★ ★ SPECIALS ★ ★ ★
POWERSTATS & TEST EQUIPMENT

Type 20/0-135V/3 Amp/LN	$ 10.98
Type 116U/0-135V/7.5 Amp/LN	16.98
Type 116/as above, except cased N	20.49
Type 1126/0-135V/15 Amp/LN	41.98
Type 1226/0-270V/9 Amp/LN	41.98
3000 8U/0-135V/30 Amp/4KV/N	48.00
3020 8U/0-270V/18 Amp/4.9KV/N	48.00
GR50A/0-135V/45 Amp/5KV/LN	100.00
GR50B/0-270V/31 Amp/7KV/LN	100.00
SIMPSON MODEL 260 VOM N	34.98
HICKOK 600A Mutual Tube CHKR N	142.98
GE ST4A Sweep Generator (N)	300.00
GE ST5A Marker Generator (N)	325.00
GE ST2A Oscilloscope (N)	275.00
HF-1 Oscilloscope, new special	79.95

NEW (N) LIKE NEW (LN)

OIL CONDENSER

DUAL 8 MFD
600 VDC
$2.25
FITS STD 4 PRONG SOCKET
4 HOLE FLANGE MOUNTING

RHEOSTAT SALE

2 ohm 50W Model J	2.25; 5 for 10.00
6 ohm 25W Model LH	1.49; 2 for 2.49
15 ohm 25W w/knob	1.49; 2 for 2.49
20 ohm 50W Model J	1.98; 2 for 3.50
60 ohm 50W w/knob	2.25; 2 for 3.98
100 ohm 50W Model K	1.98; 2 for 3.50
200 ohm 25W Model D	1.49; 2 for 2.49
250 ohm 25W ......ea.	1.19; 3 for 2.98
300 ohm 225W Model P	2.98; 2 for 5.00
350, 500, 5000 ohm Slotted shaft. 25 watt	79¢; 3 for 2.00
1200 ohm 225W Model P	4.98; 2 for 9.00
2500 ohm 25W	1.98; 2 for 3.50

CONDENSER SPECIAL

2 MFD
1000 VDC
330 VAC
"CD" MFGR
25¢ Lots of 10

..Smaller Quantities, each..49¢; 3 for $1.25
2MFD 600VDC Porcelain Insulators with Adjustable Mounting Clamp...3 for $1.50

PALMER CLAW HAMMERS

85¢ Lots of 3
REGULAR $2.95
STD 16 OZ BRAND NEW
SMALLER QUANTITIES, EACH 98¢
Stillson Wrench 1st Quality 8". 98¢
Stillson Wrench as above 10". $1.25
Vernier Caliper 5" capacity.
Precision Vernier action $1.10

YOU PICK THEM 59¢ WHILE THEY LAST

LOTS OF 10
Your selection of 10 at 59¢ each or smaller quantity at indicated prices.

ELECTROLYTIC CONDENSERS

2X 20MFD/450VDC	.69¢: 3 for $1.95
3X 15MFD/450VDC	.98¢: 3 for 2.50
3X 20MFD/400VDC	.79¢: 2 for 1.29
80MFD/450VDC	.79¢: 2 for 1.29
25MFD/450VDC	.69¢: 3 for 1.95
45MFD/450VDC	.79¢: 2 for 1.29
20MF/450V&20MF/25V	.3 for 1.95
50 mf/350vdc FP	5 for 1.00
30-15-10 mf/250vdc	5 for 1.00
40-20mf/250-25vdc	6 for 1.00
30-2x20mf/450-25vdc	3 for 1.00

ELECTROLYTIC CONDENSER KIT

POPULAR VALUES **25¢ ea.** lots of 15
Here is a handy assortment of 15 condensers for the serviceman $3.75

TV & COAX CABLE

300 Ohm Twinex. Heavy duty 65 mil all copper TV lead in.
per ft. 2¢: 100 feet $1.39
1000 foot reel $11.95
RG59U 73 ohm TV Coax Cable MFGRD to rigid UHF specs.
per ft. 5¢; 100 feet $4.50,
SPECIAL 500 feet $22.00

INFRARED SNOOPERSCOPE

SEE-IN-DARK TUBE
Image-Converter Tube HiSensitivity simplified design 2" dia. Willemite screen—data & tube, ea. ......$4.98; 2 for $9.49

SNOOPERSCOPE PWR SUPPLY
1800VDC/35MA, Using Doubler Crkt. Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram $6.98

TUBE SPECIALS

YOU PICK THEM **39¢** lots of 10
Cracked base or broken key electrically perfect
TESTED & 90 DAY GUARANTEED
ORDER NOW, WHILE THEY LAST
5U4G — 6SN7 — 25L6GT — 35Z5
5Y3GT—6K6GT—12SA7GT—6H6
6V6GT—6BQ—6W4GT—12SG7

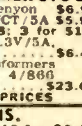
"TABS" NEW TRANSFORMER STOCK

2.5VCT/10A 12.5KVINS Kenyon $6.98
778VCT/200MA 5V/3A, 6.3VCT/5A $5.98
800VCT/150MA Stancor $5.98; 3 for $16;
850VCT/148MA 5V/3A, 6.3V/5A, 6.3V/3A $6.49
2500VDC/200MA KIT. Transformers power & bridge filaments & 4/866 rectifiers. Special $23.00
WRITE FOR QUANTITY PRICES

FILAMENT TRANS.

2.5V/2A @ 79¢; 2 for $1.49; 10 for $6.49
6.3V/2AMP @ $1.08; 2 for 1.98
2.5VCT/10A 5KVINS 3.59
5VCT/10A/12KV INSUL G.E. 8.25
7.5VCT/12A CSD KENYON 15 KVINS 10.95
24V 1.25A CSD @ $1.98, Two for 3.49
2X12V/2A or 24V/2A @ $3.89. Two for 6.98

TRANSFORMERS



All 115 V 60 Cyc Input TV, & CR pwr Xmfr up to 20" tubes. HI VOLTS to 20 Kv (w/quadrupler ckt.) ALL tubes. PL & FIL wndgs 300 VDC/275 Ma Full-Wave; 6.4/10.3A, 5.4V/8A, 2.5V/3A Hypersil Core Oil Impreg. $6.49; Two for $12.49
1000VCT/45MA, 795VCT/80MA, 360VCT/55MA 3X5V/3A, 6.3VCT/1A, 6.3VCT/1A CSD HVINS CAN BE USED 2X RATING RAYTHEON HYPERSIL CORE ....$ 4.98
950VCT/100 MA, 5V/2.5A, 5V/5A, 45V/1A, 10V/1.5A WESTERN ELECT ....$ 5.49
900V/35MA, 2X2.5V/2A, XCLENT 1800V DBLER TWO 2X2 FIL WNDGS ....$ 2.25
840VCT/110MA, & 530VCT/21MA. 2X5V/3A, 6.3VCT/1A, 6.3VCT/1A ....$ 3.45
780VCT/250MA, 5V/6A, 12.6V/5.5A $ 7.95
770VCT/200MA, 5V/6A, 12.6V/5.5A $ 6.95
770V/2.5MA, 2.5V/3A, HVINS HMSLD includes FILTER PARTS 4/scope ...$ 3.69
700VCT/120MA, 2X6.3V/3A, 6.3V/1A Price ....$3.98; Two for ....$ 7.25
700VCT/100MA, 2X6.3V/1.5A, 5V/2A, Isolation Winding 120MA ....$ 3.49
680VCT/200MA, 5V/3.5A, 6.3V/4A, 78V/1A ....$4.39; 3 for $12
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6, 12, 24, 115VDC & 115 & 230 VAC @ $ 1.49

FILTER CHOKES

12Hy/80ma/H'Sld/3KVins 2.25
10Hy/125ma/UTC/Csd/H'Sld/1Kvins 1.49
50Hy/125ma/Csd/H'Sld 2.69
20 Hy/300ma or 15HY/400ma/12KVins 8.95
13.5Hy 1 amp 17 Kvins Raytheon..39.95
6 Hy/175ma. 250 ohm...1.49; 2 for 2.49
12 Hy/300ma, Hmstd 5KVins 4.95
10 Hy/85ma 350 ohm ...95¢; 2 for 1.69
3 Hy/40ma UTC Hi "Q"..95¢; 2 for $1.39

ONE YEAR GTD PICTURE TUBES

10 BP4	$13.98
10 BP4A	14.49
12" Glass	17.95
12" Metal	21.98
14" Rectangular	20.95
16" Glass	22.95
16" Metal	23.98
17" Rectangular	23.49
19" Round	27.98
20" Rectangular	29.95
21" Rectangular	30.98

Your old pict. tube is worth money, write for trade-in allowance on RMA coded and dated tubes with one year guarantee. Ship your defective picture tubes prepaid only. When ordering metal tube, defective metal tube is required.

TUBES

*From This Special List We Ship $10.00 and Up Tube Orders At Our Expense (Postpaid) Within Continental Limits of U.S.A.
90 Day Gtd. When ordering mention 10RE

OA2	.95
OA3/VR75	1.04
OB2	1.37
OB3/VR90	1.09
OC3/VR105	1.15
OD3/VR150	.90
183/3016	.81
1X2A	1.29
2X2	.49
2X2A	1.53
5R4GY	1.55
5R4WGY	1.75
5U4G	.69
5Y3GT	.43
6AG5	.79
6AG7	1.39
6AH4G	1.49
6AH6	1.22
6AJ5	1.40
6AK5	.74
6AK6	1.05
6AL5	.54
6AL7GT	1.29
6AN5	2.90
6AQ5	.55
6AQ6	.81
6AQ7GT	1.29
6AR6	2.9[illegible]
6AS5	.79
6AS6	2.43

6AS7G	4.65
6AT6	.63
6AU5GT	1.10
6AU6	.59
6AV5GT	1.29
6AV6	.49
6AW6	1.89
6AX5	1.23
6BA6	.63
6BA7	1.27
6BC5	.63
6BC7	1.23
6BD5GT	1.65
6BD6	.83
6BE6	.59
6BF5	.98
6BF6	.55
6BF7	2.55
6BG6G	1.39
6BG7	1.98
6BH6	.83
6BJ6	.69
6BK7	2.15
6BL7GT	1.45
6BN6	1.79
6BN7	1.69
6BQ6GT	1.20
6BQ7	1.65
6C4	.50
6C86	.69

6CD6G	1.69
6D4	2.70
6H6	.60
6J4	6.95
6J5GT	.47
6J6	.63
6K4A	6.45
6K6GT	.59
6L6	2.09
6L6G	1.35
6L6GA	1.35
6L6GAY	2.29
6SA7GT	.63
6SC7	.90
6SD7GT	.80
6SF5	.73
6SF7	.73
6SG7	.72
6SH7	.61
6SJ7	.70
6SK7GT	.69
6SL7GT	.69
6SN7GT	.70
6SQ7GT	.63
6SR7	.65
6SS7	.75
6ST7	.98
6V8	1.39
6V6GT	.57
6W4GT	.57

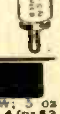
6X4	.59
12AH7GT	1.4[illegible]
12AK5	1.9[illegible]
12AL5	.59
12AT6	[illegible]
12AT7	.81
12AU6	.72
12AU7	.63
12AV6	.49
12AV7	.98
12AW6	1.79
12AX4GT	1.20
12AX7	.63
12AY7	2.7[illegible]
12AZ7	1.49
12B4	.79
12BA6	.59
12BA7	.79
12BD6	1.23
12BE6	.59
12BF6	.85
12BH7	1.29
12BY7	1.35
12BZ7	1.25
12SA7GT	.69
12SC7	.80
12SF5GT	.72
12SF7GT	.49
12SG7	.83
12SH7	.63
12SJ7GT	.59

12SK7	.74
12SL7GT	.65
12SN7GT	.75
12SQ7GT	.61
19T8	1.09
19V8	1.62
25BQ6GT	1.19
25L6GT	.69
25Z5	.79
25Z6GT	.99
28D7	1.9[illegible]
35Z5GT	.69
50L6GT	.69
80	.69
81	1.69
82	1.19
82V	1.39
83	1.45
83V	1.7[illegible]
84/6Z4	.99
117L/M7GT	1.59
117N7GT	2.49
117P7GT	1.39
117Z6GT	1.13
117Z7GT	1.49
CK501X	1.26
CK501AX	2.20
CK502AX	1.49
CK503AX	1.49
CK505AX	1.79
CK506AX	1.49
CK509AX	1.79
CK512AX	1.45
CK522AX	1.29
CK525AX	1.29
CK526AX	1.49
CK528AX	1.49

CK529AX	1.79
CK5310X	1.89
CK532DX	1.89
CK533AX	1.29
CK534AX	.99
CK536AX	.99
CK537AX	3.04
CK538DX	.98
CK539DX	2.19
CK5430X	.99
CK5440X	.99
CK546DX	1.99
CK547DX	1.98
CK571AX	2.49
CK573AX	3.49
CK1005	.85
1625	.33
2050	1.47
2051	1.15
5636	[illegible]
CK5676	1.29
CK5678	1.89
5687	5.49
CK5702	3.49
CK5703	1.29
Xtal Diodes	
1N21A	1.55
1N21B	2.89
1N21C	2.50
1N22	1.25
1N23	1.35
1N23A	2.20
1N23B	2.25
1N34	.64
1N34A	.90

Many types in stock. Write

CRYSTAL DIODES



1N23B Sylvania $1,89 Lots of 10
Smaller Quantity, Unit Price $2.25

1N21	85¢: 6 for $ 4.00
1N21A	$1.55; 5 for $ 7.00
1N21B	$2.89; 4 for $10.00
1N27	$1.55; 5 for $ 7.00
1N46	69¢; 5 for $ 3.25

REDUCED METER SPECIALS

0-30 VDC "AN"	1.98; 2 for 3.25
0-60 ADC "AN" Type Less Shunt	2.95; 2 for 5.00
0-15 VAC GE 2½ RND 800cy	1.29
0-150 VAC WSTGHS/2½/RND 60 cyc.	3.49
0-150 VAC/25-125cy/3½"Sq/RA35	5.98
0-1 MADC WSTGHS/3½"SQ/RA35	6.49
0-50 Microamps Weston 301 3½" Sq.	13.98
0-500 MADC 2½"/RND Triplett/221T	4.98
VU–20 +3WESTON/301/3"Sq/L.P.$41	14.98
0-120 MA RF 3½" RND Weston 301	12.98

SELSYNS

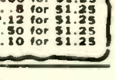
AY1 & AY5 28V/400 cy or 22V/60 cy. Each ... **$3.49**
AY20 Brand New 12.98
2J1H1 GE Selsyns ....Each 8.98
2J1F3 GE Brand New 115V/400 cy. Each 9.75
C78248 Sync Trans. 115/60 cy. .....$30.00; 2 for $55.00
C78249 Sync. Diff 115V/60 cy 12.95
Sync. Repeater 115/60 cy Type 11-4 49.50
OTHER TYPES IN STOCK

YOU PICK THEM $1.00 WHILE THEY LAST

LOTS OF 5
KITS AND COMPONENTS

Oil Condensers Asst.	5 for $1.25
Electrolytic Condensers Asst.	5 for $1.25
SPRGE CRP 3 Vert Integrator Netwk 3 Res-3CNDS R only 3 LEADS 29¢	6 for $1.00
50 PWR Magnifier & Condsr	2 for $1.25
Silver & Mica Cndsrs	15 for $1.25
Controls, Popular Values	5 for $1.25
Resistors, ½&1W.	100 for $1.25
Vitreous W W Resistors	8 for $1.25
Sockets, Asstd. 8, 7, 5, 4P.	12 for $1.25
Iron Core Slug & Screw	50 for $1.25
Knobs, Asstd. w/Insert	10 for $1.25

TELEVISION ANTENNA



VEE CONICAL Broad response, all channel, powerful for fringe areas. .$8.95
FOLDED DIPOLE Hi & low antennas, all channel, sturdy const. $4.95
TV CONICAL ANTENNA All Channel. Sturdy Inclds 8 elements & 100 ft. Twinex. $5.25
DUBL-STACK CONICAL ARRAY, 16 Elements Hardware, 2 Crossbars & 100 ft. All copper Twinex $9.98
DOUBLE-V Ant. All Channel, Sturdy Cons. w/Mtg Clamps & 100 ft. Twinex....$4.49
WINDOW CONICAL ANT. All Channel, Hvy Const. Mounts outside window........$3.95
DELTA BEAM Adjustable Indoor Antenna, No More Snow, Interference, Ghosts, Lines. Powerful, for Fringe Areas. $3.98
5 FOOT Interlocking Mast Sections, Hvy Duty, rustproof.....2 for $1.49; 10 for $7

OIL CONDENSERS WAREHOUSE CLEARANCE SALE

RECTANGULAR CASE

.5MFD	1500VDC	.95¢; 2 for $1.50
5MFD	600VDC	1.50; 3 for 4.00
10MFD	600VDC	1.98; 2 for 3.50
3MFD	330VAC 1000VDC	.49¢; 3 for 1.20
2x2MFD	600VDC	.89¢; 2 for 1.59

BATHTUB SIDE TERMINALS

1MFD	600VDC	.39¢; 3 for 1.00
4MFD	50VDC	.50¢; 5 for 2.00
.1MFD	2000VDC	1.05; 5 for 4.50
2x.1MFD	400VDC	.49¢; 5 for 2.00

OIL CONDENSER SPECIAL

10 MFD
600 VDC
$1.75 ea lots of 3
Case dimensions, not including insulators, 4¼H x 3¾W x 1¼"D.
Smaller Quantities, special Each $1.98

TAB "SUN-FLASH" LAMPS

"Tab" No.	Replaces	W-Sec. Max.	Each
U5W	SPRG/FA104	150	$5.98
U10	GE FT114	100	7.25
No. 1	AMGLO 5804X	100	10.98
23ST	GE FT 210	200	9.98
VA	SYLV. 4330	200	9.98
22ST	FT 110	200	9.98
V4X4	X400	200	10.98
DX	SPRGFA100	150	9.00

100 WATT SEC PHOTOFLASH KIT

Includes DX Flash Lamp Rated 150 Watt Sec. Flash Lamp Holder & 8" Reflector & Cable, Power Transformer & CD Flash Capacitors, (3) 200 Mfd Each W/Output of 100 Watt Sec. All Resistors, Capacitors, Rectifiers & Sockets $29.98
"CEBE" I Photoflash, Lite & Compact, completely built. W/Case & Battery....$49.95
AC PACK for "Cebe" I 10.95
HOBBY I Complete, 120 Watt Sec... 69.95
WRITE FOR DETAILS & SPECIAL PRICES

PHOTOFLASH CONDENSERS

100MFD/500WVDC	$1.98
200MFD/450WVDC	2.89
300MFD/450WVDC	4.39
15MFD/330VAC/1500VDC Intermit't.	3.98
25MFD/330VAC/1500VDC Intermit't.	6.49
16MFD/600VAC/2800VDC Intermit't.	6.95

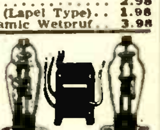
AUDIO AMPLIFIERS READY TO GO

Model 305MP 5 Watt Ampl, as Pictured Above Features Mike & Phono Inpts. W/Sep. Gain Ctnrls. Latest Compensated Tone Cntrl Design. Complete with Tubes $14.98
Model 302PA 3 Tube Phono Ampl. Ideal for Custom Building Your Phonograph. . $4.98
TAB300 Hi-Fi Pre Amp & Pwr Supply $45.00
TAB312 Hi-Fi 12W Pwr Amp & Supp 45.00
TAB310 Hi-Fi Pre & Power Amp ... 65.00
TAB325 Hi-Fi Williamson Pwr Amp & Supply 89.00
GARRARD-RC 80 & GE RPX-050 ... 45.00
WRITE FOR DETAILS & PRICES

AUDIO COMPONENTS

GE RPX041 Phono Cart.	$4.49
GE RPX050 Triple Play Cart.	6.98
Electrovoice Triple Play	2.69
Pickup Arm & Xtal Hi-Outpt	2.39
PM 12" Hi-Fi British Speaker	4.98
PM 12" GE S1201A Speaker	18.69
PM 8" Blue 8T18-1 Permflux	13.00
PM 5" Speaker Gud Tone	1.98
PM 10" Hi-Fi Woofer & Separate Horn Tweeter. 10 Watt 40-20000 cy	19.98
Crystal Mike & Cable	2.98
Crystal Mike Cartridge (Lapel Type)	1.98
Crystal Mike Cart. Ceramic Wetpruf	3.98

866A KIT and XFORMER



2 Tubes, Sckts, xmfr, 115v60cyc Inpt, outpt 2.5vct/10A/Hivins $4.98
DIODE PROBE TUBE Unexcelled for No-Loss VHF testing. Ultra-sensitive subminiature-envelope. .New. w/data VR92 ....25¢; 5 for $1.

CIRCULAR SLIDE RULE

Equiv to 12"—Only 2⅛" Radius. LAMINATED—Print Stays On! Mult. Div. Sqs, Cubes & Roots, Log. Decimal Equiv. 98¢
Parrallel Rules. Precision Drafting Tool Mfr. BRUNING 6". SPECIAL ....3 for $1

MERCURY THERMO REGULATOR

DUAL CKT. 105° F & 32° F. Extremely sensitive & accurate for most exacting requirements—Research, Fire Prev., Freeze, Pt Control, or Max-Min Temp Control. Brand New, w-data & ckt. Ea. 98¢; 12 for $10.00

STORAGE BATTERIES

36 volt WILLARD MINI-BRAND NEW; 3 oz Designed Portable Equip Models.98¢; 4 for $3
(4) 36V Batteries w/acid* $3.35
2V/20AH Willard PLUS 2V, Vibrator. 2.98
2V/20AH w/vib & acid* 3.59
6V/6AH Wilid NT6/BB214U 2.98
6V/6AH Battery w/acid* 3.25
6V/40AH Battery 6.98
6V/40AH Battery w/acid* 9.25
* We ship acid in bottles. R exp only

RELAY SALE

SPST mini size 115VAC 3A cts......98¢; 3 for $2.75
SPDT min. size 115VAC 3A cts ..$1.39; 3 for $3.75
SPDT 24V DC, 5A CTS 98¢
SPNO 115 V AC, 15A CTS S'Dunn ..$1.98; 2 for $3.50
DPDT & SPNO 12 V DC, 10 A CTS $2.25; 2 for $3.75
DPDT Clare SK 5010, Octal Base 18-28V 2Amp Cts, Nitrogen Sld. New Stock SPECIAL........$2.98

SOCKET ASSEMBLIES

½" JEWEL BAYONET SOCKET
Unit Price 39¢
Lots of 5 **29¢ ea**
1" JEWEL Candelabra (screw) base 59¢
PANEL LAMPS #40-41-44-46-47 10 for 69¢

"LAST MINUTE SPECIALS"

HELIPOT 50K OHM 10 Turn 0.5% 50KAJZ ....$ 8.95
DUAL ATTENUATOR 7470 & 1063 ohm 12 step #KS9458 ....3.49
DAVEN ATTENUATOR T323G dual 600 ohm, 20 step 1½DB per /step 10.98
EVEREADY 6V Hotshot 1461 Battery .98
VECTOR TURRET SOCKET 8N9T & Base Shld ....2 for .98
LACING CORD #6 Waxed for cabling 1.39
LACING CORD #12 Waxed, linen 1.89
K. MILLER stripper #100 & cutter .89
CLOCK RADIO 5 tube famous make 16.95
CARBIDE DRILLS for TV Antenna Installation ¼", ⅜", ½" ......3 for 3.89
LINE FILTER F/5 AR for AN/ARC5 installation, used, as-is 1.98

ORDER NOW, WHILE THEY LAST

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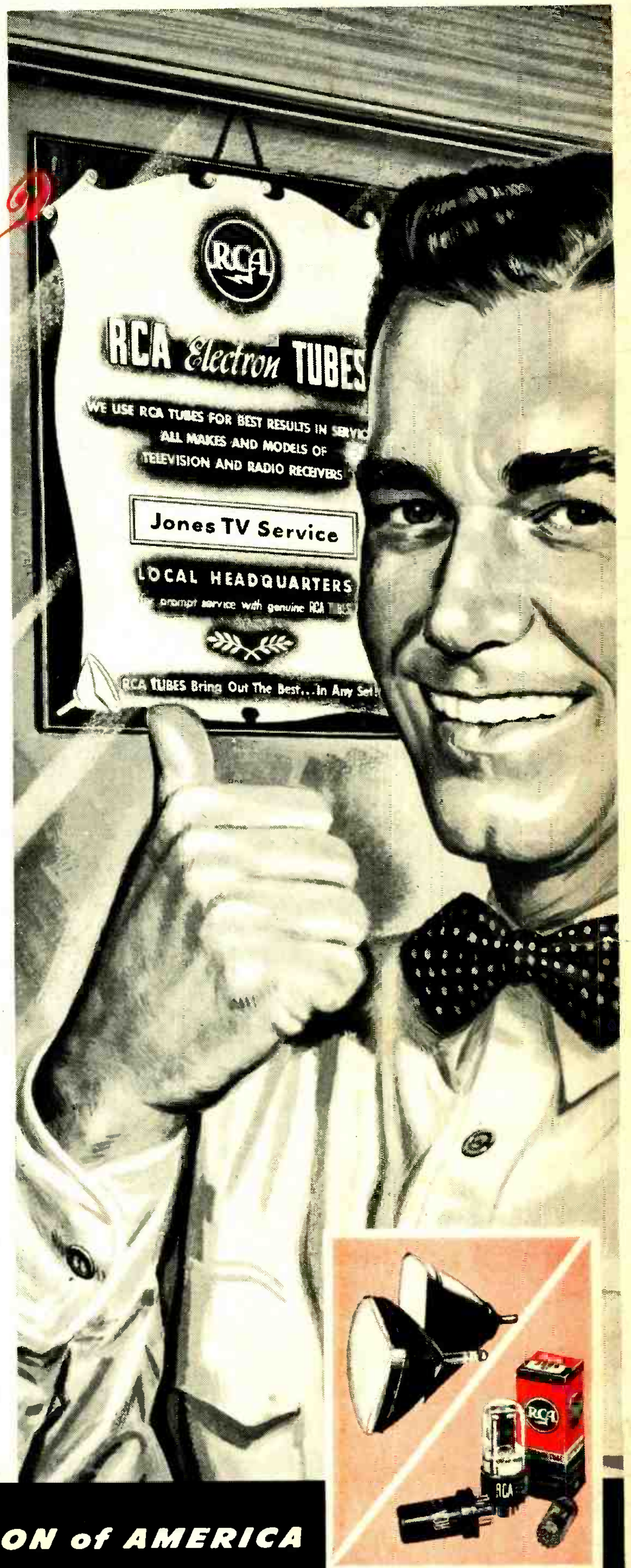

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