MARCH 1953

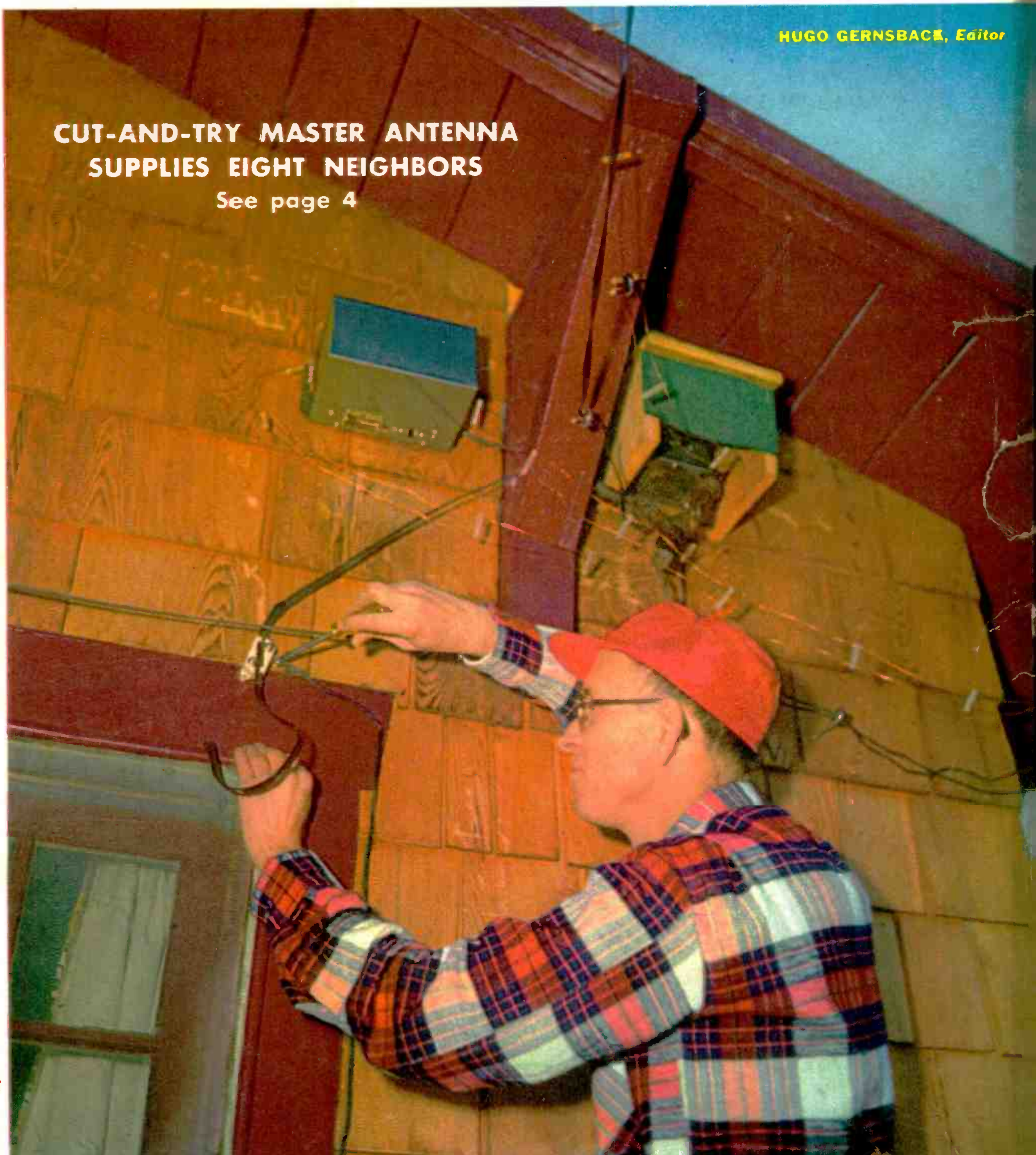
RADIO-ELECTRONICS

LATEST IN TELEVISION • SERVICING • AUDIO

HUGO GERNSBACK, *Editor*

CUT-AND-TRY MASTER ANTENNA SUPPLIES EIGHT NEIGHBORS

See page 4



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In this issue: **High-Speed Remote Mike Control • Video Amplifier Design • A Transistor Receiver**


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RADIO-ELECTRONICS

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

CONTENTS

MARCH, 1953

> **"WHAT IS ELECTRONICS?"**
> Due to the large number of definitions received, it has not been possible to complete judging the entries in the "What Is Electronics?" contest. Prizes will be paid immediately the judging is finished, and the winners will be announced in the April issue.

ON THE COVER
(Story on page 44)
Installing a distribution amplifier on the Mount Baldy system's transmission line.

Color original by John Gartner

MEMBER Audit Bureau of Circulations

Vol. XXIV. No. 3

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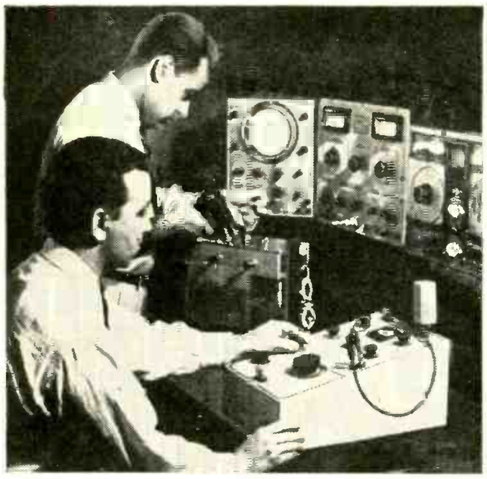

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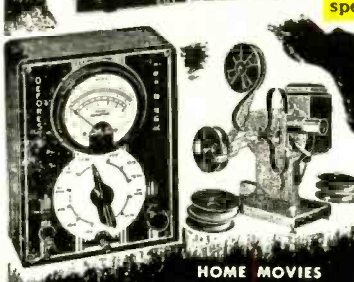
If you're subject to military service, the information we have for you should prove very helpful.



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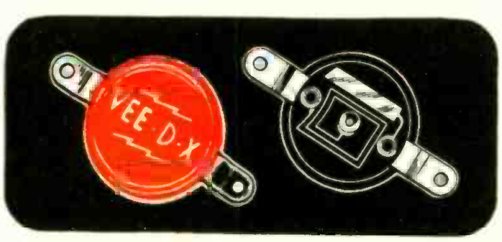
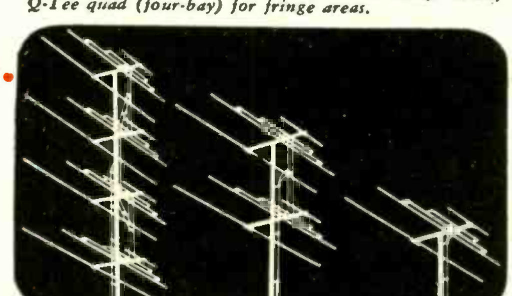


Secret of the Q-Tee all-channel operation is the patented printed circuit electronic channel separator in this colorful red plastic housing. Lic. A.A. K. Pats. 2,422,458; 2,282,292; 2,611,086, others pending.

Easy stacking makes the Q-Tee a pleasure to install especially when in combination with new UHF antennas. Three series: Q-Tee single bay for primary areas; Q-Tee double (two-bay) for near-fringe areas; Q-Tee quad (four-bay) for fringe areas.



There is only one Q-Tee! It's powerful — it's revolutionary — it's patented — it's made only by Vee-D-X. Embodying an entirely new engineering approach to all-channel reception, the Q-Tee has met with sensational success. Its brilliant performance, ease of installation, ease of stacking and clean-cut appearance have won for it the reputation of "Antenna of the Year". Ideal for all multi-channel areas (primary, near-fringe and fringe), the Q-Tee provides the high front-to-back ratio found in no other broadband antenna. In areas of co-channel interference this often means the difference between a good picture and none at all. The Q-Tee is an excellent basic VHF antenna for use in combination with UHF antennas.

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Letter from Chief Engineer, Broadcast Station, North Carolina, "Need men with radiotelephone 1st class license, no experience necessary. Will learn more than at average station for we are equipped with Diesel Electric power, transmitting and studio equipment."

Telegram from Chief Engineer, Broadcast Station, Wyoming. "Please send latest list available first class operators. Have November 10th opening for two combo men."

These are just a few examples of the job offers that come to our office periodically. Some licensed radioman filled each of these jobs . . . it might have been you!

HERE'S PROOF FCC LICENSES ARE OFTEN SECURED IN A FEW HOURS OF STUDY WITH OUR COACHING AT HOME in Spare Time.

Name and Address	License	Lessons
Lee Worthy, 2210½ Wilshire St., Bakersfield, Calif.	2nd Phone	16
Clifford E. Vogt, 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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"I have had a half dozen or so offers since I mailed some fifty of the two hundred employment applications your school forwarded me. I accepted a position with the Civil Aeronautics Administration as a Maintenance Technician. Thank you very much for the fine cooperation and help your organization has given me in finding a job in the radio field."
Dale E. Young, 122 Robbins St., Owosso, Mich.

GETS FIVE JOB-OFFERS FROM BROADCAST STATIONS
"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."
Elmer Powell, Box 274, Sparta, Tenn.

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."
Charles E. Loomis, 4516 Genesee Ave., Dayton, Ohio.

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"AUDREY"—Bell Laboratories' Automatic Digit Recognizer—selects the right circuits automatically when numbers are spoken distinctly into the telephone.

BELL LABS' "AUDREY" (automatic digit recognizer) translates *spoken* numbers directly into selective switching operations. Audrey now responds dependably only to clearly enunciated syllables, but may some day do away entirely with dials and even operators —you may literally "call" a number merely by speaking into your telephone.

The recognizer compares speech sounds with electrical equivalents of standard phonetic patterns stored in memory cells. The appropriate circuit —an indicator lamp at present—is energized when the waveform of the spoken numeral matches one of the stored standards.

A TRANSISTOR TRANSMITTER on the 146-mc amateur band, operated by George M. Rose of K2AH, Mountain Lakes, N. J., worked three stations—the farthest over 25 miles away—with power supplied only by a tiny 22½-volt hearing-aid battery. According to Mr. Rose, who manages the advanced development group at RCA's transistor laboratory, the entire transmitter, including the quartz frequency-control crystal, takes up no more space than a pack of cigarettes. Transmissions were reported strong and clear, even at W2UK in New Brunswick, N. J., more than 25 miles from Mountain Lakes.

THE ARMSTRONG MEDAL for outstanding achievement in radio was awarded to a Briton, Capt. Henry J. Round, by the Radio Club of America at its 43rd Annual Banquet in December. Captain Round, one of the few surviving pioneers who aided Marconi in his early work, developed radio direction-finding equipment which enabled the British to intercept the German fleet in World War I, and bring on the Battle of Jutland. Captain Round is well known to radio old-timers throughout the world as an operator at the first commercial radio station in the United States, at Babylon, N. Y., from 1905 to 1907.

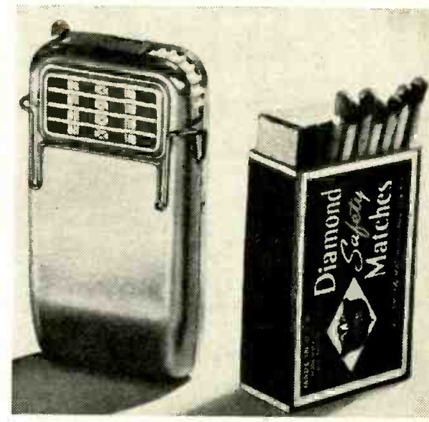
A YEAR-END SURVEY OF TV production released by Admiral Corporation points out that nearly 20% of all TV and radio receivers made in the United States are produced in the Chicago area. Philadelphia, New York City and Syracuse follow in that order as electronic manufacturing centers.

TV's biggest year was 1950, when nearly 7,500,000 receivers were sold, with a value of $2,000,000,000.

Of the 19,000,000 TV receivers in use in the United States at the end of 1952, 9,000,000 were over 4 years old, and had screens smaller than 16 inches. The survey estimates the replacement market alone will hit 5,000,000 sets a year when television reaches all sections of the country (See P. 26 for NBC estimates).

COMMITTEES to study television-interference problems were recently named by the RTMA. Acting on the FCC's request that the industry take steps to standardize receiver i.f.'s and reduce oscillator radiations, Dr. W. R. G. Baker, director of the RTMA Engineering Department, appointed the groups to work with the Joint Technical Advisory Committee and the Institute of Radio Engineers.

One task committee, headed by J. A. Chittick of RCA, will tackle receiver problems. A second group, under J. E. Keister of G-E, will work on transmitter interference. The third committee, headed by Donald G. Fink of Philco, will co-ordinate the work of the first two, and act as liaison with the JTAC, I.R.E. and FCC.



Above—Hearing aid models of the past 15 years, terminating in the new Maico transistor type. The model at rear is using a still older type. Right—The new Sonotone transistor hearing aid.

TRANSISTOR-EQUIPPED hearing aids have been offered to the public for the first time. Weight and operational costs are greatly reduced. Their small size may be seen from the photographs of the Maico aid, which uses three transistors, and the Sonotone model, which uses a transistor to replace the power tube and retains two voltage amplifier tubes.

NEW GERMANIUM SOURCE—the richest found thus far—has been discovered in a Kentucky coal deposit by prospectors seeking new supplies of the urgently needed substance. Worth $350 a pound in pure metallic form, the germanium is little more than a trace in the coal and must go through an elaborate process of extraction and refining before it is suitable for use in transistors, diodes, and power rectifiers. Despite the new find, the tremendous increase in the demand for the valuable metal will probably bar any immediate decrease in cost.

THE 1953 I.R.E. SHOW and convention will be held at Grand Central Palace, New York City, on March 23, 24, 25, and 26. In anticipation of an even larger attendance than the 28,000 who visited last year's I.R.E. show, the layout has been improved and simplified to enable visitors to circulate more comfortably among the exhibits. RADIO-ELECTRONICS extends a cordial invitation to visit its exhibit on the second floor—Booth 2-141—directly opposite the elevators on the 46th Street side of the building.

Technical sessions in connection with the show will take place at the Waldorf-Astoria.

TV SETS OUTNUMBER PHONES in many leading U. S. cities. Baltimore, Boston, Cleveland, Los Angeles, Philadelphia, and St. Louis already have given TV a comfortable lead, while in New York, Chicago, Detroit, and Washington the two vital services are running just about even. Opening of u.h.f. channels and new assignments in the v.h.f. band are expected to pull TV far out in front in cities that have had at least one channel for five years or more.

THE SERIAL-NUMBER RACKET, which has victimized thousands of purchasers of radios, television sets, and other appliances over many years, is being fought vigorously by Better Business Bureaus through proposed legislation already submitted in New York, Nebraska, and other states. Unscrupulous dealers remove or deface manufacturers' serial numbers on equipment to evade warranty obligations, transfer merchandise irregularly to non-franchised, cut-price channels, or conceal stolen merchandise. The bill introduced in New York calls for a fine of $50 for the first offense, with penalties up to $1,000 for subsequent convictions. Nebraska's proposed legislation goes even farther, carrying cash penalties of $50 to $5,000, and prison terms of 6 months to 5 years.

EUROPEAN TV has been further expanded with the opening of a television station by the Northwest German Radio Network, which has been in operation since the beginning of the year.

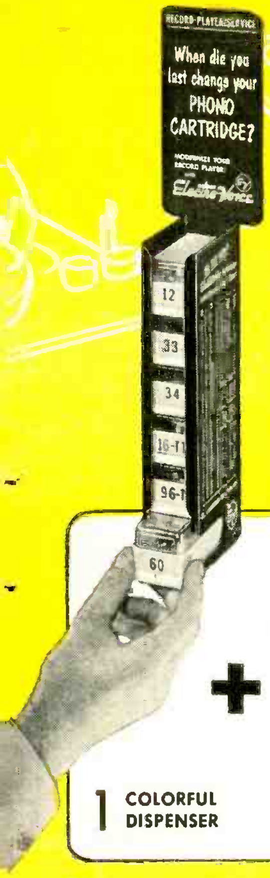
The station is so located as to cover about 60% of northwest Germany, and reaches West Berlin. The audience is still limited—unofficial estimates state that about 5,000 sets are in use in West Germany. Many are leased rather than sold outright, as the prices (ranging from $300 to $600 in American money) are from three to six times the average worker's monthly salary.

Broadcasts are reported to consist of 2-hour daily programs. No commercials are carried.

There is a monthly television tax of five marks ($1.25 approximately) on each set. The Northwest German Radio Network and the Post Office radio administration share the proceeds.

EDUCATIONAL TV has been given the support of no less an authority than Dr. W. R. G. Baker, vice-president of the General Electric Company and one of the country's television pioneers.

"To my mind it is not a question of whether we can afford television," Dr. Baker said in a statement to the New York State Temporary Commission on the Use of Television for Educational Purposes, which is holding hearings to determine whether New York State should embark on a program of educational television. "Instead, I believe we cannot afford, if we have the least concern for our country's future and for the future of our children, to pass up the opportunity offered us." END



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Handsome All-Metal Maroon, Yellow and White Dispenser. Holds any 6 E-V Cartridges in their New Jewel-Like Golden Yellow Plastic Boxes.

Hang it on a Wall or Shelf. Cartridge Boxes Easily Removed from Bottom or Top.

Complete Cartridge Interchangeability Chart on Both Sides of Dispenser

USE this handsome, all-metal dispenser in your store or shop. It catches the eye and makes your customers want to buy!

This modern merchandiser is the *new way*, the *positive way* to cash in on the $70,000,000.00 phono-cartridge modernization-replacement market.

Not only does it sell cartridges, but the handy Cartridge Interchangeability Chart on each side makes your replacement service quick and easy.

In addition, the unique colorful, transparent Decal and the complete Manufacturers Set Model Replacement Guide make *you* the authority on Phono Service in your community.

All three are Free, without extra cost, from your E-V Distributor with *every* purchase of *any* 6 E-V Phono Cartridges. (The 6 basic Preferred E-V Models shown here, of course, enable you to make over 92% of all replacements.)

Use this profit key to '53! Open up the treasure that holds 10,000,000 Phonograph Modernization Sales. *Make money selling Cartridge replacements now the E-V way.*

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Radio's Master BAROMETER of the PARTS INDUSTRY

During January, 54 of the leading 400 manufacturers of Radio-Television-Electronic parts and equipment made changes in their lines. Actually there was a decrease in "change activity" as compared to December. In price revisions by the number of manufacturers and products affected, the following summary illustrates the comparative trend for the months of December and January.

	No. of Manufacturers	
	December	January
Increased prices	18	19
Decreased prices	10	14

	No. of Products	
	December	January
Increased prices	265	207
Decreased prices	88	123

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

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.	3	17**	3	38*	7	117**	8	75**
Capacitors	0	0**	0	0	1	44**	0	0
Controls & Resistors	0	0**	1	45*	1	4**	1	1**
Sound & Audio Prod.	5	8*	3	9**	14	47**	13	40*
Test Equipment	2	2*	0	0	8	49*	5	17*
Transformers	2	2	1	1	2	4**	0	0**
Tubes	7	178*	6	30*	5	19**	5	29**
Wire & Cable	0	0	0	0	1	2**	1	4*

* Increase over December
** Decrease from December

Comment: Since the last reported period, fewer manufacturers were engaged in "change activity." TV and radio receiving tube manufacturers are continuing their tendency toward increasing prices, while other product group price changes remain spotty with no apparent trend.

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

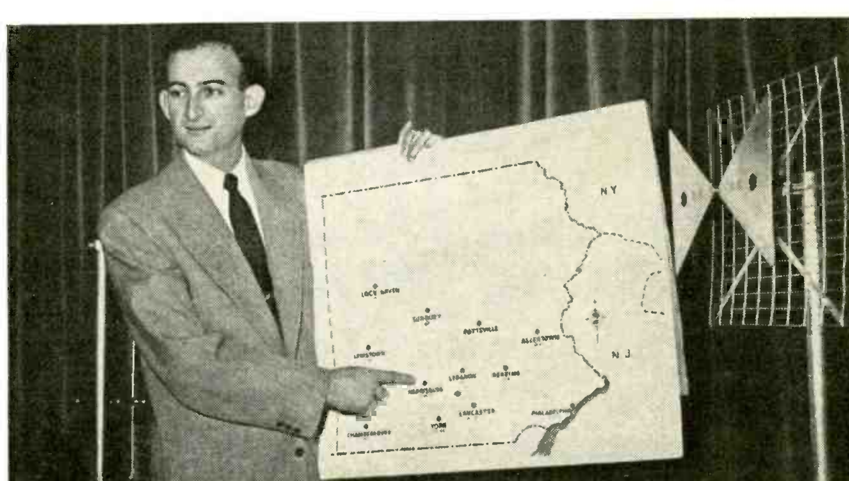
Channel Master Corp., Ellenville, N. Y., presented the 200th performance of its film, "The Antenna is the Payoff," at Philadelphia's Benjamin Franklin Institute under the sponsorship of Radio Electric Service Co., Channel Master's Philadelphia distributor, and leading dealer associations in that area. Following the film, Sam Schlussel, Channel Master u.h.f. engineer, addressed the group.

The General Electric Tube Department will continue its consumer advertising program in support of television service technicians with a series of consumer magazine ads in 1953.

Merit Coil & Transformer Corp., Chicago, is packing a new form in each HVO-7 flyback box. The form provides complete hookup data and five applicable schematics to cover various chassis. The company plans to include similar information in future TV "*Repl*" Guides. The forms are also available from the company for counter distribution.

Simpson Electric Co., Chicago, has made reprints of an article on efficient TV installation techniques by two of its engineers, Jack Whiteside and L. J. Austin, available in Instruction Forms No. 19 and No. 20.

(*Continued on page* 26)



Sam Schlussel, Channel Master u.h.f. development engineer, at a demonstration.

AMAZING NEW TRAINING PLAN

Leonard C. Lane, B.S., M.A.
President of Radio-Television Training Association,
Exec. Dir. of Pierce School of Radio and Television

NOW . . . YOU CAN BECOME A

LICENSED* TV TECHNICIAN

LICENSED TV MEN MAKE MORE MONEY

AT NO EXTRA COST! YOU GET A ROUND TRIP TO NEW YORK CITY

FROM ANYWHERE IN THE U.S. OR CANADA—I pay your way to New York and return, PLUS 2 FREE weeks, 50 hours of advanced instruction and shop training at the PIERCE SCHOOL OF RADIO & TELEVISION. You use modern electronics equipment, including student-operated TV and Radio stations. You go behind the scenes of New York's big Radio-TV centers, to study first hand. And I give you all this AT NO EXTRA COST! (Applies to complete Radio-TV course only.)

Only RTTA makes this amazing offer.

SET-UP YOUR OWN HOME LABORATORY WITH THE 15 BIG TELEVISION-RADIO KITS WE SEND YOU (At No Extra Cost)

YOU BUILD AND KEEP ALL THESE UNITS

—INCLUDING BIG SCREEN TV RECEIVER, plus Super-Het Radio Receiver, R.F. Signal Generator, Combination Voltmeter-Ammeter-Ohmmeter, C-W Telephone Receiver, AC-DC Power Supply. Everything Furnished Including All Tubes, and Big TV Tube

EXTRA FEATURES THAT MEAN MORE MONEY FOR YOU!

Thousands of new job opportunities will be available for you right in your own state, now that the government has lifted restrictions on new TV stations. My simple, successful methods can PREPARE YOU NOW to take your place in America's booming TELEVISION and Electronics industries . . . help you get the success and happiness that you always wanted out of life. You learn the practical, easy way by using actual parts and equipment in the 15 big Radio-TV kits I send you, including a COMPLETE TV RECEIVER . . . yours to build and keep.

My Advanced Training Prepares You For Better Jobs

Then, after you finish your training for a position as a full-fledged TV Technician—where you can write your own ticket and choose from dozens of fascinating careers—*I don't stop there!* I continue to train you—AT NO EXTRA COST—to qualify for even better pay in the BETTER JOBS that demand FCC licenses, with my . . .

FREE* FCC COACHING COURSE

PREPARES YOU AT HOME FOR YOUR FCC LICENSE

THE BEST JOBS IN TV AND RADIO REQUIRE AN FCC LICENSE

Given to every student at NO EXTRA COST after TV Theory and Practice is completed.

NOW! Advanced FM-TV Training For Men Who Know Radio

Prepares You For Higher Pay Jobs In A Few Months

COMPLETE theory and practical training course . . . complete with kits including large screen TV receiver.

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ATTENTION! VETERANS!

MY SCHOOLS FULLY APPROVED TO TRAIN VETERANS UNDER *NEW* G. I. BILL! If discharged after June 27, 1950—CHECK COUPON BELOW! Also approved for RESIDENT TRAINING in New York City . . . qualifies you for full subsistence allowance up to $160 per month.

I GET MY GRADUATES GOOD PAYING JOBS

"As Merchant Ship Radio Officer, I receive $867. for 40-day trip. Your training helped me get this fine position." —Stanley Nawrocki

"I now hold a fine airlines position at La Guardia Field, New York City, thanks to your excellent training." —Joseph Rosenberg

"Your excellent instruction helped me get my present job as an airport radio mechanic for American Airlines." —Eugene E. Basko

"Thanks to your training. I qualified for a good job as a Receiver Tester at Federal Telephone and Radio." —Paul Frank Seier

Many others working at NBC, RCA, CBS, Dumont, Philco, Emerson, Admiral and other leading firms.

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BOTH FREE New Illustrated Book plus Sample Lesson

NO SALESMAN WILL CALL!

Mr. Leonard C. Lane, President
RADIO-TELEVISION TRAINING ASSN.
1629 Broadway, Radio City Station
New York 19, N. Y. Dept. R-3

Dear Mr. Lane:
Mail me your *NEW* FREE BOOK and SAMPLE LESSON that will show me how I can make BIG MONEY in TELEVISION. I understand I am under no obligation and no salesman will call.

Name ______ Age ______

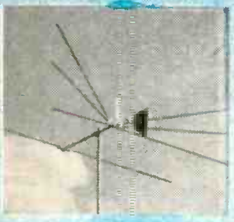
Address ______

City ______ Zone ______ State ______

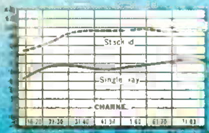
I am interested in: ☐ Radio-TV ☐ Advanced FM-TV

VETERANS: If qualified under new G.I. Bill, check here ☐

ULTRA FAN series — Complete VHF-UHF coverage



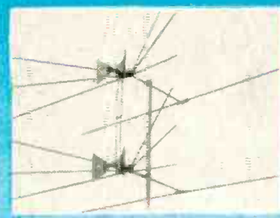
single bay — model no. 413



Today's most sensitive All-VU* antennas! The Ultra Fans actually operate on three separate electronic principles — automatically:

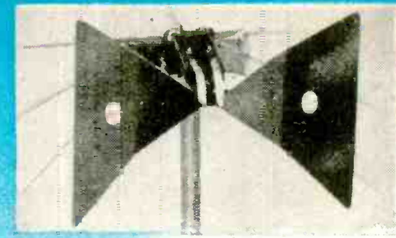
1. Low Band VHF (Channels 2-6) . . . *Conical antenna with parasitic reflector*
2. High Band VHF (Channels 7-13) . . . *Large diameter V antenna*
3. UHF (Channels 14-83) . . . *Triangular dipole with sheet reflector*

One set of All-VU* stacking rods provides higher VHF and UHF gain. Each Ultra Fan has its own 2-stage inter-action filter, so that only one transmission line to the set is required.



stacked — model no. 4132

*All VHF, all UHF



ULTRA DAPTER

model no. 414

Instantly converts all Channel Master Super Fans into high gain, all-channel, VHF-UHF antennas. Features a built-in inter-action filter.

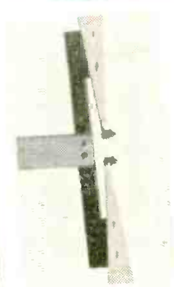
Your best bet for UHF!

CHANNEL MASTER Ultra-Tennas

America's most complete — most effective — UHF antenna line.

Channel Master's advanced engineering pays off again! While rain caused hundreds of UHF antennas to FAIL recently in Portland, *not one Channel Master antenna dimmed or shorted out a picture!* The facts speak for themselves: Rain or shine, Channel Master antennas outperform all others.

Only Channel Master Antennas are designed to eliminate the "TWIN TERRORS" OF UHF RECEPTION:



- Vibration, which causes picture flicker.

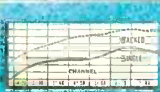
  Eliminated by Channel Master's Ultra-Rigid construction and advanced mechanical design.

- The accumulation of dirt or moisture around the antenna terminals, which dims and eventually shorts out the TV picture.

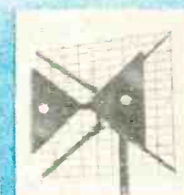
  Eliminated by Channel Master's sensational "free-space" terminals which prevent the accumulation of foreign deposits at the feed points.

ULTRA BOW

model no. 401

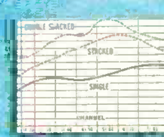


The basic UHF antenna for primary signal areas, and the outstanding member of the bow-type antenna family.

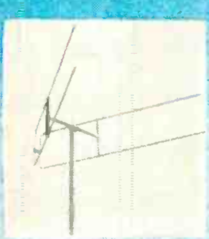


ULTRA BOW with SCREEN REFLECTOR

model no. 403

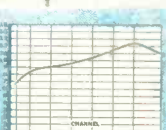


Can be stacked in 1, 2 and 4 bays. High all-channel UHF gain, excellent front-to-back ratio.

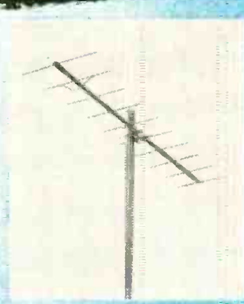


ULTRA VEE

model no. 404



- Good UHF gain
- Low VHF gain
- The most rigid UHF antenna of its type and size.

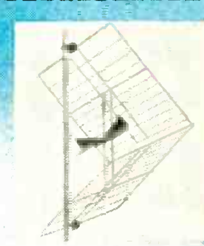


Gain: 11 DB, single
14 DB, stacked

DELTA WELD

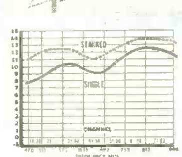
Wide Band 10 Element UHF Yagi

Custom-designed for full coverage of your specific area! Brilliant high gain performance across as many as *23 different channels.*



CORNER REFLECTOR

model no. 405



The outstanding all-channel UHF FRINGE antenna. Now — can be stacked for even greater gain.

MEMBER ANTENNA MANUFACTURERS ASSOCIATION

Sold through the nation's leading distributors

CHANNEL MASTER CORP.

ELLENVILLE, N. Y.

Write for complete technical literature

ULTRA-TIE model no. 9034

Electronic Inter-Action Filter

JOINS separate antennas into a single VHF-UHF antenna system, for use with a single transmission line.

SEPARATES VHF and UHF signals at the set or converter where separate inputs are provided.

The only filter with "free-space" terminals

NOW —read this true story of

UHF ANTENNA FAILURE IN PORTLAND!

GARRETSON RADIO SUPPLY, INC.
INDUSTRIAL DIVISION
2416 SECOND AVENUE
SEATTLE 1, WASHINGTON
SE. 0640 • MU. 0422

January 22, 1953

Channel Master Corporation
Napanoch Road
Ellenville, New York

Attn: Harold Harris

Dear Harold:

Now that the UHF station, KPTV in Portland, Oregon has been on the air for a few months, it may interest you to know some of the results of antenna performance.

Antennas of all descriptions, both multi-channel and single channel UHF have been installed in the Portland area. The results in most cases were fair, however in some instances certain types of antennas specifically for the UHF channels failed completely to perform. Several of the so called "all channel" antennas performed in strong signal areas, but failed completely where gain was needed, or ghost problems were encountered. These results were obtained while the weather in Portland was good.

For the past few weeks it has been raining consistently in the Portland area and the antenna failures have been numerous, due to the shorting out of the terminal connection at the antenna. The result -- antenna crew men have been out drilling small holes in the terminal blocks trying to provide as much air insulation as possible. Certain types of antennas, which used an isolation filter at the antenna also had their troubles. In many cases this filter broke down and moisture leaked into the filter, causing it to short out at the terminal.

Many of the Channel Master UHF antennas have been sold and installed by our dealers in Portland, with no complaints whatsoever. In all cases, the antennas have given excellent performance and provided clean pictures, regardless of weather conditions. This, we feel, is the result of research and engineering, and the foresight to foresee the many problems which would confront the UHF antenna.

The use of your free-space terminals has forestalled any problems of signal loss due to moisture conditions and in all cases, our dealers tell us that the Channel Master antennas live up to the published catalog information.

May we offer our congratulations on an excellent unit - and let's keep them rolling!

Very truly yours,

GARRETSON RADIO SUPPLY, INC.

Paige C Lundberg

By: Paige C. Lundberg

VMH/pl

Look to Channel Master for UHF— IT PAYS OFF!

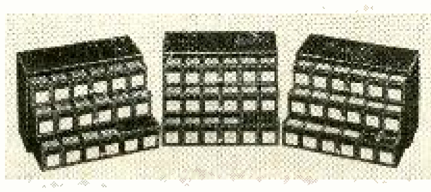
(Continued from page 20)

Jensen Manufacturing Co., Chicago, developed a new 9-way merchandising package as a high-fidelity selling aid. The plan includes counter cards, folders, catalog material, etc.

Weller Electric Corp., Easton, Pa., designed a new crowd-stopping display for use in regional and local dealer trade shows which it lends, free, to its distrib-

utors. Built around a shooting-gallery theme, the display uses audience participation to gain additional appeal.

P. R. Mallory & Co., Inc., Indianapolis, designed three new kits for its controls. Any one of the three permits servicing of over 50 different models of radio and TV sets. Individual kits are recommended for Western, Central, and Eastern states.



Precision Apparatus Co., Inc., Elmhurst, N. Y., manufacturer of radio and TV test equipment, opened its 1953 series of lectures on television circuitry and servicing in New York City recently. The lectures and demonstrations are scheduled to be presented in 110 cities throughout the United States and Canada during 1953.

Permo, Inc., Chicago, manufacturer of phonograph needles, recording tape and wire, and record brushes, released a new brochure to distributors showing photographs of the representatives who handle the Permo line.

Radio Merchandise Sales, Inc., (RMS), New York City, held another in its series of forums on TV antennas in Quebec. The company also participated in a forum at Bridgeport, Conn., conducted by the local station WICC-TV.

Production and Sales

The RTMA estimated TV set production for 1952 at approximately 6,000,000 and radio set production at 9,500,000. Officially, the RTMA reported production of 5,175,194 TV sets and 8,386,076 radios for the first 11 months of 1952, as compared with 4,798,056 TV sets and 11,701,115 radios produced in the 1951 period.

The NBC Research and Planning Department reported that there were 20,439,400 TV sets installed in the United States as of December 1. New York had over 3,000,000 and Chicago, Los Angeles and Philadelphia over 1,000,000 each. Boston was close to the million mark, and the new TV areas of Denver, Colo., and Portland, Ore., rang in with 70,000 and 35,000 respectively.

New Plants and Expansions

Aerovox Corp., New Bedford, Mass., purchased the entire outstanding stock of Acme Electronics, Inc., Pasadena, Calif., designer and manufacturer of filters. Acme will be operated as a wholly owned subsidiary of Aerovox under the continuing management of Hugh P. Moore, president.

Radio Apparatus Corp., Indianapolis, has transferred the national sales offices of its Monitoradio line of receivers and transmitters for mobile or stationary communications systems to Chicago, according to an announcement by Roy True, corporation president. At the same time he announced the appointment of Verne Roberts and Paul Redhead as director of sales and sales manager, respectively, of the newly formed group. Both are well known in the industry.

General Cement Manufacturing Co. opened an additional plant in Rockford, Ill., according to R. G. Ellis, general sales manager. This is the company's third plant in that city. Main offices remain at 919 Taylor Ave. in Rockford.

Granco Products, Inc., 36-17 20th Ave., Long Island City, N. Y., was established as a new firm in the electronics field. The company will design, manufacture, and distribute u.h.f. converters for TV and u.h.f. measuring instruments.

Radio Corporation of America announced plans to build a factory in Spain for the production of phonograph records, record players, and TV home receivers.

Crest Laboratories relocated its factory and offices in expanded facilities in Rockaway Beach, N. Y. The new facilities, quadrupling the company's former space, will produce transformers.

Blonder-Tongue Laboratories, Inc. completed its new factory and office building in Westfield, N. J. It will be used for the manufacture of TV boosters and distribution amplifiers.

David Bogen Co., manufacturer of sound systems, moved to new and larger quarters occupying the entire six-story building at 29 Ninth Ave., New York City.

Radio Craftsmen, Inc., Chicago, established the Hi-Fidelity Manufacturing

"Check your air, Sir?"

Air compressor and tank are at right. Long cylinders on rack dry air before it enters cables.

He's checking the air pressure in a branch cable, one of scores serving a town. The readings along the cable are plotted as a graph to find low-pressure points which indicate a break in the protecting sheath.

Master meters keep watch over the various cable networks which leave a telephone office in all directions to serve a community. Air enters the system at 7 pounds pressure, but may drop to 2 pounds in outermost sections—still enough to keep dampness out.

To keep voices traveling strongly through telephone cables, you have to keep water *out*. This calls for speed in locating and repairing cable sheath leaks—a hard job where cable networks fork and branch to serve every neighborhood and street.

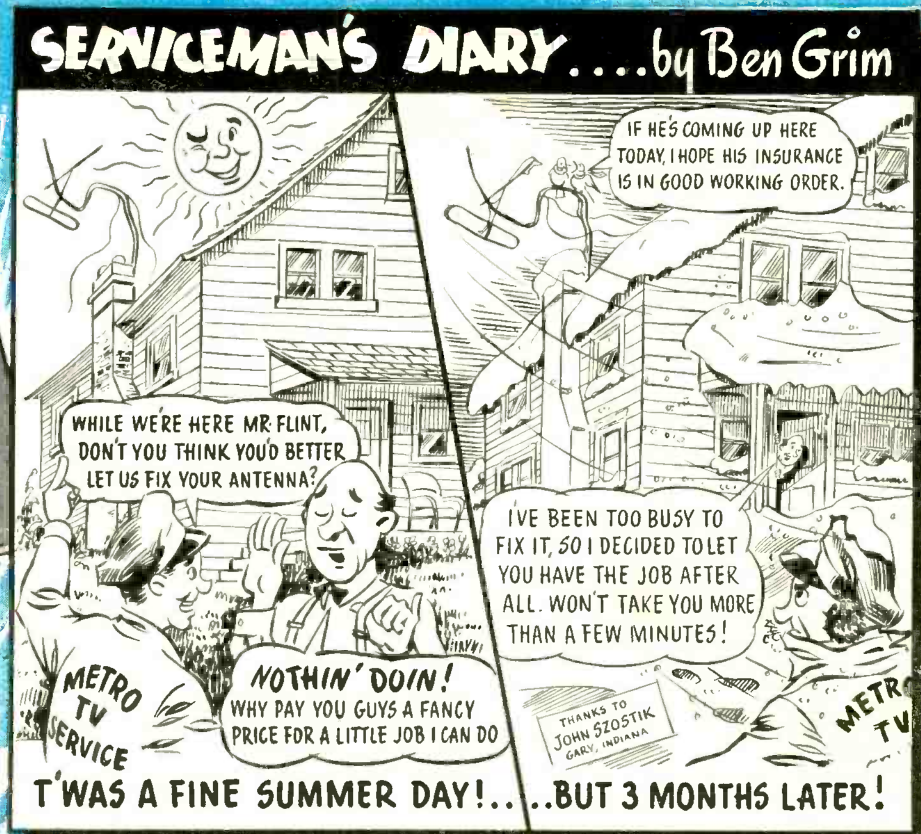
At Bell Telephone Laboratories, a team of mechanical and electrical engineers devised a way to fill a complex cable system with dry air under continuous pressure. Pressure readings at selected points detect cracks or holes, however small. Repairman can reach the spot before service is impaired.

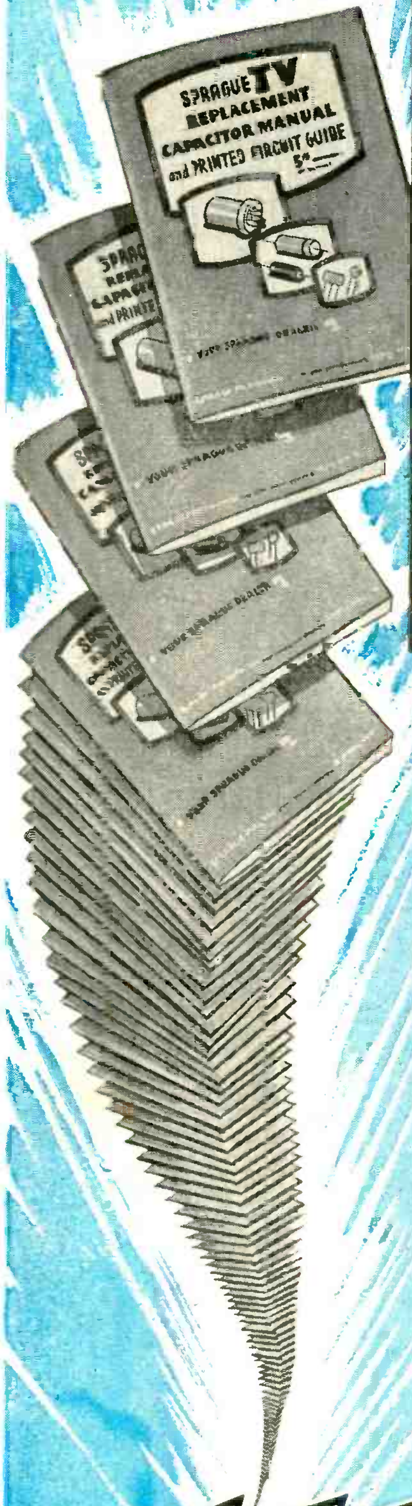
It's another example of how Bell Laboratories works out ways to keep your telephone service reliable—and to keep down the cost to you.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in mechanical engineering

SPRAGUE





Do you have the *NEW* 5th Edition of the SPRAGUE TV REPLACEMENT CAPACITOR MANUAL?

If not, get your copy from your distributor without delay!

This 44-page reference guide shows the accurate, up-to-the-minute Twist-Lok☆ and Atom☆ Electrolytic Capacitor replacements for 2460 receiver models by 78 set manufacturers. It's the most comprehensive of all such manuals and it's yours FREE!

Also included for the first time in this new edition is a Printed Circuit Guide for the resistor-capacitor plates used by 46 manufacturers as well as a complete capacitor color code chart, two extra features to make the Sprague TV Replacement Capacitor Manual even more invaluable to every television technician!

P.S. If your distributor is temporarily out of stock, you can also get copies by writing Sprague Products Co., **81** Marshall St., North Adams, Mass. Please enclose 10c to cover handling and postage.

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SPRAGUE®

WORLD'S LARGEST CAPACITOR MANUFACTURER

SPRAGUE PRODUCTS CO. IS THE DISTRIBUTORS' DIVISION OF THE SPRAGUE ELECTRIC CO.

Corp. in West Palm Beach, Fla., to manufacture tuners, amplifiers, and eventually television chassis as subcontractors for Radio Craftsmen.

Arcturus Electronics, Inc., Newark, N. J., has been merged into General Electronics, Inc., Paterson, N. J., with Delbert E. Replogle as president and Frederick D. Gearhart, Jr., as chairman of the Board.

Stromberg-Carlson opened a sales and sales engineering office for its Sound Division in Dallas to serve an eight-state area in the South.

American Phenolic Corp., Chicago, signed a licensing agreement with the Cornish Wire Co. of New York, giving Cornish rights to manufacture, package, and sell tubular twin-lead under Amphenol's Krueger patent.

Sarkes Tarzian, Bloomington, Ind., is expanding its Rectifier Division, with the addition of a two-story structure to its present plant. When completed the building will double the company's production capacity.

Business Briefs

. . . **International Resistance Co.**, Philadelphia, presented a lecture to over 150 executives, engineers, supervisors, and other plant personnel, by Jack Lacy, widely known sales-training lecturer. The talk was part of IRC's long-range plan to increase customer service.

. . . **The 1953 Electronic Parts Show** management reports that 234 companies, with a total of 374 display units, reserved space at the annual show to be held in Chicago May 18-21.

. . . **The RTMA** held an industry-wide engineering conference in New York City to explore all phases of the problem created by spurious receiver and transmitter radiations.

. . . **General Electric** will double its production of germanium diodes this year to meet the rising demand by television manufacturers.

. . . **L. B. Calamaras**, executive vice-president of NEDA, reported that a program has been outlined for the 1953 NEDA Convention and Conference to be held September 14-16 at the Chase Hotel in St. Louis, Mo.

. . . **Electronic Instrument Co.**, Brooklyn, N. Y., announced the production of its 250,000th Eico instrument since the company began business in 1945.

. . . **Howard W. Sams & Co.**, Indianapolis, announced that RCA, Harrison, N. J., Sarkes Tarzian, Inc., Bloomington, Ind., and the J. W. Miller Co., Los Angeles, have become participants in the Sams Photofact service for transformer components, selenium rectifiers, and coils, respectively.

. . . **John F. Rider Publisher, Inc.**, New York City, announced that Merit Coil & Transformer Corp., Chicago, is now participating in the Rider Replacement Parts Listing Program. END

Depend on Mallory for Approved Precision Quality

The Vibrator

Preferred by 5 out of 6 Service Men

How do we know? We surveyed hundreds of service men like yourself . . . maybe you were one of them. We found that Mallory Vibrators were preferred over others because of their long life and dependability.

There is good reason for that vote of confidence. It is the same reason why more Mallory Vibrators are used as original equipment than all other makes combined. The patented, tuned mechanism in Mallory Vibrators assures completely dependable performance, every time . . .

Less wear because of slow contact

Low resistance because of high contact pressure

Reduced arcing because of clean, fast break

You can depend on Mallory Vibrators for highest quality . . . yet they cost no more. Ask for Mallory, by name, the next time you call your distributor. It is a sure way to beat the call-back problem . . . make sure every job is right the first time.

P. R. MALLORY & CO., Inc.

MALLORY

CAPACITORS • CONTROLS • VIBRATORS • SWITCHES • RESISTORS
RECTIFIERS • POWER SUPPLIES • FILTERS • MERCURY BATTERIES

APPROVED PRECISION PRODUCTS

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA


145K SIG. TRACER KIT $19.95 WIRED $28.95
950K R-C BRIDGE & R-C-L COMP. KIT $19.95 WIRED $29.95
360K SWEEP GEN. KIT $34.95 WIRED $49.95
New 214K VTVM KIT $34.95 WIRED $54.95
320K SIG. GEN. KIT $19.95 WIRED $29.95
OVER 1/4 MILLION
EICO INSTRUMENTS
in use the world over!
New 536K MULTIMETER KIT $12.90 WIRED $14.90 1,000Ω/v; 31 ranges
New 377K SINE & SQUARE WAVE AUDIO GEN. KIT $31.95 WIRED $49.95
EICO new modern facilities for research, development and production—your greater assurance of . . .
1040K BATTERY ELIM. KIT $25.95 WIRED $34.95
LABORATORY PRECISION AT LOWEST COST
NEW 7" Push-Pull OSCILLOSCOPE
• Boosted vert. sensitivity: 10 mv rms/in.
• Extended flat freq. response: 10 cps—1 MC (±2 db).
• 3-step freq.-compensated attenuator; cathode follower input.
• Internal voltage calibrator; dir.-cal. screen.
• Extended sweep range: 15 cps—100 kc.
• Int. pos. or neg., ext. & line sync.
• On front panel: sawtooth, 60 cps outputs; intensity mod. & ext. sync inputs.
• Var. phasing of int. 60 cps sweep.
• Direct connection to CRT plates.
470K KIT $79.95 WIRED $129.50
1171K RES. DECADE BOX KIT $19.95 WIRED $24.95
625K TUBE TESTER KIT $34.95 WIRED $49.95
CRA PIX TUBE ADAPTOR for Tube Tester $4.50
New 565K MULTIMETER KIT $24.95 WIRED $29.95 20,000Ω/v; 31 ranges
315K DELUXE SIG. GEN. KIT $39.95 WIRED $59.95
You Build EICO Kits in One Evening, but . . . They last a Lifetime! and You SAVE OVER 50%
YOU be the judge. See the famous EICO line TODAY — in stock at your local jobber — and SAVE!
HIGH VOLTAGE PROBE $6.95
221K VTVM $25.95 WIRED $49.95
425K 5" PUSH-PULL SCOPE KIT $44.95 WIRED $79.95
Write NOW for FREE newest Catalog 3-C.
America's greatest instrument values bear the name—
See EICO'S Exhibit Booth No. 4-401 at the I. R. E. Show
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ELECTRONIC INSTRUMENT CO., Inc., 84 Withers Street, Brooklyn 11, N. Y.
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Reg. U.S. Pat. Off.
Prices 5% higher on West Coast. Specifications and prices subject to change without notice.

RADIO ASTRONOMY

. . . Newest and Fastest-Growing Science . . .

By HUGO GERNSBACK

RADIO Astronomy, a comparatively new branch of radio electronics, dates back only to about 1931. At that time Dr. Karl G. Jansky, of the Bell Telephone Laboratories of New York, discovered that unusual and previously unobserved radio signals, emanating from the direction of the Milky Way, were received on Earth.

Astronomers and physicists alike paid little attention to the new discovery. But a radio amateur, Grote Reber, before World War II, set up a rotating 30-foot antenna in his back yard. This antenna, bowl-shaped like a searchlight, could be pointed into any direction in the sky, like a telescope.

Reber, like Dr. Jansky, found that the strongest signals originated somewhere in a plane near the center of our galaxy. He soon noted that the signals *did not* seem to come from the biggest or brightest stars.

Reber at the time theorized that the radio signals really did not come from the stars themselves, but that they originated in the huge hydrogen gas clouds which we know exist in interstellar space.

With better modern instrumentation that was not available in 1931, a great deal of progress has been made toward solving many unsolved riddles of the cosmos. Today we know that most stars—including our own sun—give out radio energy at various frequencies.* In the near future we are certain to learn a great deal more about the mysterious behavior of matter. Man once more realizes that even one of his greatest achievements, radio, is old (and ancient) hat! Radio waves, it now appears, have existed for at least *five billion years*—perhaps longer.

This, then, explains the sudden and feverish international activity in radio astronomy. Nearly all the major countries are in the race. Much of the work unquestionably is going on in secret, much of it behind the Iron Curtain.

Large radio telescopes are now installed at the National Bureau of Standards, Naval Research Laboratory, Harvard Observatory (under construction), and Cornell University (Sacramento Peak, N. M.), in the United States; in England at Manchester University and Cambridge University; in France, at the École Normale Supérieure (Laboratoire de Physique); in Holland at Leyden University; and in Australia at the Radio Physics Laboratory.

How important the subject is can best be expressed by the generous funds that are being poured into the various installations. Thus, Great Britain will be spending over one million dollars on the world's largest and most modern radio telescope at Manchester University. Its huge parabolic lattice-bowl antenna measures 250 feet in diameter. It swings in a cradle between metal-lattice towers which are 180 feet high. The whole assembly is mounted on a metal platform which runs on a circular railroad track. Thus the telescope antenna can be pointed toward any region in the sky. Clockwork then guides the telescope and will keep it on any selected point in the heavens.

Why all this great and feverish activity on such a seemingly highly scientific and improbable endeavor? Why, on top of spending millions on radio telescopes, do all the above-mentioned countries add extensive—and expensive—faculty centers of radio astronomy to their present seats of learning?

The answer is not difficult to find. Radio astronomy is in an exactly parallel position today to that which existed in atomic science in the twenty years before 1945, the date of the first atomic explosion.

Many scientists realize that reception on Earth of interstellar radio signals, which have taken from one hundred to one billion years to reach us, poses important problems concerning their origin. At present there is some indication that a solution of such problems may be of vast scientific importance, contributing to the understanding of many fields of science—even the atom. This may in time open the road to entirely new sources of *energy*—POWER.

Scientists, too, suspect that there may be an important connection between cosmic rays and radio energy—both may turn out to be closely related.

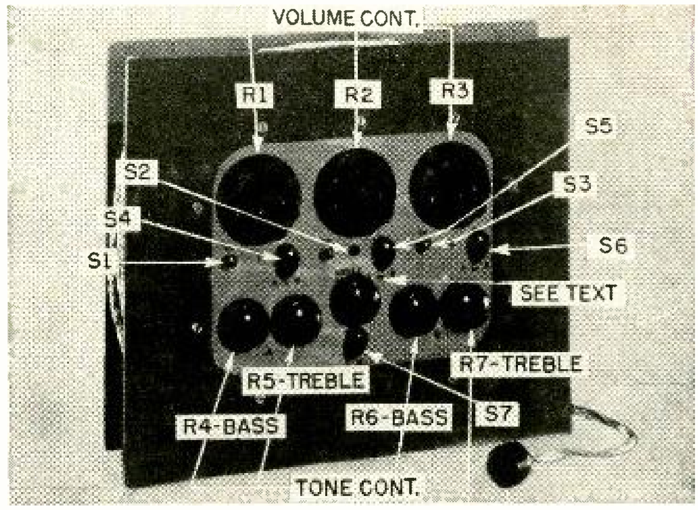
What does man stand to gain by the understanding of the origin of radio waves from interstellar space? No one can tell. We do not immediately expect to gain from it vast amounts of power—this lies in the future. We are, however, certain that the knowledge of cosmic radio manifestations is as fundamental to the future of science as was Maxwell's electromagnetic theory to the development of our present radio communication.

By 2023, the present population of the Earth (1949—2,367,737,000) will have doubled to 4¾ billion humans. To feed and clothe them, man will require more and still cheaper power. Only by understanding Nature's still unknown, immense energy sources can we hope to achieve prosperity for all mankind and consequently a real planetwide Peace.

*See also the writer's editorial "Our Electronic Universe", October 1952, RADIO-ELECTRONICS.

RAPID REMOTE MICROPHONE CONTROL

By N. H. CROWHURST



The completed remote-control panel does double duty as a reel for control cable. The "Middle" control was transferred to the amplifier in later models.

REMOTE microphone control in PA work has obvious advantages, and once you try it you'll find it indispensable. The control panel can be moved to any convenient point where the operator can hear what the audience hears, and can watch the stage for cues. The simplest method of remote control is *electronic mixing*, using d.c. bias on the control or suppressor grids of the individual microphone-input stages. The chief advantages of this method are that low-level audio signals go *direct to the amplifier inputs* instead of first passing through noisy switching circuits, and the control lines carry only hum-free d.c.

The d.c.-bias supply can be a dropping resistor in the common negative return, or a well-filtered-d.c. heater supply for the first stages can be used. Either way there must be sufficient decoupling and filtering to keep hum or noise off the grid used for gain control. Simple resistor-capacitor filters are sufficient.

On PA jobs where two or more microphones are required there will be less danger of acoustic feedback if only one microphone is alive at any time, or at least if only those microphones actually needed at the moment are alive. This is no problem with direct microphone switching, but a *remote-control switching circuit* is not easy to design. If bias voltage is switched, loud clicks or plops come from the system. One alternative is to change the bias quickly with fader-type controls, but this can cause peculiar effects until a great deal

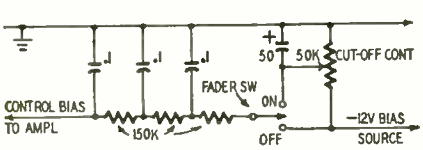


Fig. 1—Circuit of the basic bias-control unit for one microphone. The three-section filter eliminates audible switching transients without noticeable delay.

of skill is acquired; and with nice fat decoupling capacitors in the circuit, there can be a disconcerting delay in the microphone changeover action.

The problem is to provide the quickest possible change of bias without any audible effect. The solution is an *automatic* switching circuit. See Fig. 1.

Various arrangements were tried for smoothing out the switching clicks, from a single R-C combination to a multisection low-pass filter. A single resistor-capacitor section produced a loud click unless the values were made so large that the time delay became unbearably long; with multisection filters the click was transformed into a *plop*—the filters changed the proportions of the component frequencies in the switching voltage transient.

High-speed switching means that some disturbance—in the form of a simple step transient—is bound to get into the amplifier. The problem is to make this transient inaudible, while still attaining satisfactory operating speed. To do this, all the component frequencies in the step must be inaudible. We dug out an old copy of Fletcher-Munson loudness contours, from which we found that the slope of the curves at the low-frequency end is approximately 18 db per octave near the threshold of audibility. The answer obviously was to use three R-C stages —each with a slope of 6 db per octave —to produce an inverse modification of the step response. This should give the highest possible speed of action without producing any audible effect—and it worked! When this system is in use there is not the slightest indication that at one instant a certain mike is dead, and a second later it is alive.

Two systems were modified to incorporate this method of switching. The first was simply a twin version of Fig. 1 for switching two microphone circuits; the second is far more versatile, and is shown in block form in Fig. 2. There are three remote-control microphone inputs with universal input transformers so that microphones of any impedance can be used. After mixing, the frequency spectrum is divided into three channels, with individual low-, medium-, and high-frequency amplifiers. Two of the channels have remote gain control (operating the middle channel at fixed gain eliminates an extra control).

6J7's are used in the input and tone-control stages. Tubes were scarce over here when the original amplifier was built, and the 6J7 and the Z63 (a British type) can be used interchangeably. With the control bias applied to grid 1, 12 volts provides complete cutoff. This is much less than would be needed with remote-cutoff tubes, and no microphone has large enough output to produce appreciable distortion due to the curvature of the tube characteristic even in the second stages.

Grid 1 control was chosen in preference to suppressor control because the earlier KTZ63, for which the Z63 is now a replacement, was a tetrode.

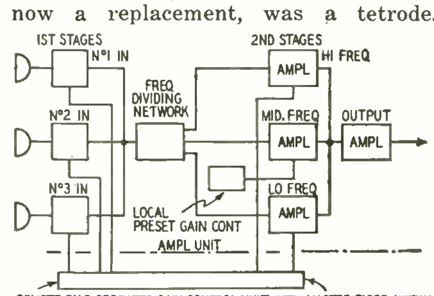
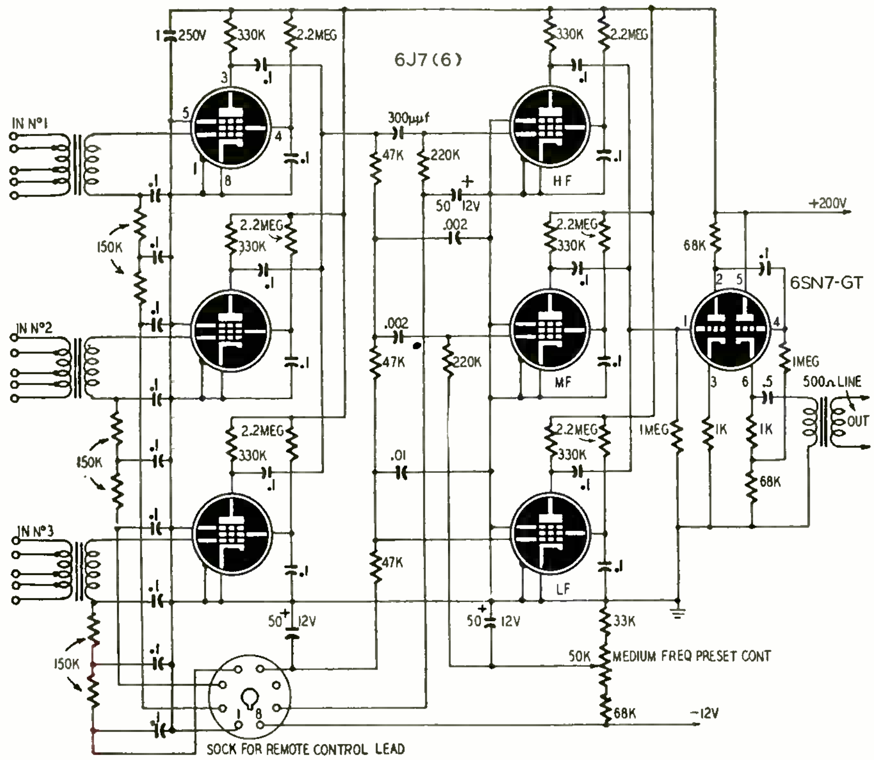


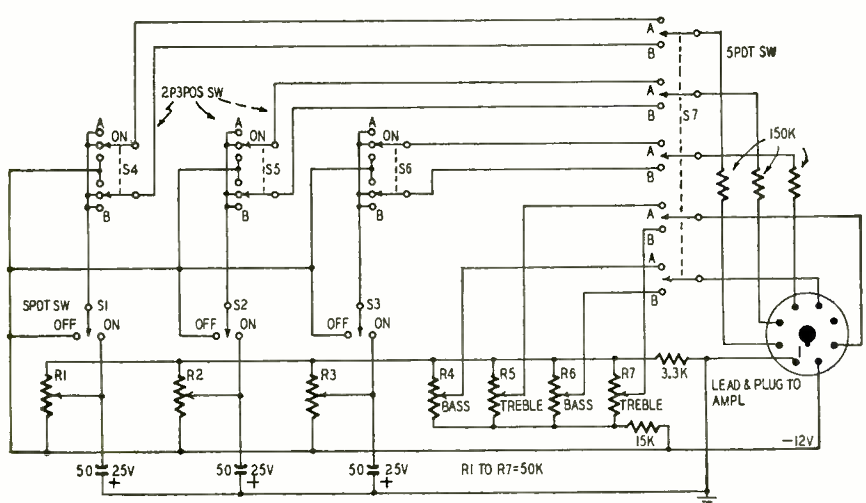
Fig. 2—Block diagram of the de luxe remote-control amplifier described in the text. One or more microphone inputs may be selected, mixed, and divided into low-, medium-, and high-frequency amplifier channels with independent gain controls.

Use care in selecting tubes, to find suitable nonmicrophonic samples. Special low-noise pentodes such as the 1620, 7000, and British EF37A might be better for this application, but this does not invalidate the method. Fig. 3 is the complete amplifier circuit.

The control-panel circuit is shown in Fig. 4, and the panel in the photo. The remote-control connection is through an octal plug and socket on a 7-wire cable.



Figs. 3 and 4—Schematic of controlled system (above) and control unit (below).



There are two switches with each microphone gain control. The lower one (S1, S2, or S3 in Fig. 4) is a simple on-off toggle switch: when it is OFF, that mike circuit is definitely off. When it is ON, the mike is controlled by the remaining switches and controls. The additional switch above each gain control (S4, S5, or S6) has three positions, marked A, ON, B; in the center (ON) position, the mike circuit is on, subject to control only by gain controls R1, R2, or R3. But in either side position A or B it is further subject to control by the tone-control switch S7.

Two pairs of tone-compensation controls—one pair shown as R4 and R5, and the other pair shown as R6 and R7—are provided for low- and high-frequency gain. (The mid-frequency gain is preset in the amplifier.) Between these pairs is a two-way switch S7 whose positions have been marked A and B. When this switch is in the A position R4 and R5 control tone, while in B position R6 and R7 control tone. Besides selecting tone-control settings, this switch will also select mike circuits set to position A or B on the individual mike-circuit switches.

This layout may seem complicated, but a little thought will show that it provides extremely versatile control. Suppose two individuals are talking alternately into two different mikes. Using S4 and S5, one mike can be set to A position and the other to B position, and the master tone-control switch S7 can be used to switch from one to the other as each speaks in turn; tone-control group A can be set to give the most pleasing result with mike and voice A, independent of the B position setting. S7 changes the tone setting automatically every time the mikes are switched. If desired, a third mike can cut in on either A or B position, by having its three-way circuit switch S6 in the ON position, and just bringing it in with its ON-OFF switch S3. It is best to keep any circuit not in use with its ON-OFF switch on OFF, and its selector switch in the middle ON position. Then it can be cut into the circuit instantly, simply by throwing the ON-OFF switch. The high- and low-frequency tone controls can be used to create special effects such as artificial distance, by accenting or attenuating extreme frequencies. (This system can be adapted for use with an echo chamber like the one described by Charles L. Hansen in RADIO-ELECTRONICS for July, 1952.—*Editor*)

One feature of the panel's versatility is that a new tone-control setup can be prepared while one or two mike circuits are being used. At the right moment the changeover between the tone controls is made with a flick of the A-B switch S7. If for any reason the new arrangement would be better on B circuit, and the present arrangement is already on B circuit, then the present setup can be transferred to A circuit first. Set the *live* mike-selector switches to the middle ON position, set both tone controls in the same position, and change over from B to A with S7. Then switch the live mike-selectors to A. Now preparation can proceed on the B circuit. This does not interfere with the program. A little thought is needed to master the principle of operation, but once understood, its extreme versatility is ample reward.

Two more points should be made clear before concluding. The values used for the switching-filter circuits, three 150,000-ohm resistors and three 0.1-μf capacitors, proved adequate for practically all jobs. But if more than usual gain is required, due to using a low-sensitivity microphone at long range, switching clicks may come through, particularly when switching *off*. One method of preventing this without modifying the circuit, is to turn the gain control down first; then switch *off*; and then reset the gain control to the desired level ready for the next switching *on*. If the operator finds this difficult, further controls could be added to reduce the gain by a fixed amount in the OFF position (just enough to render the microphone insensitive), instead of cutting the tube off completely. Less switching voltage will be needed with this method, but the first method has been found satisfactory for the comparatively few occasions where clicks are audible

Some readers may feel that 6J7's will not give much range of control, but will act like on-off switches. Try it. You will find that any tube can be used as a variable-mu tube, provided the signal level is small enough so the tube curvature does not cause distortion. The range of gain variation is as great as can be obtained with a remote-cutoff tube. END

VOLTAGE REGULATORS FOR HIGH-FIDELITY AMPLIFIERS

VR tubes decrease hum and improve amplifier stability and response

By JOSEPH MARSHALL

VOLTAGE-REGULATED power supplies find considerable application for stabilizing high-frequency oscillators in receivers and transmitters. Their purpose is to minimize frequency drift if the line voltage varies. Less well known, but of even greater value, is the use of voltage regulators, especially gas-tube types, as hum and decoupling filters in high-fidelity audio amplifiers. They provide a highly effective and low-cost method of improving the hum level and transient response, and can transform an excellent amplifier into a superlative one. I have used this device for many years and it is one of the features of the *Golden Ear* amplifier. ("For Golden Ears Only," by Joseph Marshall. *Audio Engineering*, April, 1950.)

A voltage regulator is the equivalent of a highly effective low-pass filter consisting of a series impedance A and a shunt impedance B (Fig. 1). We know from Kirchoff's law that when a current is introduced at a junction of several branches it will divide among the branches in inverse proportion to their resistances or (in the case of a.c.) their impedances. In the low-pass filter, part of the current will go through series element A and part through shunt element B. If the combined resistance or impedance of the series element and the load is 10 times greater than the impedance of the shunt element, 90% of the current will flow to ground through B and only 10% will flow through A and the load.

In a power supply we are dealing with both d.c. and a.c. The d.c., of course, is what we want to apply to the load, while the a.c. is the ripple we want to suppress or bypass to ground. We need a series circuit, which will offer a high impedance to the a.c. and a low resistance to the d.c., and a shunt circuit with high resistance to the d.c. and *a very low* impedance to the a.c. We achieve it by using either resistance or inductance for the series element and capacitance for the shunt element. The capacitor has very high resistance to d.c. and relatively low opposition to a.c., while the inductance has high impedance to a.c. and a low resistance to d.c. Thus we can bypass a good deal of the a.c. without reducing the d.c. too much. Unfortunately, it takes very bulky inductors and capacitors to do the job at hum frequencies (60 and 120 cycles). And when the hum level must be held to 60 db or more below the signal level—which means reducing the ripple to one-ten-thousandth or even one-hundred-thousandth of its value at the rectifier output, four or five filter sections are required.

This is where the VR tube can perform a valuable service. It is an ideal hum filter, and it is very much less costly and bulky than any combination of capacitors and inductors or resistors capable of equal filtering action.

The use of VR tubes as hum filters combines perfectly with their use as decoupling filters.

Amplifier "definition"

The ideal amplifier delivers an exact counterpart of the input signal to the load. It neither adds to nor subtracts anything from the *form* of the signal. An amplifier may distort a signal by subtracting some of the tonal values through frequency discrimination, or by adding harmonic distortion and intermodulation. Another addition affects the *definition* of the amplifier.

An amplifier with good definition maintains the distinctness of the individual elements of the signal. Definition in an amplifier can be compared to resolution in a camera. A camera with good resolution will show individual blades of grass and individual hairs in a coiffure; a camera with poor resolution blurs the separate components so that they cannot be distinguished. Similarly, an amplifier with good definition reproduces the individual notes and instruments distinctly; one with poor definition will blur the individual tone elements and instruments until they cannot be distinguished separately.

Definition in an amplifier is very largely a function of transient response. An amplifier with good transient response is nonresonant, nonregenerative and nonoscillating. It is always merely a reproducer, never a generator. Unfortunately, this is much easier to stipulate than to achieve. Most amplifiers are regenerators or oscillators of the triggered type. At some point in the frequency range they are resonant, possess a feedback loop, and will break into momentary oscillation if triggered by a strong-enough impulse. These oscillations are not always audible as such in the output. They are manifested not as constant tones but as "hangover" effects, and consist of a series of echoes of the signal. They may even be pleasing to some because they give a resonant effect which sometimes simulates room resonance. But they reduce the definition of the amplifier, blurring the individual elements and instruments instead of maintaining their distinctness.

Transient oscillations

Fig. 2 shows what happens. The figure at *a* represents the wave-train of a damped (soft pedal) piano trill plotted on amplitude-time co-ordinates. There are definite valleys between the separate tones in the original signal. An oscillating or regenerative amplifier, however, will prolong each pulse with a series of spurious pulses—hangovers or echoes—which not only change the shape of the original pulse, but also

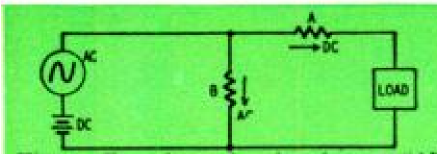


Fig. 1—Functions of series-element "A" and shunt element "B" in low-pass filter.

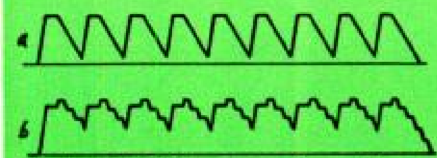


Fig. 2—(a) Original waveform of piano trill. (b) Oscillations in amplifier add "hangover" pulses to each trill cycle.

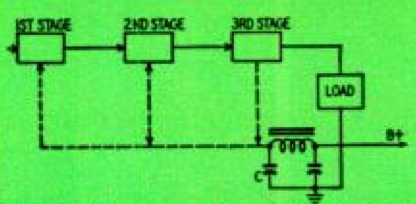


Fig. 3—Diagram of possible feedback loops in a three-stage amplifier with one B supply and no decoupling.

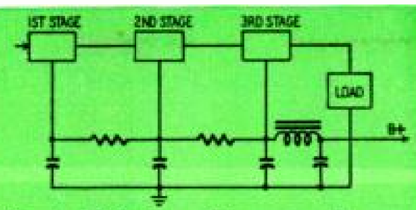


Fig. 4—R-C decoupling networks.

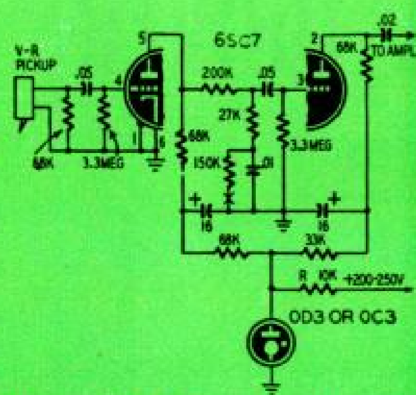


Fig. 5—Adding voltage regulation to a variable-reluctance pickup preamplifier.

fall into and partially fill the valleys between pulses. The result is indicated at *b*. The separation between pulses is no longer distinct and sharp, and the total effect is blurred. In fact, the effect is very much like that of playing the same trill undamped—that is, with the loud pedal depressed.

Moreover, if the amplifier is resonant at any frequency, it can be triggered into oscillation at this point by any strong transient regardless of its frequency. In good amplifiers the resonant points will be at the inaudible extremes of the frequency range and the oscillations themselves will not be audible. Nevertheless the oscillations will have two disastrous effects: first, they create intermodulation distortion; second, they are usually of much higher amplitude than the signal and may drive one or more stages of the amplifier into the nonlinear regions of their curves and produce violent distortion of every possible form, even at low signal levels.

To be a true reproducer, an amplifier must be as nearly nonresonant, nonregenerative and nonoscillating as possible. To achieve these qualities we make the amplifier frequency response flat away below and away above the audible range (from 10 to 100,000 cycles in good amplifiers). We also try to eliminate or reduce the bad effects of feedback loops in the amplifier.

Feedback loops are inescapable in any amplifier when several stages are fed from the same power supply. Fig. 3 is a block diagram of a three-stage audio amplifier with a common power supply and no decoupling filters. The dashed lines are the feedback loops created by the common plate-supply line. If capacitor C does not bypass *all* audio voltage on the line to ground, part of the audio voltage in the output stage will be fed back to the first and second stages. Regeneration will occur where the feedback is in phase with the stage signal, and oscillation will start if the amplifier has a resonant point.

With 3 resistance-coupled stages or 2 transformer-coupled stages the feedback will always be in phase over some portion of the frequency range. To minimize feedback we must insert low-pass filters in the feedback loops—filters which will pass the d.c. plate currents but will bypass most if not all of the signal frequencies. Typical R-C decoupling networks are shown in Fig. 4. These will reduce feedback at normal frequencies; but adequate bypassing below 50 cycles calls for enormous values of shunt capacitance. For this reason cheap amplifiers cut off the low-frequency response very sharply at about 100 cycles.

But as we have already noted, really high-fidelity amplifiers must be designed for a pass-band from 10 to 100,000 cycles. How are we going to decouple effectively at a frequency as low as 10 cycles? One way is to use two or more power supplies. Some expensive amplifiers actually do this. A much simpler and equally effective device, is to use one or more VR tubes at appropriate points in the power-supply loop.

VR decoupling

Any regulator which holds a d.c. voltage absolutely constant, is a *perfect* bypass for a.c. As a shunt unit a VR tube is effective down to subaudible frequencies. The installation of VR tubes for decoupling and hum filtering is simple and inexpensive. Only one VR tube is necessary in most amplifiers. The need for decoupling and hum filtering is progressive; we need much less attenuation of hum and feedback in the final stages of an amplifier than in the input stages. By combining brute-force inductance-capacitance filters with a single VR tube we can usually achieve almost complete hum and feedback suppression in amplifiers of five or even six stages (assuming that the final stage and the drivers are push-pull and that no interstage transformers are used).

The most effective point for a VR tube is the input stage, or the preamplifier for a low-level phono pickup. Fig. 5 shows how to use a VR tube with a G-E-type preamplifier. If a commercial amplifier is used, the 10,000-ohm resistor and VR tube can be inserted at the B plus-input point. If the preamp is home-built, the 16-μf filter capacitors and 33,000-ohm series resistors can be eliminated. In any case, the 150,000-ohm resistor in the frequency-correction network can be removed. This resistor limits the bass compensation at very low frequencies to guard against motorboating. With the much better decoupling provided by the VR tube, this limitation is no longer necessary, and removing the resistor extends the effective range of the bass boost circuit.

Application to any other input circuit is just as simple. The VR tube is simply inserted in the B plus line in place of the usual decoupling network. The stage in which the VR tube is connected should be designed for a plate supply of 150 volts. Most amplifiers designed for a 250-volt plate supply will work all right with a 150-volt supply. In any case, the improved decoupling extends the low-frequency limit and a larger cathode bypass capacitor (at least 25 μf), and a larger grid-coupling capacitor should be installed. In all cases the series resistor R should be adjusted so that a minimum current of 10 ma flows through the VR tube. Two or more stages may be fed by one VR tube provided the total current does not exceed 30 or 40 ma.

The addition of a VR circuit to a well-designed audio amplifier with a very wide, flat frequency range will produce a marked improvement in transient response, especially at very low frequencies. The "Golden Ear" amplifier—although transformer-coupled—will reproduce the 1¼-cycle wave of a phonograph record with an off-center hole without any tendency toward oscillation or instability. In large part this is due to the use of two VR tubes—one at the phono-preamp and one at the stage feeding the push-pull drivers. The expedient is highly recommended to high-fidelity enthusiasts and designers.

Audio amplifiers using Class AB pentodes and beam power output tubes require a regulated screen voltage for maximum output. This can be supplied by one or more VR tubes operated in series. Use tubes whose total operating voltages equal or approximate the required screen operating voltage. The 0B3 operates at 90 volts, the 0B2 and 0C3 at 105 volts, and the 0A2 and 0D3 operate at 150 volts. The VR-75 (obsolete but often available on the surplus market) supplies 75 volts. END

PUSH - PULL DRIVERS

Part IV—This circuit, the "long-tailed pair," is considered by the author to be the best of the phase-splitters.

By GEORGE FLETCHER COOPER

IN this series of four articles about the phase-splitting stage which must provide the link between a single-ended amplifier and a push-pull stage we have examined several bad circuits and two classes of good circuits. As we have seen, the single tube with a split load is good if you do not need too much drive; and the anode-follower or *see-saw* circuit gives more output, but less gain. For conventional audio work the tubes and supply voltages you plan to use will determine whether you take the single-tube or two-tube phase-splitting circuit.

There are some special jobs, though, for which these push-pull driver types are not suitable. The most important of these is when you want to go down to extremely low frequencies, or even all the way to zero frequency. The anode follower (see Part III, in the February issue) includes one coupling capacitor, so that it will not stay balanced once the capacitor starts to take control; the split-load circuit (Part II, January, 1953) has the disadvantage that the two output terminals are at different d.c. potentials. A symmetrical direct-coupled deflection amplifier for a cathode-ray oscilloscope calls for a phase splitter which provides two outputs at the same average d.c. potential, because any unbalanced difference will pull the undeflected spot away from the center of the tube.

"Long-tailed pair"

One phase-splitting circuit is particularly good for cathode-ray oscilloscope work. It has other uses too, but we shall come back to those after we have examined its characteristics. The circuit itself is known as the "long-tailed pair," or more prosaically, as the Schmitt cathode-coupled phase inverter. If you look at the basic circuit in Fig. 1, you will see why the name "long-tailed pair" was adopted. This circuit is related to the anode-follower discussed last month in a rather interesting way. The anode-follower circuit, you may remember, could be described simply by saying that the second tube is driven by the *difference* in the *plate-voltage* swings of the two tubes. The second tube of the long-tailed pair has its grid grounded, and the effective drive to this tube is applied at the cathode. The driving voltage is equal to the cathode resistance R_k multiplied by the *difference in plate currents* of the two tubes.

Suppose we raise the potential of grid 1 by 1 volt, causing an extra current I_1 to flow through tube 1. The current in tube 2 will *drop* by an amount I_2, and the cathode potential will change by $(I_1-I_2)R_k$. This *change* is the input to tube 2, and if R_k is very large, we can have (I_1-I_2) very small and still get some drive into tube 2. In fact, we can draw Fig. 2-a, for comparison with Fig. 2-b, which is the *see-saw voltage* diagram from last month's article. If you look at Fig. 2-a you will notice that in order to get any drive at all for tube 2 it is necessary to have unequal values of I_1 and I_2 (C_1-R_k and C_2-R_k). Drive for tube 2 is Og. The only way to get equal swings at the two plates is to use slightly different plate-load resistances R_{L1} and R_{L2}.

We can do some very simple calculations to see the sort of difference.

At plate 1 we have a swing of I_1R_{L1}. The input to tube 2 is $(I_1-I_2)R_k$, which gives a plate current of $gm(I_1-I_2)R_k$ and, therefore, a swing at the plate of tube 2 equal to $gm(I_1-I_2)R_kR_{L2}$, which is, of course, also equal to I_2R_{L2}. Therefore $gmI_1R_kR_{L2} = I_2(1+gmR_k)R_{L2}$, and

$$I_1/I_2 = 1 + \frac{1}{gmR_k}$$

Since we want

$$I_1R_{L1} = I_2R_{L2}$$

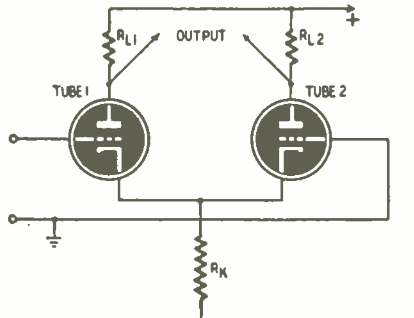


Fig. 1—Circuit of the "long-tailed pair" cathode-coupled phase-inverter.

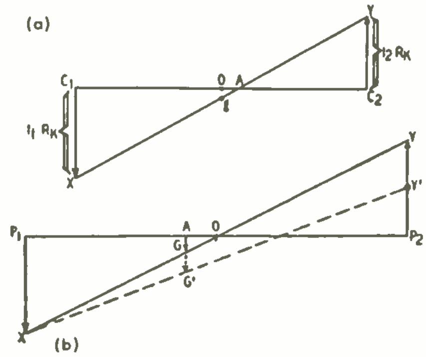


Fig. 2—(a) Current see-saw diagram of the "long-tailed pair". (b) See-saw diagram of balanced-voltage phase inverter reprinted from last month's article for comparison with balanced-current type.

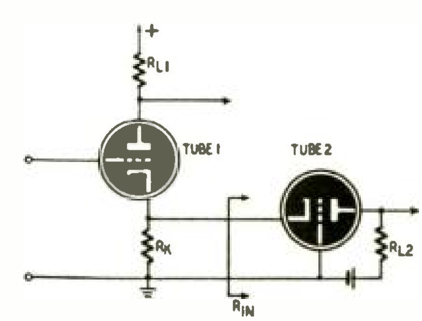


Fig. 3—"Long-tailed pair" redrawn to show grounded-grid operation of Tube 2.

we have

$$\frac{R_{L2}}{R_{L1}} = \frac{I_1}{I_2} = 1 + \frac{1}{gmR_k}$$

Typical values for this circuit are
R_k = 5,000 ohms and
gm = 5ma/v (5,000 μmhos),
giving a ratio
$R_{L2}/R_{L1} = 1.04$.
This means that even without unequal load resistors we get a balance correct to 4%, which is quite good.

The rigorous approach

This result, obtained by very simple reasoning, applies quite well if tube 1 and tube 2 are pentodes, though it leaves a rather tricky gap if you wonder how to bypass the screen grids right down to zero frequency. It shows that the circuit looks good, anyway. And now we come up against the main problem of the writer of technical articles: do you want it easy, or do you want it right? Sometimes the writer can put in all the mathematics—if he is French he seems to put in nothing but the mathematics—sometimes he collects a dense mass of small-print equations at the end. Usually he must tack between the Scylla of editorial condemnation and the Charybdis of long-haired readers who write and point out the smallest deviation from rigor.

My own preference is to start off with the exact mathematical solution, and then simplify. Any reader who wants to get more detail can then build up on the sound foundations I have provided. If you try to simplify *first*, you will have nothing to build on later.

It will be much easier to understand the long-tailed pair if we redraw the circuit in the form of Fig. 3. This is not as elegant and symmetrical as Fig. 1, but it is a good deal more useful. Tube 2, you now see, is a grounded-grid stage, a subject we discussed recently in RADIO-ELECTRONICS (October, 1952, issue). I shall save myself a lot of trouble by using some of the results I worked out in that article. In particular, the input impedance (R_{in}), looking in at the cathode, is $R_{L2} + R_{p2}/1 + \mu_2$ and the gain is $(1 + \mu_2)\ R_{L2}/R_{L2} + R_{p2}$.

Let us look at the first stage first. The tube has a plate load R_{L1}, and there is some negative feedback because of the unbypassed cathode resistor. If we represent the cathode circuit (R_k in parallel with the input resistance of tube 2) as R_x the gain is just $\mu_1 R_{L1}/[R_{L1} + R_{p1} + (1 + \mu_1)\ R_x]$ and the voltage across the cathode circuit is R_x/R_{L1} times the voltage at the plate. So if we have 1 volt at the grid of tube 1 we have $\mu R_{L1}/[R_{L1} + R_{p1} + (\mu_1 + 1)\ R_x]$ volts at plate 1, $\mu_1 R_x/[R_{L1} + R_p + (\mu_1 + 1)\ R_x]$ volts at the common cathode, which we can write as V_x, and $[(1 + \mu_2) R_{L2}/R_{L2} + R_{p2}]\ V_x$ at plate 2.

We want the voltage at plate 1 to be the same as the voltage at plate 2, so we put

$$\frac{\mu R_{L1}}{R_{L1} + R_{p1} + (\mu_1 + 1)\ R_x} = \left(\frac{(1 + \mu_2)\ R_{L2}}{R_{L2} + R_{p2}}\right) V_x$$

and

$V_x = \mu_1 R_x / R_{L1} + R_{p1} + (\mu_1 + 1) R_x$

There is one more equation, because R_x is made up of R_k in parallel with R_{in}—$[(R_{L2} + R_{p2})/(1 + \mu_2)]$—so $R_x = R_K (R_{L2} + R_{p2})/(R_{L2} + R_{p2} + \mu R_K)$.

That last paragraph is tough but true. Assume the two tubes are similar and struggle with it for a while and you will come out with the equation for true push-pull balance,

$R_{L1}/R_{L2} = (1 + \mu) R_k/R_{L2} + R_{p2} + \mu R_k$

This doesn't look too bad, and if we assume further that we have pentodes, so that μ and R_{p2} are very large, $1 + \mu \simeq \mu$ and

$$\frac{\mu}{R_p} = gm$$

we arrive at

$R_{L1}/R_{L2} = gmR_k/(1 + gmR_k)$

which is equivalent to the answer given by our very simple treatment.

It is interesting to compare the exact solution with the simple one for a typical case: consider a 12AT7, with R_p=10,000 ohms, μ=50, gm=5,000 μmhos and R_k = 5,000 ohms. We can choose R_{L2}=50,000 ohms and we obtain

$$R_{L1}/R_{L2} = 51 \times 5{,}000/50{,}000 + 10{,}000 + (50 \times 5{,}000) = \frac{255{,}000}{310{,}000}$$

This is about 0.825, whereas with the simple formula we had

$R_{L1}/R_{L2} = 1/1.04 = 0.96$

There is quite a difference between a 17% unbalance and a 4% unbalance, and obviously we are justified in adopting a more rigorous approach. Energetic readers may care to consider what happens if Tube 2 ages and R_{p2} gets bigger: as R_{p2} represents only 10,000 in the total 310,000 of the numerator it cannot be a very serious factor. If μ_2 gets smaller, things are rather more complicated, because μ_2 appears in both denominator and numerator; anyway, μ_2 is more nearly constant during the life of the tube.

Oscilloscope applications

For applications in which a good stable balance is needed, a much higher value of R_k would be used. As an example, we might take R_k = 50,000 ohms, when

R_{L1}/R_{L2} = 2,550,000/2,560,000, = 0.996

and the unbalance is only about ½%. Changes in tube characteristics can only unbalance the circuit to the same limited extent, assuming that we start with correctly proportioned load resistors, so that we have a very satisfactory circuit here. But 50,000 ohms is a very long tail.

The reader who has been watching these numbers carefully may be getting a little worried. If each tube draws 5 ma there will be a total of 10 ma through the cathode resistor. All this talk of 50,000 ohms implies a drop of 500 volts across R_k, and even if we cut R_k to 20,000 ohms, we need a -200-volt supply if we are to work with the grids around ground potential. This is not a serious matter in oscilloscope circuits, because negative high-voltage supplies are generally used. In some other circuits, where the grid of tube 1 is connected directly to the plate of a preceding tube it is an advantage to have the whole tube circuit lifted up above ground. But 200-500 volts is rather high, and when an extra-large cathode impedance is needed for special high-balance jobs, special circuit tricks are usually adopted.

One very important circuit uses a pentode in place of R_k. A 6AQ5, for example, will pass 10 ma with only 20 volts on the plate, but the impedance so far as constancy of current is concerned will be very high, certainly above 100,000 ohms. This means that we can make $R_{L1} = R_{L2}$, and still have a virtually perfect balance. The form the circuit takes is shown in Fig. 4, which

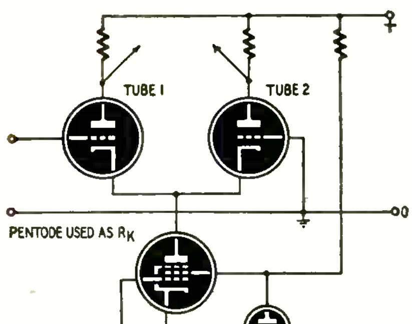


Fig. 4—A high-impedance pentode as a common cathode resistor swamps out variations in Tube 1 or Tube 2 that might unbalance the phase-inverter currents.

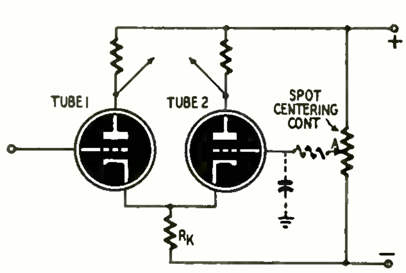


Fig. 5—When using the "long-tailed pair" to feed the balanced deflecting plates of a cathode-ray oscilloscope the grid of Tube 2 may be returned to an adjustable d.c. divider to restore the beam to the center of the scope screen.

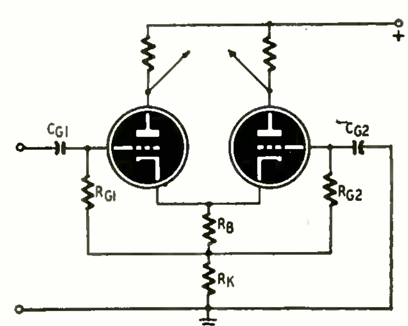


Fig. 6—One method of eliminating the negative voltage supply for the cathode return. R_B is tapped off the total cathode resistance at the desired bias point.

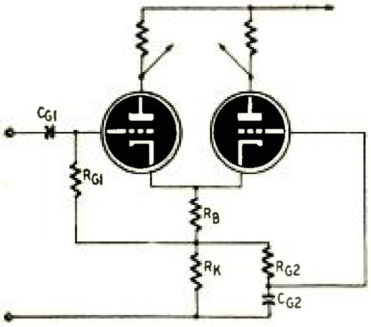


Fig. 7—The circuit of Fig. 6 redrawn to show the high-frequency shunting effect of C_{G2}, the coupling capacitor to Tube 2.

also shows a voltage-regulator tube as a screen bypass, to insure operation down to zero frequency.

Another way of providing the necessary high impedance in the cathode circuit is to use a saturated diode for R_k. The tungsten-filament diodes used as noise sources in receiver testing give full emission (saturate) at a relatively low plate voltage, and increases in plate voltage give almost no change in current. The only disadvantage in using them is that the diode current depends on the filament temperature, so that the filament current must be stabilized.

Our purpose in seeking such highly accurate balance is not to get 10.01 watts from an amplifier instead of 10 watts, but to meet the requirements of some special measuring instruments. If you look back at Fig. 1, you will see that apart from the ground connection of the grid of tube 2, the circuit is absolutely symmetrical. In fact, this ground connection is there only because we assumed a grounded input: we are really using the voltage G_1-G_2 as the input, and deriving two equal antiphase outputs from this. Suppose, however, that we connect both grids together, and then apply a signal. There will be an in-phase signal at the plates, but it will be relatively small, since the large cathode resistance R_k provides a great deal of feedback. We can easily calculate what will happen, because we can assume that each tube has $2R_k$ in its cathode and then treat one tube alone. The gain from grid to plate is $\mu R_L/[R_L+R_p+(\mu+1)2R_k]$.

With a 12AT7,
$R_L=50{,}000$ ohms, $R_p=10{,}000$ ohms, $\mu=50$, $R_k=50{,}000$ ohms.

This gives a gain of about 0.5, so for *push-push* input the gain from grid to plate is less than unity. For *push-pull* input, applied *between* the grids instead of to grids in parallel, the gain is 30, so the balance ratio is 30: 0.5, or 60 to 1. If a pentode is used for the cathode resistor this figure can be increased still more.

This circuit is used in electroencephalography: the two grids are connected to electrodes applied to the head of the patient, and the tiny brain currents produce a *push-pull* voltage between the electrodes. Stray 60-cycle fields produce a relatively large *push-push* voltage which must be eliminated, of course, because it would mask the brain signals even if it did not overload the final stages of the recording amplifier.

For use with oscilloscopes there are two possibilities. In the first, the two grids can be regarded as the two input terminals, and we have the feature that *push-push* voltages are discriminated against, while *push-pull* voltages are applied to the deflecting plates of the oscilloscope tube. This is excellent if you wish to work around zero voltage. But if you are interested in the variations of a voltage which is always well away from zero, this push-pull input is not very satisfactory, because the d.c. component of the input will deflect the spot away from the center of the screen. The arrangement of Fig. 5 is then more useful. The grid of Tube 2 is connected to point A, which provides a positioning voltage to bring the spot near the center of the screen. The grid of tube 1 takes the input signal, which is converted to push-pull to avoid defocusing and trapezium distortion (keystoning). A capacitor (shown in dotted lines) may be added to keep supply hum off the grid of tube 2, where it would be amplified as an ordinary signal. A resistor (also shown dotted) is sometimes added to improve the smoothing. (In some oscilloscopes the time constant of this R-C filter is so long that the spot goes on drifting long after you have taken your hand off the positioning control.

Stages of this kind can be connected in cascade if you have generous power supplies. The subject is slightly outside our present field, but you can see that if the first pair is to operate at about zero grid volts, the plates will be up at about + 100, while the cathode resistor is returned to, say, –150 volts. The second stage grids are then at + 100, so we have a 250-volt drop in the second cathode resistor (assuming this also goes back to –150 v). The second-stage plates will be at + 200-250 volts, so that the supplies needed will be +400 v, 0 and –150 v. You just apply Ohm's Law to find the resistance values.

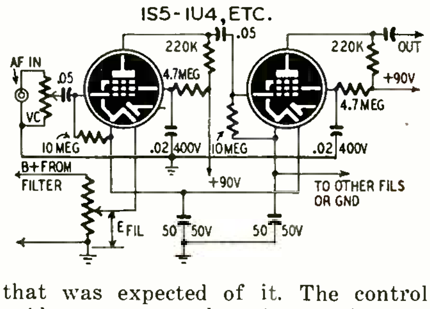
Although this circuit is not used much for audio amplifiers, we should examine how it *can* be used, and in particular how we can get away from this negative voltage line. A simple and apparently symmetrical form of circuit is shown in Fig. 6. Bias is provided by R_B, which has its usual value for the tubes (about 100-500 ohms) according to the operating conditions, and the grids return to the bottom of R_B through R_{G1}, R_{G2}. The coupling resistor R_k lifts the whole group of resistors up to perhaps +100 volts, so that blocking capacitors C_{G1}, C_{G2} are needed to connect the input and to provide the a.c. ground on grid 2. This circuit is not as symmetrical as it looks, as you will see if you consider it as redrawn in Fig. 7. At high frequencies the grid of tube 2 is grounded, but at low frequencies, when C_{G2} is no longer a low impedance, the grid is returned to somewhere between ground and the top of R_k. At zero frequency, the coupling resistance is down to R_B, which is too small to provide any satisfactory sort of balance. In practice this means that we must make $2\pi fC_{G2}R_{G2}\gg1$ at the lowest frequency we intend to use. We also need $2\pi fC_{G1}R_{G1}>1$ if we are to get the signal into the circuit at all. At high frequencies the only sources of trouble are tube capacitance, in particular the grid-cathode capacitance which is effectively in parallel with R_k, since grid 2 is grounded.

If you now look back at Fig. 1 you will, no doubt, admire the elegant simplicity of the circuit: just three resistors, a pair of tubes, and that little $-V_c$ sign. Every few years I come back to this point of indecision. It's a good simple circuit, but where will I get that negative supply? For special jobs, with double input, it is possible to elaborate the long-tailed pair to give a really well-balanced system, though the balance is usually not as good as you can get with a transformer. But the long-tailed pair stays balanced down to zero frequency.

I hope that in these four articles I have succeeded in making it clear that it doesn't cost any more to make your push-pull circuit really balanced. The shoddy circuits described in Part I will add to your troubles if you want to use a reasonable amount of negative feedback, and as far as I can see they amount to nothing more than a public avowal that you "couldn't care less." If an amplifier is designed on that basis I would expect it to be pretty badly constructed, too, and I should stay well clear of it. END

LOW-HUM AMPLIFIER

While constructing a high-gain a.f. amplifier for minute input voltages, I was faced with the problem of 60-cycle heater hum. Unable to lick the problem using 6.3-volt tubes, I switched to 1.5-volt, 50-ma, battery-type tubes, wired the filaments in series and connected them to a bleeder on the power supply. The circuit shown does all



that was expected of it. The control grids are operated with zero bias in this circuit. Fixed bias can be applied by inserting dropping resistors in the heater line and returning the grids to the point which gives the desired bias with respect to its negative heater pin.

The tap on the bleeder must be adjusted so the voltage does not exceed the sum of the voltage drops across the tubes. If biasing resistors are used this voltage must be raised accordingly.— *David Simon.*

Volume Expanders and Compressors

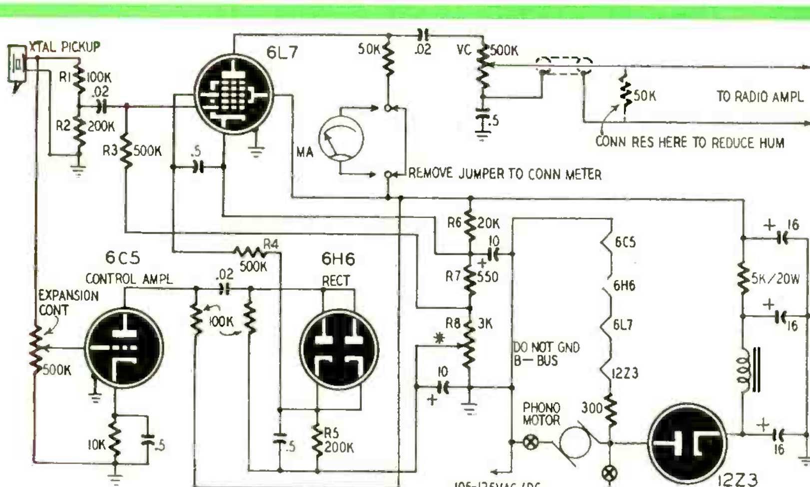


Fig. 1 *ADJ WITH SCREWDRIVER UNTIL METER IN PLATE OF 6L7 READS .15MA WITH NO SIG

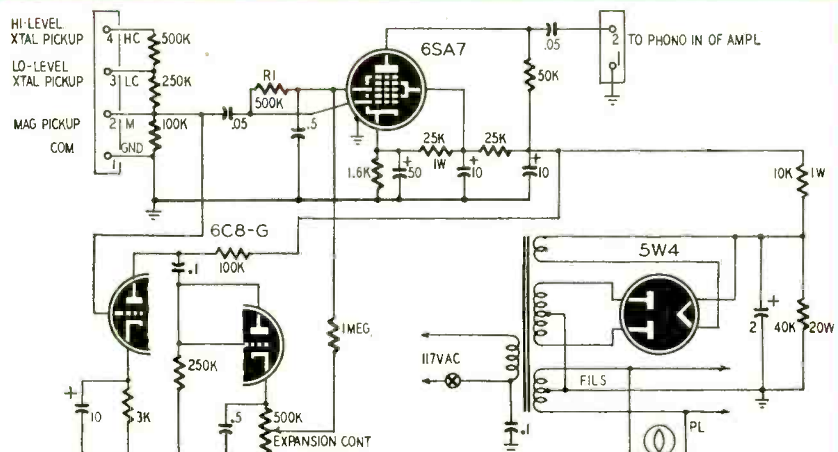


Fig. 2

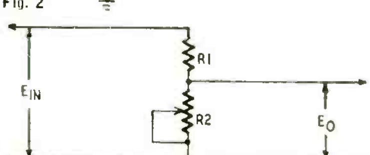


Fig. 3

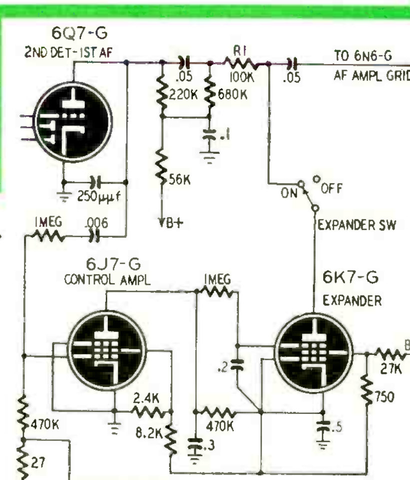


Fig. 4

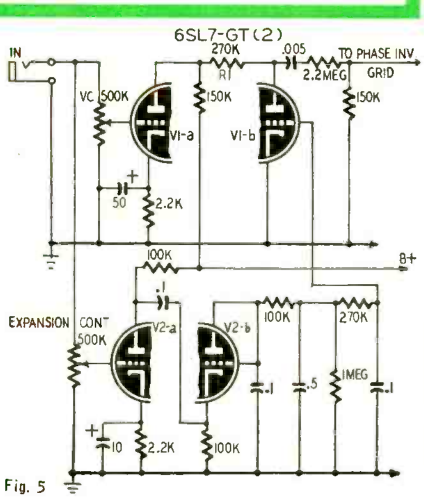


Fig. 5

Fig. 1—The Ansley *Phantom Conductor*. Fig. 2—The Bogen model SLX volume expander. Fig. 3—Equivalent circuit of a constant-gain expander. Fig. 4—An early Sparton circuit. Fig. 5—Masco's constant-gain volume-expander circuit.

By ROBERT F. SCOTT

Automatic volume expanders (also called contrast expanders) were developed in an effort to restore the original dynamic volume range to broadcast and recorded music which had been limited or compressed to prevent overmodulating the transmitter or overcutting the record. While FM broadcasting and LP and 45 r.p.m. records have reduced the need for expansion (little or no compression is used at the studios), the technician still runs across the circuits in older or special equipment. Commonly used volume expanders are of three basic types, namely: variable-gain, constant-gain variable-output, and inverse-feedback. An example of the variable-gain type is shown in Fig. 1.

Ansley Phantom Conductor

Fig. 1 is the circuit of the Ansley model DA-PC *Phantom Conductor*, a volume expander similar to the one which was described in several editions of the RCA Receiving Tube Manual. This unit is designed for use between a crystal pickup and audio amplifier.

The variable-gain expander tube is a 6L7 pentagrid mixer, a tube designed for superheterodyne circuits having separate oscillators and for other applications where dual gain control circuits are desired in a single tube. In audio applications, grids 1 and 3 may be used as separate control grids. The amplification of a signal applied to either grid can be controlled by varying the bias voltage applied to the other grid.

The full output of the pickup is developed across the expansion control and R1 and R2 in series. A portion of the a.f. signal is tapped off the junction of R1 and R2 and is applied to the signal grid (grid 1) of the 6L7. Operating voltages for cathode and signal grid are taken from taps on a voltage divider consisting of R6, R7, and R8. The bias voltage for the injector grid (grid 3) is obtained from a movable slider on R8 and is applied to it through R4 and R5 in series.

The signal appearing across the expansion control is amplified by the 6C5 control amplifier and then rectified by the 6H6. When the 6H6 conducts, it develops a positive voltage across R5 which adds to the fixed bias to reduce the potential difference between grid 3 and the cathode and to increase the amplification of the signal applied to grid 1.

The tap on R8 is adjusted so the 6L7 plate current is 150 microamperes with no signal input. The setting of the expansion control determines the amount of signal applied to the 6C5 and subsequently, the amount of dynamic d.c. bias applied to grid 3 of the 6L7.

Bogen model SLX expander

The Bogen model SLX expander shown schematically in Fig. 2 is fundamentally similar to the unit shown in Fig. 1. A 6SA7 replaces the 6L7 as the variable-gain amplifier. One triode of the 6C8-G replaces the 6C5, the other has its plate and grid strapped together as a substitute for the 6H6.

In this unit, the signal voltage is applied to grid 1 of the 6SA7 and to the control grid of the triode section of the 6C8-G. The dynamic bias voltage from the rectifier is applied to grids 1 and 3 to provide a greater control over the available amplification. The 0.5-μf capacitor bypasses the a.f. voltage to ground so it will not reach grid 3. The 500,000-ohm resistor R1 isolates the grids and prevents the a.f. signal on grid 1 from being bypassed to ground.

Single-ended variable-gain volume expanders produce a peculiar form of distortion when the incoming signal is modulated by the ripple and harmonic content of the dynamic bias developed by the control rectifier. Ripple and harmonics cannot be readily removed from the bias signal by filtering because this increases the time constant of the circuit to the point where the expander will not follow staccato passages.

To eliminate this effect and to permit the use of a short time constant, Amplifier Corp. of America has used a circuit which is basically a push-pull version of the single-ended expanders in Figs. 1 and 2. A push-pull audio signal is applied to the control grids in each of the push-pull variable-gain tubes and the dynamic bias is applied to the tubes in parallel. In this way, transients, ripple, and harmonics are balanced out because they are in phase on the grids and out of phase in the plate circuit. A modern version of the push-pull expander is used in the model 100-DC amplifier produced by Amplifier Corp. of America.

Constant-gain expanders

In a constant-gain variable-output expander, the output of a constant-gain stage is applied to a voltage divider in which one element is variable from zero to infinite resistance. The principle of this very interesting type of expander is illustrated by Fig. 3. The input voltage (from a constant-gain source) is applied across a voltage divider consisting of R1 and R2. The output voltage E_o can be varied from approximately E_{in} when R2 is infinite to zero when R2 is zero. In practice, R2 is replaced by the plate-cathode resistance of a vacuum tube. A control amplifier and signal rectifier supply dynamic bias to the tube represented by R2.

Fig. 4 shows the volume expander used in the Sparton 827X, 997X, 1167 and similar receivers, which were manufactured about 15 years ago. A part of the voltage output of the 6Q7 is fed into the grid of the 6J7 expander-amplifier (control tube) which is biased to cutoff by returning its grid to the center tap on the power transformer. The plate of the 6J7 is coupled directly to the suppressor grid of the 6K7 expander stage through a 1-meg-ohm resistor. The control grid of the 6K7 is tied to the suppressor through a filter consisting of 0.2- and 0.3-μf capacitors and a 470,000-ohm resistor. The time constant of this filter network permits only very large changes in 6J7 plate current to affect the grid voltage of the 6K7.

The 6K7 and 6J7 are connected in series across the B supply. The 6J7 plate receives much of its voltage from the 470,000-ohm resistor connected to the 6K7 cathode. The voltage drop across this resistor biases the suppressor of the 6K7 expander tube.

Since the 6J7 expander amplifier is biased to cutoff, a fairly large signal must be applied to its grid to produce an appreciable change in plate current. With low signals, the 6J7 remains cut off, and there is no voltage drop across the 470,000-ohm plate resistor. Since there is no voltage drop across the resistor, the 6K7 suppressor is at cathode potential and the tube conducts heavily. Under these conditions, the plate-cathode resistance of the 6K7 is low compared to R1 and much of the output of the 6Q7 is lost in the voltage divider consisting of R1 in series with the plate-cathode resistance of the 6K7.

On loud passages, the 6J7 draws heavy current and the voltage drop across the 470,000-ohm plate load resistor is sufficient to place a heavy bias on the suppressor of the 6K7. This increases the plate-cathode resistance of the 6K7 and permits a greater voltage to be fed to the grid of the 6N6 a.f. amplifier.

Masco constant-gain circuit

Fig. 5 shows a simpler version of the variable-output constant-gain expander circuit, as used in recent Masco amplifiers. V1-a and V2-a are conventional voltage amplifiers. V2-b is the bias rectifier, and V1-b is the expander tube whose plate-cathode resistance is represented by R2 in Fig. 3.

When the signal applied to the grid of control amplifier V2-a is low, the dynamic bias voltage developed by V2-b is not high enough to cause a substantial increase in the plate-to-cathode resistance of V1-b. The resistance of V1-b is low and a large part of the signal developed in the plate circuit of V1-a is dissipated across R1. When a strong signal reaches the grid of V2-a, the dynamic bias reduces the plate current and increases the internal resistance of V1-b so that a greater portion of the output of V1-a reaches the grid of the following stage. The attack and release times of the expander are determined by the charge and discharge time-constants of the capacitors connected between the plate of the rectifier V2-b and the grid of V1-b.

Inverse-feedback expanders

If inverse feedback is applied to one or more stages in an amplifier, the gain of these stages may be varied by varying the feedback voltage. Fig. 6 is the diagram of the Thordarson T-31W11 and T-31K11 audio amplifiers designed for use with a radio tuner. These units use an inverse-feedback type of expander.

The output of V1-a is applied simultaneously to the variable-gain stage V1-b and to control-voltage amplifier V2-a. V2-b is a half-wave shunt rectifier connected to develop a positive output voltage. This voltage is filtered by R1, R2, and C1 and fed to the paralleled grids of V3, the feedback control stage, which is initially biased to cutoff by a positive voltage on its cathode taken from the 6B4 bias resistor.

The cathode of V1-b is unbypassed and its grid is returned to a point on the cathode biasing resistor. This causes degenerative feedback which reduces the gain of the stage to a level considerably below that which would be obtained without feedback. The amount of feedback depends on the a.c. cathode impedance of the stage.

The plate-to-plate impedance of V3 is reflected into the secondary of T1 which parallels the cathode resistance of V1-b. When V3 is cut off, its plate-to-plate impedance is so high that it has little or no effect on the cathode impedance of V1-b.

When the positive dynamic bias voltage on the grids of V3 reaches a point which permits conduction, the plate-to-plate impedance drops. Since this impedance is in parallel with the cathode impedance of V1-b, the amount of cathode feedback decreases and the gain of V1-b rises.

The grids of V3 are fed in parallel and the plates work in push-pull. In this way, the feedback control stage effectively eliminates thumps and transients which would normally be caused by rapid rises in the dynamic bias voltage.

Fig. 7 shows another Thordarson inverse-feedback expander circuit. In it we have a two-stage variable-gain amplifier with a 25-db feedback loop (R1, R2, and C1) connected between the plate of V2 and the cathode of V1. The secondary of the feedback control transformer is connected between ground and the junction of R1 and R2 to form a T network.

The control amplifier circuit is similar to that used in Fig. 6. However, this circuit was used in a recording-playback amplifier so it incorporates volume compression as well as expansion. The control amplifier V3-a is connected to the phono-radio input when used as an expander and to the second variable-gain stage when used as a compressor. This switching is handled by section S1-b of the EXPAND-COMPRESS switch. Switch sections S1-a, S1-c and S1-e reverse the polarity of the rectifier and cut in separate filter circuits for compression and expansion.

When the switch is set for expansion, the rectifier V3-b develops a positive control bias and V4 is biased to cutoff. When the input signal level is low, little or no voltage is developed by the control rectifier and the plate-to-plate impedance of V4 is high. This high impedance is reflected into the secondary of T1,

Fig. 6

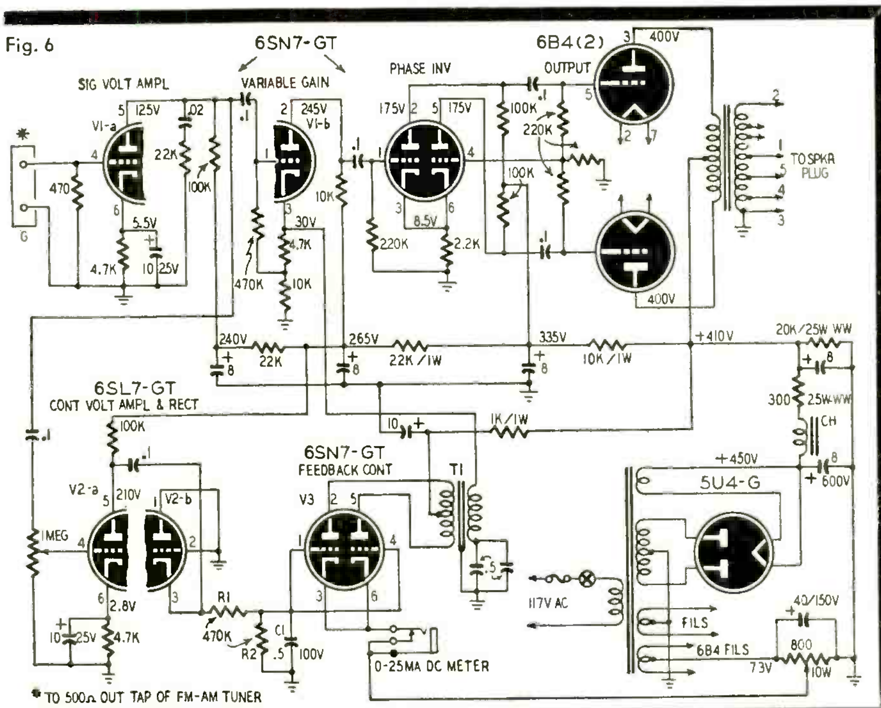
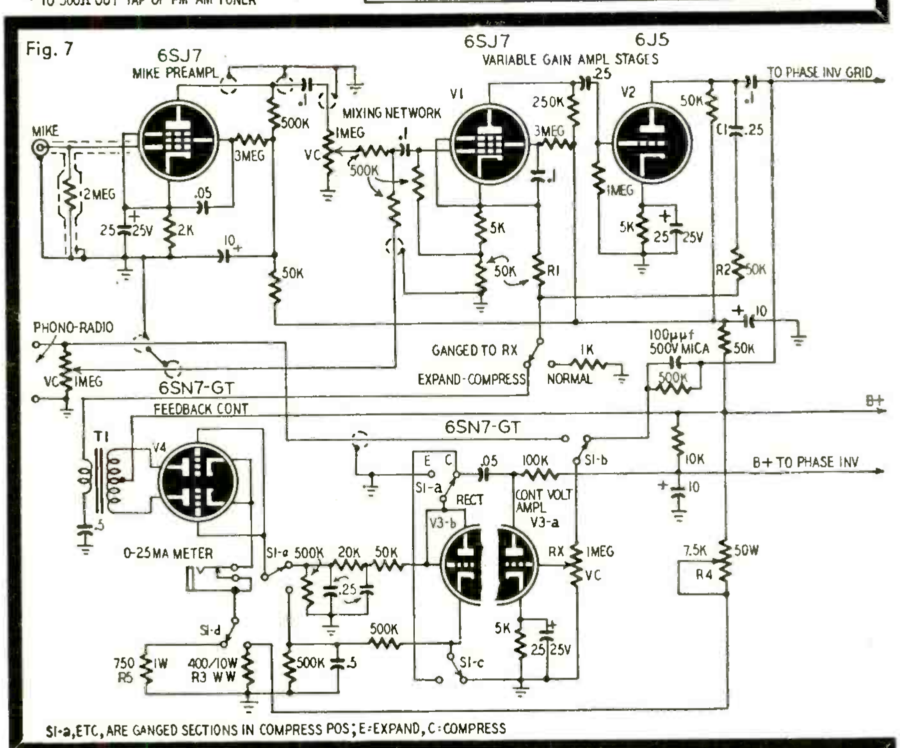


Fig. 7



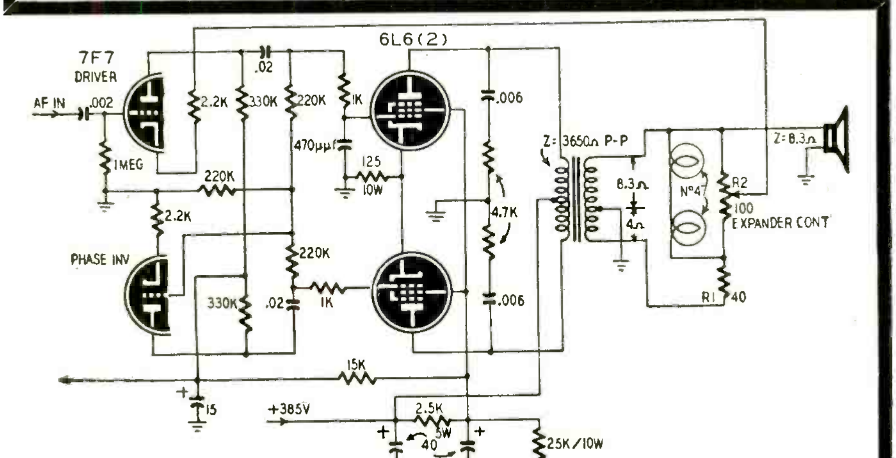


Fig. 8

where it forms a high-impedance shunt path in the inverse-feedback loop.

A sudden rise in signal voltage produces a high positive bias voltage at the output of V3-b. The positive voltage on the grids of V4 causes the plate-to-plate impedance to drop and lower the impedance reflected into the secondary of T1. This decreases the impedance of the shunt leg of the T, reduces the voltage fed back to the cathode of V1 and allows the gain to rise.

When the circuit is used as a volume compressor, the cathode biasing voltage across R5 limits the total plate current of V4 to about 16.5 ma and keeps the plate dissipation just within its maximum permissible value. The high plate current results in a very low plate impedance being reflected into the shunt leg of the T feedback loop. This reduces the voltage being fed from the plate of V2 to the cathode of V1 so the amplification of V1 and V2 is about normal.

When the audio signal rises above a given level, V3-b develops enough *negative* bias voltage to reduce the plate current and increase the plate-to-plate impedance of V4 and the impedance that is reflected into the shunt leg of the feedback loop. The increase in the shunt impedance increases the feedback voltage and causes a corresponding decrease in the gain of V1.

The attack-time of the compressor is about .03 second and the decay time is 0.25 second. This compares favorably with the 0.25-second attack and decay times of the expander circuit. The decay or *hangover* time of the expander circuit can be increased by replacing the 500-000-ohm bleeder resistor with a higher resistance.

A 1,000-ohm resistor is switched into the circuit to replace the secondary of T1 when the EXPAND-COMPRESS-NORMAL switch is turned to NORMAL.

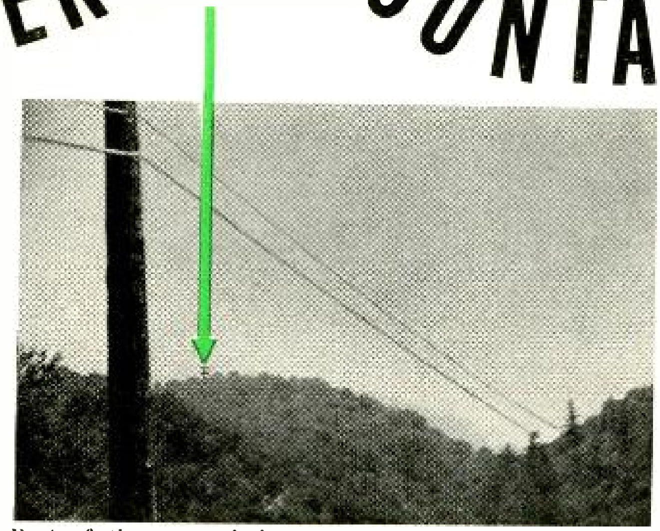
Lamp-operated expander

Fig. 8 shows the novel inverse-feedback volume expander circuit used in the Silvertone model 8160 audio amplifier. Inverse feedback for the cathode of the driver stage is obtained from a voltage divider (R1 and R2) across the secondary of the output transformer. R2 is paralleled by two type 47 pilot lamps in series. When the signal level is low, there is comparatively little voltage across the lamps and their resistance is low enough to practically short-circuit R2 and permit maximum voltage to be fed back into the cathode of the driver stage. Loud passages increase the voltage in the transformer secondary and cause the lamps to heat. Their resistance rises and decreases the amount of feedback applied to the driver cathode. END

Fig. 6—The schematic diagram of the Thordarson model T-31K11 and T-31W11 amplifiers using an inverse-feedback type volume expander. Fig. 7—Another adaptation of the Thordarson inverse-feedback expander. Fig. 8—A lamp-operated type of inverse feedback volume expander used in Sears Roebuck Silvertone type 8160 audio amplifier.

TV COMES OVER THE MOUNTAIN

Distribution antenna systems are critical, but "technical sense" can make them work



Part of the transmission line. Arrow points at antenna.

By DOUGLAS W. STEPHENS

WITH the surging wave of television station construction and installation, which will eventually give us more than 1,900 new transmitters, TV will be brought to many who have before been without this new wonder of our age.

But, because TV, unlike radio, will not go up, over, or around mountains, hills, or even large buildings, many new problems are encountered.

In towns which are large enough to support elaborate layouts and in other areas where the expense of coaxial cables, aerial towers, master amplifiers, and distribution units can be borne by large groups, the problem presented will be only one of engineering.

The television lessons learned by residents of Mount Baldy, a resort community deep in the Sierra Madre of Southern California, may be helpful to many small groups living in locations where TV reception is hindered by geographical reasons and where funds available are limited because of the size of the group.

This picturesque mountain resort is situated in a deep canyon at an elevation of 4,500 feet, a scant hour drive from the heavily populated Los Angeles area.

At first glance the TV problem at Mount Baldy did not look difficult. Mount Wilson, the site of all seven transmitters for the Southern California area, was only 25 miles away. But when Cecil May and E. Leslie, full-time residents, tried out antennas on their cabin roofs, they found that Mount Sunset and Lookout Peak, towering 3,000 feet above the valley, blocked off the Mount Wilson transmitters. Channels 4 and 5, full of snow and ghosts, could be viewed by pointing the antennas toward 9,000-foot Mount Ontario to their rear, but as the signal bounced from one peak to the other, back and forth across the valley. the picture was far from satisfactory.

Hearing that some residents at the lower end of the valley could bring in TV signals over a saddle connecting Sunset and Lookout, these men conceived the idea of putting an antenna on the top of Signal Rock across the stream and to the back of their cabins 2,500 feet up the steep side of the mountain. Here Mount Wilson could be seen over the saddle. The lower valley group, however, was situated closer to the saddle. and the line from their antenna was less than 1,500 feet long. As the distance from the antenna on Signal Rock to the last cabin on the line was close to 4,500 feet, the cost of engineering such a project with coaxial cables, 200-foot towers, large amplifiers, and other equipment such as Panther Valley used, would be prohibitive.

The problem then was to find an *inexpensive* way to bring the signals down the mountain. Finding two other cabin owners, Jack Fountain and Mr. Garrison, who also wanted television, the four put up $120 each to purchase materials.

Four V-cone antennas in a stacked array were installed on the summit of Signal Rock. Fifteen feet of 300-ohm flat ribbon line was used to connect the antenna to two No. 14 insulated copper wires which were run, 12 inches apart, down the mountain, attaching the wires enroute to trees with insulators on wood cross-bars. Across the stream the line ended at the junction, a tree centrally located to the cabins. Four separate 300-ohm flat lead-in lines were run from this point to the cabins.

Reception fair to middling

With this long setup, the Baldy men found channels 4 and 5 came in from fair to good, while channels 2 and 9 could be viewed occasionally late in the evening. But even at best there were heavy ghosts on these channels, the reception was subject to every whim of the weather, and the sets interfered with each other. There was no picture on channels 7, 11, and 13.

This was the situation from November 1951 until March 1952, when a heavy, wet snow broke down the 300-ohm flat leads connecting the cabins with the junction. Viewing the breakdown, the group decided to consult Roger Howell, owner of the Reliable Radio and TV Service Co., at Long Beach, 50 miles away. Howell was an old-timer in radio and television, having built one of the first television sets, in 1931.

Realizing the limited financial structure of the undertaking, Howell came up to Mount Baldy and with Jack Fountain and Leslie climbed Signal Rock to the antenna. This trip, 2,500 feet almost straight up through snow and thick underbrush, took several hours. On reaching the summit, Howell found all four antennas were hooked up in such a manner that they were working out of phase and the connections were badly corroded. As they had no way of soldering, they scraped the wires, reattached them in the conventional parallel-series hookup—which properly harnessed the stack so each antenna worked in phase with the

Jack Fountain, in the picture above, resolders the transmission line with the assistance of a split coffee can.

Right, above—Snowy picture received before soldering the antenna; below—moving parallel lines cleared up ghosts.

others—and taped the connections. Jack Fountain took the hard way down, following the line, taking up the slack where the heavy snow had stretched it and repairing it in one place where it had been broken.

Nothing else could be done for a couple of weeks until the snow melted. In the meantime, four other cabin owners joined the group, each new man putting up another $120. With this additional money the group bought enough 450-ohm Gonset line to run from the junction to the eighth house, each member attaching to this main line with 300-ohm flat lead. Howell estimated the No. 14 line down the mountain being a foot apart would have an impedance of about 750 ohms. To compensate for this, he advised tapering the last few feet of the No. 14 line before it joined the Gonset at the junction.

This improved the pictures so that channels 4 and 5 came in with only a slight ghost, and channel 2, though not quite as good, was satisfactory. There was not too much snow on these channels, but only sound was present on 7, 9, 11, and 13. However, there was a great deal of set interference and the reception was bad in the daytime.

As there was still money in the treasury, Howell installed a booster amplifier (amplifying the signal 30 db) 2,000 feet down the mountain from the antenna where a near-by cabin could be tapped for power. Four distribution boxes were put in the line at the cabins, two lead-in lines coming out of each box. This improved the pictures already received and eliminated set interference. However, there was a loss of 3 db on the low channels and 6 db on the high channels at each box. This resulted in a poorer picture being received as the signals moved down the line until at the last two sets there was a loss of 12 db on the low channels and 24 db on the high ones. Howell advised Jack and Leslie to check the main line and the connections at the antenna. Lower channels, he told them, would come in even though there were great signal losses on the line, but if there were any losses due to unsoldered joints or other causes, the high channels would be held back.

Cleaning up the line

On climbing the mountain, the two men found the connections at the antenna corroded. Inserting new 10/32 brass bolts at all eight connections, they attached Gonset between the antenna and the No. 14 wire, replacing the 300-ohm line at that point. The Gonset and No. 14 wire connection was soldered and the eight connections at the antenna were sprayed with Krylon plastic spray to prevent further corrosion.

On following the line down the mountain—a difficult descent through heavy brush and down steep cliffs—Leslie noticed several places where the No. 14 wire had been wound around insulators to tighten the line. As Howell had warned them that all loops in the line would result in a weaker signal (acting as r.f. chokes), they straightened these out and soldered all connections that had previously been taped. This last was done by cutting a slot in either side of a coffee can and slipping it over the wire to protect the soldering flame from the wind.

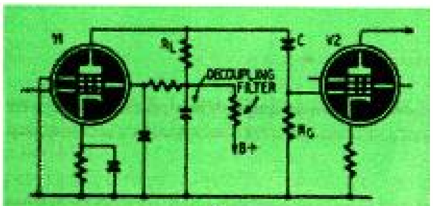
When they got back to the first cabin they found they could bring in all channels except 7 with very little snow and practically no ghosts. Channel 7 was too weak for good viewing. Checking the line from the junction, they found that the lead from the first box ran parallel to the main Gonset line and only a few inches below it for 75 feet before going to the first cabin. Paralleling of lines for such a distance put the line out of phase. To correct this, they raised the Gonset on the pole and moved the lead-in four feet away and out of parallel to the Gonset. This strengthened channel 7, but when they checked the other sets down the line, they found signals were progressively weaker until at the last set, channels 7, 9, and 11 were too weak for good viewing. As there were two more cabin owners who wanted television, $120 was collected from each, and another large amplifier (30 db), like the one on the hill, was put at the junction and a distribution box was installed to take care of the two new members. This resulted in clear pictures all down the line on channels 4, 5, 11, and 13. Channels 2, 7, and 9 were not quite as good as the others, showing slight ghosts and snow. It is hoped to run Gonset later all the way up to the antenna and thereby strengthen the signals on these last three channels.

The story of Mount Baldy proves that by taking advantage of the skilled knowledge and modern equipment available at their local distributors, small groups, even though located in so-called blind TV areas, can bring the wonders of television into their homes without overtaxing the family budget. END

Part I

How to overcome the inherent circuit characteristics that limit h.f. response

Design Data



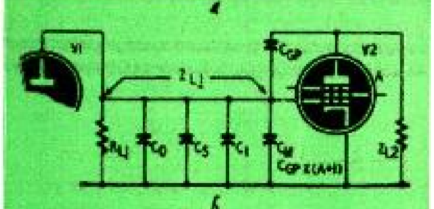


Fig. 1

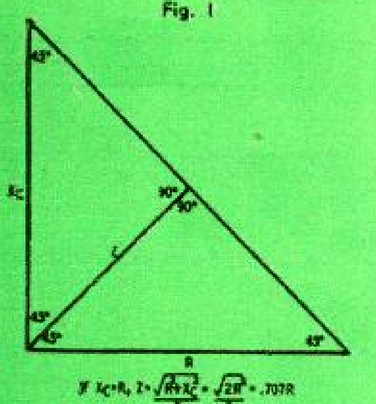
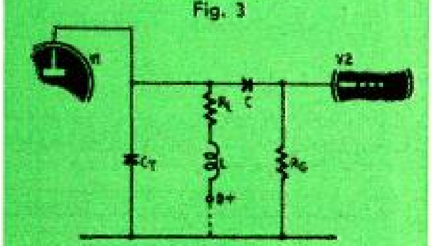


Fig. 2

Fig. 3



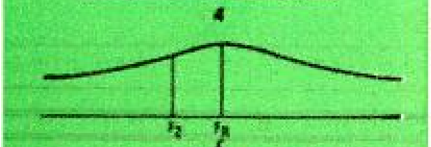


Fig. 4

MANY present-day applications of electronic equipment call for uniform amplification over a very wide range of frequencies. The video amplifier in a good television receiver must pass all frequencies from 30 cycles to 4 mc *with equal gain*. Laboratory oscilloscopes must be able to reproduce frequencies from 0 cycles (pure d.c.) to 10 mc and higher, and other types of equipment cover even wider frequency ranges.

Ordinary amplifier stages cannot handle these wide ranges. Special circuits are required. This series of articles will try to reduce to simple terms the complete design procedure for wide-range amplifiers.

To begin with, let's take a look at a typical R-C-coupled amplifier, and some of its shortcomings. Fig. 1-a is a typical pentode voltage-amplifier circuit. With parts values normally used in audio circuits (see *RCA Receiving Tube Manual RC-16*, pages 246 to 261), the response will be substantially flat from about 100 cycles to 15,000 cycles. This is nowhere near the response required of a video amplifier. What causes this drop in gain below 100 and above 15,000 cycles?

At the *low end* the major factor responsible for this is the grid-to-plate coupling capacitor C. This capacitor and R_G form a voltage divider across the output of V1. The reactance of the capacitor *increases* as the frequency is lowered

$$X_C = \frac{1}{2\pi FC},$$

thereby reducing the signal voltage available at the grid of V2. The V1 screen- and cathode-bypass capacitors and the B+ decoupling filter also affect the low-frequency response. At the moment, though, we are more interested in what happens at the *h.f. end* of the amplifier response curve. The low end will be taken up in full detail later in this series.

Fig. 1-b is the equivalent circuit of the amplifier at high frequencies. (Coupling-capacitor C can be omitted because its reactance at high frequencies is so low that it can be considered a dead short.) The loss in gain at this end is caused by the combined shunting effect of all the capacitances shown. C_O is the output capacitance of V1; C_S is the total stray capacitance to ground of all the components and wiring except the tubes; C_I is the input capacitance of V2; and C_M is the Miller-effect capacitance of V2. (When a tube operates as a grid-to-plate amplifier, the input capacitance is *increased* by $C_{GP}(A + 1)$, where C_{GP} is the grid-plate capacitance, and A is the tube gain. This comprises what is known as the Miller effect. In triodes, which have relatively high grid-plate capacitance, and very-high-gain pentodes, the Miller-effect capacitance is large. In low-gain pentodes the effect is almost negligible.)

Since these capacitances are all in *parallel*, their total C_T is found by simply adding them together:

$$C_T = C_O + C_S + C_I + C_M$$

The shunting effect of C_T across R_L decreases the output voltage as the frequency *rises*. When the reactance of C_T is equal to the resistance of R_L the net load impedance Z_{L1} will be 70.7 R_L and the output voltage will be reduced by the same amount, or 3 db. See Fig. 2.

One way of reducing this effect is to use a smaller value of R_L. The equation for the gain of a pentode ($A = gm \times Z_L$) shows that the maximum gain of the stage will be reduced, but in this case, flat frequency response is much more important than gain.

In the actual design we must first decide what tubes we want to use. A point of caution here: The tubes selected must have high gm and low interelectrode capacitances. Types like the 6AC7, 6CB6, and 6AH6, were designed especially for this application. For the output stage, types 6AG7, 6CL6, or 12BY7 are recommended. The average gain per stage will be rather

Fig. 1—(a) Typical R-C coupled pentode amplifier stage discussed in the text. (b) Equivalent circuit of the amplifier showing circuit capacitances that affect the response at high frequencies. Fig. 2—Impedance diagram for resistance and capacitive reactance in parallel. Fig. 3—Response with and without compensation. Curve A shows response without shunt peaking. B and C show improvement with different peaking-coil factors. Fig. 4—(a) Inserting a peaking inductance L in the load circuit cancels the shunting effect of C_T. (b) Resonating the circuit at a frequency above F_2 increases the high-frequency response of the amplifier stage.

ON VIDEO AMPLIFIERS

By ALAN G. SORENSEN

low. Decide what total gain you require and what tube line-up you want to use. For demonstration we will assume a total gain of 100 and use a 6AH6 followed by a 6AG7.

The next step is to find the shunt and stray capacitances. A tube manual will be needed here. According to the manual, the output capacitance of a 6AH6 is 2 μμf, and a 6AG7 has an input capacitance of 13 μμf. So, in substituting numbers for letters in the equation, C_0 and C_1 will be 2 and 13 μμf, respectively.

C_S includes the capacitance to chassis of the wiring, sockets, and components. Keep this capacitance as small as possible, by using low-loss sockets, and point-to-point wiring, and mount the parts up off the chassis. A perpendicular parts layout is best. Or even a nonmetallic chassis-strip. C_S is much too small to be measured easily. For the time being we'll estimate it at 10 μμf. In order to find C_M we must first know the gain of V2.

According to the tube manual, a 6AG7 has a transconductance of 11,000 μmhos (.011 mhos), and a grid-plate capacitance of .06 μμf. We will assume the 6AG7 plate-load impedance (Z_L) is a resistance of 3,000 ohms. Then the gain of the 6AG7 is

$$A_2 = gm \times Z_{L2}$$
$$= .011 \times 3{,}000$$
$$= 33$$

The Miller-effect capacitance is

$$C_M = C_{GP} \times (A + 1)$$
$$= .06 \times (33 + 1)$$
$$= .06 \times 34$$
$$= 2.04, \text{ or approximately } 2\ \mu\mu f.$$

Then $C_T = 2 + 10 + 13 + 2$, or 27 μμf. This value of 27 μμf is the *estimated* total shunt capacitance C_T. Now we can proceed to find the correct load resistance R_L.

As mentioned earlier, the response of the amplifier will not begin to drop off noticeably until the reactance of C_T equals R_L. R_L must have a value that will keep the response up to at least the 70.7% point at the highest frequency the amplifier is expected to handle without discrimination. This frequency is called F_2, and if the circuit we are working on is a television video amplifier, it would have a value of about 4 mc. R_L, then, must be equal to the total shunt reactance X_C at 4 mc. With C_T in μμf, and F_2 in mc, we use this formula:

$$X_C = \frac{1.59 \times 10^5}{F_2 \times C_T}$$

$$X_C = \frac{1.59 \times 10^5}{4 \times 27}$$

$$X_C = 1{,}472 \text{ ohms}$$

$$R_L = 1{,}472 \text{ ohms}$$

The nearest standard RTMA values are 1,300 ohms and 1,500 ohms. There will be only a slight difference in gain between the two, and in a conservative design it would be better to choose the lower value.

Now we can find the maximum gain of the 6AH6 stage ($A_1 = gm \times Z_{L1}$). The tube manual gives the gm of a 6AH6 as 9,000 μmhos, and Z_{L1} is 1,300 ohms.

$$A_1 = .009 \times 1{,}300$$
$$= 11.7$$

Checking results

If we now set the circuit up for an operating test and measure the actual frequency response, we find that instead of being flat all the way out to 4 mc, the response begins to *drop at only 500 kc*. See Fig. 3. Apparently, a low-value load resistor *was not* the complete answer to our problem. What we need is a means of *cancelling* the effect of C_T.

We know that inductance and capacitance have opposite characteristics. If we insert a small inductor L between the load resistor and the B supply, we create the broadly tuned parallel-resonant circuit shown in Fig. 4-a. The impedance of a parallel-resonant circuit *rises* as we approach the resonant frequency. If we choose a value of L that will resonate with C_T at a frequency F_R somewhere *above* F_2, the impedance of the load circuit will *increase* as the frequency rises and will compensate for the original drop in response. See Fig. 4-b.

This system is known as *shunt peaking*. L can be varied to give flat response to F_2, or even raise the output at that frequency. But the value of L must be held within certain limits to avoid excessive phase shift.

When the load of an amplifier contains either inductive or capacitive shunt reactance the input and output voltages will never be exactly 180° out of phase. In the mid-frequency range, where the reactances have negligible effect, the phase shift will be practically 180°, but at the high-frequency end, where capacitive reactance begins to dominate, the output voltage will be shifted *more* than 180°. At the low end, inductive reactance shifts the output voltage *less* than 180°.

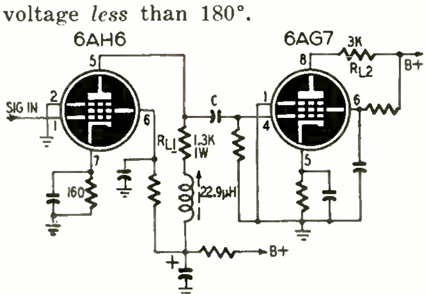


Fig. 5—Final interstage circuit of the video amplifier with values derived from the text for flat response to 4 mc.

In a TV receiver with excessive phase shift, a low-frequency video component which follows immediately *after* a high-frequency component may actually reach the picture-tube screen *first*. This gives pictures a smeary quality.

The ratio between the peaking inductance L and the shunt capacitance C_T determines this phase shift. Various ratios (K) have been worked out for specific applications. For ideal phase characteristics, at the expense of a slight drop in response, K should have a value of 0.34. Values of K above 0.414 introduce a peak just below F_2. A good compromise for a video amplifier is to use a K value of 0.5. This gives a rise of about 3% just below F_2.

To find L in μH, where C_T is given in μμf we use the formula:

$$L = K \times C_T \times 10^{-6} \times (R_L)^2.$$

In our sample problem, taking K = 0.5 we have:

$$L = 0.5 \times 27 \times 10^{-6} \times 1{,}300^2$$
$$= 22.9\ \mu h.$$

If the peaking coil L is wound on a small slug-tuned coil form, its inductance can be adjusted to the exact value.

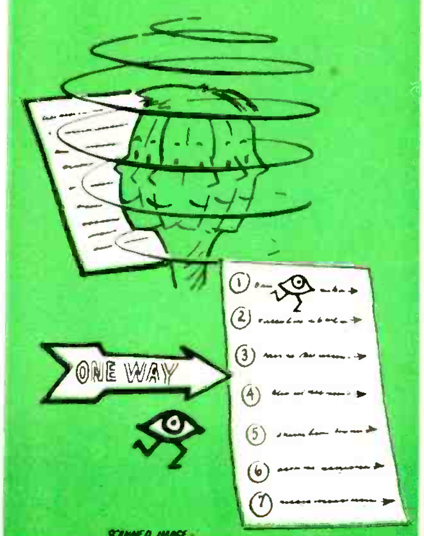
Fig. 5 is the final circuit. The components which have not been given values do not affect the high-frequency response. These parts control the *low-frequency response* and will be dealt with in Part II of this series.

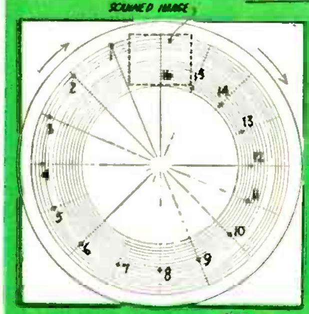
TO BE CONTINUED

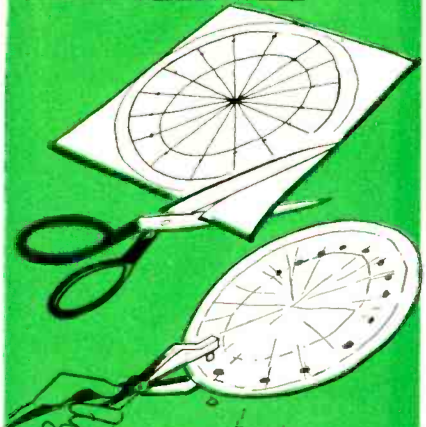
TELEVISION? ...it's a cinch!

By E. AISBERG

Second Conversation—— The Nipkow Disc







Our hero's dizzying adventure

Ken—Don't bother telling me what you're trying to do, Will. Either you're practicing to become a whirling dervish, or TV has you going around in circles!

Will—Wrong on both counts, Ken! I'm just trying to read without having to jerk my eyes back from right to left at the end of each line.

Ken—I know I'll regret asking, but why?

Will—Because I've been thinking about the way a scene is scanned in television. You remember, the last time we talked you said it was like reading a book—line by line. But when you think of how fast the TV camera has to read, it seems there ought to be some way to save the waste of time getting back from the end of one line to the beginning of the next. So, when I finish one line, I spin rapidly round so my eyes fall on the beginning of the next one without having to snap back from the end of the last!

Ken—Bright idea, but I don't think you're going to save much time that way. You *can* get pretty dizzy, though! But you might be interested to know that your continuous-scanning method was the one they used in most of the early mechanical television systems.

A little geometry

Will—I'd like to hear a little more about some system that really was used! All you've told me about "scanning" and "image analysis" so far has been pretty much up in the air. But just how do you "explore successively the elements of the image" in real live television?

Ken—I hadn't figured on telling you how mechanical television worked, because it's been abandoned entirely in favor of electronic methods. But maybe you'll be able to understand the more advanced systems better if we start in with the simplest—and the oldest—system: the Nipkow disc!

Will—The Nipkow disc? I've heard about it somewhere. What is it?

Ken—We're going to make one right now! Take a look at this piece of thin Bristol board. We'll cut a circle about 16 inches across out of it. Now I'm going to lay out a series of concentric circles on it. The first will be 13 inches in diameter, and each one will be an eighth of an inch bigger, till we have 16 circles. Then we proceed to divide up the circumference of our disc into 16 equal parts. . . .

Will—This is fine! We've been going through arithmetic and algebra—now we're getting a geometry exercise. When do we start integral calculus?

Ken—Never mind the calculus—I'll be satisfied if you learn television! Now let's get back to our disc. We have 16 radii, or arms, going to equally-spaced points on its circumference. I needed all these lines so I could lay out a spiral. I just mark the point where the first radius crosses the first circle, another point where the second radius crosses the second circle, and so on, going around the circle clockwise.

Will—That gives you 16 points arranged in a spiral. What do you intend to do with them?

Pinhole view of life

Ken—You'll see in a minute. First let's make—with a very small punch—a series of holes, one at each point on our spiral. And here is our Nipkow disc!

Will—And you really think you can use this for scanning television images?

Ken—I do, and what's more, I'm going to prove it! Let's make a little design—something very simple in black and white—about two by three inches. Fasten it on the bottom of the lampshade here. Now put the disc on this knitting needle, hold it in front of the design, and spin it

Will—I see your design just as though the disc were transparent!

Ken—Now—just so we can see what's going on—let's turn the disc a little slower.

Will—I get it! This is just a big improvement on the piece of paper with the window in it we had last time. When the disc turns the first hole scans a line across the design. (Not exactly a straight line either, it's an arc of a circle, but that doesn't seem to make any difference.) Just as it finishes its line, the second hole starts across the picture and scans a line just below the first. And each hole follows (beginning at the outside of the circle or top of the design) and scans a line, till the whole design is covered.

Ken—And then the whole thing starts again with the second revolution of the disc. You see that if you turn the disc fast enough you apparently see the whole image, though really only one of its elements is visible at any one instant through one of the holes in the disc.
Will—I see too that the disc reads in the whirling-dervish style, without having to make any backward movement to get to the beginning of each line. And I can see that it has to turn pretty fast before the eye blends all the elements into a single picture.

Reading—the hard way

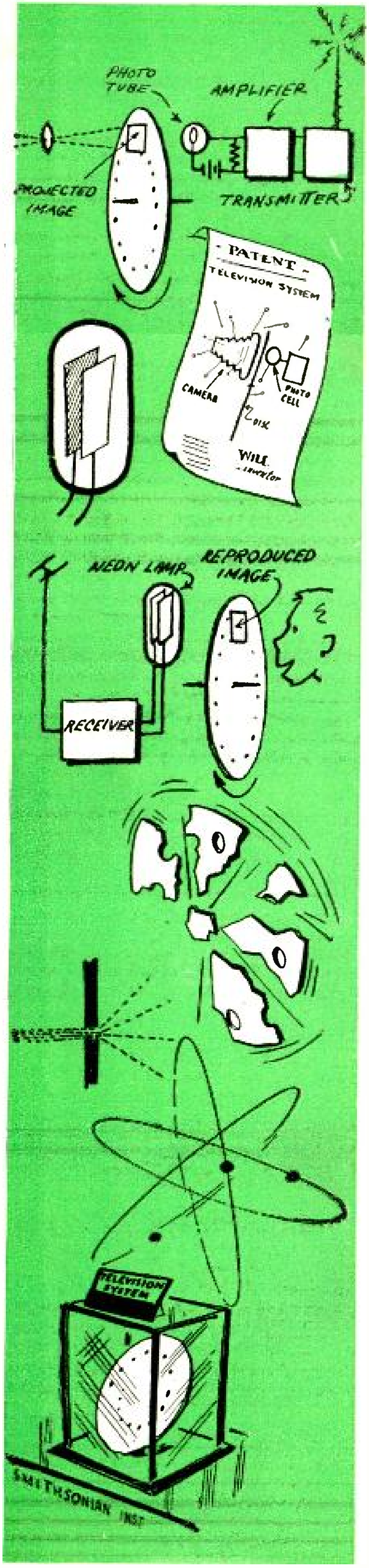
Ken—Yes, and when I let the disc slow down just a little, the image shimmies as if light and dark waves were going across it. That's because the sensation produced in the eye by the light from each hole doesn't last very long.
Will—Just how fast does the disc have to turn to get rid of this flickering?
Ken—You know—to do a good job you need 30 complete images a second.
Will—Yes, that's our television standard. You told me before the Europeans get by with fewer. But is 30 really enough? Wouldn't it be a good idea to scan even faster?
Ken—Don't forget that your video frequency is proportional to the number of images you transmit a second. It's not a good idea to do anything that will increase that frequency too much. Fortunately, there's a way you can kill the flicker without increasing the band of frequencies you have to transmit. It's called *interlacing*.
Will—This TV business really has a language of its own! What's interlacing?
Ken—Instead of starting at line No. 1 and transmitting all the lines of the image one after the other, you transmit all the odd-numbered lines first: 1, 3, 5, etc.; then go back and transmit all the even ones. The whole scanning time is 1/30 second. That means that half the lines, covering the whole surface of the image, are transmitted in 1/60 second, and the rest of the lines are transmitted during the next sixtieth.
Will—If I tried to read a book that way, I wouldn't get much out of it.
Ken—If it were an ordinary book, you wouldn't! But try this little sheet; you'll have to "interlace" to read it. Your eye will follow the exact course that would be followed by the scanning beam of a modern television camera.

To read this text correctly, you must
ner in scanning first the group (or
first peruse the odd lines, then the
field) of odd lines, then afterward
even ones. Interlaced sweep permits
the even ones. To sweep the image 30
"reading" the lines in the same man-
times a second, 60 fields are scanned.

Will—This is interesting, to say the least. Maybe it was turned out by a drunk compositor! But can you really scan that way in television? It sounds awfully complicated.
Ken—No problem at all! Suppose we make a Nipkow disc with two spirals, one on each half of the disc. We'll have lines 1, 3, 5, etc., on one spiral and lines 2, 4, 6, and the rest on the other.
Will—Of course! It can't help but work! But now that we've proved that we can scan a picture—interlaced or otherwise—with a Nipkow disc, where do we go from here? How does it help to transmit a television program?

Now a little chemistry

Ken—Do you know anything about photocells?
Will—Of course! I use an exposure meter when I take photographs. It's a photocell connected to a meter. The meter is calibrated to show how much light there is on the subject being photographed.
Ken—Then the photocell is a device for changing light energy into electric energy. The current from the cell is proportional to the amount of light that falls on it. The photocells (or rather phototubes) used in television are the *photo-emissive* type. The simplest phototubes of that kind are little glass vacuum tubes with one inside wall covered with *photo-emissive* material.
Will—Is that material that emits light?
Ken—On the contrary. It's material that emits electrons when struck by light rays.
Will—What kind of substances do that?
Ken—Most of the so-called alkaline metals: cesium, sodium, potassium, rubidium and lithium, as well as some of the rare earths, though they're not as commonly used.
Will—I've got an idea! If all these metals give out electrons when you turn a light on them, you could use them for vacuum-tube cathodes! Then you could get along without filament supplies. In the daytime, just keep the tubes in the light. And at night, put your radio near a lamp!
Ken—Believe it or not, the idea isn't absurd! Unfortunately, the number of electrons emitted wouldn't give you enough current to be of much practical value. But to get back to our television—if we are going to have current in our phototube, we need one thing more. The photoactive surface is the cathode. . . .



Will—I see! We need an anode. We'll have to put a plate in our tube and put a positive voltage on it to attract the electrons.
Ken—That's the idea, but a "plate" would block off the light. So our anode will be a wire ring or a fine grid.

The image is scanned

Will—Now I think I see how to make a TV transmitter. I'll take my camera, but in place of the ground glass I'll put the outer part of our Nipkow disc. Then it'll be right where the lens forms its image. And behind the disc, I'll put a phototube. What do you think? Will it work?
Ken—Absolutely! You're practically reinventing television! Your phototube is now receiving—from instant to instant—the light from each successive element of the picture being scanned, and translating it into an electric current of proportional intensity. That gives us a video-frequency signal that can be amplified easily and used to modulate the v.h.f. or u.h.f. carrier that takes it out into space.

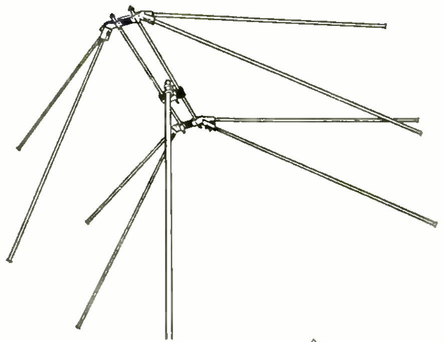
The image is reproduced

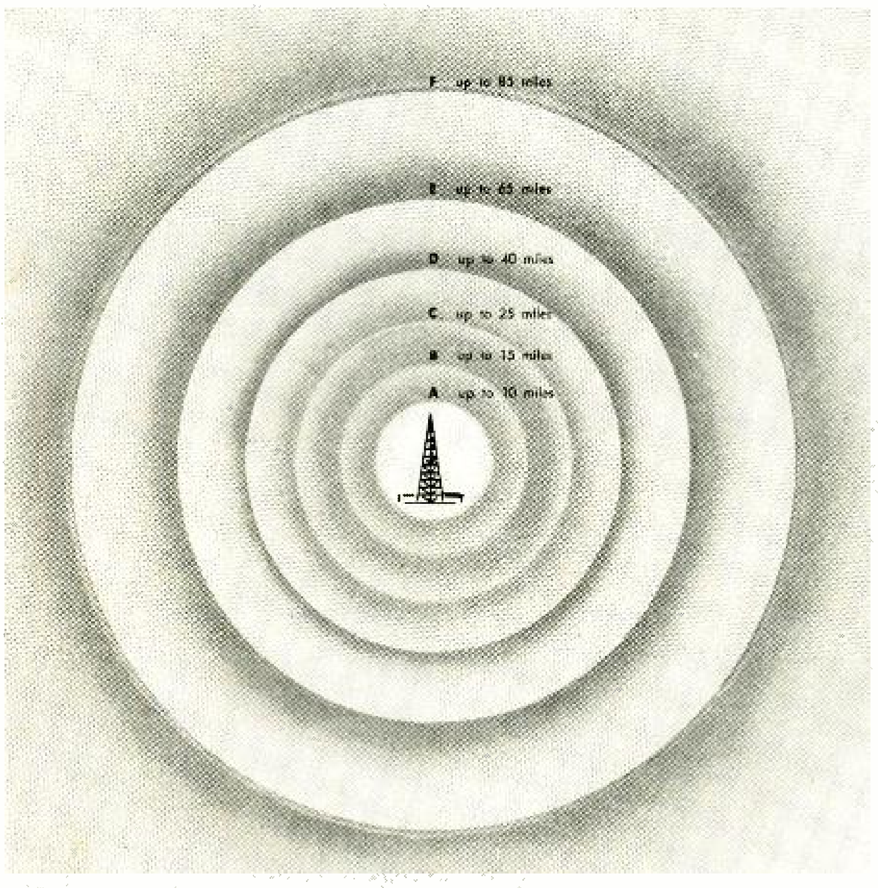
Will—How about the receiver?
Ken—It has to have a Nipkow disc like the one at the transmitter, and moving in exact step with it.
Will—Is that what they call synchronization?
Ken—Right! And that's another word for your technical vocabulary.
Will—But how do we get the variations in current back into light again?
Ken—Very simply—with a neon lamp. You understand them, of course?
Will—Oh, yes! I even engineered an accident to the one on the restaurant across the street when it began putting out more static than light.
Ken—I'm not interested in your criminal record. The lamps most commonly used in television in this country had two plates about the size and shape of the image to be reproduced. When you put enough voltage between the two electrodes, one of the plates glows over its whole surface. A large d.c. voltage makes a bright glow. . . .
Will—And less d.c. means a weaker one, I suppose. But how . . . ?
Ken—Let me finish! If we add the varying voltage of the video signal onto the d.c. we started with, the brightness of the plate varies with the instantaneous signal voltages.
Will—Yes, but how do we manage to light each point of the plate to the brightness of that exact spot in the televised scene?
Ken—You don't have to! Your Nipkow disc in front of the neon lamp will show you each point on the plate at the instant it has the right brightness.
Will—Of course! At any instant the disc lets us see just one element of the surface of the plate. And at that same instant, the brightness is just right for that spot in the televised scene. For instance, when the first element of the picture is transmitted, the whole neon lamp is lighted to the brightness of that point. But we can see only that one spot through the hole in the disc. And when the hole passes to the next element, the whole plate is just as bright as *that* spot ought to be, and so on. So we see all points of the scene in their proper places and with their proper brightnesses, and the whole image is reproduced!
Ken—Bravo! You have described exactly the system of television first outlined about the end of the 19th century and put into practice around 1924 by Jenkins, Baird, and others.

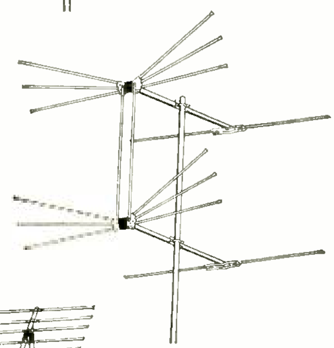
Mechanics vs electronics

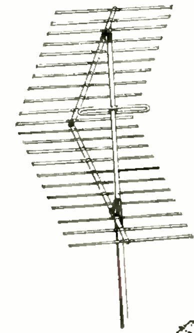
Will—It looks like a very simple and practical system to me, and I doubt if it would be easy to improve it!
Ken—Pull in your hat-band, chum! They gave up that idea years ago! They couldn't get enough detail with it—180 lines was about the most you could get in a single image.
Will—Couldn't they get more lines by using bigger discs with more holes?
Ken—No. At the speed the discs would have to turn, centrifugal force would tear them apart.
Will—Couldn't you make the holes smaller?
Ken—Not very much smaller. You would cut down the amount of light that could get through, and after a certain point you'd be up against the very disagreeable phenomenon of diffraction.
Will—It seems I don't have any good ideas today!
Ken—No matter how good they might be, you wouldn't be able to save mechanical television. It had other bad faults. For example, the phototube at the transmitting end received the light from each point of the image for such a short time you had to use very high illumination on the subject to get enough photoelectric current to use. And the efficiency at the receiving end was very low, because you can see only a very small part of the neon lamp's plate at any instant. And finally, we're living in the age of electronics now!
Will—Then why did you take time off to explain a system that belongs in a museum?
Ken—Because once you understand a simple system of television, your brain cells will find it easier to absorb the more complex details of the electronic systems.
Will—I've got a feeling I'm letting myself in for something awfully complicated!

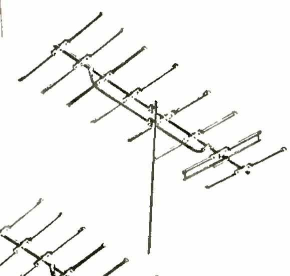
ANTENNA REFERENCE CHART

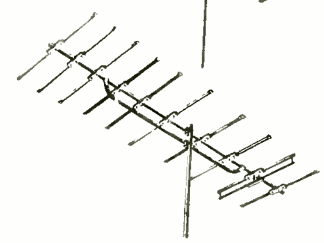












This chart takes into consideration only proportional signal strength over unobstructed terrain at given distances from the transmitter, based on the effective radiated power of the average v.h.f. television transmitter. It ***does not*** cover the possible effects of natural obstacles or buildings on the path or strength of the received signal.

For example: the single-bay in-line antenna has fairly high forward directivity, and works best at distances up to 25 miles from the transmitter (B and C). Where you want to receive ***two*** stations from different directions at this distance, select an antenna that has the necessary gain without the sharp forward directional characteristic, such as the 8-element conical V. (The ranges given are for v.h.f. only, and will be much shorter on u.h.f. due to increased ground attenuation on the higher frequencies.)

In built-up areas close to the transmitter, there may be difficulties from rear and side reflections, especially where tall buildings are involved. Use a conical with a large number of reflector elements (a 6-front, 6-back type for example) to raise the forward gain and reduce signal pickup from the rear and sides.

Our thanks to *Radio Merchandise Sales*, for permission to reproduce this chart, which was prepared by their engineering department.

Gain Reference Code Letter	Television Antenna Types
A	Built-in or indoor ("rabbit-ears")
A	Window
A and B	Piggy-back
A and B	V type (4-element end-fire array)
A	Conical (4 directors—4 reflectors)
B	Conical (6 directors—2 reflectors)
B and C	Single-bay in-line
C	Conical V (8-element end-fire array)
C and D	2-bay in-line
C and D	2-bay V type
C	2-bay conical (6 directors—2 reflectors)
D	5-element Yagi
D and E	2-bay conical V
E	8-element Yagi
D and E	4-bay conical (6 directors—4 reflectors)
D and E	4-bay conical V
F	10-element Yagi
E and F	Corner array
E and F	Rhombic antennas

TV SERVICE CLINIC

Conducted By
MATTHEW MANDL*

Fig. 3—Effect of transient oscillation.

THE voltage boost circuit of the horizontal flyback system is a simple circuit consisting of a pair of capacitors and a coil. These are connected to the cathode of the damper when the horizontal output transformer has a secondary winding for the deflection coils. On occasion, however, the

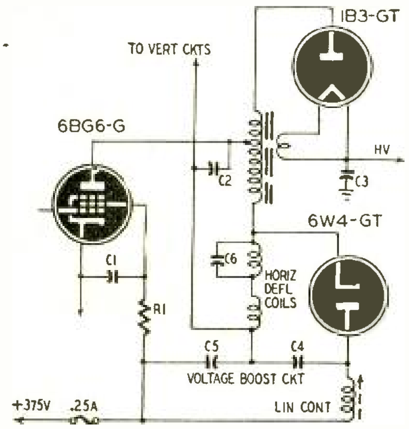


Fig. 1—Voltage boost circuit in the RCA 6T53 direct drive sweep system.

boost circuit may be in the *plate* side of the damper as shown in Fig. 1. This is a partial schematic of the *direct drive* type of horizontal output system, in which the deflection coils are in series with the transformer primary. The only secondary winding is for the filament of the high-voltage rectifier.

Despite the simple circuit, the voltage boost system contributes a good percentage of the many troubles which occur in horizontal sweep stages. A gassy or shorted rectifier can mean raster loss, while defective capacitors and coil affect linearity. Defective tube and components can also produce white vertical bars on the screen which denote insufficient damping of the transient oscillations developed during collapse of the fields in the yoke during retrace.

The transient oscillations occur at the beginning of the sawtooth sweep and thus are usually positioned near the left of the screen. They interrupt the gradual incline of the sawtooth sweep one or more times for each line traced on the screen. A single dip as shown in Fig. 2 means that the forward trace is slowed down, then reversed as the sawtooth dips. When the waveform comes out of the dip the beam within the tube moves across the screen again. This reversal of the beam at the beginning of the trace makes this section of the scan brighter, and successive horizontal trace lines produce the vertical bar down the screen. This appears (in exaggerated form) in Fig. 3. Often the bar (or bars) may be just barely visible. (Fig. 3 has been retouched for better reproduction.)

If damping is exceptionally poor, the bar interference becomes more visible. Since the bar is caused by poor sweep linearity a similar symptom may be observed if the horizontal output tube or circuit develops defects. If, for instance, the drive control is advanced too far, sweep linearity is affected and a bar can be produced. Usually, however, it is located nearer the center of the screen and is often the result of a misadjustment in both linearity and drive controls.

If components in the boost circuit open, much more serious symptoms are produced. Fig. 4, for instance shows the multiple bar interference which occurs when C4 of Fig. 1 opens. Besides the bars, horizontal shrinkage and foldover at the left are also present.

Initial trouble-shooting procedures consist of replacing the damper tube. If this fails to correct the defect, check the linearity coil for continuity and shorted turns, and check capacitors (C4 and C5 of Fig. 1) for leakage and off values. If a capacitor checker isn't available, try direct substitutes with values agreeing with the schematic. Off-value capacitors are a common cause of poor linearity and white vertical bars. Unless the capacitors are open, bridging with new ones is a useless test. If the capacitor is shorted, it also shorts the shunting capacitor. If leaky, the leak still exists despite the shunting capacitor. If off value, the shunting capacitor adds additional capacitance beyond the required amount for normal function of the circuit. Disconnect the capacitor, then try the known good one.

*Author: Mandl's Television Servicing

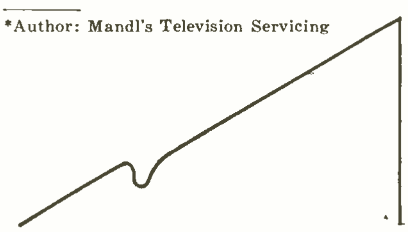


Fig. 2—Transient oscillation in sweep.

Picture tube leakage

In a GE 14T2 receiver brightness is excessive and can't be reduced by the brilliancy control. A test showed B plus voltage on the control grid of the picture tube even with the coupling capacitor disconnected. I checked the socket and found nothing wrong. It appears that the picture tube is defective, but was wondering if there is any remedy other than replacement.—N. T., Brooklyn, N. Y.

Your checks indicate a defective picture tube which should be replaced. Some technicians, on occasion, have been able to correct the internal defect by high voltage arcing. They remove the picture tube socket and ground pin 2, the control grid. They then connect a high-voltage insulated probe to the high-voltage connector (this is removed from the tube and connected to the probe). The probe is applied to pin 11 of the tube. This causes an intense high-voltage arc between the cathode and grid of the tube and often burns away any shorting flakes of conductive material or any coatings which have formed between terminals. This is repeated by applying the high-voltage probe to pin 10 (grid 2). This arcs between grid 2 and grid 1 and helps eradicate any leakage.

This procedure is of course dangerous because of the high voltage. And no guarantee of success can be made. I've tried this on a 10-inch tube lately and good results were secured for only about three weeks, when leakage again developed.

Barkhausen

In a GE 803 receiver I am getting severe Barkhausen effects (black vertical bars as shown in Fig. 5). I've replaced the 6BG6 horizontal output tube,

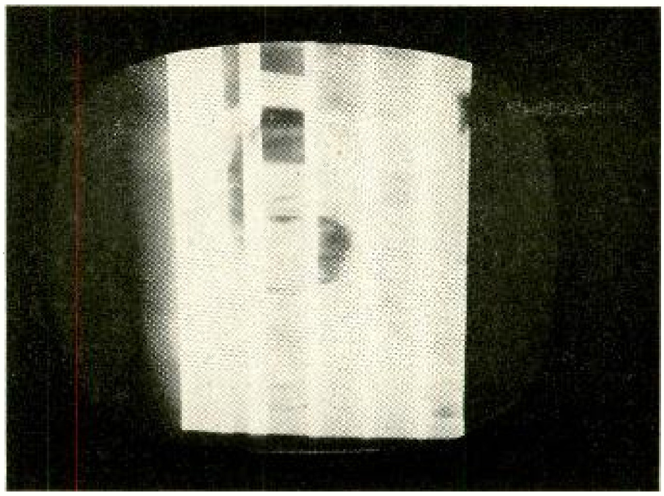


Fig. 4—Effect of an open capacitor.

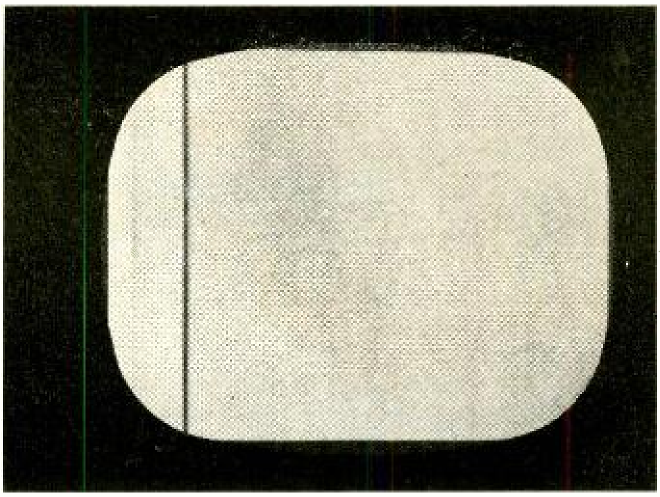


Fig. 5—Barkhausen effect (retouched).

and tried a magnet type eliminator on the tube without success. What other remedies are there?—R. B., Havertown, Pa.

You should try 75- or 100-ohm resistors in series with the control and screen grid leads. Wire the resistors as close to the tube as possible. Also check lead dress. If this fails, the trouble may be in the tuner, which picks up the radiated signals from the horizontal output tube and permits their final appearance at the grid of the picture tube.

Often Barkhausen effects can be eliminated by tuner tracking to bring performance up to peak sensitivity for the incoming signal. The video i.f. stages should also be aligned with an accurate marker, sweep generator, and oscilloscope. (Many new receivers now use double shielding in the tuner to minimize Barkhausen and other undesirable signal pickup.)

Interlace

In several receivers lately I've noticed what appears to be interlace trouble. The horizontal trace lines seem split up instead of being clearly defined. I notice that if the vertical hold is adjusted slightly the lines are much clearer and more visible. Could you give me some information on this?—J. K., Chicago, Ill.

You are misinterpreting the appearance of true interlace. *Without* interlace, line pairing results with the horizontal line structure more coarse and better defined. With proper interlace, however, horizontal line structure is much fainter in appearance. When the vertical hold is set just at the point where vertical sync loss is about to occur (or during loss of sync when picture rolls) interlace is lost and the lines actually look clearer and more visible. But since coarse line structure is undesirable, an interlaced raster is preferred.

In most instances interlace is lost on occasion because of the nature of the transmitted signal or because of noise interference. Proper interlace is aided by the *integrator* circuit of resistors and capacitors at the input to the vertical oscillator. Definite loss of interlace calls for a check of these components. (Some sets have poor interlace due to faulty design. This is beyond the technician's control.—*Editor*)

Excessive picture tube bias

In a Westinghouse H-630T14 receiver there is sound but no raster. The picture tube has 275 volts on the cathode instead of 120. Also, with no raster I still get a flash of light on the screen when the receiver is shut off. I am assuming, therefore, that high voltage is present. What causes raster loss?—J. K., Grand River, Mich.

The excessive cathode voltage indicates excessive bias which is cutting off tube emission. First take a voltage reading between the picture tube grid and cathode as the brilliancy control is varied. The voltage should vary from a low value to well over 50 volts (grid minus with respect to cathode). In all probability you will find the grid-cathode voltage relationship remains unchanged because of a defective brilliancy control, or bad resistors and capacitors in these circuits. Use an ohmmeter for isolation of the component which is causing the trouble.

Conversion parts

In a conversion job on an RCA 9TC247K, can I use a Merit HV07 horizontal output transformer in the same manner as the autotransformer in the receiver by connecting terminals 4 and 1? If this is possible, I can avoid extended circuit changes.—A. F., Baltimore, Md.

The direct-drive type of horizontal output system in this receiver cannot be replaced with a similar circuit unless a direct-drive type of transformer is used. The conventional two-winding type of transformer such as the Merit HV07 is not suitable for this job. The direct-drive transformer permits matching the output tube impedance to a *high-impedance* yoke, while the secondary type of transformer steps down the tube impedance to match a low-impedance yoke. Wiring the transformer as you suggest would not give proper impedance transfer characteristics.

Defective a.g.c.

In an RCA 9T79 receiver the picture becomes poor and excessively dark on strong stations. On weak signals picture quality is good. I've tried a new 6AL5 (second detector and a.g.c.) but this didn't help. Could this be a leaky capacitor somewhere in the a.g.c. line?—C. H., Leroy, N. Y.

Yes, a leaky or shorted capacitor in the a.g.c. bus could cause this trouble, as could an open series resistor. Check all such parts from the 6AL5 a.g.c. detector to the various feed points ending at the grids of the r.f. and i.f. tubes involved. A v.t.v.m. placed from any a.g.c. point to ground will show the amount of bias. This negative potential should increase as a strong local station is tuned in, and decrease for a weak station. It should also vary as the fine tuning is adjusted when a station is tuned in. Also check the 6AV6 first sound amplifier, as this is also the bias clamp for the a.g.c.

Lead losses

Would running the flat 300-ohm ribbon type of transmission line through four feet of mast affect performance? The installation consists of a 37-foot mast with the antenna mounted above an Alliance motor. The lead is run through the four-foot mast as an expedient way to get around the motor. The mast is grounded. With similar antennas (but with the line running outside the mast) neighbors get better reception. Their receivers, when used with my antenna, also perform poorly. I suspect the four-foot section, but would appreciate your advice.—L. S., White House Station, N. J.

As you suspect, there is loss when a ribbon line is run through a mast section. When the transmission line carries signals, a field is set up around it, and the capacitance effect between the line and the metal of the mast creates losses which get worse at the higher frequencies. The longer the run inside a metal enclosure, the greater the loss. You will find that signals will improve when the lead is installed properly with standoffs. Keep the line away from large metal objects. END

U.H.F. TREATMENTS TO IMPROVE WINES

Ewing Galloway

Irradiation reduces acid content and contamination

By M. LAFARGUE
Central Radio School Paris, France

EXPERIMENTS in the field of preservation of foodstuffs by exposing them to radio waves during varying periods of time have been made at different times since 1925, by such workers as Lakhowsky, Foyaz, Copin, and others. This has always been an important problem, since refrigeration as the solution has always been an expensive one. On the other hand, certain products must live and age as part of the process of preservation. Wine is one of these products, and because of its economic importance in France, experiments to determine the effect of short-wave radiation in its processing have been carried out to considerable length in this country.

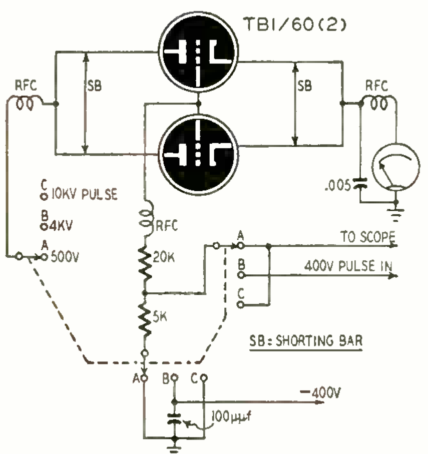


Fig. 1—The transmitter output stage.

In our experiments, wavelengths of 10 centimeters, several millimeters, and between 90 centimeters and 1.20 meter were used, most of the work being done on the 1.20-meter wavelength, just below the edge of the ultra-high-frequency region.

A transmitter with a range from 0.9 to 1.50 meters was constructed. Since a stable or exact frequency is not necessary, a simple long-lines oscillator worked satisfactorily. There are three methods of operation. At switch position A in Fig. 1, 500 volts d.c. is applied to the plates, and the output is 45-48 watts. In position B, pulsating current at 4,000 volts is supplied. The pulsations are controlled by square positive 400-volt pulses on the grid. Waveform and other characteristics are precise, controllable, and stable. In position C, only the voltage peaks (10 kv) are stable, and the pulses have no special form.

The useful peak power in position B is 1.8 kw and in position C, 5.7 kw.

Radiation methods

In most of the tests, a setup like that of Fig. 2 is used. The antenna is a half-wave dipole fed directly by a two-wire line which is coupled to the transmitter by the usual adjustable hairpin link placed below the plate circuit of the oscillator.

Glass vessels of special construction fit over the ends of the dipole and hold the wine. Note that, as in Fig. 2, two experiments (such as treating two kinds of wine) can be carried on during the same transmission. In all these experiments, the degree of heating was negligible, being less than 1 degree C.

Much of the energy from the dipole radiates into the surrounding space and is lost. To increase efficiency, a waveguide was next tried.

Wine, being mostly water, has a dielectric constant a trifle over 80. The length of a wave in wine therefore is its length in air divided by the square root of 80 (8.944). Thus, a circular waveguide of 9 cm diameter can easily operate on waves in the $TE_{1,1}$ mode throughout the transmitter's frequency range.

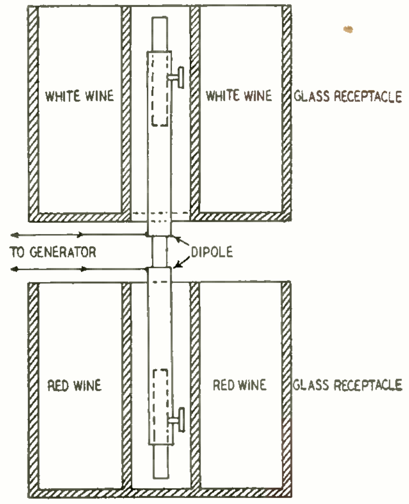


Fig. 2—The simplest radiating system.

The liquid waveguide has its own problems. Coupling cannot be adjusted by slits or movable wires, because of leakage. Silvered waveguides cannot be used, as silver dissolves in the wine. Therefore the impedance of the transmitter was matched with a double-stud coaxial line (Fig. 3). The coax is of the air-dielectric type (except at the joint where it enters the wave-

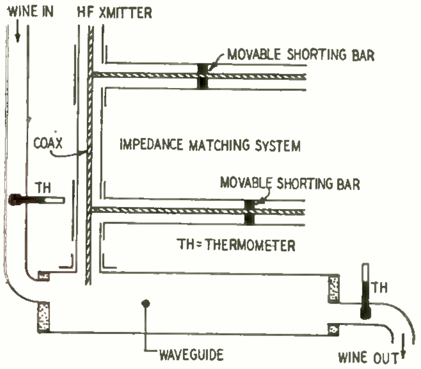


Fig. 3—A more complex, but more controllable method of irradiating wine.

guide) to keep losses down. The insulation must be capable of withstanding pulsed energy. The coupling loop to the transmitter is of the symmetric-asymmetric (balun) type. (Fig. 4). The coax has an impedance of 50 ohms.

The "wine circuit" is so arranged that the same wine can be recirculated for treatment several times. There is also a control circuit in which wine is circulated in exactly the same manner without being exposed to r.f. energy, to indicate effects caused simply by the handling.

The pulse generator

This generator (Fig. 5) has an oscillator stage, a peak clipper, a monostable multivibrator producing the pulses, and a power amplifier. The oscillator is of the low-frequency Wien-bridge type, using an ECH21. Pulse frequency is variable from 1 to 1,000 per second without affecting the output power. Coarse frequency setting is by changes in capacitance, controlled by ganged switch S1, and fine tuning by the ganged potentiometers P1 and P2. The signal goes to a peak-clipping tube (EF50), whose voltages are so adjusted that only the part of the wave with the steepest slope is retained. The differentiator which controls the multivibrator has a single fixed resistor and a separate capacitor for each band. If the sides of the square signal thus differentiated are not sharp enough there is danger that the multivibrator either will not work on the lowest frequencies, or that it will supply two successive pulses per cycle for the weakest voltages.

The 6N7 monostable multivibrator has one grid biased to cutoff while the other has a variable positive voltage (through P4) which controls the width of the pulses (variable control of power output). A variable resistor in this circuit (P3) is ganged to P1 and P2. Thus for a given setting of the power output, the width of the pulses varies with frequency, maintaining output power constant.

The output amplifier consists of an EBL21 first stage and an EL39 final. The square-wave output signal goes direct to a 5,000-ohm load. Very narrow (though not rectangular) pulses can be obtained by differentiation with a small coupling capacitor.

60-kilovolt generator

A generator which delivered 60-kv peaks for transmission as damped waves through a Hertzian discharger also was designed for higher-frequency work. The circuit (Fig. 6) was the one that seemed most economical. A 6N7 multivibrator controls a Philips TB 2/500 transmitter tube operated as a blocking oscillator. (A blocking oscillator without control was first tried, but was unstable and at times erratic.) The high-voltage coil operates on the principle of a television high-voltage transformer, and is constructed of six large honeycomb coils from old Philips superregenerative receivers, well spaced along a cylindrical bakelite form with an iron-wire core. Double discs of bakelite between the coils insulate the leads between coils from both the coils between which each lead was attached. The Q and inductance-capacitance ratio of such a coil is important, and its insulation is a delicate task not to be entrusted to inexperienced hands.

Conclusions

Some interesting results were obtained. Some of the more important were:

1. A decrease of 10 to 20% in the volatile acid content was noted in wine that had been subjected in small quan-

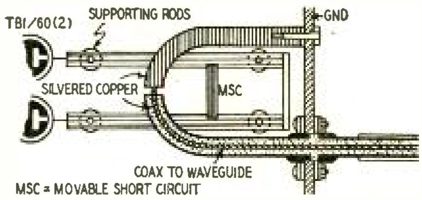


Fig.4 —Balanced-unbalanced transformer matching push-pull tubes to coax.

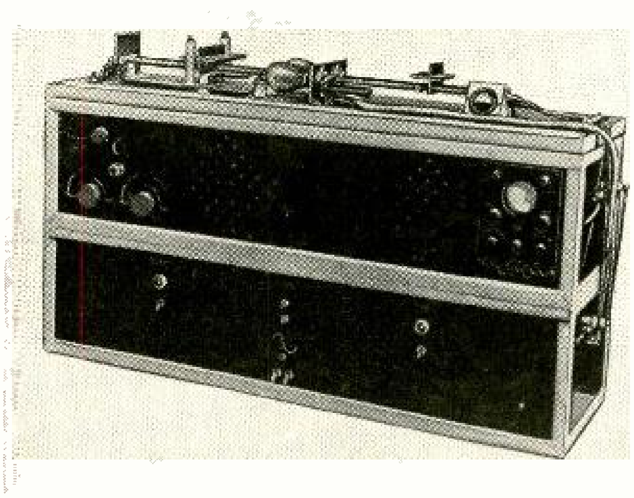
tities to the action of *damped waves* of 1 millimeter wavelength (approximately) over a period of 3 to 11 days.

2. A decrease of 34% was noted in the volatile acidity of wine (original acidity 0.58 gram per liter) was noted after subjecting it to the action of *continuous waves* for 17½ hours over a 3-day period.

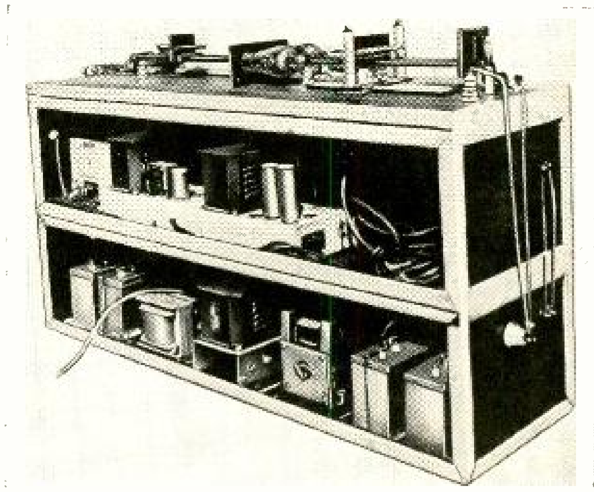
3. Absolute cessation of specks and considerably less "turning" of the wine.

The following further features were noted:

1. There was an excitation thresh-



The transmitter used in most of the experiments. It is a long-lines, push-pull circuit with provision for various means of excitation. Power can be varied, but control over the output waveform decreases as power is increased.



A rear view of the equipment. Dimensions of the long-lines circuit are well shown here. Power supplies, excitation apparatus and even an oscilloscope for checking pulse waveforms are also built into the two sections of the equipment.

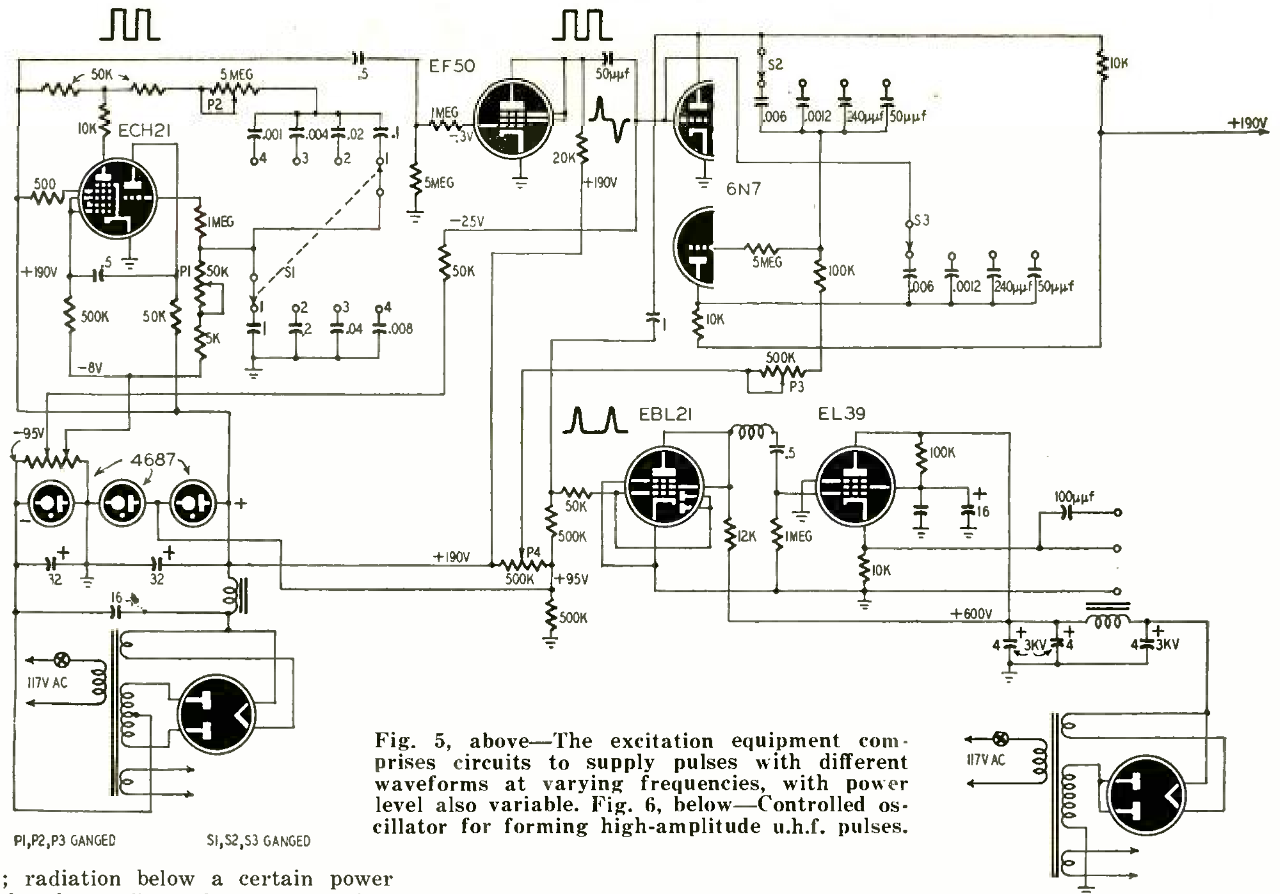
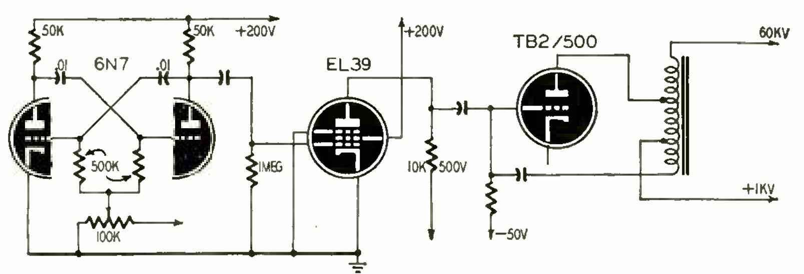


Fig. 5, above—The excitation equipment comprises circuits to supply pulses with different waveforms at varying frequencies, with power level also variable. Fig. 6, below—Controlled oscillator for forming high-amplitude u.h.f. pulses.



old; radiation below a certain power produced no effect whatever on wine.

2. The treatment must be spaced—for example, one hour out of every three.

3. Improvement was not always noticeable until several days after treatment.

The above discoveries, as well as the techniques worked out for irradiating liquids, may be useful in the treatment of other foodstuffs and beverages, as well as for performing operations on liquids consisting mostly of water. One may well hope that a cure for the maladies that occur in wine and other products which require aging or fermentation may be evolved.

On the other hand, we still do not know just *how* the ultra-high-frequency waves produce their effect on wines and other living organic matter. To us, it seems that this scientific aspect of the problem is by no means unimportant. END

Characteristics of the tubes

EBL21—Duo-diode and output pentode. Plate dissipation (pentode) 11 watts. Transconductance is 9,000, plate resistance is 50,000 ohms with 250 volts on plate and screen.
ECH21—Triode-heptode converter tube. Similar to 6J8, 7J7, and 7S7 except that each grid has a separate pin terminal and the oscillator (triode) grid is not connected internally to any of the grids in the heptode section. A triode-pentode such as a 6X8 will probably work in this circuit.
EF50—High-transconductance pentode. A 6AC7 is probably the best American substitute in this application.
EL39—Power-amplifier pentode. Plate resistance is 30,000 ohms and gm is 4,000 with 600 volts on the plate. A 6L6 or 807 is probably applicable.
4687—Voltage regulator tube. Operating voltage 95.
TB1/60—50-watt transmitting triode. Amplification factor is 10.5.
TB2/500—300-watt transmitting triode. Amplification factor is 30 with 2-kv plate supply.

SONIC DELAY LINES

MODERN electronic computers, radar equipment, and oscilloscopes for observing high-speed transient phenomena need some way to delay a signal for a definite time interval. One of the most practical methods is to feed the signal into a sonic delay line. It can handle a wide range of frequencies and can be adjusted to give various time delays.

With this system the electrical signal travelling through the circuit at a little less than 186,000 miles per second, is applied to a quartz or rochelle-salt crystal fitted to one end of a long, narrow metal tube. The tube may be folded to provide the required overall length in the smallest possible space. It is filled with water, mercury, or some other liquid. The far end is fitted with another crystal identical to the one at the input end.

The input crystal changes the electrical signal into a mechanical vibration, which travels down the fluid column as a sonic wave. Since the velocity of sonic waves in water is approximately 5,000 feet per second, the signal takes about .001 second to reach the far end of a 5-foot line and strike the receiving crystal. This crystal then converts the sonic wave back to an electrical signal, which is applied to the output circuit.

Lines can be made longer or shorter for other delay intervals; and mercury, which has a higher velocity of propagation than water and is not subject to evaporation, can be used where extremely short delays are needed.

The high attenuation in the liquid absorbs reflections from the walls of the tube, so that only the main signal reaches the receiving end. END

COMMUNICLIP

TV installation intercommunicator uses the lead-in as a phone line.

By MILTON LOWENS

MOST service technicians have grown up with the feeling, at one time or another, of a strong urge to communicate with others over a distance. We recall our first experiments—the signal flags, the string stretched between the ends of two cans (or were they oatmeal boxes?), the telegraph lines to the neighbor's house, the toy telephone, and finally (in many cases) amateur radio.

Possibly forgotten is a very simple and inexpensive communication arrangement which can now be used by TV antenna installation teams. The essential component, which practically all service technicians already have, is a pair of headphones. Connect two phones together through any reasonable length of wire as shown in Fig. 1 and you have a sound-powered telephone system: no batteries, microphones, transformers, or amplifiers are required. No wire is required either—the antenna down-lead serves the purpose.

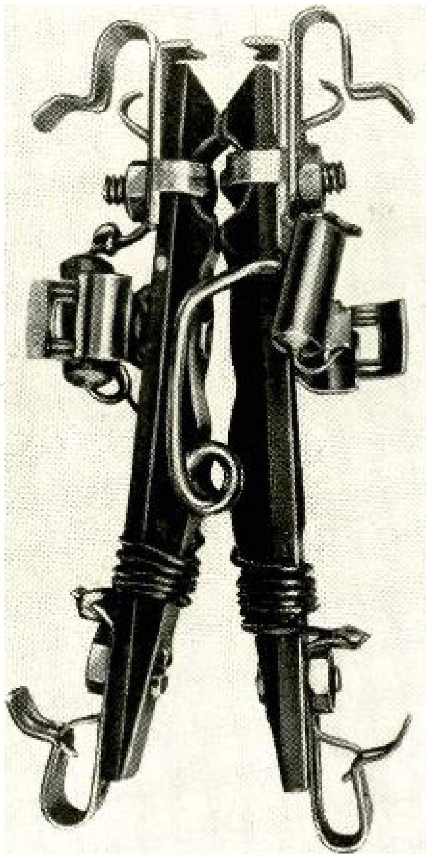
The phone is one of the simplest radio devices and its normal operation is well known. Send audio current into its electromagnet and the resulting variations in pull will cause the steel diaphragm to vibrate, producing sound. Not so readily remembered is the fact that the operation is reversible; make the diaphragm vibrate—as by speaking into the phone—and a small audio voltage will appear across the coil terminals. The reason is that as the steel diaphragm changes its distance from the pole pieces of the permanent magnet upon which the coil is always wound, the strength of the magnetic field varies because of the changing reluctance of the magnetic circuit. Going back to fundamentals: whenever the strength of a magnetic field around a coil changes, a voltage is induced. Thus the headphone is really a dynamic microphone. Although its output—like all dynamic mikes—is rather low, it is great enough to operate another phone to produce a "readable" signal. Since two identical units are used at both ends of the line, the impedance match is good and power transfer is optimum.

Putting it into practice

The usual TV antenna installation team consists of two men; one at the set, the other on the roof. If each clips his phones to the two wires of the TV transmission line (lead-in), communication theoretically is possible. Actually there are a number of problems to be overcome before the system is practical:

1. If a folded dipole antenna is used, the phones would be shorted out.
2. The antenna coil in the TV set will in most cases also short-circuit the phones;
3. Even if the above were corrected, attaching phones directly to the line could interfere with antenna performance and make adjustments difficult.

The solution to the problem is shown in Fig. 2. The capacitors prevent short-circuiting the low-frequency audio by low-resistance antenna and set components without interfering with TV signal frequency transmission. The chokes RFC isolate the phones for r.f. without interfering with audio currents. Values of the capacitors and r.f. chokes are not critical: about 500 μμf and 6 turns of No. 22 wire on a ⅜-inch dowel will do nicely.



Though the Communiclip looks formidable, it is just a plastic clothespin.

The Communiclip

While almost any arrangement of parts will work, the assembly should be rugged so as to be trouble-free despite the hard use it is likely to get, especially on the roof. The design shown in Fig. 3 is suggested. It is built around a plastic clothespin, of the type that sells for about two for 5 cents in most hardware stores. Fig. 3 shows only half the clip—the other half is identical.

In use, the clip is left attached to the phone tips, using the proper Fahnestock terminals. The man at the set attaches the ends of the lead-in to the center terminals, and clips the whole "clothespin" onto the teleset's antenna terminals by means of the ears K improvised from a piece of light metal. At the antenna, the lead-in is cut at a convenient point and its ends are clipped to the proper terminals. Communication is then established. The man at the set, whose hands are free, does most of the talking. His partner on the roof wears his phones, leaving his hands free for shifting or turning the antenna as directed by the man at the set. Whenever he wishes, however, the man on the roof may speak to the other by talking into one of the phones.

A few final precautions: Any kind of phones may be used as long as both pairs are electrically similar. *They must be in good condition*; weak magnets will not produce sufficient output. Single phones at each end are somewhat more effective than pairs because when one phone is used as a mike, the generated energy must drive *three* other receivers when pairs are used. However, the received signal is quite adequate even with pairs, and a pair of phones is more comfortable. END

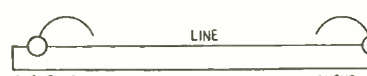


Fig. 1—Simple sound-powered phone.

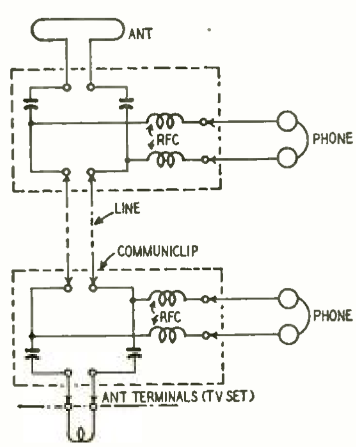


Fig. 2—The intercommunicator circuit.

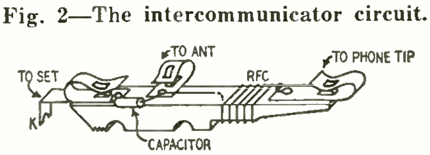
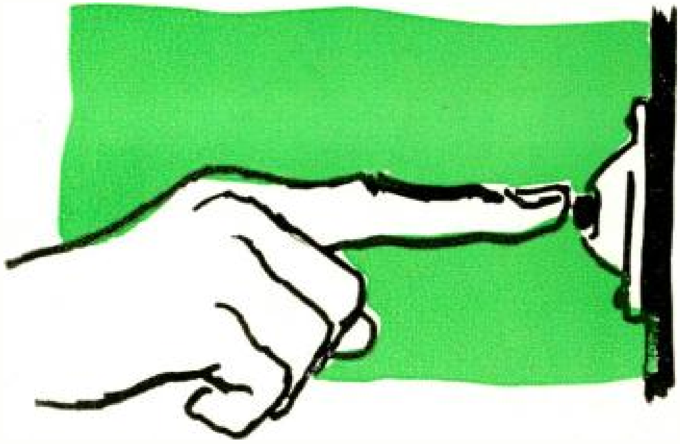


Fig. 3—Drawing of one half of the clip.



CANVASSING BUILDS BUSINESS

By JIM KIRK

WHENEVER salesmen visit me, or telephone solicitors call me, I try to be always polite and friendly. I remember the times when I wished I might have been treated that way but wasn't. Sometimes, the salesman himself is to blame for the way he is treated; sometimes he abuses privileges. But oftener, it is the other way around.

I don't mean to infer that canvassing, by ringing door bells or telephones is on the whole an unpleasant business. On the contrary, 99% of the prospects are kindly, friendly, and anxious to be helpful. Canvassing is the backbone of my present business and is the way I started two other businesses in two other cities.

In 1929, I was working from my garage on Edenhurst Street, Los Angeles. That business was built entirely by canvassing, door to door. The canvassing was done methodically. I drew a large map of the vicinity and began ringing doorbells on the streets nearest my shop. I kept a notebook with every street number in it and made back calls where no one was home the first visit. By 1934 the business was well established and I had moved to a store on Glendale Boulevard. However, I wanted to leave Los Angeles. Each summer I spent my vacations in the San Francisco Bay area, so I sold and gave away radio parts and moved to Oakland. I had a salaried position until 1939 when I deliberately moved to a neighborhood where there was no radio shop. I canvassed nights and Saturdays until there was so much radio business that I could not handle both jobs. I gave up the job that paid me the most money (my salaried position) but I was happy!

In Oakland I drew a large map to scale (drawing is a hobby of mine) of the territory in a mile radius from my location, and moved to a store a block from my home on West 14th Street. I canvassed every morning, and it was the backbone of a business, which in 1946 was soundly established and paying well. But I always did like dear old S. F. better than any city I have ever seen. In 1946, there was a neat, clean, little store for rent in an attractive neighborhood in San Francisco (Church Street). I rented it and hired help in both shops. (Oakland shop was paying well, then.)

I drew another large map, to scale, of the territory within a mile radius of the S. F. shop. (That map is still hanging on the wall of my reception room and excites favorable comment from customers.) While my employees handled the radio work, I did the canvassing for my San Francisco shop. That canvassing is still the backbone of this business.

Time and again, my card index shows that old canvass customers are returning. I couldn't make a living on simply new, drop-in business.

Chasing back and forth between the two cities was driving me frantic. Besides, I had unhappy experiences with employees. Business prospered when I was on the ground but went back when the employee was alone. I didn't blame anyone, but I decided I must drop one shop and go back to a one-man business again. I hated to turn either shop loose. I loved San Francisco and the new location, but the Oakland shop was really paying. I put the Oakland business in the hands of two real-estate operators. One actually brought around *one* prospect but all either operator ever did for me was to take my money. It seems that just anyone can't operate a radio service shop. What I was looking for was a radio man with money. Ever see one? I finally regretfully abandoned Oakland.

The effective opener

I have experimented with various approaches, but my favorite is the one I was using in 1932 and am using today:

"How does your radio work?"

(The prospect will ask you if you do television work, also.)

Having done no canvassing in this city since my first campaign six years ago, I decided recently that business could stand a tonic. What better method than the tried and true results that canvassing brings? However, in life's twilight, Grandpa could not see fun in climbing hills and steps and taking a lot of exercise for small results. My business had progressed from exclusively radio work to mostly television work. Why not progress from ringing doorbells to ringing telephones? I found it best of all, because more people could be contacted in a given amount of time.

I got out my card index of customers and looked up their phone numbers, where I did not have them already. I asked the same old question, quoted above. I received some orders to pick up radios that I would not have had without reminding the customers. I also received television service work. I got some unexpected replies, such as:

"My radio hasn't worked since you fixed it. I am thoroughly disgusted with your service!"

My card index showed that the service was rendered three years ago, so I doubted the veracity of the statement, but did not say so. I do not suppose I made a friend of the customer, but I tried my best to do so. I explained that the parts I installed were guaranteed for three months, and that if he had brought in the set during that time, I would have been happy to look it over without charge. If any part I had installed was defective, there would be no charge whatsoever for a replacement, even though it would take time and work to locate it and replace it. In three years, everything could happen, so I could not give free inspection at this late date.

(My fellow service technicians will agree with me, that we give the customer a better break than other kinds of service businesses do. Take the auto repair shops, for example. You have your valves ground this week, and next week the rear end of the car drops out. Does the mechanic install a rear end free? No. He not only charges you for new parts; he adds a towing charge and a labor charge for installing the new rear end. A radio and TV repairman, however, is something different. He should guarantee everything about the set the minute he touches it. I have had customers hit the ceiling and threaten to sue, because I would not replace—free of charge—an old tube that happened to burn out the day after I repaired the set. I asked the customer if he would expect an auto mechanic to supply a tire free because the old tire blew out the day after he had changed the crankcase oil. Of course, an appeal to reason is hopeless in such cases.)

Customers are nice people!

I don't want to give the impression that all customers are chiselers—that

the technician must be careful to hold onto his eye-teeth. The big majority are fine people, but when I get a chiseler—I get a dilly! To illustrate how wonderful some people can be, just take the case I got last week. I completely overhauled an old set, even supplying some parts that were not necessary, simply to have it play for the time being. The customer returned next day, and I said, under the breath that I was holding (along with my stopping heart): "Oh-oh. Now, what the . . . ?"

The customer said:

"We just want to compliment you on how well you made that radio play. It never worked so well when it was new! Thank you for your thorough service."

They didn't *have* to say that. I was well paid for my work. Just wonderful people!

Another unexpected reply to my phone call was:

"We certainly won't ever patronize you again! We think your price is away out of reason. You took us for plenty!"

Again, I looked at the card-index record. The customer called Saturday afternoon and insisted the TV be back Sunday morning. I picked up the set in my truck, and to make a good impression with a new customer, I had it back and installed Sunday morning. A shorted capacitor had been replaced and the charge was around $10. Well, I don't want that kind of customer, but again, I didn't say so.

"Don't let these few undesirables throw you! On the whole, canvassing is an enjoyable business," I tell myself.

A phoning list

Next I rented, from the telephone company, a list of phone numbers listed by street addresses. I copied them off for a half-mile radius round my shop, and after deleting names of my present customers, started cold-turkey canvassing. This, I told myself, would be 100 percent pleasant. No one could say what the two customers quoted above had said. And I did talk to some fine people and created some friends and customers. It takes all kinds to make a world, some wise-cracker has said. Here are three of the other kind:

"No-no-no! Don't bother me."

"I do *not* like telephone solicitors!"

"I didn't call a radio man. What right have you to call me?"

(I could think of some appropriate answers, but they would only lead to mayhem.)

It is good discipline to practice not getting hot under the collar with that small minority of . . . (can I call them people?).

Technique and consideration count

I learned some things about the telephone approach, by experience. Don't ask, "Is this Mrs. Jones?" It may be *Miss* Jones, or some other member of the family, and they will hang up, right away. You don't care what the name is, anyway. You want to talk to any radio or television set owner. The right opener is:

"Is this Valencia four one three five six?"

That will *always* keep the prospect on the phone (if you have dialed the right number). The next words I use are:

"This is the radio shop on the corner of Church and Duncan. How does your radio work?"

From there on, you are on your own, but *keep it short* and *do not hang on* and insist. In most cases, if they say everything is working fine (to background music of noisy and horribly distorted radio) I say, quickly:

"I'd like to leave my phone number, to use in case of an emergency. I have a truck to pick up your radio and TV and save you the trouble of bringing it in."

I started the telephone canvassing in April of this year. I set an hour a day aside for this work and it brought in too much business. I'm not kidding! I want time to play with my hobbies. I agree with Frank L. Moch in his letter to RADIO-ELECTRONICS, October, 1952, issue. I close at 5:00, and *do not* work evenings, Sundays, or holidays. Not for customers, that is. For myself, plenty! Ham radio is one of my main hobbies, but by no means my only one. I like singing, dancing, drawing, playing the organ, making tape recordings, and experimenting with electronic equipment, too! END

MAKING METER SCALES

SPECIAL meter scales are often required for field-strength meters, v.t.v.m.'s, and other types of special equipment. Inking in new markings on the original meter scale leaves the finished apparatus with an unprofessional appearance. An amateur photographer with a good camera and enlarger can make special meter scales which are as neat and clear-cut as that supplied with the meter. If photographic equipment is not available, a professional photographer will do the work at a very reasonable price.

We constructed a new face for a 1-ma meter used in a pH electrometer which required two special scales. The

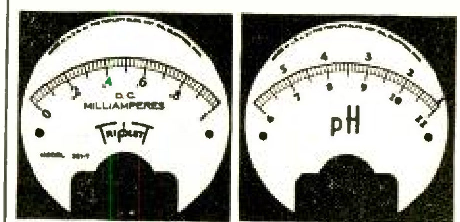


Fig. 1, left, and Fig. 2, right, show the transformation in the meter scale.

original dial scale was removed and photographed full size on Contrast Ortho film. The scale was flat-lighted to prevent reflections, and the camera stopped down. The photograph was then enlarged to about 8 inches (exact size unimportant). A camera with a ground glass is best. Otherwise center the scale to reduce distortion, and focus very carefully. A photograph of the original scale is shown in Fig. 1.

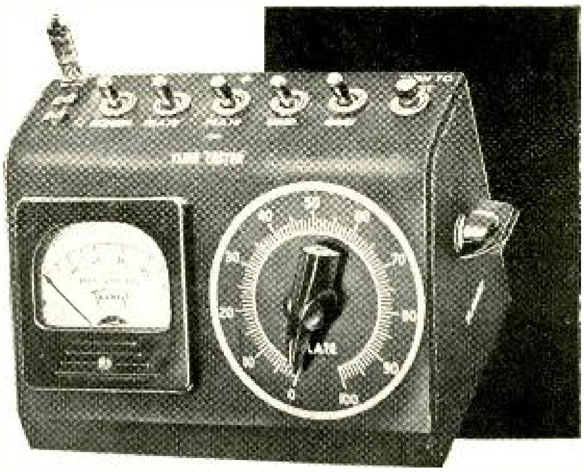
New numbers were cut from an old calendar and pasted in place on the dried enlargement of the meter scale. In cutting out numbers for this purpose, it is sufficient to cut rough squares around them because all roughness will fade out and be lost in the subsequent steps.

The completed paste-up was photographed on Contrast Ortho film to a size slightly smaller than that required for the meter. The negative was processed in D-8 developer as before. The resulting negative is a considerable reduction from the 8-inch paste-up, and therefore slight imperfections are reduced to the point where they are not noticeable.

This negative was enlarged to the exact size required by placing the original dial on the enlarging easel while adjusting the enlarger. The negative was printed on contrasty enlarging paper. Fig. 2 is the finished scale for the pH meter.—*Paul Halmbacher.*

(Scales which have fine graduations close together will reproduce clearer if they are photographed on Kodalith Ortho film type 2—available only as cut film in 5 x 7 inches or larger—and processed in Kodalith developer. Kodalith Fine-Line developer should be used where the scales have extra-fine line work.—*Editor*) END

subminiature TUBE TESTER design....



The completed tester is compact and easy to use.

By RICHARD J. SANDRETTO

SUBMINIATURE tubes are becoming increasingly popular, yet there are very few tube checkers on the market which will test them. The checker described here tests battery-type subminiatures for filament continuity, internal shorts and opens, filament emission, effectiveness of control grid, and microphonics. It features small size, light weight, and simplicity of design and construction.

This tester was built especially for hearing-aid tubes, but it will test many other types without modification. Extra grid and plate switches have been provided to accommodate multisection tubes; and, since some tube manufacturers use different base-pin arrangements, suitable sockets properly connected can be added or substituted to adapt the tester for any filament-type subminiatures.

One of the basic considerations in the design of this tester was that the tubes should be tested at approximately their normal low operating voltages. Most modern tube testers cannot be adapted easily to meet this requirement, due to the need for relatively high electrode voltages to produce readable indications on the meter. With subminiature tubes, the electrostatic charges developed by higher-than-normal voltages may attract the elements to each other to such an extent that they short out.

Circuit details

The tester schematic is given in Fig. 1.

The 50-microampere meter is placed in the circuit in such a manner that it reads filament current when the d.p.d.t. push-button switch S1 is in its normal (UP) position. Pressing the push-button switches the meter out of the filament circuit, and connects it in series with the B supply line to the plate and screen circuits.

Because filament-type subminiature tubes have widely different filament voltage and current requirements—ranging from 0.625 to 1.25 volts, and from 10 to 50 milliamperes—a 50-ohm rheostat (R1) is connected in series with the filament line. This rheostat is adjusted until the filament current is the value given in the manufacturer's data for the particular tube under test. When this control is turned past its minimum-current (maximum resistance) position, the arm slides off the resistance element onto the insulating strip, thereby serving as an on-off switch for the entire tester.

The s.p.d.t. switches S2 and S3 were inserted to shift the control-grid d.c. potential from zero to minus 1½ volts. The change in plate and screen current when the bias is shifted indicates the effectiveness of the control grid. When S1 is pressed down, the meter and B supply line are connected in series with the plate and screen switches S4, S5, and S6. Plate and screen currents can then be read separately or in combination by closing one or more of these switches.

A plate-screen-voltage control in the form of a voltage divider across the B battery is necessary. This control (R2) is a wire-wound potentiometer of about 30,000 ohms resistance. A large bar knob and calibrated scale permit adjusting this control to a predetermined value for the particular tube under test. The method of determining this value is explained later in this article.

Construction

The checker is assembled as shown in the photograph. The cabinet is a standard, sloping-front type, approximately seven inches wide and four inches high. While not shown in the diagram, the meter may be fused if desired.

The only critical component is the meter-shunting resistor R3. This resistor multiplies the meter reading by 1,000 when the push-button switch is in the UP position for measuring filament current. The value required is approximately 4.7 ohms, but the specific resistor for each tester must be selected as described below.

Wire the tester, with any 4.7-ohm, 10% resistor connected temporarily for R3. Caution: *Never disconnect this meter-shunting resistor unless the filament rheostat is in its* OFF *position.* Otherwise, a dangerously high current will flow through the meter. Connect a resistor of known value—preferably between 50 and 100 ohms—across the filament pins of one of the tube sockets; then turn the filament rheostat all the way up and measure the voltage across the known resistor. This voltage reading divided by the known resistance (E/R) gives the current flowing through the filament circuit. The meter reading multiplied by 1,000 should be the same as this calculated current. If it is not, try several 4.7-ohm (nominal value) resistors as meter shunts until you find one that makes the meter reading agree with the calculated current.

Most battery-operated subminiature tubes with the same number of base pins have the same base-pin-to-tube-element arrangement. For the very few exceptions, however, it will be necessary to wire a few sockets especially for these tube types. Provision should also be made on the panel for future socket types, because simply wiring in additional sockets later is less of a problem

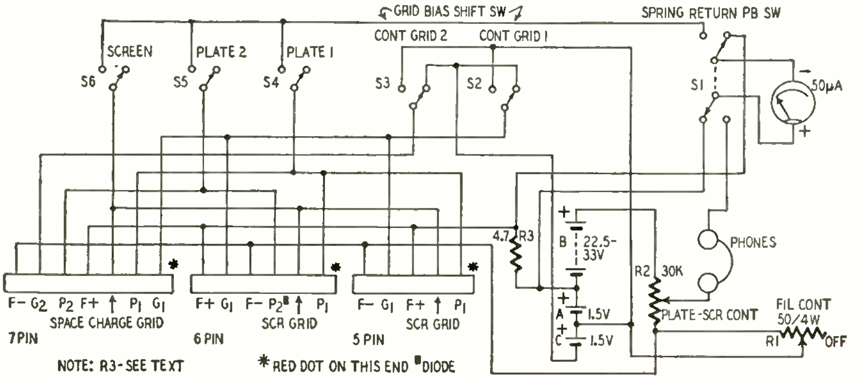


Fig. 1—Schematic of the subminiature tube tester. Extra sockets for tubes with special basing may be added as required. The duplicate plate and grid switches permit the operator to test twin-triodes, converters, and other multi-element types.

SUBMINIATURE TUBE TESTER CHART

TUBE TYPE	FIL. (ma)	PLATE-VOLTAGE CONTROL SETTING	SWITCH POSITIONS S P2 P1 G2 G1	METER READS	SWITCH POSITIONS S P2 P1 G2 G1	METER READS	SWITCH POSITIONS S P2 P1 G2 G1	METER READS
CK501AX	30	32	P * P * P	45	P * N * P	38	P * N * N	0
CK503AX	30	21	P * P * P	45	P * N * P	36	P * N * N	0
CK505AX	30	52	P * P * P	45	P * N * P	38	P * N * N	0
CK506AX	50	15	P * P * P	45	P * N * P	36	P * N * N	0
CK507AX	45	20	P * P * P	45	P * N * P	38	P * N * N	0
CK509AX	30	85	* * P * P	45	* * P * N	0.5		
CK510AX	50	6	P P P P P	45	P P P P N	41	P P P N N	37
CK512AX	20	39	P * P * P	45	P * N * P	36	P * N * N	0
CK516AX	20	36	* * P * P	45	* * P * N	0.5		
CK518AX	30	15	P * P * P	45	P * N * P	39	P * N * N	0

A specimen calibration chart for testing battery-type subminiature tubes. Other types may be substituted and new ones added as the need arises. Asterisks indicate that there is no element connected to that base pin in that type of tube. Letters under SWITCH POSITIONS headings: S—screen or space-charge grid; P2—plate 2; P1—plate 1; G2—control grid 2; G1—control grid 1.

than trying to find room for them a few years after the tester has been completed.

Flat-type subminiature tubes have a red mark at one end to indicate the proper way of inserting the tube in its socket. Mark the corresponding side of each tube socket in the same way or with some unmistakable label. Then, when inserting a tube, make the marks coincide.

Calibration and operation

Make up a chart like the one shown for calibration and testing. The chart data will vary, of course, depending on the voltage of the B battery used. To simplify directions for calibrating the tester, each of the five element switches is specified as having a POSITIVE and a NEGATIVE position. Therefore, the P and N symbols shown opposite meter readings on the chart indicate the positions of the corresponding element switches when each meter reading was obtained. Where an asterisk is shown, there is no element connected to that base pin in that tube type, and it makes no difference what position the corresponding switch is in.

Take a group of new tubes of each type you will want to test, make the necessary readings on each one, and set down the average readings for that type in the chart. Also, by comparing readings on known good tubes and known bad tubes, you can figure out what variation from the average readings a tube may have in order to still be considered good.

In using the tester, always start with the filament-current control in its OFF position. Otherwise, it may be set at a value much too high for the tube to be tested and may burn out the filament. Also make sure the plate-voltage control (R2) is at its *minimum* position *before* the tube is inserted. A pair of high-impedance headphones must be plugged into the tester, or the headphone terminals shorted out, to complete the plate circuit. (In this connection, results will be more accurate if calibration and testing are done under the same conditions. For example, if the instrument is calibrated with the headphone terminals shorted out, and a tube of the same type is tested later with headphones plugged in, the headphone resistance may reduce the plate current below the normal value for that tube type.)

Next, insert a tube in its proper socket, aligning the plate-end markings. Now advance the filament-current control (R1) until the meter reads as close as possible to the value specified by the tube manufacturer. Let's assume the tube we are checking is a pentode. Throw the screen switch S6, plate 1 switch S4, and control-grid 1 switch S2, to their POSITIVE positions. Next, press down the meter switch S1, and advance the plate-voltage control R2 *slowly* until the meter reads 45 microamperes. Record the R2 setting on the chart. Now throw S4 to its NEGATIVE position, and record the new meter reading. Then throw grid switch S2 to its NEGATIVE position, leaving the plate switch alone, and record this new reading, which should be close to zero. (If the control grid connection of the tube is open, there will be no change in the screen current.) It is entirely normal for the meter to show more screen or space-charge-grid current than plate current on some tube types.

Tubes to be tested are handled the same way as for calibration purposes, except that the plate voltage control is advanced slowly with the meter switch pressed down, to the setting given in the chart. The actual reading is then compared with the standard value of 45 to see whether the variation is too great for the tube to be good. The importance of always bringing R2 up *slowly* from its lowest position cannot be overemphasized. If the tube under test has a screen-to-control-grid short, this fact will be shown almost instantly by a large deflection of the meter long before the plate-voltage control has been brought up to the setting shown on the chart. Remember, if this control is brought up to setting *before* pressing the meter switch, excessive current will flow through the meter circuit when S1 is pressed.

To test tubes for microphonics, set the filament control, throw all element switches to their POSITIVE positions, and press the meter switch. Now, tap the tube gently while you listen in the headphones. If you hear *loud* ringing sounds, the tube is microphonic. Practically all tubes are microphonic to some degree, but some are so much so that they are very objectionable, and this test will indicate these quickly.

Once the chart has been made up, and you have a little experience, it takes only a few seconds to check the condition of a tube. The time required for testing is much less than with most other types because these tubes are instant-heating. END

Materials for tester

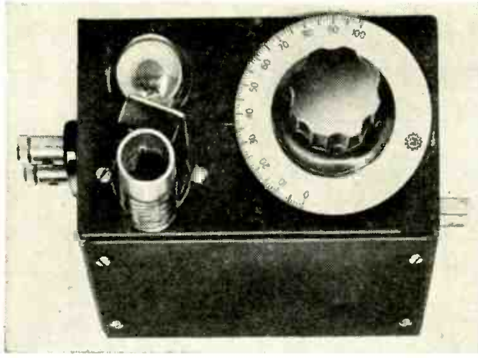
Resistors: 1—30,000-ohm wire-wound potentiometer; 1—50-ohm 4-watt potentiometer; 1—4.7-ohm, 1/2-watt resistor (see text).
Miscellaneous: 1 d.p.d.t. spring-return push-button switch; 3 s.p.s.t. toggle switches; 2 s.p.d.t. toggle switches; 1—0-50 microammeter; subminiature tube sockets as required; 1 pair high-impedance headphones; 1—1 1/2-volt A battery; 1—1 1/2-volt C battery; 1—22 1/2-volt, 30-volt, or 33-volt B battery; dial plate; meter fuse and fuse holder if desired; cabinet; knobs; hardware; wire; solder.

TROUBLE IN ADMIRAL TV SETS

Vertical white bars at left of the picture in Admiral 24D1, 24E1, 24F1, 24G1, and 24H1 chassis may be minimized by inserting a filter between the horizontal output transformer and the yoke. The filter consists of the following parts connected in parallel: Width coil (part No. 94A4), .01-μf, 600-volt capacitor (part 64B5-10), and a 470-ohm, 1-watt resistor (part 60B14-471). Connect the filter in series with the lead between terminal 4 of the horizontal output transformer and pin 5 of the damper tube.

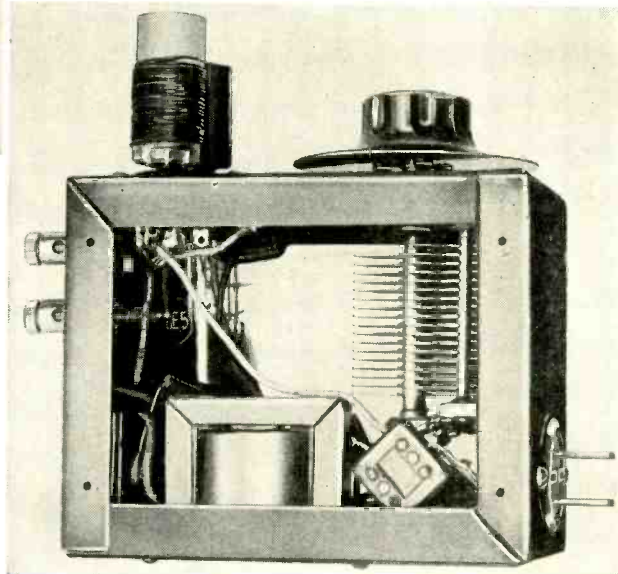
Adjust the slug in the coil until the vertical bars are reduced to a minimum. In some instances, leaving off the 470-ohm resistor may provide a greater reduction.

Note: Do not confuse this trouble with the vertical bars produced by misadjustment of the horizontal drive control.—*Admiral TV Service Hints.*



R. F. Circuit Tester

By I. QUEEN



Above, coil and crystal mount in the same socket.

Right, an inside view of the handy little instrument.

THIS instrument is designed to test crystals and measure coils and capacitors. It is built into a 3 x 4 x 5-inch box and has its own self-contained power supply. Only one tube is used, a 6E5 combination oscillator-electron-ray indicator. The triode section of the tube is the oscillator.

An octal socket is wired to receive crystals which are either FT-243-mounted or octal-mounted. When an octal is plugged in, it is automatically connected into a Pierce-type circuit requiring no tuning. A type 243 (½-inch pin spacing) is plugged into terminals 3 and 5 of the socket for the Pierce connection. In either case C should be left at minimum capacitance for the Pierce circuit.

For a conventional tuned circuit crystal oscillator, plug the crystal into terminals 1 and 3 of the octal socket, and plug a coil into 6 and 7. As seen in Fig. 1 the coil is resonated with capacitor C to the crystal frequency. This coil may be wound on a miniature 5-prong Amphenol polystyrene form (¾-inch diameter). Three prongs of the form are cut off, leaving only pins 3 and 4. There is ample room on the octal socket for both coil and crystal.

When the circuit is in a nonoscillating condition the triode grid is at zero bias and the magic eye shadow is open. The grid goes negative during oscillation, so the angle is reduced. The more intense the oscillation is, the smaller the angle. Resistor R may be varied slightly until the angle is at or near zero when an active crystal is plugged in and when a high-Q coil is used. Sluggish crystals cause only partial closing of the eye.

To measure capacitance a "standard" coil is wound. It should resonate at the desired crystal frequency when C is set at maximum capacitance (0 on the dial). We use a 3750-kc crystal with a coil wound with 23 turns of No. 22 enameled wire to extend about ⅞ inch.

Having adjusted the eye to close with the main dial at 0, connect an unknown capacitor across the binding posts. The circuit is thrown out of oscillation. Then rotate the main dial to restore resonance. It is better to approach from the low end of the dial (high-capacitance end) because this gives a much sharper indication on the eye. The circuit oscillates again when the unknown capacitance equals the change in C.

The main dial may be calibrated by connecting various known capacitors across the binding posts and noting the dial readings for resonance. Use a straight-line-capacitance capacitor at C to obtain a linear calibration. A curve or chart may be drawn up from the data. The instrument used here shows about 2.5 μμf per dial division. A maximum of about 260 μμf may be measured.

The circuit may be padded for greater capacitance values. Connect a known capacitor of 250 μμf across the binding posts and use a coil which will resonate when C is at maximum setting. Remove the 250-μμf and substitute the unknown, rotating C for resonance. The unknown capacitance equals 250 plus the change in C (which may be determined from the calibration curve). A maximum of 500 μμf may then be measured. A bridge is more convenient if still larger capacitors are to be measured (see "Linear Resistance Bridge," RADIO-ELECTRONICS for July, 1949).

It is seldom necessary to know the exact inductance of a coil. More often it is simply desired to know the frequency range when it is tuned with a given capacitor. To check a coil, connect it across the binding posts, insert a crystal into 1 and 3 of the octal socket and then tune to resonance. The capacitance of C at any position may be determined from its calibration chart and its known maximum capacitance. If needed, the inductance may also be calculated since the crystal frequency and the capacitance are known.

The circuit becomes an excellent r.f. signal generator by plugging a center-

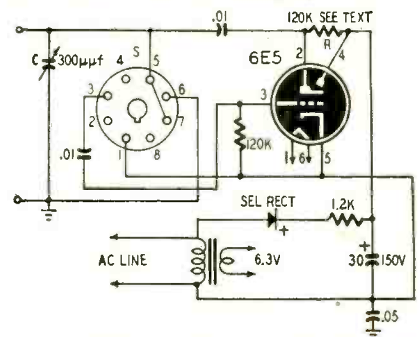


Fig. 1—This circuit can check crystals or coils and measure capacitors.

tapped coil into the octal socket. The center-tap goes into terminal 1, the ends into 5 and 3. The coil may be wound over the base of a glass octal tube or an octal plug.

We have also used this circuit to check points on a v.f.o. To do this, use the tester as a Pierce oscillator and couple its hot binding post to a low power transmitter. A piece of wire connected to the binding post and left near the transmitter is sufficient. As the v.f.o. is tuned through the crystal frequency, the eye shadow will show a change. END

Materials for the circuit tester

Resistors: 1—1,200, 2—120,000 ohms, ½ watt.
Capacitors: (Mica or paper) 2—.01, 1—.05 μf, 400 volts. (Electrolytic) 1—30 μf, 150 volts. (Air-type variable) 1—300 μμf, straight-line capacitance.
Miscellaneous: 1—6.3-volt filament transformer, 2—octal sockets, 1—75-ma selenium rectifier, 1—3 x 4 x 5-inch metal utility box. Dial, binding posts, hookup wire, and assorted hardware.

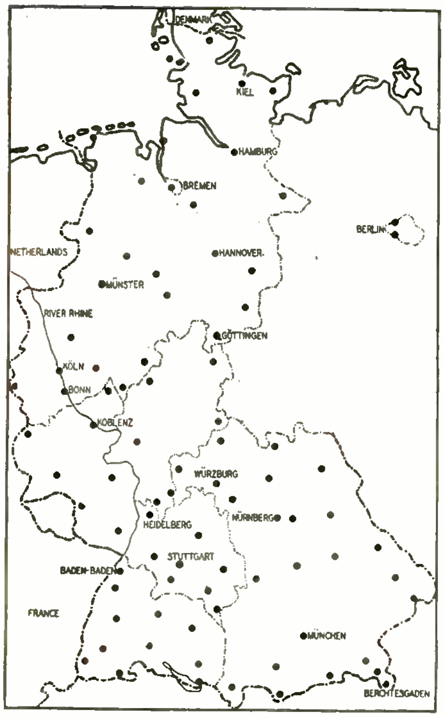


Fig. 1—Locations of stations in Western Germany's nationwide FM network.

FM BROADCASTING IN WESTERN GERMANY

Blanketing a nation with high-level signals brings FM benefits to 50 million

By PROFESSOR WERNER M. NESTEL*

BROADCAST-FREQUENCY assignments in Europe are based on two international agreements:

1—The Atlantic City Agreement (1947), which assigned the frequency band 525-1605 kc for "medium-wave" broadcasting. (Europe also has a number of "long-wave" broadcast stations on various frequencies between 150 and 530 kc.)

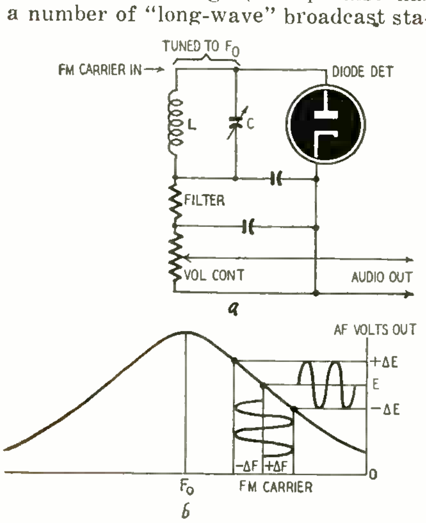


Fig. 2—(a) FM slope detector circuit. (b) Peaking the tuned circuit below the FM carrier converts carrier-frequency deviations to audio voltage variations.

2—The Copenhagen Agreement (1948), which assigned specific channel frequencies to nearly 600 European stations operating within a relatively small geographic area.

Western Germany, which was not represented at the Copenhagen conference, was allotted only a few undesirable frequencies at the high-frequency end of the medium-wave band. These were all shared channels, with unreasonable power limitations, and had to compete with very powerful stations in other countries operating on the same frequencies and on adjacent channels. The fact that Western Germany, with about 50 million inhabitants and some 10 million listeners, would be open to Communist propaganda by radio as long as its own broadcasting system did not work effectively, was not taken into account at this conference.

Faced with the difficult situation, Western Germany had to devise a means of serving all its listeners through a new system of program distribution, if broadcasting as one of the most effective and important modern instruments of culture and education was not to be given up entirely. In seeking a satisfactory solution, the following possibilities were considered, and each method was tested by thorough experiments:

a. Carrier-current distribution of programs over telephone circuits.
b. Carrier-current distribution of programs over power lines.
c. A combination of methods *a* and *b*.
d. Low-power common-frequency broadcasting (on various frequencies).
e. Short-wave broadcasting.
f. V.h.f. AM broadcasting.
g. V.h.f. FM broadcasting.

System *g* (FM) proved so superior to all the others that it was decided to make it available to the public as fast as possible. Much of the experience gained with FM broadcasting in the United States was utilized, but in many respects new techniques had to be developed.

The basic plan

In general, FM receiver circuits developed in the United States have such high sensitivities that large areas can be served by low-power transmitters. The comparatively low prices of sets, tubes, and parts in the United States make it possible to manufacture and sell the elaborate multitube receivers needed there. In spite of these favorable

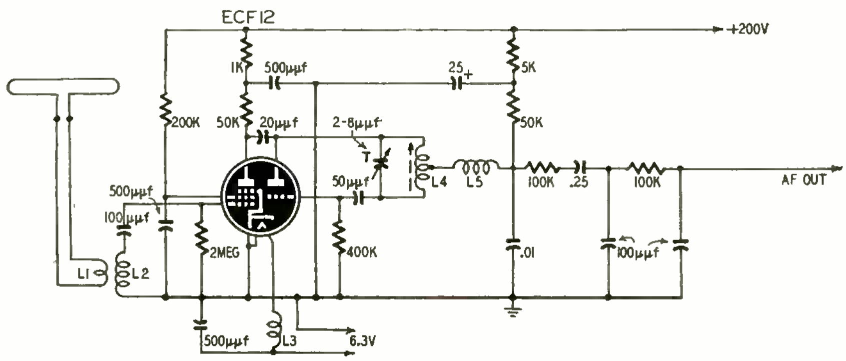
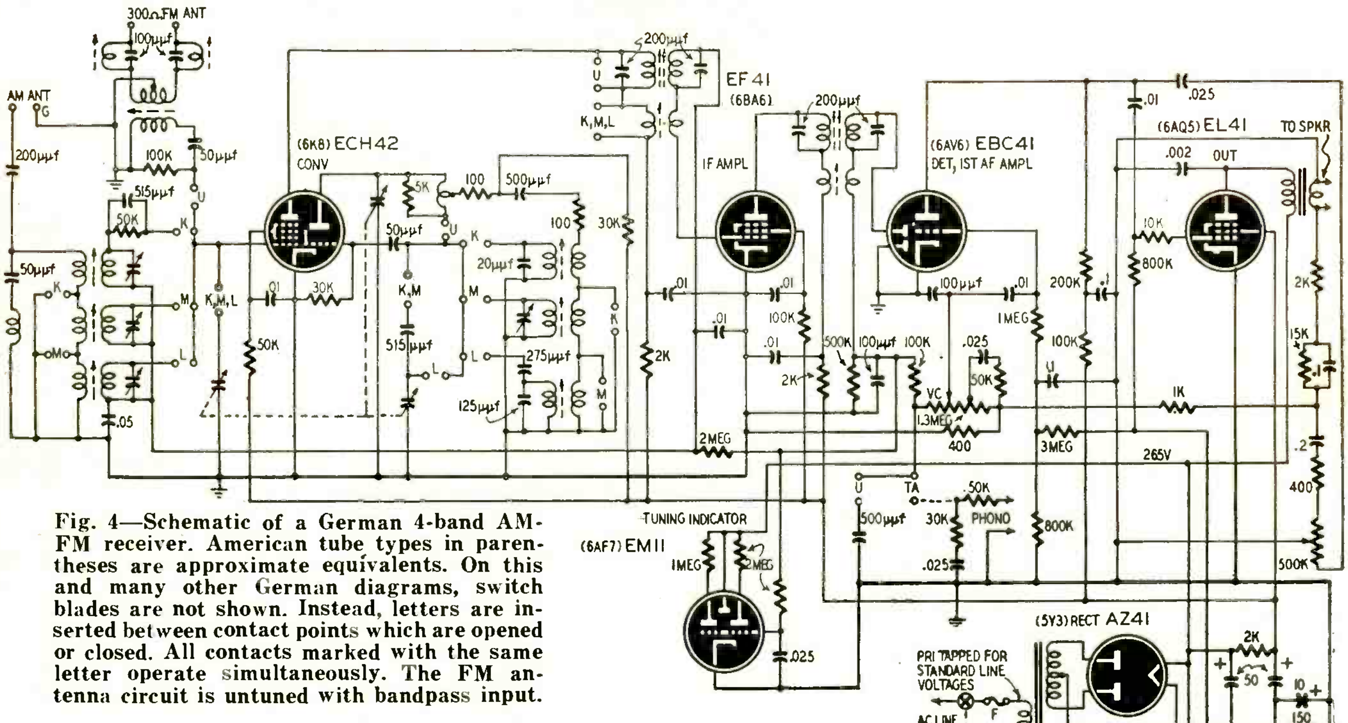


Fig. 3—Low-cost superregenerative FM adapter developed for the NWDR national network. The 6U8 and 6X8 are approximate American equivalents of the ECF12.

*Technical Director, Nordwestdeutscher Rundfunk (Northwest German Radio System).



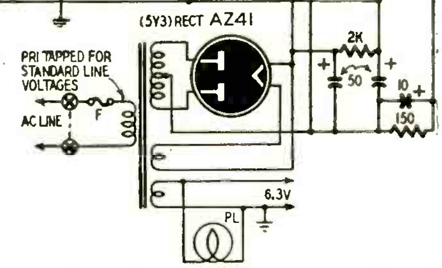


Fig. 4—Schematic of a German 4-band AM-FM receiver. American tube types in parentheses are approximate equivalents. On this and many other German diagrams, switch blades are not shown. Instead, letters are inserted between contact points which are opened or closed. All contacts marked with the same letter operate simultaneously. The FM antenna circuit is untuned with bandpass input.

factors, FM broadcasting has not developed as a serious competitor to AM in the United States. To make sure that it does so in Western Germany—and this was not merely a matter of preference, but an absolute necessity—it was decided to blanket the entire country with field strengths of more than 1 mv/m by installing an adequate number of high-power FM transmitters. To be able to provide this high field strength over the large area required and to make a complete network of transmitters as quickly as possible the following basic requirements were established:

The FM transmitting antennas were to be mounted on top of existing 600-foot vertical transmitting antennas used for medium-wave broadcasting. Assuming that the radius of the area to be served is 30% greater than the optical distance to the horizon and that the signal level at the fringes of this area should be 1 mv/m measured at 30 feet above ground level in accordance with international definition, the effective radiated power (ERP) of each transmitter must be about 60 kw. Horizontal polarization is used, as in the United States. Antenna gains of 8 to 1 can be obtained easily. Line losses between transmitter and antenna can be figured at about 20% if the FM transmitters are installed in the existing buildings now used for the medium-wave transmitters, which are generally about 600 feet from the bases of the antenna towers. This calls for a 10-kw output from the FM transmitter, a power that can be provided at reasonable cost.

The high field strength available with this system everywhere has two important advantages from the receiving side:

Very simple and inexpensive receiving antennas—in most cases indoor types—can be used;

Good quality reception is possible without the high-sensitivity FM circuits developed in the United States.

To reduce receiver selectivity requirements—helping to keep receiver costs as low as possible—the minimum frequency separation between channels was set at 0.4 mc, twice the separation used in the United States. (This does not mean that each station utilizes the full 400-kc bandwidth provided by this arrangement. Deviation is limited to ±75 kc, as in the United States, and the unused separating channels may be used eventually for additional stations.)

Sixty-two FM transmitters operating between 87.5 and 100 mc have been installed in Western Germany in the two years since FM was introduced. The map (Fig. 1) shows how completely they cover the territory to be served. Relatively few transmitters are needed to cover the flat northern part of the country with transmitting antennas on top of existing 600-foot towers. The southern part of the country has mountains of 6,000 feet high available for the stations, but there are deep valleys as well, so that more transmitters are needed to cover a given area in the south. One of the most important facts that made this network of transmitters possible is that the "shadow" areas cast by mountains, houses, and other obstacles are only gray—never quite black. Reception is possible not only with roof antennas, but also with indoor antennas on all floors of buildings, the ground floor included. Even indoors the electrical shadows are only gray and not black, and the high field strength assures adequate receiver-input voltages for good reception.

For the future it is intended to install many more transmitters in order to offer a bigger choice of programs in the FM range.

One of the many interesting special problems that had to be solved for the development of the FM technique in Western Germany should be mentioned.

In many cases a single tower is used simultaneously for radiating two different medium-wave programs with up to 100 kw power each; for one or two FM programs; and will soon also be used for television with picture and sound. The same tower also carries an FM-relay receiving antenna besides power circuits for aircraft warning lights and de-icing heaters.

FM receiver design

The ability to provide listeners with adequate receivers is the real key to success or failure of FM broadcasting. Although at first the German radio industry was against FM—partly on the grounds of the high cost of adapters and complete receivers—it finally, after several heated conferences, changed its attitude. Once the industry started developing FM receivers, such simple and inexpensive solutions were found as to start a positive race on the part of the industry in their eagerness to promote FM broadcasting.

The decisive move was a complete break with accepted standards for FM receivers. The strong signals provided by the transmitters in Western Germany nearly always make limiters unnecessary. According to American ideas, FM reception without limiters and discriminators is unthinkable. Of course, these features allow good reception with inputs of only a few microvolts, but they also entail a great outlay in tubes and components. Abandoning the idea that these circuits alone are

feasible, German manufacturers then were able to use two very simple receiving circuits which do not require one single component more than similar AM circuits. These are the *superregenerator*, and the *slope detector* (Fig. 2).

The cheapest receivers and adapters are superregenerators. In this connection the broadcasting authorities and the Post Office (which has the same authority over broadcasting here that the FCC has in the United States) made very strict regulations requiring that the interference produced in the superregenerative circuit must not get into the antenna. Out of this were developed 2-tube adapter circuits, with both tubes—a pentode and a triode—in a single envelope.

The circuit of a typical adapter is given in Fig. 3. One of the tubes has a fixed-tuned grid circuit and merely serves to isolate the antenna from the actual receiving tube. It blocks oscillator radiation and reduces the effects of variations in the antenna circuit on receiver tuning. The actual FM detector is the triode section, in a superregenerative circuit. The production of the auxiliary (quench) frequency is completely reliable, even during line-voltage fluctuations. Following the superregenerative stage is a simple RC h.f. de-emphasis filter. The output is adequate for feeding the audio sections of existing receivers.

The sensitivity of these simple FM adapters is about 0.1 mv—that is, at this input voltage the "no-signal" noise is suppressed satisfactorily.

Adapters of this type, which cost between 27 and 50 German marks ($6-$12) can be added to any existing receiver, and the availability of such inexpensive units probably is the underlying reason for the popularity of FM broadcasting. The obsession that expensive receivers are absolutely essential no longer exists, but—curiously enough—the cheapest adapters are by no means the most popular. Most listeners prefer a slightly higher quality signal, but it was imperative psychologically to make such very inexpensive adapters available.

The second type of receiving circuit mentioned above (slope detection) is used to provide 3-band (short-, medium-, and long-wave) receivers with an additional range for FM broadcasting. Compared with the usual superhet circuit, this type requires only few additional components: a band switch with four positions instead of three; and 10.7-mc i.f. transformers in addition to the 470-kc transformers already in the receiver. The price differential between a 3-band AM superhet and one with the added FM range is only about 10 marks ($3).

Fig. 4 is the circuit of a typical receiver of this type. Whereas during the first year of FM broadcasting in Western Germany only one-third of the receivers made had an FM band, the current public demand is so great that now over 90% of all sets produced are equipped for FM.

In addition to these inexpensive sets, a group of first-class receivers selling at higher prices was developed. The FM sections of these receivers have r.f.-amplifier stages, and limiter-discriminator-type detection, and give very high-grade reception even at great distances.

It is now an accepted fact in many parts of Western Germany that long-distance FM reception is practicable, and there are many districts where the owner of one of these FM receivers can pick up several—often as many as seven—different stations.

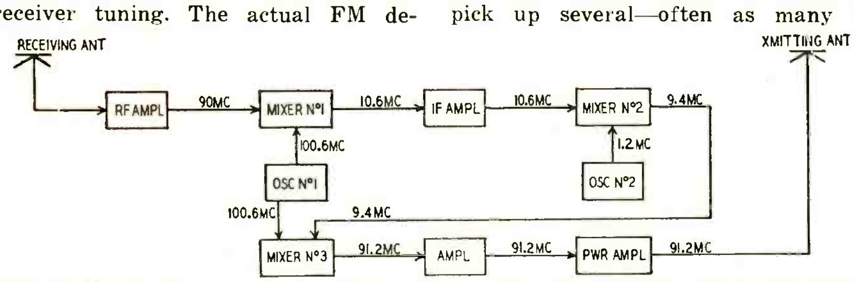


Fig. 5—Block diagram of the unique relay-receiver-transmitter which eliminates wire lines and special point-to-point links in the West German FM network.

Another circumstance has helped in the very quick swing toward FM broadcasting in Germany. During the war and post-war years (from 1938 to 1948) German listeners could not buy receivers. When FM started, home receivers were completely out of date. Everyone was in the market for a new receiver, and it was possible to get one incorporating FM immediately.

Other advantages

FM broadcasting fulfills the two main requirements which led to its adoption.

a. Coverage of areas not reached by medium-wave stations.
b. Giving all listeners a choice of programs not available on medium waves under the Copenhagen plan.

Beyond this, however, it has become very evident that FM broadcasting gives the public a very welcome improvement in audio quality, and has helped to overcome certain misconceptions. According to popular belief, standard AM stations have an audio limit of about 5 kc, while FM transmits everything up to 15 kc. But since very few loudspeakers will reproduce such high frequencies satisfactorily, FM was held to be of no value from the point of view of improved quality.

The true picture is quite different. Most European medium-wave receivers, to provide adequate adjacent-channel selectivity, have a restricted r.f. bandwidth, which limits the sideband response to about 3 or at most 4 kc. The audio stages of such sets, including the loudspeakers, generally have reasonably good response to 8 kc. Therefore even the simplest and cheapest adapter, selling for only about 27 marks ($6), extends the audio response from an upper limit of 3 kc to 8 kc, which is such a very great improvement that every listener is impressed.

The reduction in harmonic distortion —from 4% at 100% modulation with AM to only ½ of 1% with FM—means a corresponding improvement in audio quality at the receiving end.

Another advantage is the reduction in interference. Even receivers without noise limiters do not suffer the interference—from electrical devices or natural static—which frequently ruins medium-wave reception.

Transmission up to 15 kc over long-distance phone lines is still not practicable except at prohibitive cost. High audio quality is maintained over the entire network by a novel method of rebroadcasting from station to station. Each station is equipped with a special FM receiver and directional pickup antenna. (The usual 8-kc long-distance wire lines are provided as a standby.) The relay receiver contains the r.f. and i.f. sections of a normal receiver, but the i.f. is transposed by means of an 0.8- or 1.2-mc crystal oscillator to a frequency 0.8 or 1.2 mc higher or lower than the original r.f. carrier. See Fig. 5. This new frequency is amplified and then radiated. Receiver and transmitter thus have very simple design.

In planning the network, the channel separation and the geographic distances between transmitters were co-ordinated with the designs for very cheap and simple receivers.

The great success of FM broadcasting in Western Germany has led many other European countries to start or at least to plan FM broadcasting, and a European conference on FM and TV frequencies was held at Stockholm in June, 1952. The frequency plan decided upon at Stockholm provides for 2,000 FM stations in Europe.

Summary

In summing up, it may be said that: All the individual technical problems of FM broadcasting from the transmission, propagation, and reception points of view, have been solved in every way. FM broadcasting is economically and technically beyond reproach. In many ways it is cheaper than other systems.

If the deterioration in medium-wave reception throughout Europe since the adoption of the Copenhagen Plan is to be overcome, then thought must be given right away to the outcome of the next Wavelength Conference. Only one path will lead to improved broadcasting. Only if as many countries as possible adopt FM for all local and regional programs will it be possible to reduce the number of medium-wave transmitters. END

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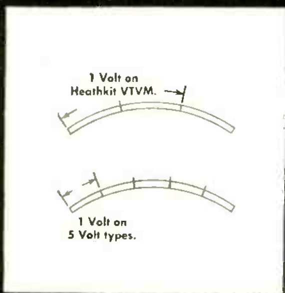

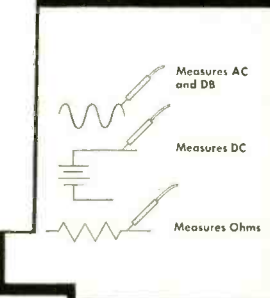

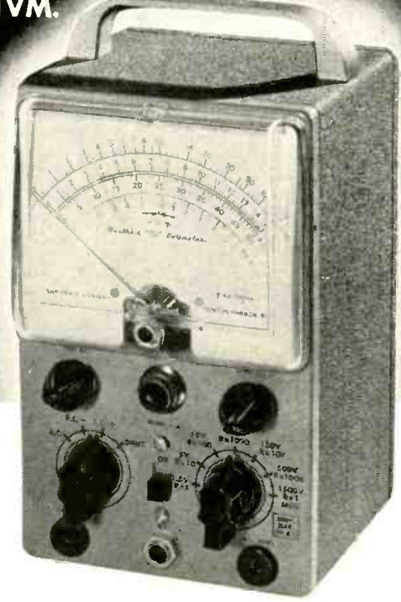

- New 1½ volt low range gives over 2" of scale per volt instead of less than ¾" found on 5 volt range type.
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- Seven ranges in all. 1½, 5, 15, 50, 150, 500 and 1500 volts DC (1000 volts maximum AC only).
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The 1953 Heathkit V-6 VTVM has improved ranges! The lowest range has been moved way down to 1.5V full scale. This gives 3½" of actual scale length for the 1.5V covered — *that's 2⅓ inches per volt!!* Now you can make your low level measurements faster and with greater accuracy.

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New vertical chassis mounting gives added chassis space for really easy wiring — no tight corners to worry about. Uses only highest quality components throughout. Simpson 200 microampere meter movement combined with 1% precision resistors in multiplier circuit insure highly accurate and dependable readings.

AC and DC voltage ranges are 0-1.5V-5V-15V-50V-150V-500V-1500V. (1000V max. reading on AC) — a total of seven ranges for convenient, accurate readings. Instrument also measures resistance from .1 ohm to over 1 billion ohms in seven handy ranges of RX1, X10, X100, X1000, X10K, X1 Meg., — all convenient multiples of 10 with no skips. Has Db scale in red for easy indentification.

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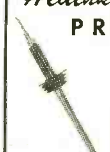

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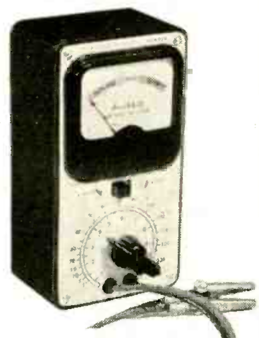
The new Heathkit Battery Tester measures all types of dry batteries between 1½ volts and 150 volts under actual load conditions. Readings are made directly on a three-color GOOD-WEAK-REPLACE scale that your customers can readily understand. Operation is extremely simple and merely requires that the leads be connected to the battery under test. Only one control to adjust in addition to a panel switch for A or B battery types.

The Heathkit Battery Tester features compact assembly. An accurate meter movement and wire wound control mount in the portable, rugged plastic case.

Use the BT-1 to check portable radio batteries, hearing aid batteries, lantern batteries and photo flash gun batteries.



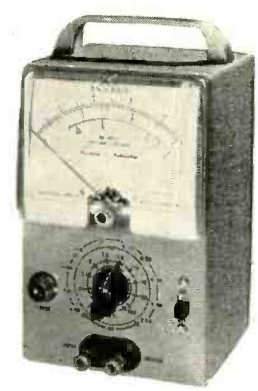
MODEL BT-1

SHIPPING WT. 3 LBS.

$7.50

Heathkit AC VACUUM TUBE VOLTMETER KIT

A new AC VTVM that makes possible those sensitive AC measurements required by laboratories, audio enthusiasts and experimenters. Ten full scale ranges of .01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts RMS. 10 DB ranges from −52 to +52 DB. Frequency response within 1 DB from 20 cycles to 50 kc. Simpson 200 microampere meter with large plainly marked meter scales. Precision multiplier resistors. Two amplifier stages using miniature tubes. A unique bridge rectifier meter circuit and a clean layout of parts. Order the AV-2 today and become acquainted with the interesting possibilities offered by this instrument.



MODEL AV-2

SHIPPING WT. 5 LBS.

$29.50

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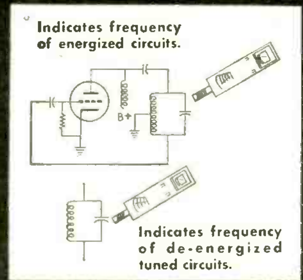
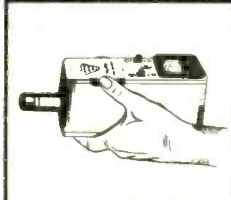
NEW *Heathkit* GRID DIP METER KIT

• CONVENIENT ONE HAND OPERATION.





Complete unit easily held and operated with one hand.

MODEL GD-1

SHIPPING WT. 4 LBS.

$19.50

- New GRID DIP METER with assembled calibrated coils.
- Uses quality Simpson 500 microampere meter.
- One hand operation, extremely compact. Only 2½" wide by 3" high by 7" long.
- Variable meter sensitivity control.
- Uses newest type 6AF4 high frequency triode in a Colpitts oscillator circuit.
- Continuous coverage from 2 megacycles to over 250 megacycles in 6 ranges.
- Head phone monitoring jack.
- AC power transformer operated for maximum safety.

Here is the GRID DIP METER KIT you have been asking for. This new HEATHKIT instrument is compact, highly sensitive and easy to use. Housed in a handsome formed aluminum cabinet—rounded corners—durable oven baked finish on panel and cabinet. The entire instrument can be easily held and operated in one hand, tuning accomplished with the thumb wheel drive. This excellent design feature leaves the other hand entirely free for making circuit adjustments. The instrument with many applications — with oscillator energized, use it for finding the resonant frequency of tuned circuits, locating parasitics, determining characteristics of filter circuits, roughly tuning transmitter stages with power off, and neutralizing transmitters. Useful in TV and radio repair work for alignment of traps, filters, IF stages, peaking and compensation networks within the 2 to 250 megacycle range. With the oscillator not energized, the instrument acts as an absorption wave meter and indicates the frequency of radiating power sources. Locates spurious oscillations, as a relative indication of power in various transmitter stages, etc. Phone jack permits monitoring of AM transmitter for determination of radiated hum, audio quality, etc. (Head phones not included). Complete kit includes plug-in coils, tube, all necessary parts and detailed assembly and instruction manual.

Heathkit IMPEDANCE BRIDGE KIT

MODEL IB-1B

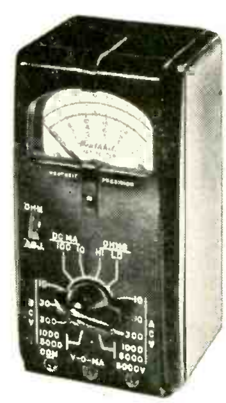
SHIPPING WT. 15 LBS.

$69.50

The HEATHKIT IMPEDANCE BRIDGE is especially useful in educational training programs, industrial laboratories and for experimental work. Use it for measuring AC and DC resistance value of resistors, determination of condenser capacitance and dissipation factor, finding coil inductance and storage factor, electrical measurements work, etc. Quality components: GR 1000 cycle hummer, GR main control, Mallory ceramic wafer silver plated contact switches, ½% precision resistors, etc. The basic circuit is a self powered, 4 arm bridge. Choice of Wheatstone, Capacitance comparison, Maxwell or Hay bridge circuits. Resistance from 10 milliohm to 10 megohm. Capacitance 10 mmf to 100 mfd. Inductance 10 microhenry to 100 henries. Dissipation factor .002 to 1. Storage factor (Q) 1 to 1000. The IMPEDANCE BRIDGE has provisions for external generator use for measurement at other than the 1000 cycle level. Take the guess work out of electrical measurements. The HEATHKIT IMPEDANCE BRIDGE mounted in a beautiful polished birch cabinet with large easy reading panel calibrations will furnish years of accurate, trouble free measurement service.

Heathkit HANDITESTER KIT

The HEATHKIT Model M-1 HANDITESTER fulfills requirements for a portable volt ohm milliammeter. This kit features precision 1% resistors, 3 deck switch for trouble free mounting of parts, specially designed battery bracket, smooth acting ohms adjust control, beautiful molded bakelite case and a 400 microampere meter movement. 5 convenient AC and DC voltage ranges as follows: 10 - 30 - 300 - 1000 - 5000 volts. Ohms ranges 0 - 3000 and 0 - 300,000. DC milliampere ranges 0 - 10 milliamperes and 0 - 100 milliamperes. The instrument is easily assembled from complete instructions and pictorial diagrams. Test leads are included. Carry the HEATHKIT M-1 HANDITESTER in your tool box at all times for those simple jobs and eliminate that extra trip for additional testing equipment.



MODEL M-1

SHIPPING WT. 3 LBS.

$13.50

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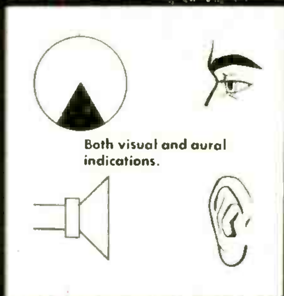
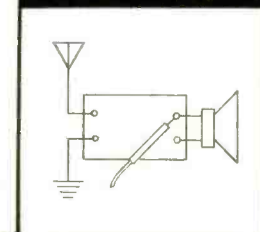
NEW *Heathkit* VISUAL-AURAL SIGNAL TRACER KIT

• NEW NOISE LOCATOR AND WATTMETER CIRCUITS.




Traces signals from antenna clear through speaker.

MODEL T-3

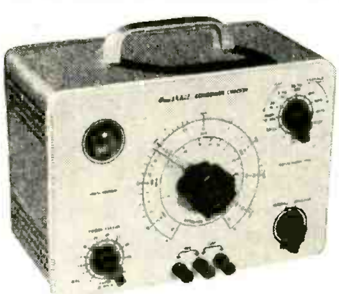
SHIPPING WT. 8 LBS.

$22.50

- Permits visual signal observation as well as aural operation.
- Two separate input channels.
- Tremendous RF channel sensitivity. Adequate for actual signal detection at receiver input.
- Separate high gain RF and low gain audio channels.
- A unique and useful noise locater circuit.
- Built-in calibrated wattmeter.
- Two separate shielded probes for RF and audio application.
- Additional test leads supplied.
- Substitution test speaker and output transformer eliminates necessity for speaker removal in service work.
- Utility amplifier. Check record changers, tuners, microphones, instrument pickups, etc.
- VTVM and Scope panel terminals.
- 5 tube transformer operated circuit.

The new HEATHKIT VISUAL AURAL SIGNAL TRACER represents one of the most convenient and useful instruments the service man can use in AM, FM and TV service work. The electron ray beam indicator constantly monitors both input channels for visual observation of the signal. Now, see and hear the signal level for easier estimation of signal strength and gain per stage in a receiver circuit. Separate high gain channel and special shielded demodulator probe for RF circuit work. Low gain channel for audio circuit investigation and for use as a noise locater. In this feature, approximately 200 volts DC is applied to a suspected circuit component and the action of the voltage in the component can be seen and heard to determine satisfactory operation. This feature alone will prove tremendously helpful in locating the source of objectionable noises in coils, transformers, resistors, condensers, cold solder joints, controls, etc. A convenient wattmeter permits rapid preliminary check for voltage distribution circuit breakdown as well as transformer failures. Use the T-3 as a universal test speaker and substitution transformer and save service time by eliminating the necessity for speaker removal on every service call. Additional service uses are: as a utility amplifier for checking the output of record changers, tuners, microphones, instrument pickups, etc. Separate panel terminals permit utilization of other shop equipment such as your Oscilloscope or VTVM. Entire kit supplied complete with 5 tubes, all necessary construction material along with a detailed step by step instruction manual for the assembly and operation of the instrument.

NEW *Heathkit* CONDENSER CHECKER KIT



MODEL C-3

SHIPPING WT. 7 LBS.

$19.50

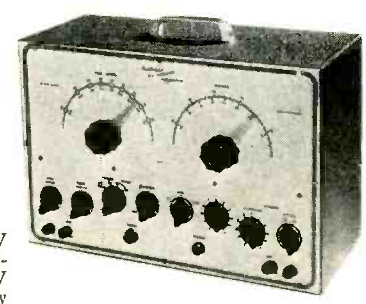
Announcing the new improved Model C-3 HEATHKIT CONDENSER housed in a new smartly styled professional appearing cabinet featuring rounded corners and snug fitting drawn panel. Adequate provisions for ventilation insures longer instrument life through cooler operation. Use the C-3 to accurately measure those unknown condenser and resistor values. All readings of condensers and resistors are read directly on the calibrated scales. Range of condenser measurements is from .00001 mfd to 1000 mfd. Calibrated resistance measurements can be made from 100 ohms to 5 megohms. A leakage test with a choice of 5 DC polarizing voltages will quickly indicate condenser operating quality under actual voltage load conditions. The spring return leakage test switch automatically discharges the condenser under test and eliminates shock hazard. An electron ray beam indicator tube is used in a new leakage test circuit for added sensitivity. The instrument is transformer operated for safety and will prove an extremely welcome addition to your shop equipment. The kit is furnished complete with all necessary parts, test leads and includes a step by step detailed construction manual for assembly and operation.

Heathkit TV ALIGNMENT GENERATOR KIT

MODEL TS-2

SHIPPING WT. 20 LBS.

$39.50



Here is an excellent TV ALIGNMENT GENERATOR designed to do TV service work quickly, easily and properly. The Model TS-2 when used in conjunction with an Oscilloscope provides a means of correctly aligning TV receivers. The instrument furnishes a frequency modulated signal covering in 2 bands the range of 10 to 90 megacycles and 150 to 230 megacycles. An absorption type frequency marker covers from 20 to 75 megacycles in 2 ranges: therefore you have a simple, convenient means of checking IF's independent of oscillator calibration. Sweep width is variable from 0 to 12 megacycles. Other excellent features are horizontal sweep voltage controlled with a phasing control — both step and continuously variable attentuation for setting the output signal to the desired level — a convenient stand by switch — and blanking for establishing a single trace with a base reference level. Make your work easier, save time and repair with confidence. Order your HEATHKIT TV ALIGNMENT GENERATOR now.

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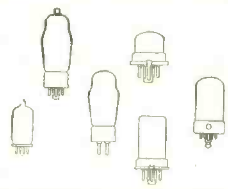
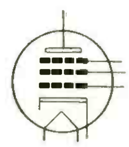
Heathkit TUBE CHECKER KIT



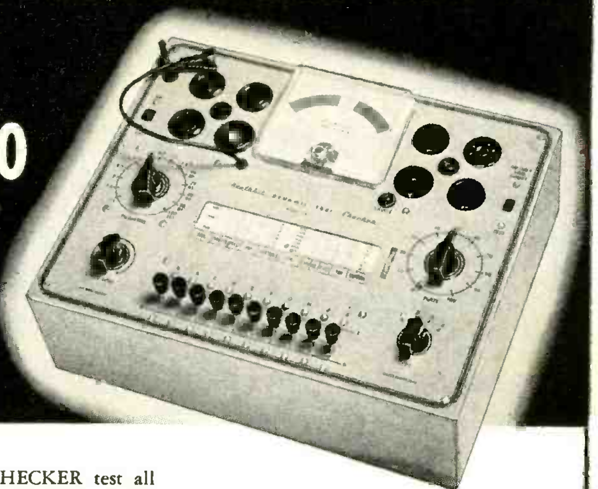
Checks 7, 8, 9 prong tubes, octals, loctals, 7 and 9 prong miniatures, 5 prong Hytrons, pilot lights.



Checks for opens, shorts, emission, filament and filament top continuity.

MODEL TC-1
SHIPPING
WT. 12 LBS.

$29.50



- Beautiful counter type birch cabinet.
- 4½" Simpson 3 color meter.
- Simplified setup procedure.
- Built-in gear driven roll chart.
- Checks emission, shorted elements, open elements and continuity.
- Complete protection against obsolescence.
- Sockets for every modern tube.
- Blank for new types.
- Individual element switches.
- Contact type pilot light test socket.
- Line adjust control.

PORTABLE TUBE CHECKER KIT MODEL TC-1P

Same as TC-1 except supplied with polished birch cabinet (with removable lid) instead of counter type cabinet. Shipping weight 14 lbs. **$34.50**

No. 365 Polished Birch Tube Checker Cabinet only. Shipping Weight 7 lbs. **$7.50**

With the HEATHKIT TC-1 TUBE CHECKER test all types of tubes commonly encountered in AM-FM and TV receiver circuits. Test setup procedure is simplified, rapid and flexible. Tube quality is read directly on a beautiful 4½" Simpson three color BAD - ? - GOOD scale that your customers can readily understand. Panel sockets accommodate 4, 5, 6 and 7 prong tubes, octals, loctals, 7 and 9 prong miniatures, 5 prong Hytrons, a blank socket for new tubes and a contact type socket for quick checking of pilot lights. Built-in gear driven roll chart for instant reference. Neon short indicator, individual three position lever switch for each tube element, spring return test switch, line set control to compensate for supply voltage variations. At this low price, no service man need be without the advantages offered by the HEATHKIT TUBE CHECKER.

Heathkit TV PICTURE TUBE TEST ADAPTER

Use your HEATHKIT TUBE CHECKER with this new TV TEST ADAPTER to determine picture tube quality. Check for emission and shorts, independent of TV power supply. Consists of standard 12 pin TV tube socket, 4 feet of cable, octal socket connector and data sheet. Quickly prove TV picture tube condition to yourself and your customer.

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

Heathkit RESISTANCE SUBSTITUTION BOX KIT

MODEL RS-1
SHIPPING
WT. 3 LBS.

$5.50

NEW HEATHKIT RESISTANCE SUBSTITUTION BOX KIT provides switch selection of any single one of 36 RTMA 1 watt 10% standard value resistors, ranging from 15 ohms to 10 megohms. This coverage available in 2 ranges in decades of 15, 22, 33, 47, 68 and 100. Housed in rugged plastic cabinet featuring new HEATHKIT universal type binding posts. The entire kit priced less than the retail value of the resistors alone.

Heathkit BATTERY ELIMINATOR KIT

A clean 6 volt d-c supply source is definitely required for successful automobile radio servicing. Has a continuously variable d-c output from 0 to 8 volts. It can be safely operated at a steady 10 ampere level and will deliver up to 15 amperes for intermittent periods. The voltage output terminals are completely isolated from the chassis to accommodate additional service applications such as supplying bias voltages or d-c substitution voltages for battery operated tube filament circuits.

The output of the Battery Eliminator is constantly monitored by a d-c voltmeter and a d-c ammeter. The circuit features an automatic overload relay of self resetting type. For additional protection, a panel mounting fuse is provided. Build this kit in a few hours and pocket a substantial savings.

MODEL BE-3
SHIPPING
WT. 20 LBS.

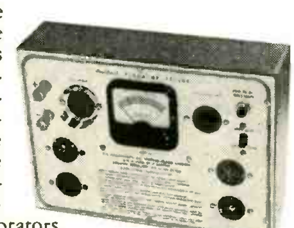
$24.50

Heathkit VIBRATOR TESTER KIT

Repair time is valuable, and the Heathkit Vibrator Tester will save you hours of work. Instantly tells the condition of the vibrator under test — and the check is thorough and complete. Checks vibrator for proper starting, and the easy-to-read meter indicates the quality of output on large BAD-GOOD scales. Tests both interrupter and selfrectifier types of vibrators. Five different sockets for checking hundreds of vibrators.

Operates from any battery eliminator capable of delivering continuously variable voltage from 4 - 6V at 4 amps. The Heathkit BE-3 Battery Eliminator is ideal for operating this kit.

Faulty vibrators can be spotted within seconds and you're free to go on to other service jobs.



MODEL VT-1
SHIPPING
WT. 7 LBS.

$14.50

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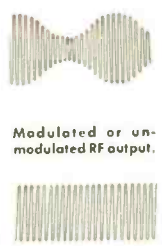
Heathkit SIGNAL GENERATOR KIT



MODEL SG-7

SHIPPING WT. 7 LBS.

$19.50

- Step attenuated RF ouput.
- 6 to 1 vernier dial ratio.
- Turret mounted coil subassembly.
- Pre-calibrated and adjusted coils.
- Hartley RF oscillator circuit.
- Colpitts oscillator 400 cycle sine wave output.
- Modulated or unmodulated RF output.
- Frequency coverage on fundamentals 160 kc to 50 megacycles in five ranges. 51 megacycles to 150 megacycles on calibrated harmonics.
- RF output in excess of 100,000 microvolts.
- Audio output 1½ to 2 volts.
- AC transformer operated.
- Professionally styled cabinet.
- Infra red baked enamel panel.

The new HEATHKIT Model SG-7 SIGNAL GENERATOR easily fulfills requirements for a controllable, modulated or unmodulated source of variable frequency. A convenient 400 cycle sine wave output is available for audio work. All RF oscillator coils are precision wound and adjusted to calibration before shipment thereby assuring maximum accuracy. The coils, band switch and tuning condenser all mount as a turret assembly so as to offer the advantage of short wiring leads and easy mounting of parts. The RF output circuit is of the low impedance type obtained by the use of cathode coupling to the output jacks. The level of RF output is varied by means of the RF step and RF output control. Use the HEATHKIT SG-7 as an RF signal source modulated or unmodulated for radio repair, laboratory work, experimental testing, 400 cycle sine wave audio testing, checking RF stages, alignment of both AM and FM IF stages, marker generator for TV alignment, etc. The kit is transformer operated and utilizes miniature tubes for ease in handling high frequency. Panel jacks and a convenient switching system permit either external or internal modulation. The entire kit is supplied complete with tubes and all necessary material as well as a detailed step by step instruction manual for the assembly and operation of the instrument.

Heathkit INTERMODULATION ANALYZER KIT

MODEL IM-1

SHIPPING WT. 18 LBS.

$39.50

The HEATHKIT MODEL IM-1 is an extremely versatile instrument specifically designed for measuring the degree of interaction between two signals caused by a specific piece of apparatus, or a chain of equipment. It is primarily intended for tests of audio equipment but may be used in other applications such as making tests of microphones, records, recording equipment, phonograph pickups and loud speakers. Use it for checking tape or disc recordings, as a sensitive AC voltmeter. as a high pass noise meter for adjusting tape bias, cutting needle pitch or other applications. High and low test frequency source. intermodulation section, power supply and AC voltmeter all in one complete unit. Percent intermodulation is directly read on three calibrated ranges, 30%, 10% and 3% full scale. Both 4 to 1 and 1 to 1 ratios of low to high frequencies easily set up. At this low kit price YOU can enjoy the benefits of Intermodulation analysis for accurate audio interpretations.

Heathkit LABORATORY REGULATED POWER SUPPLY KIT

MODEL PS-2

SHIPPING WT. 20 LBS.

$29.50

New HEATHKIT LABORATORY POWER SUPPLY provides continuously variable regulated DC voltage output from 160 volts to 400 volts depending on load. Panel terminals supply separate 6.3 V. AC supply at 4 amperes for filament circuits. A 3½" plastic cased panel mounted meter provides accurate metered output for either voltage of current measurements. Exceptionally low ripple content of .012% admirably qualifies the HEATHKIT LABORATORY POWER SUPPLY for high gain audio applications. Ideal for laboratory work requiring a reference voltage for meter calibration or for plotting tube characteristics. In service work, it can be used as a separate variable voltage supply to determine the desirable operating voltage in a specific circuit. Use it as a DC substitution voltage in trouble shooting TV circuits exhibiting symptoms of extraneous undesirable components in plate supply circuits. Entire kit, including all 5 tubes now available at this low price.

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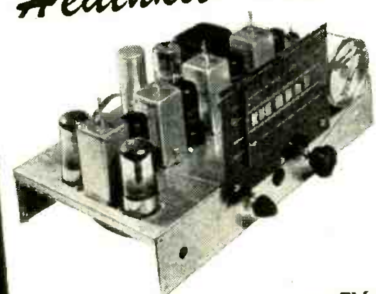
Heathkit WILLIAMSON TYPE AMPLIFIER KIT

The new HEATHKIT WILLIAMSON TYPE AMPLIFIER incorporates the latest improvements described in Audio Engineering's "Gilding the Lily." 5881 output tubes and a new Peerless output transformer with additional primary taps afford peak power output of well over 20 watts. Frequency response ±1 db from 10 cycles to 100 kc. allows reproduction of highs and lows with equal crispness and clarity. Harmonic and intermodulation distortion have been reduced to less than ½ of 1% at 5 watts. This eliminates the harsh unpleasant qualities which contribute to listening fatigue. Make this amplifier the heart of your radio system to achieve the fine reproduction that is the goal of all music lovers.

The HEATHKIT PREAMPLIFIER (available separately or in combination with the amplifier kit) features inputs for magnetic or low level cartridges, crystal pickups and tuners, turnover control for LP or 78 type records, individual bass and treble tone controls each providing up to 15 DB of boost or attenuation. Special notched shafts on preamplifier controls and switches adaptable to custom installation. The preamplifier can be mounted in any position and a liberal length of connecting cable is supplied. No radio experience is required to construct this amplifier. All punching, forming, or drilling has already been done. The complete kit includes all necessary parts as well as a detailed step by step construction manual with pictorial diagrams to greatly simplify the construction.

ACROSOUND TRANSFORMER OPTION. If desired, the output transformer with the kit will be the Acrosound output transformer, type TO-300. The use of this transformer permits ultra-linear operation as described in Audio Engineering's "Ultra-Linear Operation of the Williamson Amplifier."

Heathkit FM TUNER KIT



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

The HEATHKIT MODEL FM-2 TUNER specifically designed for simplified kit construction features a preassembled and adjusted tuning unit. Three double tuned IF transformers and a discriminator transformer are used in an 8 tube circuit. Smooth tuning is obtained through a 9 to 1 ratio vernier drive using a calibrated six inch slide rule type dial. The usual frequency coverage of 88 to 108 megacycles is provided. Experience the thrill of building your own FM tuner. Operate it through your amplifier or radio and enjoy all the advantages of true FM reception. Transformer operated power supply to simplify connections to all types of audio systems. The kit is supplied complete with all 8 tubes and necessary material required for construction. A complete instruction manual simplifies assembly and operation.

PRICES OF VARIOUS COMBINATIONS

W-2 Amplifier Kit (Incl. Main Amplifier with Peerless Output Transformer, Power Supply and WA-P1 Preamplifier Kit) Shipping Weight 39 lbs.	$69.50
W-2M Amplifier Kit (Incl. Main Amplifier with Peerless Output Transformer and Power Supply) Shipping Weight 29 lbs. Shipped express only	$49.75
W-3 Amplifier Kit (Incl. Main Amplifier with Acrosound Output Transformer, Power Supply and WA-P1 Preamplifier Kit) Shipping Weight 39 lbs. Shipped express only	$69.50
W-3M Amplifier Kit (Incl. Main Amplifier with Acrosound Output Transformer and Power Supply) Shipping Weight 29 lbs. Shipped express only	$49.75
WA-P1 Preamplifier Kit only. Shipping Weight 7 lbs. Shipped express or parcel post.	$19.75

Heathkit ECONOMY 6 WATT AMPLIFIER KIT

MODEL A-7
SHIPPING WT. 10 LBS.
$14.50

The HEATHKIT Model A-7 amplifier features beam power, push pull output with frequency response flat ±1½DB from 20 to 20,000 cycles. Separate volume, bass and treble controls. Two input circuits, output impedances of 4, 8, and 15 ohms. Peak power output rated at full 6 watts. High quality components, simplified layout, attractive gray finished chassis, break off type adjustable length control shafts and attractive lettered control panel.

THE MODEL A7A amplifier incorporates a preamplifier stage with special compensated network to provide the necessary voltage gain for operation with variable reluctance or low output level phono cartridges. Excellent gain for microphone operation in a moderate powered sound system.................... **$16.50**

Heathkit HIGH FIDELITY 20 WATT AMPLIFIER KIT

The HEATHKIT MODEL A-8 amplifier kit was designed to deliver high fidelity performance with adequate power output at moderate cost. The frequency response is within ± 1 DB from 20 to 20,000 cycles. Distortion at 3 DB below maximum power output at 1000 cycles is only .8%. The amplifier features a Chicago power transformer in a drawn steel case and a Peerless output transformer with output impedances of 4, 8, and 16 ohms available. Separate bass and treble tone controls permit wide range of tonal adjustment to meet the requirements of the most discerning listener. The amplifier uses a 6SJ7 voltage amplifier, a 6SN7 amplifier and phase splitter and two 6L6's in push pull output and a 5U4G rectifier. Two input jacks for either crystal or tuner operation. The kit includes all necessary material as well as a detailed step by step construction manual.

MODEL A-8
SHIPPING WT. 19 LBS.
$33.50

MODEL A8-A features an added 6SJ7 stage (preamplifier) for operating from a variable reluctance cartridge or other low output level phono pickups. Can also be used with a microphone. A 3 position panel switch affords the desired input service. **$35.50**

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TEST TECHNIQUES FOR TRANSISTORS

The experimenter is in a helpless position when it comes to checking his transistors. This article gives him needed information.

By RUFUS P. TURNER

IN a vacuum tube, there is no physical connection, as such, between the grid and plate. In a transistor, on the other hand, a definite amount of resistance appears between the emitter and collector. The transistor in a grounded-base circuit may be considered as a 3-terminal resistance network having direct and transfer resistances. Output changes in the transistor affect the input.

Because of the differences between tubes and transistors, common tube-testing techniques are not always applicable or adequate for checking transistors. In checking transistors, attention often must be paid to the values of input, output, and transfer resistances.

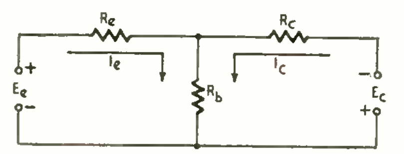

Fig. 1—Transistor equivalent circuit.

Measuring resistances

Fig. 1 shows the equivalent 3-terminal resistance network of a transistor when the unit is connected in a ground-base circuit. (E, I, and R represent voltage, current, and resistance. Subscript letters $_b$, $_c$, and $_e$ refer to base, collector, and emitter, respectively.) Polarities of emitter voltage E_e and collector voltage E_c are shown in this illustration for the point-contact transistor. The opposite polarities are employed with junction-type transistors.

Resistance R_e represents the emitter resistance, R_c the collector resistance, and R_b the base resistance. The input resistance of the transistor is equal to $R_e + R_b$ and lies between 150 and 1,000 ohms in commercial point-contact transistors. The output resistance is equal to $R_c + R_b$ and is between 10,000 ohms and 1 megohm or more in commercial point-contact types.

Four distinct resistances should be checked in a d.c. test of transistor characteristics. We will designate these as R_1, R_2, R_3, and R_4. These resistances have definite relationships to R_b, R_c, R_e, and *transfer resistance* R_m. Since transistor resistance values are never measured with a bridge or ohmmeter—to do so would probably seriously damage the transistor—we calculate the resistance values from measured voltages and currents.

The table lists R_1 to R_4 showing the transistor resistance values to which these parameters correspond and the voltage and current characteristics which determine their values. It is important to note that either the input or output circuit is open in each of the resistance measurements.

Fig. 2 shows four circuits for measuring transistor voltages and currents for calculating the values of R_1, R_2, R_3, and R_4. Operation of each of these circuits is discussed separately in the following paragraphs.

Resistance R_1. See Fig. 2-a. This meas-

TRANSISTOR TEST RESISTANCES

$R_1 = R_e + R_b = \dfrac{E_e}{I_e}$	Measured with output circuit open.
$R_2 = R_b = \dfrac{E_e}{I_c}$	Measured with input circuit open.
$R_3 = R_b + R_m = \dfrac{E_c}{I_e}$	Measured with output circuit open.
$R_4 = R_c + R_b = \dfrac{E_c}{I_c}$	Measured with input circuit open.


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urement is made with the transistor output circuit open. Starting from zero, increase the d.c. voltage until emitter current I_e, indicated by the d.c. milliammeter, corresponds to the maximum value specified by the transistor manufacturer for grounded-base operation. The high-resistance d.c. vacuum-tube voltmeter then reads the emitter voltage E_e. The value of R_1 is calculated from the emitter current (in amperes) and the emitter voltage: $R_1 = E_e/I_e$.

Resistance R_2. See Fig. 2-b. Standard test procedure requires that this measurement be made with the transistor input circuit open. By using a *high-*

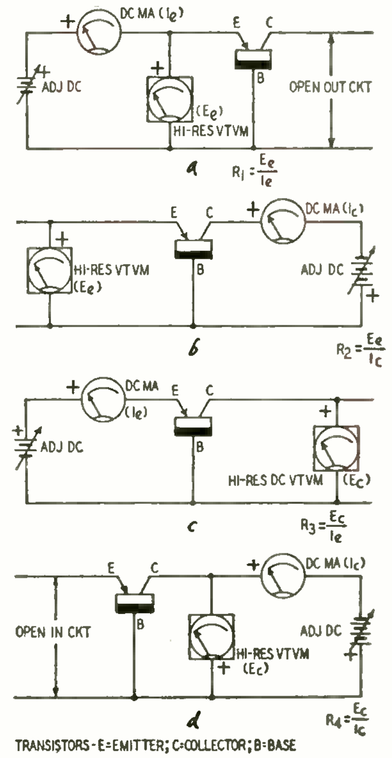

Fig. 2—Connections for the various measurements described in the text.

resistance d.c. vacuum-tube voltmeter to measure E_e, the equivalent of an open input circuit is obtained. For the highest resistance, it is advisable to use a meter which has no input resistors at all (such as General Radio type 1800-A) if such an instrument is available.

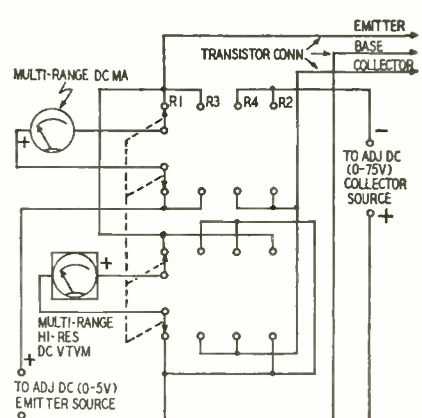

Fig. 3—A quick and efficient set-up for making the tests indicated in Fig. 2.


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Starting from zero, increase the voltage until I_c, (indicated by the milliammeter) corresponds to the maximum value specified by the transistor manufacturer for grounded-base operation. The v.t.v.m. then indicates emitter voltage E_e. The value of R_2 is calculated from the equation $R_2 = E_e/I_c$, where I_c is in amperes.

Resistance R_3. See Fig. 2-c. This measurement is made with the transistor output circuit open. As in measuring R_2, a high-resistance d.c. v.t.v.m. keeps the output circuit resistance high enough to simulate an open circuit while measuring collector voltage E_c.

Starting from zero, increase E_e until the milliammeter indicates an emitter current, I_e, corresponding to the maximum value specified by the manufacturer for grounded-base operation. The d.c. v.t.v.m. then indicates the resulting collector voltage, E_c. R_3 is calculated from the emitter current (in amperes) and the collector voltage: $R_3 = E_c/I_e$.

Resistance R_4 is measured using the setup in Fig. 2-d. This test is made with the input circuit open. Starting from zero, increase the voltage until I_c corresponds to the maximum value specified by the transistor manufacturer for grounded-base operation. The d.c. vacuum-tube voltmeter then indicates the collector voltage, E_c. $R_4 = E_c/I_c$.

The following values are specified for the Raytheon point-contact transistor

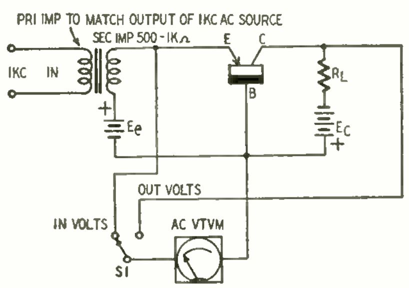


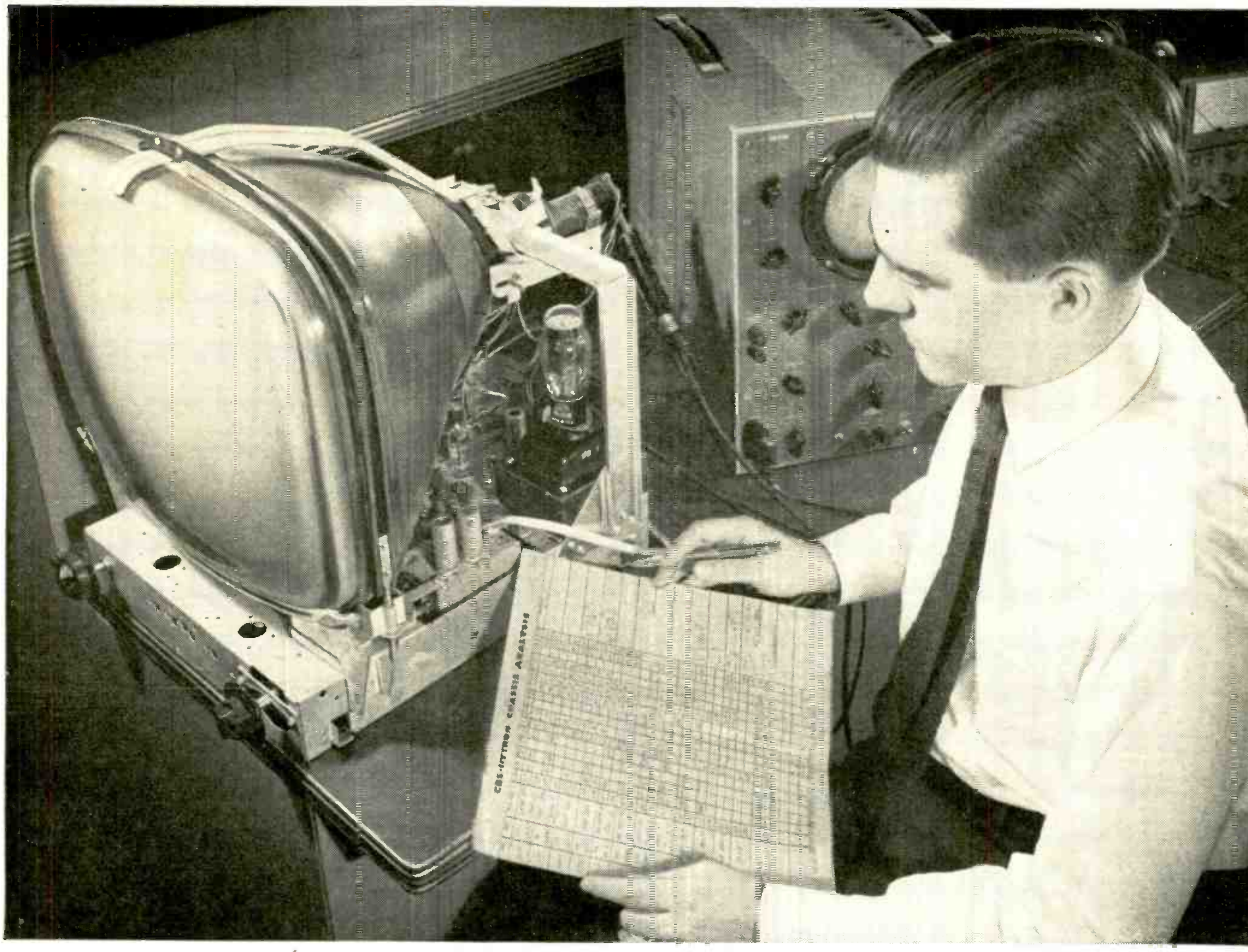
Fig. 4—Circuit for directly checking the voltage amplification of transistors.

type CK716: $R_1 = 150$ to 450 ohms, $R_2 = 25$ to 140 ohms, $R_3 = 15{,}000$ to 70,000 ohms, and $R_4 = 10{,}000$ to 40,000 ohms.

Practical d.c. tester

Fig. 3 shows a practical arrangement for quickly setting up the test circuits shown in Fig. 2 for transistor resistance measurements.

The 4-pole, 4-position rotary selector switch switches the d.c. milliammeter and v.t.v.m to the proper transistor electrodes, and shifts the polarity of the instruments and opens the input or output circuit of the transistor to correspond with the circuits in Fig. 2. Rotating the selector switch through positions R_1, R_2, R_3, and R_4 automatically sets up the test circuits in Figs. 2-a, 2-b, 2-c, and 2-d, respectively. Meter and power-supply polarities are shown for point-contact transistors. Reverse both meter and power supply polarities when checking N-P-N junction transistors. The switching circuit, meters, and power supplies might be combined into a single, self-contained transistor d.c. tester



somewhat similar in function and operation to a laboratory tube tester.

Current amplification

The *current amplification figure*, designated by α, the Greek letter *alpha*, is an important property of the transistor. It may be determined in two ways. One way is in terms of the resistance values measured according to the instructions in the preceding paragraphs: $\alpha = R_3/R_4$. The other involves setting up the transistor with rated d.c. emitter and collector voltages for grounded-base operation, and with separate milliammeters for the simultaneous reading of emitter and collector currents. The static values of I_e and I_c are recorded. Then, without changing the collector voltage E_c, shift the emitter current a small amount (dI_e) and observe the resulting shift (dI_c) in collector current. Current amplification, alpha, may be calculated from these readings: $\alpha = dI_c/dI_e$.

A minimum current gain α of 1.2 is specified for the CK716 transistor.

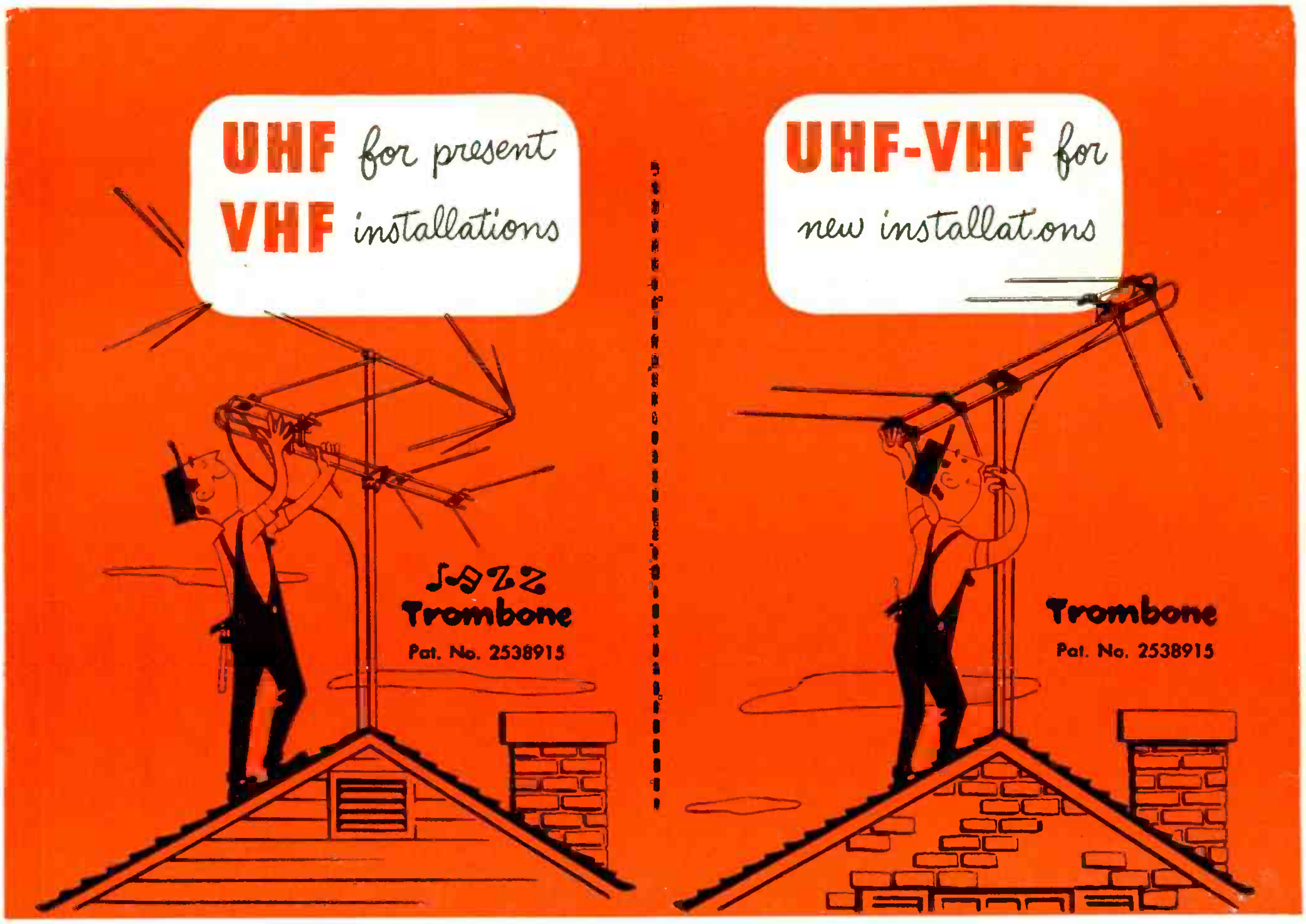
A.c. voltage gain

In some instances, it will be important to check directly the performance of the transistor with an a.c. input signal. The circuit shown in Fig. 4 may be used to measure a.c. voltage amplification. A test-signal frequency of 1,000 cycles is recommended. E_e and E_c are adjusted to give the emitter and collector currents, respectively, (in the absence of a.c. signal input) specified by the transistor manufacturer for grounded-base operation. Load resistance R_L should be not less than the specified output impedance or the measured R_4 value of the transistor under test. In most instances, the a.c. input signal (E_1) between emitter and base should not exceed 0.1 volt r.m.s.

When switch S1 is thrown to INPUT VOLTS, the a.c. v.t.v.m. reads the input signal voltage. When S1 is thrown to OUTPUT VOLTS, the meter reads the output signal voltage (E_2). The a.c. voltage gain is equal to E_2/E_1. The voltage gain in decibels is equal to 20 $\log_{10} E_2/E_1$.

In the test circuit similar to the one shown in Fig. 4, the CK716 point-contact transistor gives a voltage gain of 50 at 1,000 cycles when E_e is 0.25 volt, E_c is 67½ volts, R_L is 4,000 ohms, and $E_1 = 0.1$ volt. END

Suggested by E. Bruno, Brooklyn, N. Y.



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A DETECTOR-AMPLIFIER WITH GERMANIUM DIODES

By IRVING GOTTLIEB

GERMANIUM diodes can be used as simultaneous detectors and amplifiers. Fig. 1 is the circuit of such a simple detector-amplifier. It will be recognized as the familiar half-wave voltage quadrupler often used for transformerless voltage multiplication at power-line frequency.

The time constant of the R-C elements is made high with respect to the radio frequency, but low compared to audio frequencies. The r.f. is therefore rectified and filtered out, and the audio modulation appears across the output terminals.

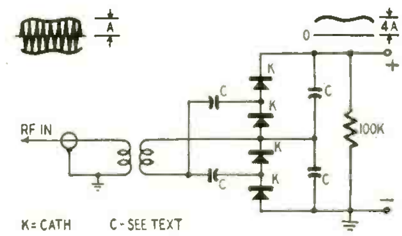

Fig. 1—A simple detector-amplifier, useful in telemetering applications.

The circuit of Fig. 1 is useful for signalling and telemetering applications in which r.f. is available from a coaxial cable. The input impedance of the detector-multiplier is comparable to that of the coax, and a good match can be obtained with closely coupled links made of several turns of wire on a 1-inch diameter form.

Size of the capacitors C will depend on the kind of operation desired. To obtain the modulation at a voltage amplitude nearly four times that on the r.f. carrier, they should be about 250 μμf in all circuits. If it is desired to rectify unmodulated r.f. and step up the resultant d.c. voltage, the capacitors may be 0.1 μf or larger, depending upon the current consumption of the load. Gain is actually about 90% of the theoretical value, due to diode back resistance.

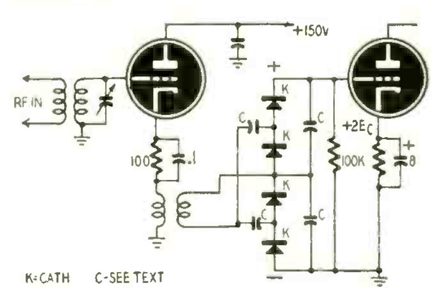

Fig. 2—Circuit with unique features.

In Fig. 2 a detector-amplifier circuit with several unique features is illustrated. It combines the *signal-handling capacity* of the diode detector, the *no-loading of the input circuit* characteristic of the plate detector, the *audio*


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frequency response of direct interstage coupling, and the *voltage boosting* of transformer coupling. This is done by using the r.f. voltage multiplier with a cathode-follower r.f. amplifier. (The low input impedance of the multiplier prevents direct connection to a resonant circuit.)

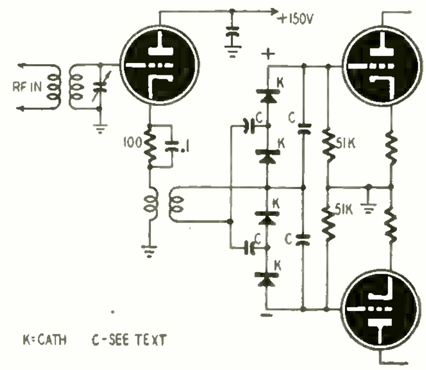

Fig. 3—Push-pull version of Fig. 2.

The audio output amplifier should be operated with a negative grid bias twice that corresponding to the operating point of the same tube in a conventional class-A amplifier with the same plate voltage. This enables Class-A operation over the same grid-voltage swing as the conventional amplifier even though the operating point will be determined by the unmodulated carrier amplitude and will therefore be subject to variation. A strong carrier will shift the operating point down toward zero bias; a weak carrier pushes it toward twice conventional bias voltage. Thus, the grid operating range is between $-2E_c$ and $0E_c$, just as in a conventional class-A amplifier. Over-all voltage gain is about 3.3 ($0.9 \times 0.9 \times 4$).

For push-pull operation of the output audio amplifier, the diode connections are altered as shown in Fig. 3. The gain from the push-pull diode demodulator is only half that of the single-ended circuit, so except for the merits of push-pull amplification, its use is not advantageous.

To obtain a voltage gain of 0.9 or better in the cathode-follower stage, a tube with high transconductance is needed. The 6J4 and the 6Q4 are good tubes for this purpose. The cathode bias resistor is 100 ohms and is bypassed with a 0.1-μf capacitor. The output resistance of the cathode follower is determined by the impedance of the coupling link in the cathode circuit in conjunction with the input impedance of the voltage multiplier. Tight coupling is necessary to make this impedance mainly resistive. The number of turns will depend somewhat upon the radio-frequency range, but is not critical. For intermediate frequencies of several hundred kc, 10 to 20 turns on a 1-inch form will be suitable. For higher frequencies, fewer turns should be used. In any case, a voltage gain of less than 0.9 from the cathode follower indicates the need for more turns.

The crystal diodes may be any of the germanium elements intended for r.f. applications. Best results will be obtained with the 1N54. END

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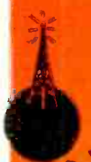

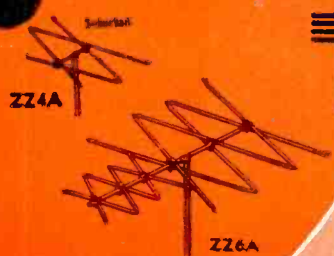

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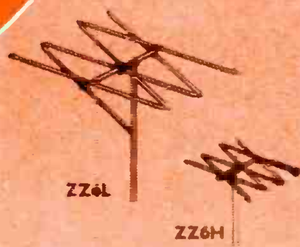

NEAR FRINGE MODELS

For near fringe area reception, the Models ZZ6L and ZZ6H are recommended. Model ZZ6L covers Channels 2 thru 6, Model ZZ6H is for Channels 7 thru 13. Both antennas offer high gain with patterns and front-to-back ratios similar to cut-to-channel yagis.

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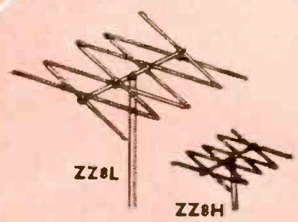

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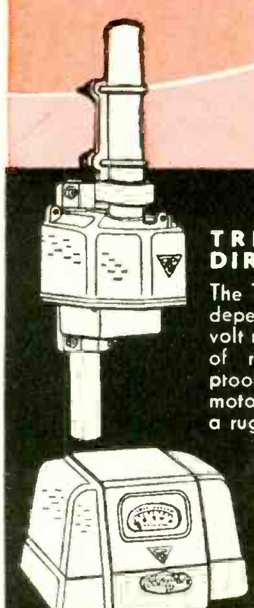

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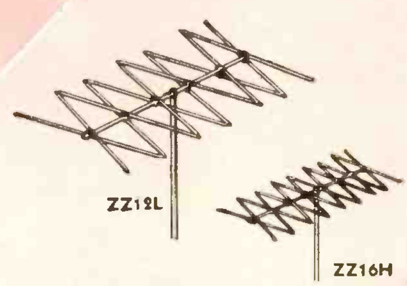

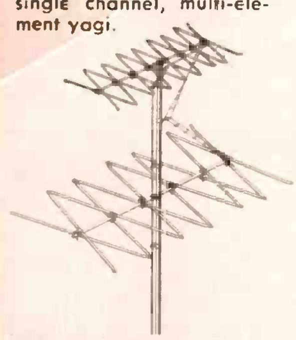

ZZ12L and ZZ16H are stacked for all VHF Channel Reception

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The extremely high gains of the ZZ12L and the ZZ16H models provide unequalled reception in ultra-fringe areas. Model ZZ12L covers Channels 2 thru 6 and Model ZZ16H, Channels 7 thru 13. These two models when stacked, are fed with only one 300 ohm line and provide ALL VHF CHANNEL RECEPTION. Line match is excellent and front-to-back ratios are unusually high.

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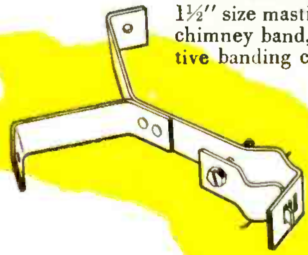

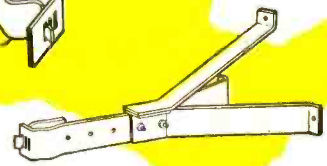

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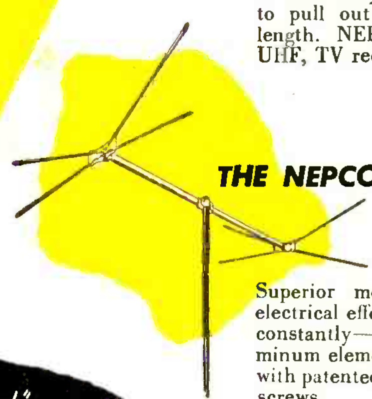

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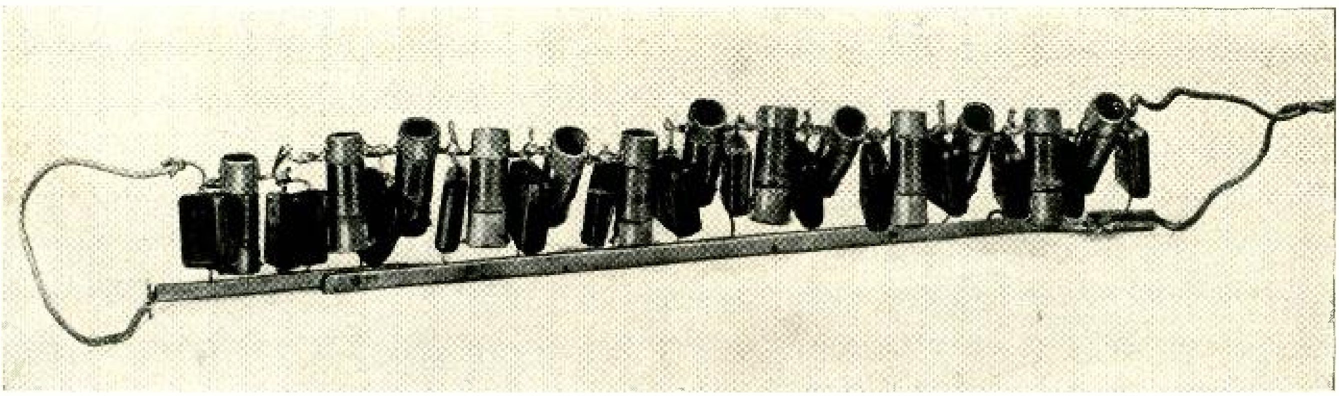
By R. C. PAINE



One way of constructing a multisection delay line. The adjacent coils are mounted at an angle, to reduce coupling.

IN RADAR a distant plane is detected by radio waves reflected from the plane as a radio echo, just as sound waves reflected by a distant cliff create an acoustic echo. The audible echo is produced because the time it takes for the sound to travel out to the cliff and return is perceptible to the human senses. Even the radio echo requires a definite time for the waves to reach the target and return, though this time is measured in microseconds. Radio waves travel through free space at the speed of light—300,000,000 meters per second, or about 984 feet per microsecond. Distance can be determined by measuring the time of arrival of the reflected waves.

The time of travel of waves between points may be referred to as "delay time." For many purposes, such as range measurements in radar and loran, and storing information in calculating devices, circuits which produce definite time delays are required. Theoretically, it would be possible to use radio transmission line for delay circuits, because the speed of radio waves in ordinary transmission cable is less than in free space; but this approach is not very practical, since thousands of feet of line would be required to produce appreciable delay times.

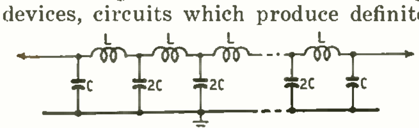


Fig. 1—An artificial transmission line assembled from identical low-pass-filter sections linked end to end. Input and output capacitors are each half the value of the internal capacitance elements.

To avoid the bulk of long transmission-cable delay lines, artificial transmission lines with lumped constants are constructed. Over a limited frequency range, a relatively compact network of coils and capacitors can simulate the distributed series inductance and parallel capacitance of a long transmission line. The more sections such a line has, the more nearly it duplicates the performance of a uniform line.

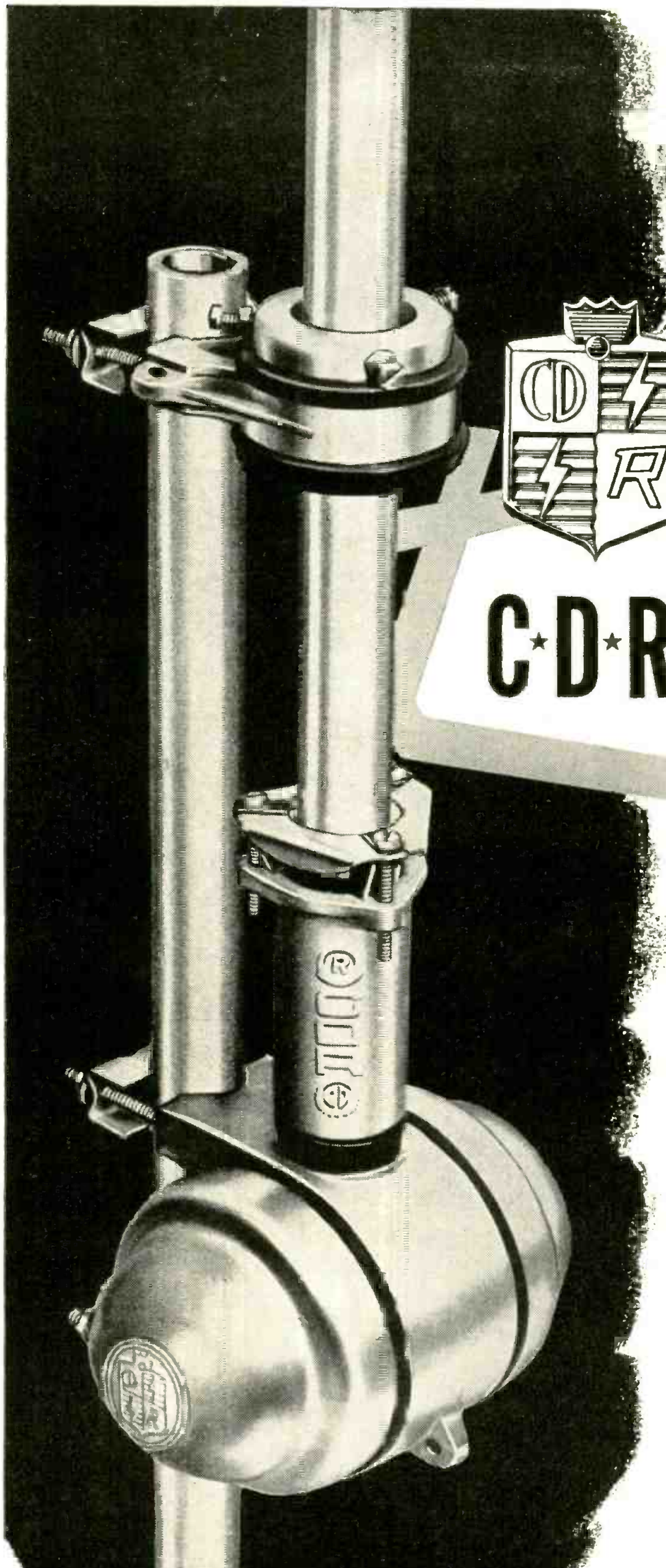
These artificial transmission lines are often used as delay lines to retard electrical impulses for a definite time (measured in microseconds, or millionths of a second) between points in a network. Such lines are used in radar and navigation systems, computing machines, and many other instruments.

The characteristics of a delay line are usually studied with pulse generators and special complex oscilloscopes. An experimental line, however, is easily constructed and its delay characteristics can be observed readily with an ordinary oscilloscope.

A delay line is shown schematically in Fig. 1 as a series of pi sections. The end capacitors have a value C, but the intermediate capacitors combine two parallel C values into a single one.

One such line constructed by the author consists of thirteen sections and is shown above. The coils and capacitors are arranged in line and connected to a common grounding strip. Adjacent coils are tilted right and left at an angle of 45° to minimize coupling between them. The inductances L are wound on paper forms $\frac{7}{16}$ inch in diameter and about $1\frac{1}{4}$ inches long, as shown in Fig. 2. They are wound with about 28 turns of No. 22 enameled wire and have an inductance of 5 microhenries. The end capacitors, C, are nominal .001-μf units selected for an actual value of 925 μμf each. The internal capacitors were selected from .002-μf units for a measured value of 1850 μμf. The line has a characteristic impedance of about 50 ohms. That is, when it is terminated by this value of resistance all the energy that reaches the end of the line is absorbed by the load, and reflected waves are suppressed. This artificial line has a time delay of about 1.15 microseconds.

(CONTINUED ON PAGE 95)



The time required for an impulse to go out *and return as a reflected wave* on this line is 2.3 microseconds. This is equivalent to quarter-wave-line resonance at 435 kilocycles, or half-wave resonance at 870 kilocycles. Resonance on this line can be demonstrated in an interesting manner. It can be driven by an oscillator operating at 870 kc. The line is coupled to the oscillator by a loop of a few turns connected across its input end as shown in Fig. 3. Its far end is short circuited.

Voltage and current ratios

The current distribution due to standing waves is at a minimum in the center of the network, but gradually increases to a maximum as each end is approached. Correspondingly, the voltage across each coil at the center of the network is low, but increases towards the ends of the line. A small flashlight bulb with probe terminals may be used to bridge each coil in succession. Near the center of the network the lamp glows dimly or not at all, but at the ends it lights brightly, and—unless caution is observed—it may even burn out.

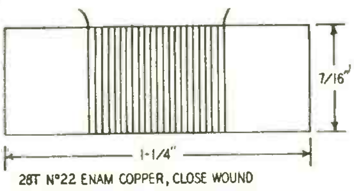


Fig. 2—One of the line-section coils.

To check the reflected waves in a line we feed in a pulse and observe its progress on an oscilloscope. By using the return sweep of the oscilloscope for the initial pulse the two functions are combined and synchronized automatically.

A portion of the sweep circuit of a typical scope is shown in Fig. 4. The input of the delay line is connected through a .001-μf capacitor to the output of the sweep amplifier (a cathode follower in this case) and also to the vertical input terminals of the same scope. With other scopes it may be necessary to connect to different points in the horizontal sweep circuit, but a small capacitor should always be used for coupling. This capacitor, together with the low input impedance of the delay line, differentiates the retrace of the saw-tooth sweep wave and produces a sharp pulse for exciting the line.

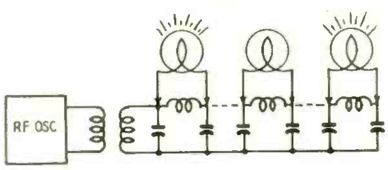


Fig. 3—Checking voltage distribution along the artificial transmission line.

Mismatched Impedances

When the delay line is connected in this manner, its input or "near" end is terminated by the relatively high impedance of the scope input amplifier. Thus, waves reflected from the open-circuited far end are re-reflected from the near end. Successive reflections take place until the energy of the original pulse is dissipated in the resistance of the line.

If the far end of the line is open, or terminated in a *high impedance*, reflected waves are of the same polarity as the incident waves at each end and build up the voltage at each reflection (See "Transmission Lines Simplified," by Hector E. French, in the October, 1952, RADIO-ELECTRONICS). This is shown in the oscilloscope photograph Fig. 5, in which the line is terminated by a 500-ohm resistor. A carbon or "metallized" resistor should be used for the termination because of its negligible inductance. An inductive termination would upset the delay-line constants.

When the far end of the line is terminated by a *low impedance* or short circuit the polarity of the reflected wave is not the same as the incident wave at that end. This results in alternate recurring waves being reversed at the near end. This is shown in Fig. 6, in which the line is terminated in a 10-ohm resistor.

The value of the terminating resistance can be varied until the observed reflections are reduced to minimum. At this point the load is equal to the characteristic impedance of the line, the incident wave is completely absorbed at the far end, and no reflections take place. This is illustrated in Fig. 7, where the 50-ohm terminating resistor is thus shown experimentally to be equal to the characteristic impedance of the line.

Delay time

The delay time of the line can be estimated from the frequency of the oscilloscope sweep and the number of reflections as indicated by the total number of positive or negative peaks in Fig. 5. In this case the peaks (including one on the dim return trace) add up to nine. The frequency of the scope sweep was checked against an audio oscillator and found to be about 48,000 cycles, or 21 microseconds per sweep. This value divided by 9 gives 2.3 microseconds for each complete reflection, or transit in both directions. The observed delay for one way is thus 1.15 microseconds.

Delay lines of different properties can be designed by using the formulas for uniform lines. Thus the characteristic impedance Z_0, in ohms, $= 1{,}000\sqrt{L/C}$, where L is in microhenries and C is in micromicrofarads. The total delay time is equal to the number of sections mul-

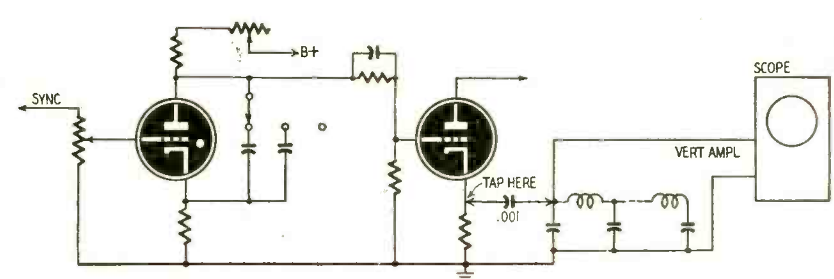


Fig. 4—Using the oscilloscope sweep as a pulse source for checking line characteristics. Reflections are observed and counted on the scope screen for different values of line-terminating resistance.

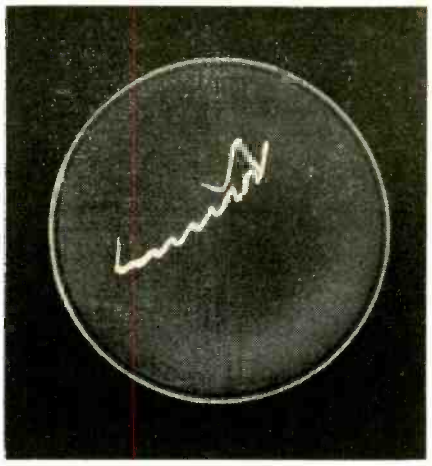


Fig. 5—Reflected signals on an open-ended line are *in phase* with the input, and cause the voltage to rise at the input end with each new reflected wave.

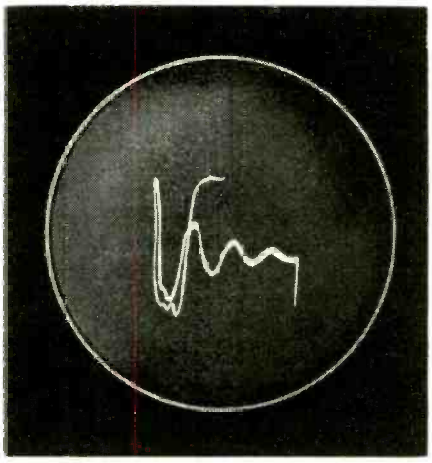


Fig. 6—A line terminated in less than its characteristic impedance creates multiple reflections which are damped out eventually by the line resistance.

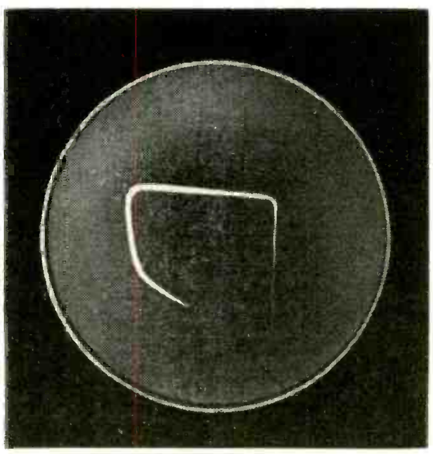


Fig. 7—Perfectly terminated line has no reflections. All energy is dissipated in the load connected across the far end.

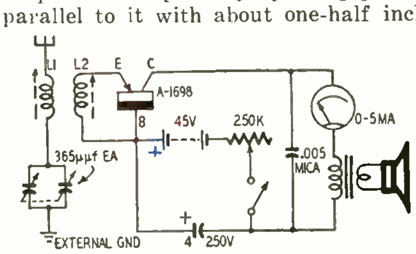
tiplied by $\sqrt{LC}/1{,}000$. These formulas for uniform lines are approximately correct for lumped multisection lines. In the line described above the calculated values are $Z_0 = 1{,}000\sqrt{5}/1{,}850 = 52$ ohms and $t = 13\sqrt{5}(1{,}850)/1{,}000 = 1.25$ microseconds. These calculated values compare favorably with the corresponding experimental values, $Z_0 = 50$ ohms and $t = 1.15$ microseconds. END

TRANSISTOR RECEIVER OPERATES LOUDSPEAKER

By W. H. GRACE, JR.

THE simple circuit shown in the accompanying diagram, was assembled to determine the possibilities of a Western Electric A-1698 transistor as a detector-rectifier at standard broadcasting frequencies. This particular transistor is of the point-contact type and is made in cartridge form to fit the Cinch EXP8672 or equivalent socket. Connections may be soldered directly to the prongs and base of the device, but heat protection on the transistor side of the joint must be provided (as with a pair of flat-nosed pliers.) This requires extreme care, as the transistor can very easily be damaged by too much heat. The A-1698 model was designed to be used in switching circuits, not as a detector-rectifier. However, it functions very well in this capacity too. (A G-E type G11 transistor should also be usable in this circuit and may be easier to obtain commercially.)

The circuit components are self-explanatory to the experienced; a certain amount of elaboration seems appropriate for the tyros. The two inductances which comprise the L1 and L2 circuits are Ferri-Loopstick coils, available in radio supply stores as loop aerial replacements in a.c.-d.c. sets. Remove the short piece of enameled wire attached to one terminal before using. These coils have a very high Q and are inexpensive. The primary circuit is tuned by the series capacitor to ground, using both sections in parallel. The secondary circuit is aperiodic and is coupled to the primary by being placed parallel to it with about one-half inch



Materials for transistor receiver
Capacitors: 1—4-µf, 250-volt, electrolytic; 1—.005 µf mica; 1—2-gang variable receiving capacitor, 365 µµf per section. Other parts: 1—250,000-ohm potentiometer; 1—Western Electric type A-1698 transistor or equivalent; 1—45-volt B-battery, 1—5-ma d.c. milliammeter, Ferri-Loopstick coils as per text, switch, headphones or speaker, wire, etc.

separation between coils. End-to-end coupling may be used with equal effectiveness if desired. Keep coupling as loose as possible for best selectivity compatible with ample volume. All point-contact type transistors appear to give best results with a grounded base type hookup. High impedance phones or output transformer winding will better match the impedance of the collector leg.

Operation of this receiver is conventional in most respects. All tuning is done with the single dial on the 700-μμf variable capacitor shaft with the variable resistance adjusted so that approximately 1 ma of current is flowing in the collector circuit. When a station is tuned in, the meter will indicate a slight rise; adjust the resistor knob to the position where 2 ma is shown by the meter dial. This will give the loudest signal for that frequency.

As the collector current is controlled by the amount of resistance in the collector circuit it is almost imperative to employ a meter with a 5-ma scale. Never allow more than about 2 ma to flow through the circuit, or the transistor may burn out. Do not apply power to the transistor without first setting the resistance to its highest value. Avoid excessive transients, as in plugging the transistor in or out of its socket with the power on. Remember that these devices, as far as the collector circuit is concerned, are merely diodes with a small amount of backward current flowing through the circuit. Naturally, the collector circuit must always be biased in the direction of high diode resistance, as a reversal will burn out the element forthwith. It is the presence of current from the incoming signal in the emitter circuit which affects the resistance of the collector reversed-diode circuit and thus accounts for the gain.

The receiver will operate a loudspeaker on several local stations at this location. Five or six stations can be heard with volume sufficient to be audible in every room of the house. *A good aerial and ground are required for speaker results.* Under favorable conditions the results compare quite well with those obtained with a single-tube receiver. The over-all sensitivity does not equal that of a grid-leak tube detector, but some dx (up to several hundred miles) has been recorded with headphones instead of speaker. Considering that less than 2 ma is drawn from the battery the volume is unusually good. END

"Wottaya mean, the reception was better a minute ago? I had the lead-in attached to the lightning rod.

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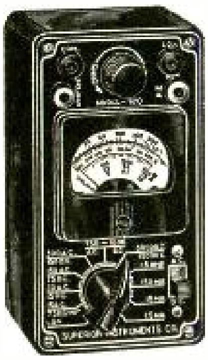
Superior's New Model 770

VOLT-OHM MILLIAMMETER

Sensitivity—1000 ohms per volt



Uses latest design 2% accurate 1 Mil. D'Arsonval type meter. • Same zero adjustment holds for both resistance ranges. It is not necessary to readjust when switching from one resistance range to another. This is an important time-saving feature never before included in a V.O.M. in this price range. • Housed in round-cornered, molded case. • Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

SPECIFICATIONS:

6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts.
6 D.C. VOLTAGE RANGES: 0-7.5/15/75/150/750/1500 Volts.
4 D.C. CURRENT RANGES: 0-1.5/15/150 MA. 0-1.5 Amps.
2 RESISTANCE RANGES: 0-500 Ohms 0-1 Megohm.

Model 770 is an accurate pocket-size V.O.M. Measures only 3⅛" x 5⅞" x 2¼".

$14.90 NET

The Model 770 comes complete with self-contained batteries, test leads and all operating instructions.

Superior's New Model TV-11

TUBE TESTER

• Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary. • Uses no combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket. • Free-moving built-in roll chart provides complete data for all tubes. • Phono jack on front panel for plugging in either phones or external amplifier detects microphonic tubes or noise due to faulty elements and loose external connections.

Operates on 105-130 Volt 60 Cycles A.C. Hand-rubbed oak cabinet complete with portable cover

$47.50 NET

Superior's New Model 670-A

SUPER-METER

A combination volt-ohm milliammeter plus capacity reactance inductance and decibel measurements

SPECIFICATIONS:

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

Comes housed in rugged, crackle-finished steel cabinet complete with test leads and operating instructions. Size 6¼" x 9½" x 4½".

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ADDED FEATURE

The Model 670-A includes a special GOOD-BAD scale for checking the quality of electrolytic condensers at a test potential of 150 Volts.

Superior's New

TV BAR GENERATOR

THROWS AN ACTUAL BAR PATTERN ON ANY TV RECEIVER SCREEN!!

CONNECTS DIRECT TO ANTENNA POST

NO CONNECTION INSIDE RECEIVER

Features—

Can be used when no stations are on the air. • Provides linear patterns to adjust vertical and horizontal linearity • Provides vertical and horizontal sweep signals • Provides signal for testing video amplifiers.

TV Bar Generator comes complete with shielded leads and detailed operating instructions. Only ....

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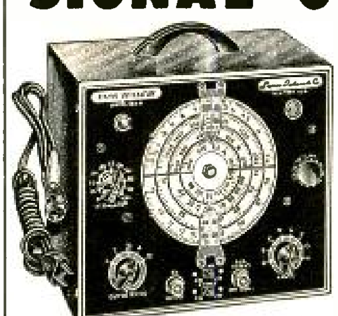
Superior's Model 660-A—A NEW A.C. OPERATED

SIGNAL GENERATOR

Provides Complete Coverage for A.M.—F.M. and TV Alignment



• Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 220 Megacycles on powerful harmonics. • Accuracy and stability are assured by the use of permeability trimmed Hi-Q coils. • R. F. available separately or modulated by the internal audio oscillator. Built in 400 cycle sine wave audio oscillator used to modulate the R. F. signal also available separately for audio testing of receivers, amplifiers, hard of hearing aids, etc. • R. F. Oscillator Circuit: A high transconductance heptode is used as an R. F. oscillator, mixer and amplifier. Modulation is effected by electron coupling in the mixer section thus isolating the oscillator from load changes and affording high stability. • A. F. Oscillator Circuit: A high transconductance heptode connected as a high-mu triode is used as an audio oscillator in a high-C Colpitts Circuit. The output (over 1 Volt) is nearly pure sine wave. • Attenuator: A 5 step ladder type of attenuator is used.

• Tubes used: 1—6BE6 as R. F. Oscillator, mixer and amplifier. 1—6BE6 as Audio Oscillator. 1—6H6 as Power Rectifier.

The Model 660-A comes complete with coaxial cable, test lead and instructions ....

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EDITOR TOURS PENNA.

Radio-Electronics' Associate Editor, Mort Bernstein, had an opportunity to study contrasting TV service problems in York and Williamsport, Pa. recently. On January 6, despite snow, sleet, wind, and rain, York technicians were frantically busy, indoors and out, trying to solve two urgent—and profitable—problems at once: In one week, York's nearest v.h.f station—WGAL-TV 25 miles away in Lancaster, Pa.—shifted from channel 4 to channel 8; and a new u.h.f. station—WSBA-TV on channel 43—opened up in York itself.

Almost every high-gain channel-4 antenna had to be replaced with one cut for channel 8, or relocated and reoriented to eliminate ghosts and the effects of changed transmission paths at the new frequency. In many cases—especially where the sets had been used solely on channel 4 for more than a year—the channel-8 segments of the tuner had to be realigned. One problem (and this is certain to crop up wherever high-band channels come on the air for the first time) was the apparent failure of sets that worked perfectly on channel 4 to work at all on channel 8. The answer was simple (after someone had thought of it): *Replace the local oscillator tube.* Most h.f. oscillators have much higher output on the low band than for channels 7-13. Normal loss of emission through use over a year or more is not generally severe enough to weaken low-band channels to the extent where they can't be brought in by turning up the contrast control; but when a high-band channel is tuned in for the first time—it just isn't there!

The problem of converting for u.h.f. channel 43 had plenty of headaches too. As could have been predicted, you couldn't predict anything! In some cases built-in antennas gave perfect results; in others—even closer to the u.h.f. transmitter—arduous hours of raising, lowering, shifting, and relocating were necessary to bring in anything at all. With some types of v.h.f. ribbon lead-in the u.h.f. signals faded out like the Cheshire cat when it started raining (leaving the grin, of course, on the face of the u.h.f.-lead-in manufacturer).

Where external converters were used, with output on channels 5 or 6, the v.h.f. receiver had first to be aligned precisely on the required channel to make sure signals could get through from the converter at all. This called for highly-accurate channel markers, since there were no stations available on these channels for reference.

With u.h.f. converters that have high-v.h.f.-band output (channel 10) the problem of the weak oscillator tube in the v.h.f. receiver was added to the complications. But these are jobs the technician gets paid for, so nobody was complaining except the customers, who face waits of two to five weeks for their antennas, converters, and installations.

At a meeting held in York on the evening of January 6, Bernstein spoke to the members of the Southern Pennsylvania Radio and Television Servicemen's Association on servicing problems, circuit analysis, and recent de-

velopments in transistors, but he feels he owes them a debt of thanks for what they taught him about u.h.f.

Williamsport, Pa.

On January 7, our Associate Editor got the low-down on conditions in Williamsport, and that evening addressed the Central Pennsylvania technicians' group. Williamsport lies in a valley, about 100 miles north of York, surrounded by high parallel ridges of the Allegheny mountain chain. These ridges run generally in a northeast-southwest line and form a crude natural waveguide for v.h.f. signals from Altoona, Johnstown, and Pittsburgh, in southwestern Pennsylvania. That is, the wave guide is effective as long as you're up on one of the surrounding ridges. Williamsport has no local TV station, but the city is fed by three competitive community antenna systems. These have their antennas, tuners, channel amplifiers, and main distribution equipment on various mountain tops surrounding the city, and run coaxial feeders on public-utility poles along the streets and local highways. Customers pay a substantial cash installation fee for a tie-in, plus a monthly rental charge.

Receiver service problems are routine, except for a.g.c. and sync difficulties, generally caused by excessive signal from the distribution lines. In some instances, the gain of the community systems on weak channels is raised by narrowing the r.f. bandwidth. This gives excessive boost to the picture carrier, and to the sync pulses which lie close to the carrier. Another undesirable effect of this practice—for which the set-owner generally blames the innocent service technician—is the loss in picture detail. With extremely limited bandwidth the pictures come out almost like simple animated cartoons—merely black and white.

The majority of the technicians' headaches are not the fault of the receivers, but they have a hard time convincing customers that they should be paid for diagnosing trouble in the community antenna systems.

LICENSING DEBATED

The question "to license or not to license" service technicians is getting intensified attention in New York, Philadelphia, Chicago, and other areas, with the result that spirited arguments and strongly worded articles on the subject are appearing in a number of trade papers. One such series—in the newspaper *Retailing Daily*, has taken almost the form of a debate.

Opener was Mort Farr, of Upper Darby, Pa., head of the National Appliance and Radio-TV Dealers Association. Opposing licensing, he pointed out that many of the complaints against TV service were due to the vast and rapid growth of the industry, which made it inevitable that technical know-how would lag behind demand, and cited surveys showing that today the average TV owner is satisfied with his service technician. The "dwindling number of

customer complaints" tends to prove the same thing, he stated.

Further, according to Mr. Farr, some of the strongest proponents of licensing favor it because they believe it will raise rates and reduce the number of technicians in the industry, thereby providing licensed operators with more income. He also pointed out that in many cases licensing may be favored purely for financial reasons by "municipalities (which) are hard pressed for funds to bolster the local treasury. They think the service field will be the most lucrative." He further stressed the point that licensing cannot possibly cure all the so-called evils, as some who are turning to it as a "last resort" apparently believe.

Mr. Farr believes much could be done to reduce the already dwindling number of customer complaints if set manufacturers would emphasize to the consumer the amount of time and skill needed to repair TV sets, and asked for "an educational program by the producers and service contractors."

In a statement published a few days later, Frank Moch of NATESA dismissed the argument that technicians were seeking licensing for selfish reasons as "unqualified baloney." He held that dealers' demands for kickbacks on service work are responsible for many abuses, since they put a financial squeeze on the service operator and make it impossible to give the customer the service he is paying for. He also branded as "absolutely ridiculous" the charge that licensing would raise present service rates, and stated "There is no movement afoot to reduce the number of technicians. Everyone agrees that there are not enough technicians to handle present business volume."

Paul Forte, executive secretary of the Television Contractors Association, attacked the anti-licensing groups in a long letter in which he declared that manufacturers, far from educating the public as to the complexity of TV installation and servicing, are following in effect an opposite course. "The public is being told" he said, "that for a few pennies and the use of a screwdriver they will have no problems in receiving the new u.h.f. signals. The public is *not* being told of the special antennas, the precise positioning, the new and special equipment, and the extremely high degree of technical knowledge, together with the cost, which will be needed before u.h.f reception becomes a fact." The practice of parts distributors of selling to non-professional TV repairers or tinkerers at wholesale prices was another of the factors which Mr. Forte considered important in the demand for licensing made by sections of the service industry.

Mr. Forte ended with the statement that he too was opposed to licensing, but considered it necessary to recognize the real reasons why such a demand was supported before attempting to solve the problem. He says, however: "In recognizing it, I find myself helpless, because the answer does not lie with me or my associates, but with the people who created this atmosphere.

RADIO-ELECTRONICS APRIL ISSUE ON SALE MARCH 25.

They can defeat licensing—with deeds, not words."

ASK NEDA TO ACT

The Television Contractors Association, of Philadelphia, has asked the Pennsylvania chapter of the National Electronic Distributors Association to prevent retail buyers from obtaining components at wholesale prices.

President of TCA, Albert Haas, pointed out in a letter to the president of the Keystone Chapter of NEDA that legitimate television contractors are seriously hurt by the fact that students, employees of TV service organizations working after hours on their own, and others, are able to purchase parts at the same rate as the legitimate TV service company. These operators, working without overhead or normal business expenses, are able to cut prices to a point where legitimate service business is imperiled. He requested that the Keystone Chapter "adopt a resolution calling for a halt to this type of unorthodox selling procedure," advocating that some independent group classify all who may rightfully buy electronic equipment wholesale.

NATESA'S NEW OFFICERS

The officers of the National Alliance of Television and Electronic Service Associations are Frank J. Moch, president; Bertram Lewis, Eastern vice-president; Fred Colton, East-Central vice-president; Vincent Lutz, West-Central vice-president; Jack MacDowell, secretary-general; John Hemack, treasurer; Harold Rhodes, Eastern secretary; W. A. Rosenberg, West-Central secretary; and Gerald Ratner, legal counsel.

The officers were elected at the NATESA convention held in Chicago during December. A number of other important actions were performed by the convention, among which were a redistricting of the organization to take care of the increase in membership, setting up a committee to determine a new dues structure, and amending the by-laws to permit voting by mail on important issues which might arise in the periods between conferences.

Committees were also set up to design and put into force a plan for manpower training and qualification; to organize a speaker's bureau and training co-ordination plan; to select a recipient for the "Friends of Service Management" award; and to work out a NATESA "Seal of Acceptance" plan.

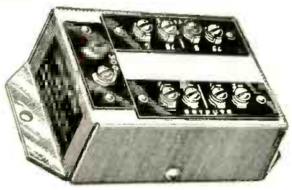
A plan was presented for the various affiliates to "visit" each other through the medium of tape recordings. Another plan—for consumer education through lectures before various fraternal, business, and service organizations—was also approved. It was proposed that the Internal Revenue Department, OPS, FTC, local zoning boards, and other government agencies be used to clean out frauds in the TV and radio service industry. A proposal for the establishment of chapters in cities and areas not yet in NATESA and in those areas still without TV was also taken up. END

TV LINE SPLITTERS

Blonder-Tongue Laboratories, Inc., 526 North Ave. E., Westfield, N. J., presents a new group of Line Splitters for dividing any TV transmission line into four branch lines. These units are available in the following models:

Model LS4-1—Divides one 75-ohm line into four 75-ohm lines.
LS4-2—Divides one 300-ohm line into four 75-ohm lines.
LS4-3—Divides one 75-ohm line into four 300-ohm lines.
LS4-4—Divides one 300-ohm line into four 300-ohm lines.

The line splitters were designed to provide branch lines to distribution amplifiers in master TV systems. Requiring no power, they can be installed at remote locations. Precise impedance match and flat response over all v.h.f. channels are featured in these low-cost units.

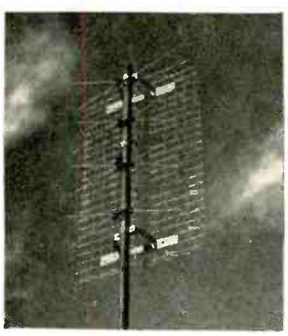


They may also be used as an inexpensive means to provide reception for two to four TV sets, from one antenna. Interaction between TV sets, when present, can be eliminated by inserting attenuation pads between the line splitter and each TV set.

Each type is shipped with two resistors which provide proper termination of unused outlets.

UHF ANTENNAS

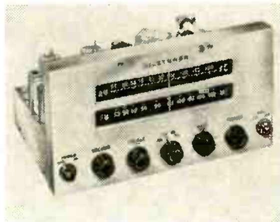
Technical Appliance Corp., Sherburne, N. Y., has designed a new line of u.h.f. antennas. Parabolic-reflector types, Yagis, modified X (bow-tie), and V type antennas are included. With the exception of the modified X design, all



are of the sharp directivity type. The modified X will be marketed for areas where reception from channels in opposite directions is required. Tuning of all antennas is such that all operating u.h.f. channels will be within the bandwidth of the antenna.

FM-AM TUNER

Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y., has announced an FM-AM radio tuner, for use as the central control head of a high-fidelity music system. The *Pilotuner* model AF-821 is a 9-tube unit incorporating a two-stage preamplifier with adjustable equalization for various makes of reluctance phonograph cartridges, sepa-

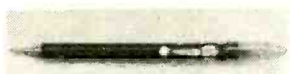


rate input connections for phono and TV operation, extended range bass and treble controls, a temperature-compensated oscillator for drift-free FM reception, automatic frequency control, full shielding against radiation, built-in antennas, and high sensitivity on both the FM and AM bands. Over-all dimensions are $14\frac{1}{4} \times 7\frac{1}{4} \times 8\frac{1}{2}$ inches.

HIGH-VOLTAGE PROBE

Kapner Hardware, Inc., 2248 Second Ave., New York 29, N. Y., has introduced its *Detecto* probe which indicates the presence or absence of high voltage, and checks proper operation of the high-voltage supply.

The probe has a built-in lamp which lights up if high voltage is present.



HIGH-VOLTAGE PROBE

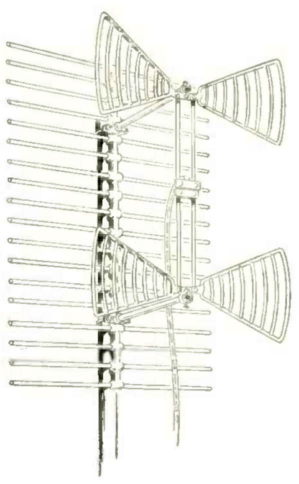
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill., has announced a tester for checking high-voltage TV circuits. The tool, about 7 inches in length, glows when in contact with high voltage.

The probe has a metal pin which is put in contact with the component to be checked when testing rectifier tubes,

output and transmitter tubes, and high-voltage transformers. For testing high-voltage filter resistors, the tester is moved along the body of the resistor. If the resistor is open or cracked the tester glows at the trouble point.

U.H.F. ANTENNA

Tel-a-Ray Enterprises, Inc., Henderson, Ky., has announced an all-channel u.h.f. antenna, the *Universal*. It is a fan-type model constructed from Dural and cast aluminum with noncorrosive hardware, giving a flat frequency response over the whole u.h.f. band. Single, double, and four-bay arrays are available.

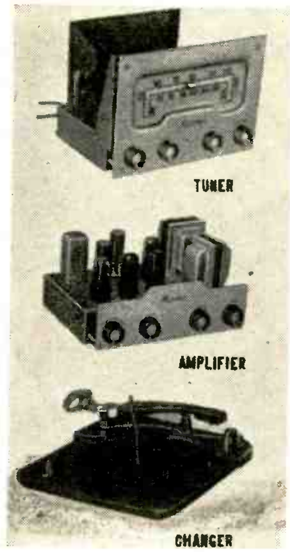


NEW DEVICES

HI-FI PACKAGE

Meissner Manufacturing Division, Maguire Industries, Inc., Mount Carmel, Illinois, has announced a matched high-fidelity radio-FM-phono system consisting of changer, tuner, amplifier, and coaxial speaker.

Changer pickup is the G-E triple play variable reluctance cartridge. Frequency response of tuner is ± 2 db throughout 50 to 15,000 c.p.s. range and it has a new type miniature tube lineup. The amplifier hum level is −70 db down, and its frequency response is flat ± 1 db throughout 20 to 20,000 c.p.s. Undistorted power output is 10 watts. Amplifier has built-in preamp.



Speaker uses two coaxially mounted cones driven from one voice coil. Frequency response is practically flat throughout range of 30 to 13,000 c.p.s. Built-in mechanical crossover at 4,500 c.p.s. permits each cone to work through its own tone range.

PAPER CAPACITORS

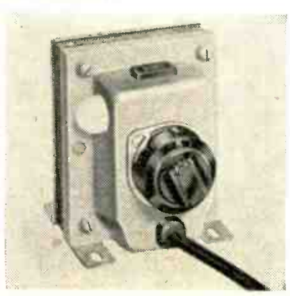
Cornell-Dubilier Electric Corp., Plainfield, N. J., now has 12 types of miniaturized, tubular metal-cased paper capacitors in its *Demicon* series.

These capacitors are hermetically sealed in metal cases, with glass-to-metal seal terminals and are available in seven mounting and container styles. Impregnants, tolerances, and internal constructions are provided to meet the most popular applications in modern engineering. All these capacitors comply with applicable parts specifications of JAN-C-25 and MIL-C-25A.

VOLTAGE BOOSTER

Crest Laboratories, Inc., 84-11 Rockaway Beach Blvd., Rockaway Beach, N. Y., has introduced its LVB-117 line-voltage booster. The unit is engineered to restore peak performance for TV sets or electrical appliances requiring 117 volts.

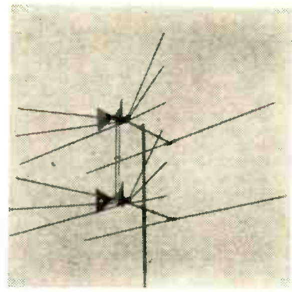
The LVB-117 has an overload cutout to protect against unsafe line voltage increases and has a multitap selector switch for exact selection and a visual indicator for precise determination of required boost.



ALL-CHANNEL ARRAY

Channel Master Corp., Ellenville, N. Y., has developed a stacked ultra-fan v.h.f.-u.h.f. array, model 4132.

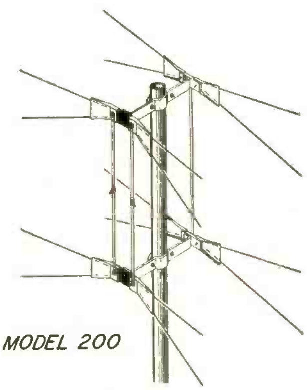
Two interaction filters separate the v.h.f. and u.h.f. bands, permitting the antennas to be used with one transmission line. Free space terminals prevent accumulation of dirt and moisture.



Based on a tuned reference dipole, its gain averages 6.5 db on low-band v.h.f., 10 db on high-band v.h.f., and a uniform 9.5 db on u.h.f. On low-band v.h.f. it is a conical antenna with parasitic reflector. On high-band v.h.f. it is a large-diameter V antenna. On u.h.f. it is a triangular dipole with the v.h.f. elements acting as a sheet reflector.

U.H.F. ANTENNA

Telrex, Inc., Asbury Park, N. J., is producing a new broad-band, stacked dipole antenna, the *Conical-V-Beam*. Completely factory-assembled, the array covers the full u.h.f. range at high signal-to-noise ratio.



MODEL 200

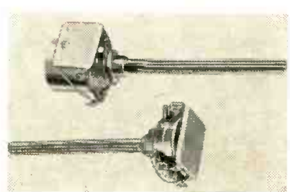
SENSITIVITY TESTER

Service Instruments Co., 422 S. Dearborn St., Chicago 5, Ill., has announced a sensitivity tester to measure TV receiver sensitivity in microvolts.

The *SensiMeter* microvolt scale is divided into very sensitive, medium sensitivity, and insensitive, and determines whether a receiver will operate in a weak-signal area.

LOUDNESS CONTROL

Centralab, Division of Globe Union, 900 E. Keefe Ave., Milwaukee 1, Wis.,



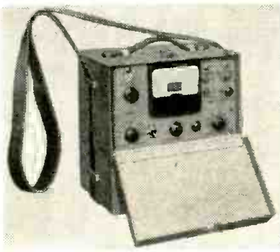
has developed a new compensated loudness control. The unit is a combination dual-tapped control and printed electronic circuit plate combining the compensating network. Since all components in the network are in shunt, there is no insertion loss, and no additional amplification is required.

Designed as a replacement for standard controls in all audio equipment, the unit compensates for the Fletcher-Munson hearing characteristic curves. It is available in ½- and 1-meg. values in both switch and non-switch types. Units are assembled and ready for installation.

NEW METER

Jerrold Electronics Corp., 26th and Dickinson Sts., Philadelphia 46, Pa., has developed a field strength meter, model 704, reading carriers in microvolts. The meter is accurate to plus or minus 0.8 db and has a continuous tuning range from 50–220 mc.

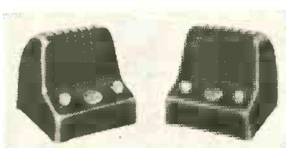
The model 704 separates and measures video, audio, and adjacent channel carriers, and locates r.f. interference.



WIRELESS INTERCOM

David Bogen Co., 29 Ninth Ave., New York 14, N. Y., has announced a new wireless communication system for home, office, factory, or institutional use.

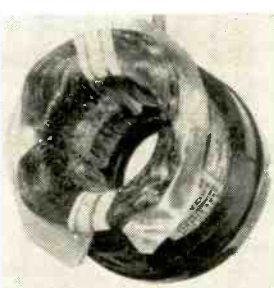
Designated model *Twin*, the unit can be used with two or more stations, with all conversation heard by all stations in the system. Each station contains a transmitter and receiver operating at 175 kc. Stations are placed in service by plugging them into a 117-volt a.c. or d.c. outlet.



DEFLECTION YOKES

Halldorson Transformer Co., 4500 N. Ravenswood Ave., Chicago 40, Ill., presents new 6,000-volt test deflection yokes DF603 and DF604, extra-heavily insulated for direct-drive TV service.

Both yokes have 30-mh horizontal inductance, but to cover all direct-drive applications the vertical inductance of DF603 is 3.5 mh, while DF604 is 50 mh. They are supplied with 20-inch color-coded leads and networks.



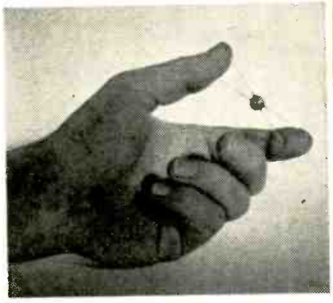
"SUBURBAN" ANTENNA

LaPointe-Plascomold Corp., Rockville, Conn., has now in manufacture a new antenna, the *Ultra Q-Tee Suburban*. It is exactly the same as the present 2-83 Ultra except that the u.h.f. V portion of the antenna is replaced by a high-gain, broad-band, 8-element u.h.f. Yagi.

The new model UQT-S was developed for critical areas and also fringe areas which will exist while many u.h.f. stations are operating temporarily on low power. UQT-S requires only a single transmission line and includes eight printed-circuit channel separators.

PULSE TRANSFORMER

PCA Electronics, Inc., 6368 De Longpre Ave., Hollywood 28, Calif., has developed a new pulse transformer, the MPT 101-0.1, which is the smallest pulse transformer now commercially available.



The unit weighs less than .03 ounce and meets MIL-T27 test specifications, including Table IA humidity resistance tests. It can operate indefinitely at temperatures from −70° to +125° C., and will operate normally for a short time at +150° C.

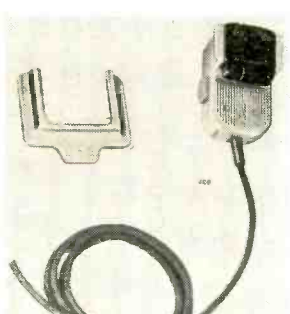
It is resin-impregnated and imbedded and is hermetically sealed with transformer leads able to withstand a 5-pound pull. Although the MPT 101-0.1 is designed for pulse forming, it can also be used for pulse coupling.

TRANSFORMER CANS

Triad Transformer Mfg. Co., 4055 Redwood Ave., Venice, Calif., has introduced a line of deep-drawn transformer cans. They are seamless, drawn from cold-rolled steel. They meet the dimensional specifications of MIL-T-27. The lids are internal and require no stops. Cans are obtainable only for military contracts.

MOBILE MICROPHONE

Electro-Voice, Inc., Buchanan, Mich. has designed a hand-held, differential type noise cancelling, high output, single-button carbon microphone. The model 208 has a flat 100-4,000 cycle frequency response to sounds of close origin, and an output of −50db. It measures 2¼ x 1½ x 1⅛-inches and weighs 3 ounces. Press-to-talk switch actuates button and relay simultaneously.



DOUBLE-O ANTENNA

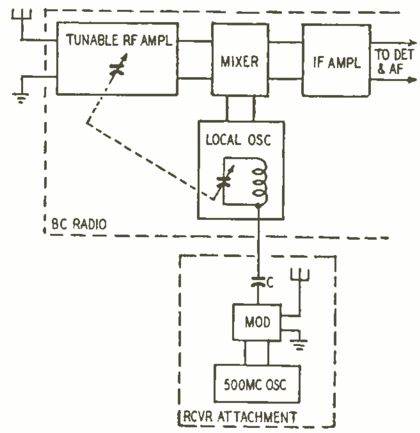
Rytel Electronic Manufacturing Co. of 9820 Irwin Ave., Inglewood, Calif. announces a new u.h.f. antenna, the *Double-O*. Its circular construction makes for greater directivity in the horizontal plane and a 1-db gain over single dipole, together with low pickup response in the vertical direction. With the two circle antennas fed 90 degrees out of phase an additional gain of 3.8 db is obtained. END

All specifications given on these pages are from manufacturers' data.

AUTOMATIC RADIO POLL

Serge A. Scherbatskoy, Tulsa, Okla.
Patent No. 2,618,743
(Assigned to A. C. Nielsen Co., Chicago, Ill.)

Radio stations, advertising agencies, and sponsors try to put on the type of program that meets wide public approval. Surveys, polls, and interviews are undertaken from time to time to determine what people like. They are expensive and not altogether satisfactory. People don't like to be bothered, and may not always know the correct answers. Here is a new method for polling radio listening habits.



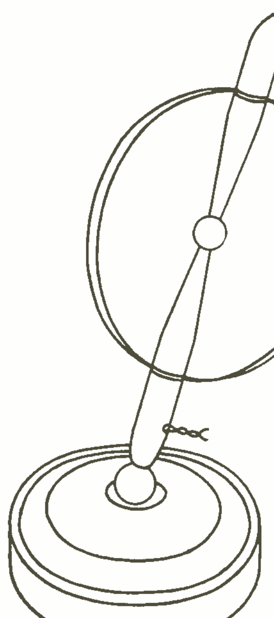
A special attachment is installed near or within the radio in a representative number of homes chosen on the basis of economic status, family size, education, and other factors. The attachment includes a 500-mc transmitter and an r.f. modulator. The latter is coupled to the radio local oscillator through a small capacitor (C). The receiver's oscillator modulates the 500-mc transmitter. (See the figure.)

In any superheterodyne, the local oscillator and signal frequencies differ by a constant i.f. Thus, by measuring the modulation frequency on the 500-mc carrier, we can determine the broadcast channel to which the radio is tuned.

At a convenient central location, a 500-mc receiver is set up to intercept the u.h.f. signals. These are demodulated and combined. The various r.f. channels are scanned by a sweep circuit and the amplitude of each channel is measured. If desired, a moving pen and chart is used to provide a continuous record of radio listening with respect to time.

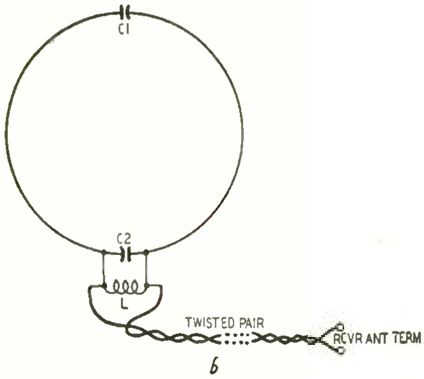
"PROPELLER" TV ANTENNA

Patent No. 2,610,296
John Drysdale Reid, Cincinnati, Ohio.
(Assigned to Avco Manufacturing Corp.)



NEW PATENTS

Fig. a looks like a model propeller, but it is actually an efficient indoor TV and FM antenna. Signals are picked up by a split loop supported by a "propeller" of polystyrene or other plastic. The loop is only about 0.1 wavelength in diameter, but sensitivity comparable to a half-wave dipole is obtained by tuning it to each channel desired. Because of its small size, the loop may be oriented and positioned for minimum ghosts, interference, and body capacitance. It can be used for u.h.f. as well as v.h.f.



b

Fig. b shows the circuit. The loop, C1, C2 and L form a bandpass filter on the desired channel. Here are typical values for a 5-inch diameter loop:

C1	C2	Frequency
10 μμf	5 μμf	108 mc
5 μμf	75 μμf	69 mc

The loop is coupled to the receiver antenna terminals through twisted leads to reduce electrostatic pickup. Besides supporting the loop, the propeller improves the appearance of the device. Cups at the top and bottom cover the coil and the capacitors and keep them out of sight.

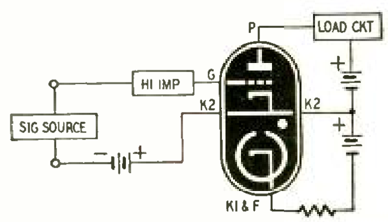
GAS TUBE AMPLIFIER

Patent No. 2,603,766

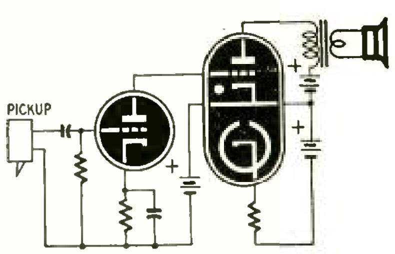
Jerome Kurshan, Princeton, N. J.

(Assigned to Radio Corp. of America)

Conventional gas tubes are never used to amplify, because there is no way of controlling conduction. Below the firing point, no tube current



flows. When the gas is ionized the grid loses control and there is considerable plate current flow. A new type of tube has been designed to solve



this problem. The new tube has auxiliary elements which provide a stream of charged particles. The main elements function just like those of a vacuum tube triode. This tube can handle large amounts of power with little distortion.

The circuit of the tube is the upper figure. K1, K2 are the auxiliary and main cathodes, respectively. When the potential between them is high enough, the gas ionizes and separates into negative electrons and positive ions. This mixture is called a plasma. Focusing electrode F focuses the plasma into a narrow beam. The electrons are attracted to the positive plate P. Ions are drawn towards the negative grid G. A high-impedance element in the grid circuit minimizes distortion.

A phono amplifier schematic is also shown. Here a vacuum triode is used in the grid circuit of the gas tube. The triode amplifies the output of the photo pickup and provides the necessary high impedance in series with the grid of the gas tube.

SAWTOOTH GENERATOR

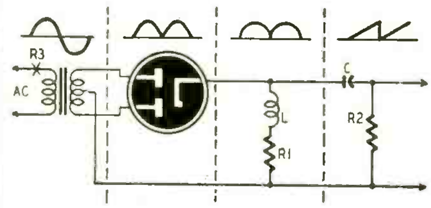
Patent No. 2,616,044

Kurt Schlesinger, New York, N. Y.
(assigned to Radio Corp. of America)

A sawtooth wave can be generated by differentiating a parabolic wave. This invention shows methods for forming the parabolic wave.

See the accompanying figure. An a.c. sine wave (which cannot be changed by differentiation) is applied to the full-wave rectifier through a transformer. The tube delivers the usual rectified sine-wave pulses shown. These are distorted by L and R1 to a rounded parabolic waveform. A differentiator made up of C and R2 converts the parabola to a sawtooth.

In an alternate method, the parabolic wave may be formed by inserting a resistor (R3) in series with the input. When this is done, L and R1 may be eliminated.



U.H.F. CONVERTER FOR TV

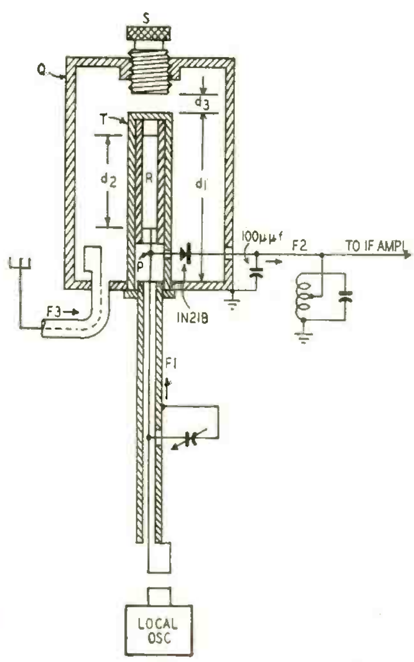
Patent No. 2,616,037

Benjamin F. Wheeler and Howard R. Mathwich, Haddonfield, N. J.
(assigned to Radio Corp. of America)

In this u.h.f converter, the incoming signal is mixed with a *harmonic* of the local oscillator. The oscillator tube may be a conventional type, operating with relatively high efficiency at less than half the frequency of the incoming signal.

The figure shows a cavity resonator Q tuned to the desired signal by a screw S. The signal frequency (F3) is coupled to the cavity through a loop. The local oscillator frequency (F1) is fed into the cavity at P. A 1N21B crystal distorts the oscillator current and generates a strong second harmonic 2F1. The difference between F3 and 2F1 is the i.f. (F2). The converter is followed by an i.f. stage.

The inner conductor T of the cavity is hollow. Within it is conducting rod R. A polystyrene tube separates R and T. Although R is much shorter than T, they can each be adjusted to an odd multiple of a quarter-wavelength at F3. This is be-



cause R and T are separated by polystyrene, which has 2.5 times the dielectric constant of air. Coax line R, T, is open as its far end, so the impedance at point P is very low with respect to F3. The incoming signal is shorted out by the low effective impedance at this point and is prevented from entering the local oscillator circuit and affecting the oscillator frequency.

Here are typical dimensions and frequencies for the harmonic converter described above.

d1	2.67 inches	F1	416-442 mc
d2	1.92 inches	F2	88-76
d3	.72-.18 inches	F3	920-960

COMBINATION HEARING AID AND RADIO RECEIVER

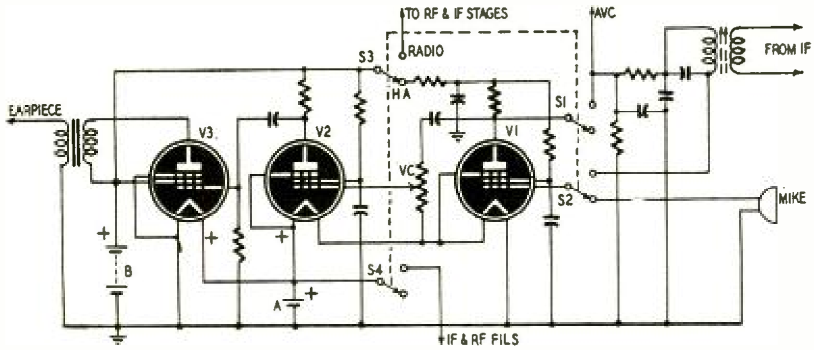
Patent No. 2,618,707
Lemuel M. Temple, Scarsdale, N.Y.
(Assigned to Raytheon Mfg. Co., Newton, Mass.)

This circuit combines a radio and hearing-aid in a single unit. Thus a hard-of-hearing person may enjoy radio programs when he is not using the device as an ordinary hearing aid.

The set may use 6 miniature type tubes. Three of them may operate as r.f. amplifier, converter, and i.f. amplifier. One tube is the diode detector when the set is switched to RADIO. This tube becomes an amplifier when the switch is thrown to HA (hearing aid). The remaining tubes are the a.f. voltage amplifier and power output tubes, respectively.

The figure shows the audio section. S1, S2, S3, S4 is a ganged switch. The first two poles switch the control grid of V1 from microphone to the i.f. transformer. In the RADIO position, only the control grid and filament are in the circuit. Then the tube is a half-wave diode detector. When the switch is thrown to HA the tube is a pentode amplifier. V2 is the audio amplifier and V3 is the power tube.

A and B voltages are disconnected from the r.f. and i.f. stages when the set is in HA position. They are controlled by switch sections S4 and S3, respectively.



MAGNETOMETER

Patent No. 2,603,687
Lawrence J. Giacoletto, Eatontown, N. J.
(Assigned to Radio Corp. of America)

This instrument measures the strength of a magnetic field by its effect on an electron stream. Electrons carry a magnetic charge and can be deflected from their normal paths by an external magnetic field. It can be used wherever space is limited, as in testing narrow air gaps. Readings are accurate and continuous. The circuit uses three tubes, one of which is a special magnetometer type shown schematically in the diagram below.

V1 is normally blocked by high negative grid bias from B1. When V1 conducts, its cathode current flows through meter M, which constitutes the entire tube load. During conduction, the voltage across the meter will nearly equal T, the peak-to-peak amplitude of the sawtooth plate potential.

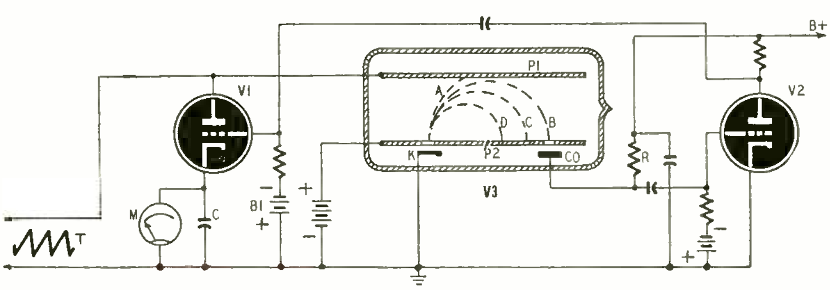
V2 is an amplifier whose output is fed to the grid of V1.

V3 is the special magnetometer tube. It has a cathode K, plates P1 and P2, and a collector CO. P2 has two small apertures, one above K and the other above CO. V3 must be placed in the magnetic field to be measured. All other components may be located elsewhere, since the connecting leads to the magnetometer tube carry only d.c. supply voltages or low-frequency a.c.

Electrons from K pass through the first aperture and are attracted by P1, which is biased by the positive voltage T. If the tube is in a magnetic field, the electron stream will be deflected. A weak field produces only slight deflection, such as A. If the magnetic force is very strong there will be a greater deflection of the electrons—along a path like D. Possible intermediate paths produced by other magnetic field strengths are shown by the positions of the dashed lines at B and C.

If T is a positive-going sawtooth voltage, the electron beam will follow paths A to D progressively, as the sawtooth rises from zero to maximum. As electrons sweep along path B, they pass through the second aperture to CO and flow through R. This produces a negative pulse at the V2 grid which is amplified, inverted, and fed to V1. The positive grid pulse unblocks V1 momentarily, and M reads the instantaneous value of T. Capacitor C integrates the pulsating voltages appearing across the meter into a steady reading whose maximum value would be limited by the peak-to-peak amplitude of the sawtooth supply voltage T.

The magnetic field strength can be determined from the reading of M. M reads a value closely equal to T, as we have already stated. For any particular value of T, only one definite magnetic-field intensity will guide the electrons along B. The strength of the magnetic field being explored can be computed from the meter readings or determined by comparison with known fields.

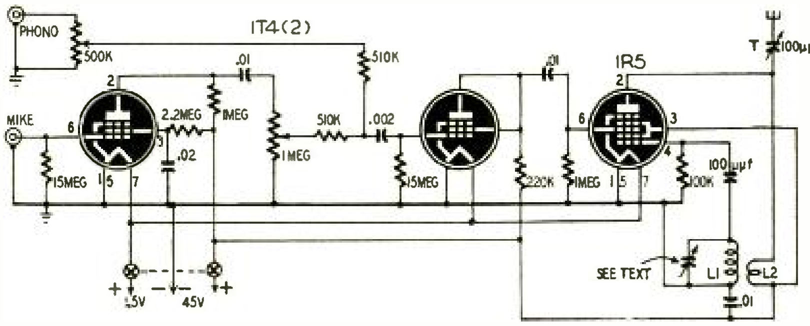


SIMPLE PHONO OSCILLATOR

Here is a neat little battery-powered phono oscillator which gives surprising results at distances up to 100 feet. Separate isolated inputs and volume controls are provided for operating the oscillator either from a low-level microphone or from a high-output phono pickup.

Coil L1 is a single-layer type broadcast antenna or r.f. coil with a 20-turn tickler (L2) of No. 30 enameled wire, wound close to the bottom of the form. The tubes, tuning capacitor, and most of the remaining parts were taken from a junked personal-type portable receiver.

If you don't care to use an antenna or r.f. coil, you can use the oscillator coil from a battery receiver. Keep the antenna as short as possible to avoid excessive radiation and possible interference with other broadcast-band receivers.—*G. R. Anglado*

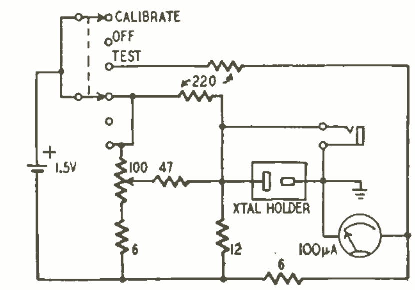


CRYSTAL-DIODE TESTER

The usual method of testing crystal diodes is to measure the forward and backward resistances and the back current with a fixed voltage. The values thus obtained are then compared to those obtained with standard crystals. Although a diode may pass these tests with flying colors, the conversion loss, noise temperature, and other factors may make it entirely unsuitable for many applications.

The crystal-diode tester shown in the diagram is the invention of Peter D. Strum and is described in Patent No. 2,585,353. The unit indicates conversion loss and noise temperature. Performance curves, calibration charts, and construction drawings will be found in the published patent.

The tester is calibrated initially by placing the switch in the TEST position with a fixed resistor between 300 and 3,000 ohms plugged into the crystal socket. The potentiometer is then ad-



justed so the meter reads full scale (100 µa). Then, without varying the potentiometer, the switch is thrown to CALIBRATE. The meter reading is then marked on the dial of the potentiometer. Other resistors between 300 and 3,000 ohms are then used to calibrate the potentiometer dial throughout its range.

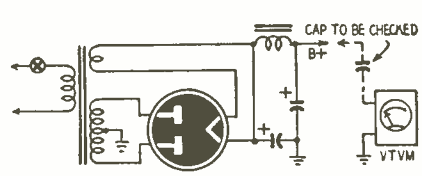
To check crystals, plug the crystal into the socket, throw the switch to CALIBRATE, and adjust the potentiometer so its dial setting corresponds to the meter reading. Switching over to TEST gives a new meter reading which is an indication of the quality of the crystal being tested.

NOVEL CAPACITOR CHECKER

I am one who likes to get as much use as possible from existing equipment so I developed this method of testing capacitors for shorts, opens, and leakage. For the test, I use a d.c. vacuum-tube voltmeter and a source of B voltage. The latter may be a bench power supply or the power supply in a piece of equipment under test.

From the supply, I tap off a d.c. voltage equal to the working-voltage rating of the capacitor to be checked. This voltage is applied to the capacitor and v.t.v.m. in series as shown in the diagram.

If the capacitor is good, the needle of the meter will immediately swing up scale as the capacitor charges; then it will drop to 1 or 2 volts. This indicates that the capacitor is good for blocking d.c. A leaky capacitor will show a much higher voltage reading—depending on the amount of leakage through the capacitor and on the test voltage.



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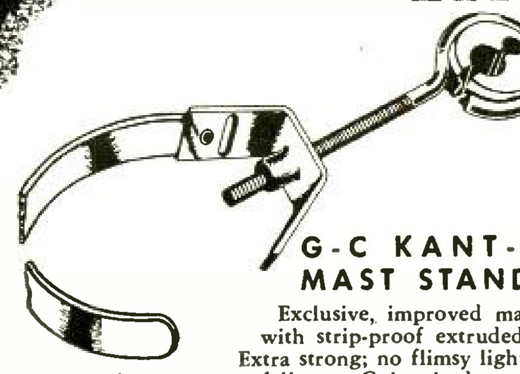

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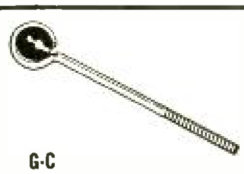
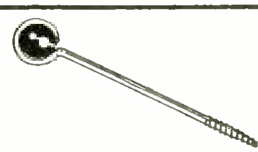
Exclusive, improved mast stand-offs with strip-proof extruded threads. Extra strong; no flimsy light metal used; no loose nuts to fall out. Galvanized strap has round end for easier threading. Genuine Polyethylene insulator, unique G-C design.

No.	Size
8253	3½" Single
8257	7½" Single



G-C UNIVERSAL STAND-OFFS
(Machine Screw Type)

No.	Length
8031	3½"
8032	5½"
8035	7½"



G-C UNIVERSAL STAND-OFFS
(Wood Screw Type)

No.	Length
8027	3½"
8028	5½"
8029	7½"
8030	12"

G-C NAIL-IN STAND-OFFS

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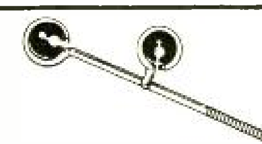
8343	3½"



G-C DUPLEX IN-LINE STAND-OFFS

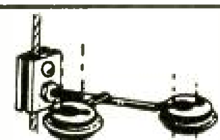
Two styles, wood screw and machine screw types. Heavily zinc plated to prevent rust.

No.	Size and Type
8225	7½" Wood Screw
8226	7½" Machine Screw

G-C SNAP-ON STAND-OFFS

NEW, improved snap-on that is easier to install, then stays on. Snap . . . and it's on; that's all there is to it! Two standard sizes. Feature exclusive G-C reinforced insulators.

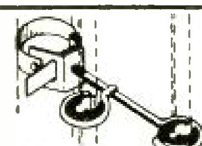
No.	Size
8797	For 1" Masts
8798	For 1¼" Masts



G-C "WIRE-GRIP" GUY WIRE STAND-OFFS

TV lead-ins and rotator wires can be brought down long guy wires. Fasten permanently; easy to use. Genuine Polyethylene insulators.

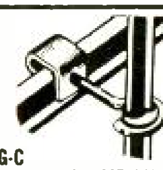
No.	Size and Type
8255	3½" Single
8256	Double Type



G-C DUPLEX KANT-STRIP MAST STAND-OFFS

Heavy steel stand-off with strip-proof extruded threads. A deluxe stand-off at a really low price. Galvanized strapping. For both 300-ohm and coaxial lines.

No.	Type
8258	Double



G-C EAVE TYPE CLAMP-ON STAND-OFFS

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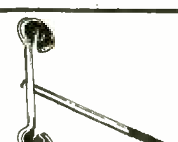
No.	Type
8811	Single
8812	Double



G-C TEE-TYPE STAND-OFFS

Heavy zinc plated for permanent installation. Two types, wood screw and machine screw. For both 300-ohm and coaxial lines.

No.	Size and Type
8809	7½" Wood Screw
8810	7½" Machine Screw

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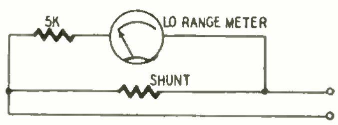
A shorted capacitor will cause the meter to indicate the full value of the impressed supply voltage. An open capacitor will not cause the meter to kick when the voltage is applied and the reading will remain at zero volts.—*Leon Gold*

SIMPLIFIED METER SHUNTS

Very often we want to use a low-range sensitive milliammeter to measure a wide range of currents which may be found in the grid, filament, and plate circuits of transmitters, receivers, and similar equipment. When we use the average low-range meter, the shunt resistors may have values considerably less than 1 ohm. Precision resistors are expensive and easily damaged. It is a lot of trouble constructing and calibrating your own, so we increase the meter resistance and use standard stock resistors as shunts.

To do this, we first connect a 5,000-ohm, 1-watt resistor in series with the meter and then shunt this combination as shown in the diagram. The resistance of the average meter is small compared to 5,000 ohms, so it can be disregarded.



Whatever the basic range of the meter, all you do to get the approximate shunt resistance is to divide 5,000 by the scale multiplication factor. Thus, if we start with a 1-ma meter and want to increase its range to 10 ma to measure grid current in a transmitter, we simply divide 5,000 by 10, and our shunt resistor becomes 500 ohms. To measure plate current, we might need a 500-ma shunt. In this case, we divide 5,000 by 500 and find that a 10-ohm resistor is required.

When selecting shunts, be sure that the resistors have an adequate wattage rating. For low current ranges, a 1-watt resistor may suffice. But, when extending the meter range to 500 ma or so, you may need a 10- or 20-watt resistor. The minimum wattage rating can be found by multiplying the resistance by the square of the current ($I^2 \times R$).

This method of shunting meters gives good results when used in constructing a multimeter.—*Mitchel Katz W2KPE.* (Be aware that by increasing the resistance of the combination the usefulness of the meter is reduced, often in direct proportion. For example, a meter-shunt combination with a range of 100 ma and a resistance of 50 ohms would be quite useless in measuring the current through the filament of the average 1.4-volt tube, as the meter would have more resistance than the filament, and the reading would therefore be less than half the normal current. In other applications it might be quite acceptable, as in the example of the 500-ma shunt. A resistance of 10 ohms in the plate circuit would make no noticeable difference.—*Editor*) END

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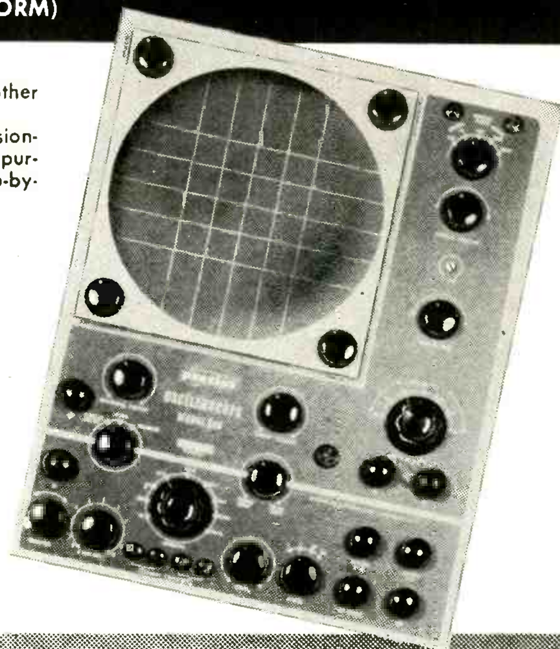

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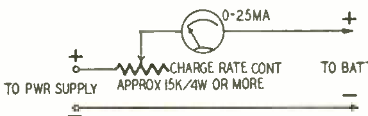
CHARGING DRY BATTERIES

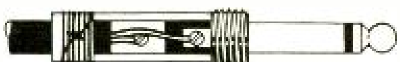
The life of 45- and 67½-volt batteries used in portable receivers and test instruments can be prolonged by the recharging scheme illustrated in the diagram. The charging current of about 15 ma can be obtained from any convenient power supply.



The batteries should be recharged before the terminal voltage drops below one-half its rated value. Check the voltage while recharging to prevent overcharging. Disconnect the battery from the power supply before checking the voltage. When the voltage has come up to normal, let the battery rest for about eight hours to allow the voltage to stabilize.—*O. C. Vidden*

ANCHORING CABLES

The cables entering PL-55, PL-54, and PL-68 plugs and JK-26 jacks should be anchored to eliminate strains on the connections. The result of the special clamping bands manufacturers use can be duplicated easily. After connecting



the cable, wrap the clamping area with No. 20 or 22 solid wire. Then twist the two ends tightly together and apply a small spot of solder. The twisting of the ends gives a strong clamping action.—*Richard Sandretto*

QUICK MIP SOCKET REPAIR

While checking a piece of defective equipment, I found that one of the pin lugs of a MIP type octal socket had broken off flush with the bakelite body. The damaged socket was in a crowded section of the chassis where it would be extremely difficult to remove.

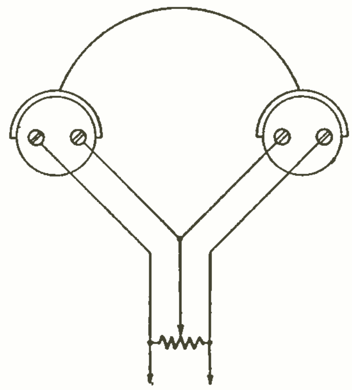
With a stiff piece of fine wire, I punched out the remaining piece of pin contact from the under side of the socket. Then I removed a perfect contact from a spare socket, slipped it into the slot, and seated it in place by inserting a tube into the socket. A slight bend on the underside of the socket locked the new contact firmly in place. I soldered on the lead from the broken lug and the job was done. This kink enabled me to make the repair in a few minutes without disturbing existing wiring. Replacing the whole socket would have taken much longer.—*Alan Palmer*

INSULATED CLAMPS

When an insulated, low-loss cable clamp is needed for unshielded grid leads (a metal one may cause detuning) and certain leads in TV high-voltage supplies, cut a small piece of 300-ohm ribbon lead and strip out the wires. When bent into a U-shape and the ends drilled for a bolt, it makes a nice nonconductive, low-capacitance clamp.—*B. W. Welz*

"PERSONAL" HEADPHONES

Headphones have been with us for many years and are simple and efficient devices for those with normal hearing or those with equal hearing loss in both ears. However, there are many of us whose hearing is near normal in one ear while the other is only a fraction as sensitive to sound. For such people headphones can be easily improved to give the impression of normal hearing. The result is truly amazing to those who have become accustomed to "one-sided" sound.



In a pair of magnetic phones, we find two identical units connected in series. Now if we connect a 50,000 or 10,000-ohm control across them, we can now proportion the voltage to each phone unit, giving the stronger or more sensitive ear less sound and the weaker ear more sound until the sensation is that of normal hearing in both ears.

It would appear from the drawing that an additional wire would be needed in the phone cord. This is not so. We need not change the appearance of the phones at all. The volume control is used just to find the value of resistance to place across each phone unit. Then it is removed and fixed resistors substituted. In many makes of phones there is space enough inside the phone housing for the resistors so that the external appearance is unchanged.

Most headphones are reversible, so a spot of paint may be added as a means of quickly determining the phone for the left or right ear.—*E. E. Youngkin*

MOUNTING ACORN TUBES

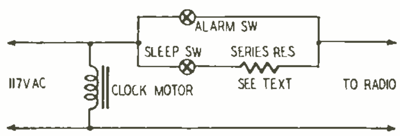
The 954 and other types of acorn tubes are useful in many types of u.h.f. and v.h.f. circuits. However, their unusual construction often makes it difficult to incorporate them into conventional circuit layouts. Try the following the next time you want to use an acorn tube:

Punch a ¾-inch hole in the chassis at the desired place for the tube. Mount the acorn socket under the chassis, concentric with this hole. The tube is then installed in an upright position, but it is put in its socket from the bottom, with its envelope projecting through the ¾-inch hole in the chassis. Since the tube is used in an upright position with the socket inverted, the pin connections must be changed accordingly. In triodes, the plate and grid connections, and in pentodes, the screen and suppressor connections, must be transposed from their positions with the tube and socket in normal relationship. This is very easy to clear up with the help of suitable base diagrams.

Acorn tubes are excellent for converter and r.f. amplifier applications at v.h.f. and u.h.f. where gain is not critical. However, their transconductances are considerably lower than those of the more modern loctal and miniature tubes. Therefore, they should not be used in local oscillator circuits designed for these tubes. Erratic or poor operation may result.—*Charles Erwin Cohn*

CLOCK-RADIO MODIFICATION

One of the disadvantages of clock-radios is that when the volume is reduced sufficiently to provide soft music using the sleep switch on retiring, it is too low to waken one in the morning. Conversely, when the volume is set high enough for satisfactory waking operation, it is too loud the night before.



The diagram shows a simple circuit modification which can be applied to most clock-radios to remedy the situation. In many clocks the sleep switch is usually a separate unit in parallel with the alarm switch. The modification consists of introducing series resistance into the sleep switch circuit. The resistor drops the voltage to the radio, causing a reduction in volume. The resistance depends on the individual radio and on personal preference, and will have to be chosen by trial and error. However, for the a.c.-d.c. sets using 150-ma heaters, a value of between 100 and 200 ohms should be satisfactory. Wattage rating will be determined by the value of resistance used, and the current drain of the radio. A 10-watt resistor should handle the 150-ma heater sets, and a 20-watt resistor the 300-ma sets. Users of radios having transformer power supplies can calculate wattage dissipation. I have used a 150-ohm metal ballast tube on a set having 150-ma heaters with very satisfactory results.—*Thomas S. Ely, W3MJP*

GONSET NOISE CLIPPER

The hum level in Gonset noise limiters can be greatly reduced and the apparent effectiveness of the device can be increased by inserting an 8- to 10-ohm resistor in series with one of the heater leads supplying the clipper. The resistor reduces the heater voltage and minimizes hum introduced into the audio circuit by heater-to-cathode leakage.

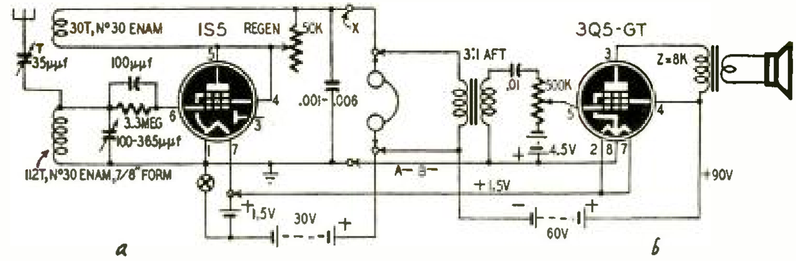
This same procedure can be used to reduce hum in similar noise limiter circuits which use a separate clipper tube.—*G. P. Oberto*

(The installation of the series resistor is one of the first steps in the instruction sheets issued with late Gonset clippers.—*Editor*) END

A.F. AMPLIFIER

? *I get good results from this little receiver and would like to add a simple audio amplifier to it. Please show how I can add a 3Q5-GT as a power amplifier with sufficient power to drive a small PM speaker.—L. C., Texarkana, Ark.*

A. The diagram of your set is shown at *a* and the diagram of the amplifier at *b*. The amplifier is hooked up to the receiver by making the connections shown in dashed lines. With these connections the amplifier and receiver are turned off with the switch in series with the common negative sides of the batteries.



(L. C. did not include the values of the resistors and capacitors in his set, so we have added typical values for those who may want to give the circuit a try. If the set does not go into and out of oscillation smoothly, try different values for the .001-.006-μf capacitor and insert a 2.5-mh r.f. choke at X. The input coil consists of a 112-turn grid winding and a 30-turn tickler. Both are wound on a ⅞-inch form with No. 30 enameled wire. The coils are wound in the same direction and spaced about 3/16 inch apart with the tickler at the bottom of the form. The plate lead connects to the outside end of the tickler and the grid lead connects to the outside end of the tuned coil. The tuning range of this coil is approximately 1100-3200 kc with a 144-μμf capacitor and 700-2100 kc with a 365-μμf unit. You can cover the range of amateur and short-wave radio bands down to about 10 meters by using a 144-μμf tuning capacitor and a set of standard commercial all-wave plug-in coils, now obtainable from some of the radio mail-order houses.—*Editor*)

TONE CONTROL FOR TV SET

? *I am enclosing a circuit of the audio section of a Magnavox CT-274 TV receiver. Please show how I can add a simple tone control to this receiver.—E. J. H., Plainfield, N. J.*

A. Fig. 1 shows a simple high-cut type of tone control. The 470,000-ohm grid resistor in the 6V6-GT circuit is replaced with a 500,000-ohm tone-control potentiometer with a .005–.01-μf

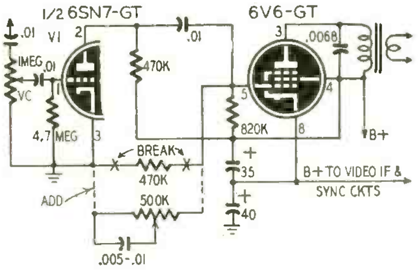


Fig. 1—A top-cutting tone control.

capacitor connected between the arm and ground. The 470,000-ohm fixed resistor must be removed since it is replaced by the resistance of the potentiometer.

The diagram in Fig. 2 is a more elaborate circuit which permits individ-

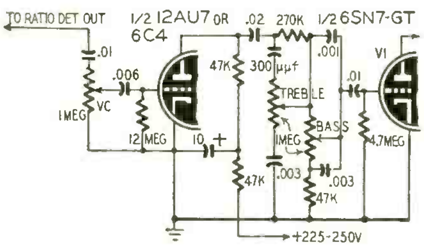


Fig. 2—Complete bass-treble control.

ual control of bass and treble notes. An extra triode stage is required to compensate for the insertion loss of the tone-control networks. You can mount the 6C4 on or under the chassis or you may replace the 6C4 vertical oscillator with a 12AU7 and use the remaining triode section as in Fig. 2.

YAGI ANTENNA PROBLEM

? *I have single-channel, 300-ohm Yagis for channels 4, 5, 7, and 9. I would like to stack the high-band antennas and connect them to one lead-in and the low-band antennas to another. How should I space the antennas and what type of stacking bars should I use? What spacing should I use between the high- and low-band stacks?—R. T., St. Joseph, Mich.*

A. Although the Yagis are single-channel models, you will probably find that all of them have considerable signal pickup on adjacent channels. For this reason, it may not be advisable to stack them and use a common transmission line. You may have interaction between the antennas which will result in reflections and ghosts. On the other hand, stacking may result in a gain of 2-3 db over a single antenna.

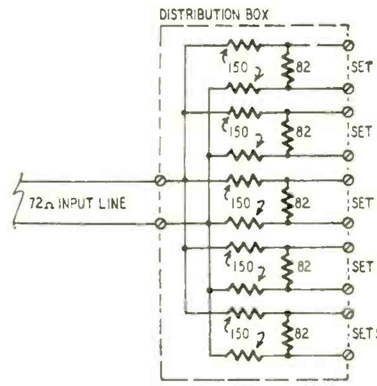
The spacing between the antennas in either pair should be approximately one-half wavelength at a frequency midway between the low-frequency end of the lower channel and the high-frequency end of the higher one. The low-band antennas should be spaced 78 inches apart and the high-band antennas 32 inches apart. Use 425-ohm stacking bars. You can use standard open-wire TV transmission line or ⅜-inch tubing spaced 6¼ inches apart.

The high- and low-band arrays should be spaced any convenient distance apart greater than 45 inches.

TV MATCHING PADS

? *I would appreciate details on constructing resistive matching pads for connecting several receivers with 72-ohm antenna inputs to the 72-ohm output of a booster.—O. R. B., Greensboro, N. C.*

A. The diagram shows a resistive pad for connecting five 72-ohm receivers to a common 72-ohm signal source. Val-



ues of the series and parallel resistors depend on the number of receiver outlets. Refer to the table for values for a different number of receiver outlets.

TABLE

No. of Sets	Series Resistors (ohms)	Parallel Resistors (ohms)
2	56	100
3	100	100
4	120	82
5	150	82
6	180	82
7	240	82
8	270	82

TRANSMITTING TUBE TESTS

? *I service industrial and medical equipment which uses transmitting-type tubes. Since a defective component can quickly ruin a new tube substituted for the suspect, I am looking for details for testing tubes of these types. Can you supply a diagram of a tube checker or details on setups for testing industrial and transmitting tubes?—W. F. M., Oakland, Calif.*

A. There are a number of procedures for testing transmitting and industrial tubes. One method is to run a series of characteristic curves and compare these curves with those given in manufacturers' data on the tube being tested. Another method is to use a C-R tube curve tracer (see "Versatile Tube Checker," RADIO-ELECTRONICS, August, 1951) which enables the operator to instantly compare a tube of unknown

quality with a standard by comparing their traces on the curve tracer screen.

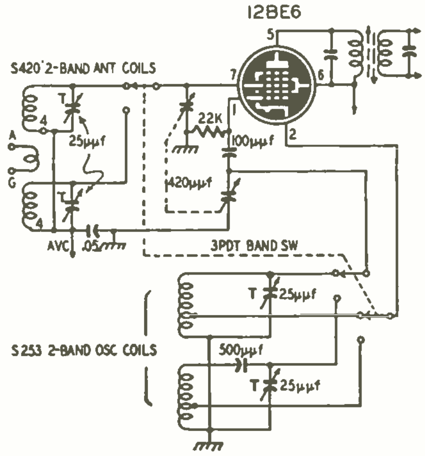
The May-June, 1951, issue of *G-E Ham News* is devoted almost entirely to procedures for testing 23 popular transmitting tubes including the 813, 4D21, 211, 807, 810, 811, and 2E26.

Copies of the May-June, 1951, issue of *Ham News* can be obtained from Tube Division, Bldg. 267, General Electric Co., Schenectady 5, N. Y.

ADDING A SHORTWAVE BAND

? *I want to convert a Fada model 740 5-tube, a.c.-d.c. broadcast receiver to a 2-band set for use on the broadcast and 6-15-mc bands. This can be done either by band-switching or using plug-in coils. The latter is preferable if I can get coils about the size of a 50B5 tube. This will permit mounting the coil socket between the 12BE6 and the front of the chassis. Can you help with this problem?—R. F. G., Washington, D. C.*

A. If you want to use plug-in coils, we suggest that you purchase miniature antenna and oscillator coils for the bands that you want to cover. The coils should be about ½-inch diameter and not more than 2 inches long.



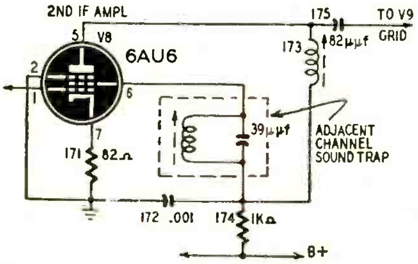
The present tuning capacitor has a 465-μμf section for the antenna and a 184-μμf cut-plate section for the oscillator. Replace this tuning capacitor with a unit of approximately the same over-all dimensions. The maximum capacitance of each section should be 420 to 467 μμf.

Sockets for the plug-in coils may be installed on a metal bracket fastened to the right side of the chassis close to the tuning capacitor. The 25-μμf trimmers and the oscillator padders can be mounted on top of or inside the small plug-in coil forms.

Band-switching coils will probably be just as easy to install and much more convenient for the operator. You can purchase 2-band coils which are about the same size as the broadcast oscillator and antenna coils that you are now using. You can use these as replacements and install a small switch to select the band that you want. The diagram shows how Stanwyck S-420 antenna and S-253 oscillator coils may be added to the set to give coverage on the broadcast and 6–18-mc bands. END

STEWART-WARNER TV SETS

Interference caused by the sound carrier of a lower frequency adjacent channel can be eliminated in the 26-tube chassis by installing an adjacent-channel sound trap. The trap (part No. 520131) is installed in the screen circuit of the second i.f. amplifier stage. The modified circuit is shown in the diagram. The installation can be simplified by following the procedure outlined below.



How the adjacent-channel sound trap is placed in 26-tube Stewart-Warner Sets.

1. Mount the trap coil in the hole directly in front of tube V9 (the 6AU6 third i.f. amplifier). (On the 9103, 9104, 9105, 9106, and 9108 series receivers, drill a 5/16-inch mounting hole for the trap.) Insert the coil from the under side of the chassis and push it through until the mounting clip snaps into place.
2. Disconnect resistor 174 (1,000 ohms) from pin 6 of V8, the second i.f. amplifier.
3. Carefully disconnect capacitor 172 (.001 μf) from the chassis ground and from pin 6 of V8.
4. Disconnect the second i.f. coil 173 from pin 6 of V8.
5. Connect one terminal of the trap coil directly to pin 6 of V8.
6. Connect the other end of the trap coil to the end of the second i.f. coil which was previously disconnected (in step 4.)
7. Connect the open end of resistor 174 to the junction of the second i.f. and the trap coils.
8. Connect one end of capacitor 172 —removed in step 3—to the junction of the two coils. Ground the other end to the chassis at a point close to the second i.f. coil.

To align the circuit, rotate the trap-tuning adjustment until the stem of the slug is as far out as possible. Use the fine tuning control to tune in a normal picture. *Do not touch this control during the rest of the adjustment procedure.*

Then connect a standard signal generator through a 330-μμf capacitor to point Q on the r.f. tuner and a v.t.v.m. across the video detector load resistor 196. (Refer to the manufacturer's diagram for proper connections.) Set the signal generator accurately to 28.25 mc. Adjust the adjacent-channel sound trap for *minimum* reading on the meter.

In fringe areas, it may be necessary to watch the screen and touch up the setting of the trap to reduce the interference to a minimum.—*Stewart-Warner Service Bulletin*

FM OSCILLATOR DRIFT

Excessive frequency drift in Motorola 1949, 1950, and 1951 FM receivers may be caused by a defective or incorrect temperature compensating capacitor in the FM oscillator circuit. This capacitor, located on the FM oscillator inductor assembly, has a value of 85 μμf and a negative temperature coefficient of either .000750 μμf per μμf per degree Centigrade (N750), or .001500 μμf per μμf per degree Centigrade (N1500). Table model receivers, which are tightly enclosed, generate more heat and require more compensation than relatively open consoles.

If frequency drift is objectionable during the warmup period, change the compensating capacitor. It may not have the correct temperature coefficient. If the oscillator drift requires retuning to a lower frequency on the dial, the compensation is too great. Compensation is too small if the set must be retuned to a higher frequency on the dial during warmup.

Replacement capacitors may be disc or tubular types. On the latter type, the temperature coefficient is indicated by the end dot. It should be either purple (for 750 parts per million) or orange (for 1,500 parts per million.). Disc type capacitors are marked directly in parts per million (PPM).

Motorola's *Service and Installation Bulletin* No. 3 (dated June 19, 1952), available from Motorola distributors, contains a printed table listing recommended conmpensating capacitors for all 1949, 1950, and 1951 Motorola FM receivers. This table should be taken as final authority for replacement capacitors, even though it may not agree in all instances with parts lists in the service manuals.—*Motorola Service Dept.*

OLYMPIC DX-621 COMBINATION

In the early models, hum may be heard occasionally on the AM-FM or PHONO positions. This can be eliminated by rerouting and shielding the three leads connected to the tone control-power switch. Disconnect the three leads from the a.c. switch and reroute them to run directly from the rear of the chassis to the switch. Cut off excess length of leads. Shield each lead with one 7½-inch length of spiral shielding (part SD-2340) and insulate with an 8-inch length of sleeving (part IT-1932). Ground rearmost end of shielding to the chassis. Connect a short jumper from the center lug (ground) of the three-terminal tie post under the record changer to the adjacent lug on which the shield braid of the phono pickup lead is soldered.

In these sets, bass response is normal when the set is operated on a hard-surfaced floor. On carpeted floors, low-frequency response may not be satisfactory. To increase it, mount a 3½ x 10½-inch piece of ⅛-inch tempered Masonite to cover the hole in the speaker baffle next to the speaker. Mount a 17½ x 16½-inch piece of the same material under the speaker on the shelf inside the speaker compartment.—*Olympic Television Service Bulletin*

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RADIO-ELECTRONICS
25 West Broadway, New York 7, N. Y.

CRYSTAL CARTRIDGE HINT

The output of a crystal pickup cartridge varies with temperature. Its output is higher at room temperature than at lower temperatures. Do not immediately reject a cartridge because of low signal output if it has been in cold storage or subjected to low temperatures. Wait until it has warmed up before passing final judgment.—*RCA Radio Phono Television Service Tips*

SPARTON 5006X AND 5007X

Reduced sensitivity and low audio output were encountered in the first production run of the 25TK10 TV chassis using a 6AX5 low-voltage rectifier for the 140-volt B-supply line.

The minimum allowable voltage on this line is 130. It has been found that the internal resistance of the 6AX5 increases enough to drop the voltage to 110–120 after the set has been operated for as little as 50 hours.

It is recommended that the 6AX5 be replaced with a 6X5 in cases where the voltage on the 140-volt line drops below 130. The 6AX5 has been replaced with a 6X5 in later production runs.—*Sparton Service Division Bulletin*

STANDARD COIL TUNER

Loss of sensitivity on all channels and split tuning on high-band channels have been encountered on several sets using Standard Coil type TV303 tuners.

In all cases, the trouble was caused by a break at the terminal on the converter plate coil.

The lead was resoldered to restore normal operation.—*A. D. Marikle*

PHILCO TV PRECAUTION

Always disconnect the outside antenna lead-in or pull the line cord from the outlet before replacing the back on Philco TV sets which use a tapered-line antenna circuit. Failure to observe these precautions may cause serious damage to the antenna input assembly.

If the antenna happens to be a folded-dipole type with a metal boom and a grounded mast, accidental contact between the high side of the power line and the chassis will cause the tapered-line assembly to become burned out.—*C. E. Wyatt*

ZENITH TV SETS

Smeary pictures in Zenith TV sets using the 24H20 chassis with interference in the form of horizontal lines, have, on several occasions, been traced to an open 10-μf decoupling capacitor in the plate circuit of the 12AT7 noise limiter. The trouble clears up when the capacitor is replaced.—*Jim Caveseno*

PHILCO 45-131

If the set is dead, the trouble is most likely traceable to an open circuit in the primary of the output transformer which is mounted underneath at the back of the chassis. If the replacement does not fit the holes used to mount the original unit, you can probably use one or more of the holes which you will find close to the position occupied by the original component.—*Howard Simpkins*

END

G. W. Duckworth was named manager of the equipment sales field force of the RCA TUBE DEPARTMENT in a realignment of the company's equipment sales activities. At the same time, four veteran field representatives were made managers of newly created districts.

Left to right, rear: C. R. Klinger, J. W. Kirschen, L. D. Kimmel. Front: G. W. Duckworth and J. H. Mosher.

They are: J. W. Kirschen, Eastern district; C. R. Klinger, Western district; L. D. Kimmel, Central district; J. H. Mosher, Interdepartmental district.

William W. Taylor, formerly assistant sales manager of the Capacitor Division of the SANGAMO ELECTRIC Co., Marion, Ill., was appointed sales manager. He succeeds John Giltner Twist who resigned to become a manufacturers' representative in Chicago. H. Laurence Kunz, general manager of the Division, was elected vice-president. He will continue as general manager of the Capacitor Division.

John H. Hauser joined HYTRON RADIO & ELECTRONICS Co., Danvers, Mass., as renewal tube sales manager, according to an announcement by John Q. Adams, vice-president in charge of sales. Mr. Hauser was formerly with Sylvania Electric.

J. H. Hauser

W. Walter Jablon was appointed vice-president in charge of sales of the DAVID BOGEN Co., New York City manufacturer of electronic equipment. He was formerly with Espey Manufacturing Co.

W. W. Jablon

Leon Golder joined CARBONNEAU INDUSTRIES, INC., Grand Rapids, Mich., as general sales manager. He was formerly chief of the Radio and Television Section, Electronics Division of the NPA. Prior to that he had been

L. Golder

with the Rola Co. and Magnavox in executive positions.

Floyd A. Hayhurst was promoted to staff assistant to Edward C. Tudor, president of I.D.E.A. (REGENCY), Indianapolis, manufacturer of Regency boosters and converters. Hayhurst was formerly purchasing agent for I.D.E.A.

F. A. Hayhurst

Lou Burzyoki joined CREST LABORATORIES, Rockaway Beach, N. Y., as chief transformer engineer. He was formerly affiliated with Berkshire Transformer Co.

L. Burzyoki

Personnel Notes

. . . Walter E. Peek has joined CENTRALAB, a division of Globe-Union, Inc., Milwaukee, as sales manager of the Mechanical Electronic Products Section, which covers variable resistors and wave-change switches, according to an announcement by W. S. Parsons, Centralab president.

. . . R. H. Siemens was appointed manager of kinescope equipment sales and J. T. Wilson, manager of receiving tube equipment sales of the RCA TUBE DEPARTMENT in a move to create separate kinescope and receiving-tube sales functions. Previously, Siemens had administered both kinescope and receiving tube sales. Wilson was formerly field application engineer for the Tube Department's Equipment Sales Section.

. . . A. D. Davis, president of ALLIED RADIO CORP., Chicago, presented a gold watch to Max Hechter, assistant purchasing agent, to mark his 25 years with the company. The presentation was made at a meeting to organize an Old-Timers Club of employees associated with the company 20 years or more.

. . . Kenneth A. Giffin was appointed district sales manager for the GENERAL ELECTRIC TUBE DEPARTMENT in the Western region. He was formerly with Aeronautical Radio, Inc.

. . . E. T. Spence of the Special Sales Division of ALPRODCO, INC., Mineral Wells, Texas, was appointed director of sales for all states along the Atlantic seaboard. The company manufactures aluminum TV towers and the Erectower, portable trailer-tower device for dealer use.

. . . Arthur L. Chapman, a vice-president of SYLVANIA ELECTRIC PRODUCTS, INC. for the past two years, was named vice-president in charge of electronics operations of the company.

. . . Charles Weyl, formerly executive vice-president of INTERNATIONAL RESISTANCE CO., Philadelphia, was elected president. Ernest Searing, former president, was elected chairman of the Board of Directors. END

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1R5	.61	6BC5	.56	6X5	.33
1S5	.52	6BG6	1.40	12AT7	.73
1T4	.61	6BE6	.49	12AU6	.48
1U4	.60	6BQ6	.90	12AU7	.57
1X2	.68	6C4	.40	12BA6	.48
3Q4	.65	6CB6	.56	12BE6	.48
3Q5	.70	6CD6	1.79	12SA7	.57
3S4	.60	6J5	.40	12SK7	.55
5U4	.45	6J6	.71	12SN7	.57
5Y3	.35	6K6	.48	12SQ7	.47
6AC7	.80	6S4	.51	19BG6	1.44
6AG5	.56	6SA7	.57	25BQ6	.90
6AK5	1.15	6SK7	.55	25L6	.50
6AL5	.45	6SQ7	.47	35W4	.34
6AQ5	.51	6SN7	.57	35Z5	.40
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6AU6	.45	6V6	.51	50L6	.53

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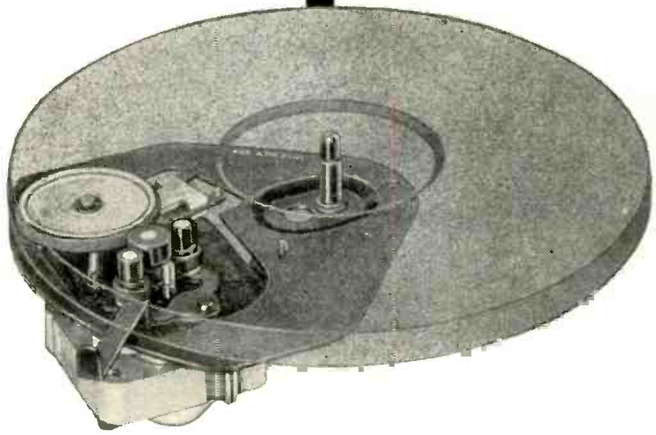

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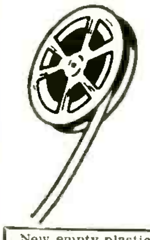

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THE FUND NEARS $10,500

HELP - FREDDIE-WALK FUND

There is always a distinct feeling of anticipation when we here at RADIO-ELECTRONICS open the Help-Freddie-Walk Fund mail, for it's fun to meet at first-hand the many friends of little Freddie Thomason, four-year-old son of Herschel Thomason, radio technician of Magnolia, Arkansas. Freddie was born without arms or legs, but his faith and courage are mirrored in the hundreds of letters we have received.

The following are excerpts from letters received this month:

"As I looked through my RADIO-ELECTRONICS I noticed the Help-Freddie-Walk Fund. I brought it to the attention of our team chief, and he suggested I contact the other team members, who each donated $2.00. They are: Lt. Col. Willis B. Scudder, Maj. Charles T. Boyle, Capt. Arthur E. Lomax, M/Sgt. Dewey Duckworth, M/Sgt. Robert F. Strosnider, and Sgt. Joseph T. Olwick." A picture of the entire team, all working with the Turkish Military in Erzurum, Turkey, was forwarded to Freddie.

"We are pleased to enclose our check in the amount of $50.00, with our best wishes for Freddie and you all," from the Radiotelephone Communicators of Puerto Rico, San Juan, Puerto Rico.

With a check for $10.00 comes a note: "Please accept this small contribution towards your fund. We all wish that we could contribute a whole month's pay—but we hope this will help just a little," from the 1st Inf. Div. Signal Repair Team #2, A.P.O. 1, c/o Postmaster, New York.

We should also like to mention the special Christmas greetings received from Linda Zeiher, age 4½, of Jackson Heights, N. Y., with her $2.00 donation.

Although the Help-Freddie-Walk Fund has now topped $10,400, the fight is just beginning. We urge each and every one to help this worthy cause by sending in his contribution, small or large, as soon and as often as possible. No donation is too small to receive our sincere thanks and acknowledgment. *Make all checks, money orders, etc., payable to Herschel Thomason.* Address all letters to:

HELP-FREDDIE-WALK FUND
c/o RADIO-ELECTRONICS Magazine
25 West Broadway
New York 7, New York

FAMILY CIRCLE CONTRIBUTIONS

Balance as of December 22, 1952	$ 577.50
Anonymous, Washington, D. C.	1.00
FAMILY CIRCLE Contributions as of January 20, 1953	$ 578.50

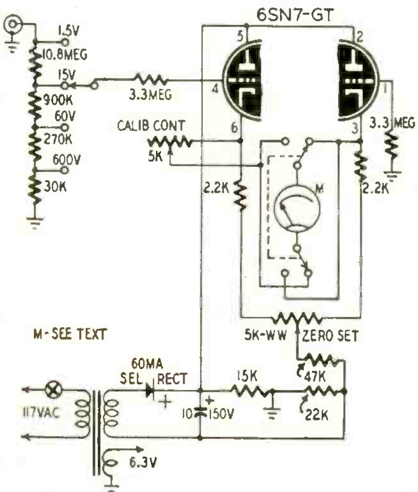
RADIO-ELECTRONICS CONTRIBUTIONS

Balance as of December 22, 1952	$9,731.22
A Friend, Worcester, Mass.	2.00
Anonymous, S. S. Irvingdale	2.00
Fred R. Courtney, Brooklyn, N. Y.	5.00
John Doe, Monterey Park, Calif.	10.00
1st Inf. Div. Signal Repair Team #2,	

A.P.O. I, N. Y.	10.00
Michael Gaffney, Lyndhurst, N. J.	1.00
P. Hoffman, E. Paterson, N. J.	5.00
M. Jarnagin, Arlington, Va.	1.00
Johns Radio Service, Griffith, Indiana	1.00
Edward T. Jones, RCA, Camden, N. J.	2.00
Sgt. Joseph T. Olwick, on behalf of his Team, working with the Turkish Military, Erzurum, Turkey	12.00
Radio Maintenance Shop, Augusta, Georgia	5.00
Radiotelephone Communicators of Puerto Rico, San Juan, Puerto Rico	50.00
Walter A. Upson, 16 Bateman St., Haverhill, Mass.	5.00
Linda Zeiher (age 4½), Jackson Heights, New York	2.00
RADIO-ELECTRONICS Contributions as of January 20, 1953	$9,844.22
FAMILY CIRCLE CONTRIBUTIONS	578.50
TOTAL CONTRIBUTIONS as of January 20, 1953	$10,422.72

CORRECTION

When the "Low-Cost V.T.V.M." is connected according to Fig. 1 on page 46 of the December, 1952, issue, the meter will not operate. The corrected circuit is shown here.



The original schematic showed an excessively high cathode bias.

Radio Thirty-Five Years Ago
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Television News	1931

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

March 1919
ELECTRICAL EXPERIMENTER

Underground Wireless & Sub-sea Radio, by H. Gernsback
My Inventions, by Nikola Tesla
Amateurs Win; Wireless Bill is Killed, by H. Gernsback
The Rogers Underground Wireless, by H. Winfield Secor
How I Invented the Audion, by Dr. Lee de Forest
Gigantic French Radio Station

TRANSFORMER POLARITY

Dear Editor:

In the article "Saturated-Core Light Flasher" by Erwin Levey on page 62 of the December issue of RADIO-ELECTRONICS, the author suggests a method for checking polarity of the transformers. For safety, a much lower voltage (any filament supply) could be used instead of 117 volts a.c. to obtain the same results. If 117 volts is used, the supply voltage should be connected to the high-voltage instead of the low-voltage winding to avoid stepping up the voltage during the test.

There are two other methods for checking polarity of transformers. The first uses a small pocket magnetic compass and a single 1.5-volt dry cell. The compass is placed above the iron core of the transformer and a 1.5-volt dry cell is connected to either winding. The movement of the compass should be noted and also which lead is connected to the positive pole of the battery. The leads are marked accordingly. The other winding can be tested in the same manner noting the direction of the flux around the core as indicated by the compass. Coil connections should be changed if necessary to obtain the same indication of flux direction as for the other winding. The low tension and high tension leads which were connected to the positive terminal +, or following the article's markings, of the dry cell can be marked A and C respectively. The other transformer can now be checked in the same manner. If the transformers are identical and the leads are colored, the positively connected leads will be the same on each transformer which is a further check as to correct polarity.

The second method calls for a dry cell and a 5-volt or 10-volt d.c. voltmeter. For a transformer with 450 volts total secondary voltage, a 1.5-volt meter is large enough, although higher range meters will give sufficient indication. Connect the voltmeter across one winding. Connect the 1.5-volt dry cell across the other winding through an s.p.s.t. switch. The switch should be left open until all other connections are made. Close the switch while watching the voltmeter. The voltmeter will either kick up momentarily in the positive direction or show reversed polarity. If the latter, reverse the connections to the dry cell. The voltmeter will now kick up when the switch is closed and immediately return to zero. On opening the switch, the meter will kick downward momentarily. Mark the transformer lead which is connected to the positive terminal of the dry cell. This lead becomes either A or C depending on which winding of the transformer is being checked. The other winding and the other transformer can be checked and leads marked in a similar manner. Then transformers can be connected in series or parallel as required, by simply observing the markings.

J. H. BROWNELL, VE4BU
Pointe du Bois, Manitoba

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.

CAPACITOR CATALOG

Wells' 1953 capacitor catalog lists a wide variety of mica, paper, oil-filled, electrolytic, and variable capacitors.

Free of charge from Wells Sales Inc., 833 West Chicago Ave., Chicago 22, Ill.

JFD CATALOG

JFD's 1952-1953 "*Television Almanac*" is a well-illustrated 35-page catalog listing television antennas, mounts, boosters, masts, lightning arresters, and screw-eye standoffs. The antennas are fully described, and of special interest are the Jetenna conical and the Baline Yagi.

Request Catalog No. 450 from JFD Mfg. Co., Inc., 6101 16th Ave., Bklyn 4, N. Y.

TRANSFORMER CATALOG

A 15-page transformer catalog listing audio and power transformers and chokes has been released by Peerless.

Copies free on request to Peerless Electrical Products, 161 6th Ave., New York 13, N. Y.

MASTER TV SYSTEMS

A manual giving complete technical data on all types of master TV systems, *The B-T Unit System for Better Television*, has been issued by Blonder-Tongue. It describes the characteristics and functions of the various units and accessories and gives information on the layout of a master system, the locations and installation of various units, and the elimination of interference.

Gratis from Blonder-Tongue Laboratories, Inc., 526 North Ave. E., Westfield, N. J.

AUDIO CATALOG

Terminal Radio Corporation's new 128-page *Audio Catalog* is divided into five sections: home music, public address, recording, broadcast, and special equipment. Completely indexed, it should be of interest to music lovers, sound engineers, and installation men.

Copies may be obtained free of charge by writing to Terminal Radio Corp., 85 Cortlandt St., New York 7, N. Y.

MICROWAVE CATALOG

Titeflex, Inc. has issued a 12-page catalog describing its line of microwave components. The booklet includes specifications for both rigid and flexible waveguides, plus schematic diagrams and application charts.

Available free of charge from Titeflex, Inc., 500 Frelinghuysen Ave., Newark, N. J.

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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.

TV TRANSMITTERS

A 12-page bulletin giving technical details of the complete range of TV transmitting equipment made by Standard Electronics Corporation is now available. It presents the electrical and mechanical specifications of the S-E 500-watt visual—250-watt aural—basic unit with final amplifiers providing complete transmitters of 5, 10, and 20 kw output.

Request Bulletin TTS-61 from Standard Electronics Corp., 285-295 Emmett St., Newark 5, N. J.

INDUSTRIAL RELAYS

Automatic Electric Co. has released a color-illustrated brochure describing its line of telephone-type relays, including hermetically sealed (in metal and glass containers) subminiature, plug-in types.

Request brochure 1702-A from Automatic Electric Co., 1033 Van Buren St., Chicago 7, Ill.

MASCO CATALOG

Mark Simpson has issued its new general catalog of 1952, revising catalog No. 50. The 24-page booklet describes high-power and high-fidelity amplifiers, transcription, mobile, and preamplification equipment, as well as institutional or school control amplifiers with microphone, radio, and phonograph inputs for up to 40 locations.

Separate individual catalogs list intercommunication equipment, tape recorders, television boosters, and the Masco economy line.

All available gratis from Mark Simpson Mfg. Co., 32-28 49th St., Long Island City 3, N. Y.

TRANSFORMER CATALOG

Stancor's revised 24-page catalog and replacement guide contains over 500 separate listings of transformers and related components and includes a separate TV component section. It is indexed. There are sections for hi-fi, input, interstage, output, driver, modulation, power, filament, plate, and isolation transformers and filter chokes. Also included is an output transformer chart, matched power supply chart, and data on the Stancor-Williamson amplifier.

Available free of charge from Standard Transformer Corp., 3580 Elston Ave., Chicago, Ill.

CIRCUIT BREAKERS

Manual 101, explaining operating principles of basic circuit-breaker designs and providing engineering data on factors of application, has been released by Heinemann Electric Co.

Simplified diagrams show the three basic types of circuit breakers in general use. There are explanations of temperature factors, inrush current effects, tripping and reset time, and time delay.

Available on request to Heinemann Electric Co., 342 Plum St., Trenton 2, N. J. END

ESSENTIALS OF MICROWAVES, by Robert B. Muchmore. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y. 5¾ x 9 inches, 236 pages. Price $4.50.

Every serious reader, whether novice or technician, can benefit from a book that features *logic* and *completeness*. This book gives a good physical explanation of the basic electromagnetic laws. Then it shows that waves and fields obey these laws. Math appears in only a few places. Illustrations appear throughout.

The practical and detailed approach of the author will make the book particularly useful to technicians lacking in mathematical training, or to engineers and scientists in other fields who may not have the time to plod through the demonstrations of a so-called "rigorous" work. The author has contented himself with simply presenting the information. The practical reader will be grateful for this, since in most cases he is much more interested in the facts than in knowing how they were developed.

Wave guides, cavity resonators, antennas and filters are developed from more conventional h.f. components. Slot antennas and microwave lenses are treated in detail. Then material is presented on tubes. Klystrons, magnetrons, lighthouse and travelling wave types are analyzed. Microwave applications and measurements follow.

This book should dispel much of the mystery that sometimes seems to surround microwaves.—*IQ*

EVERYBODY'S TELEVISION AND RADIO HANDBOOK. Published by Popular Science Publishing Co., New York 10, N. Y. 6½ x 9½ inches, 255 pages. Price. $2.49.

This book is a compilation of approximately 200 hundred "how-to-do" and "how-it-works" articles and short items reprinted from *Popular Science* magazine.

Although a number of the articles are quite basic and would be of greater interest to the general public than to the average experimenter or technician, a number of articles describe the construction of items of interest to the radio and electronic experimenter and gadgeteer. Among these are:

A power converter which operates from 115-volt, 60-cycle lines and delivers 115 volts a.c. at frequencies which permit 78-r.p.m. synchronous phonograph motors to be operated at 45 or 33⅓ r.p.m.

An electronic target range like those commonly seen in penny arcades and other amusement centers.

An induction-type model control system that does not require a licensed operator. Details include diagrams of the receiver and transmitter which operate on about 115 kc.

A vacuum-tube driven Tesla coil for experimental and demonstration purposes.

Also included is the usual array of receiver and TV booster diagrams along with short articles on simple servicing kinks and methods of improving reception.—*RFS*

END

PHOTOGRAPHS

RADIO-ELECTRONICS can use good photographs of service benches, service shops, high-fidelity audio layouts, and any other interesting and original radio-electronic photographs.

We will pay $6.00 each for good professional photos or equivalent, suitable for reproduction.

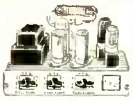
Full information on subject photographed will increase their acceptability.

The Editor, RADIO-ELECTRONICS
25 West Broadway, New York 7, N. Y.

ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in above index.

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 200MO Mike OSC. Broadcasts Through Your Radio with No Direct Connection. W/Tubes **$6.98**
Model 100PO Phono OSC Phonograph Broadcasts Through Your Radio. No Direct Hookup. W/Tube **$4.98**
Model 302PA 3 Tube Phono Ampl. Ideal for Custom Building Your Phonograph. W/Tubes **$4.98**

AUDIO COMPONENTS

GE RPX041 Phono Cart... **$4.49**
GE RPX050 Triple Play Cart **5.69**
Electrovoice Triple Play... 2.69
Pickup Arm & Xtal Hi-Outpt 2.39
PM 12" Hi-Fi British Speaker 4.98
PM 12" GE S1201D Speaker **19.00**
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 40-20 KC 19.98
Crystal Mike & Cable 3.98
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Crystal Mike Cart. Ceramic Wetpruf... 3.98

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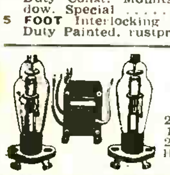
WINDOW CONICAL ANT. All Channel, Hvy Duty Const. Mounts outside your window. Special **$3.95**
5 FOOT Interlocking Mast Sections, Hvy Duty Painted, rustproof .... **.95c**



866A KIT and XFORMER

2 Tubes, Sckts, xmfr, 115v60cyc Inpt, outpt 2.5vct/10A/Hivins **$5.49**

KITS AND COMPONENTS

SPRGE CRP3 Vert Integrator Netwk 3 Res 3CNDSR only **3 LEADS 29c; 5 for $1.00**
[illegible] **CERAMIC** 2X.004 mfd/600V **6 for 1.00**
VARIAC 200CU 5A Reconditioned... **14.98**
[illegible]AC 200CU Brushes $.49 @ 5 for 2.00
[illegible] PWR Magnifier & Condsr Lenses **69c** .... **4 for 2.00**
S[illegible]ver & Mica Cndsrs .... **30 for 2.50**
[illegible] 30 ohm to 2 Meg... **10 for 2.50**
Resistors. ½ & 1W, to 2 Megs. 100 for 1.98
[illegible]ous W.W Resistors .... **5 for .69**
Sockets, Asstd. 8, 7, 5, 4P... **25 for 2.49**
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0-30VDC Aircraft Type "AN" as Illustrated— **$1.95; 3 for $5.25**
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0-60ADC "AN" type Special...**$3.25; 3 for $9.00**
0-24UADC "AN" type..**$3.49; 3 for $9.75**
-20 3VU Weston 301 Vol. Level Indicator........ Brand New **$14.98**

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Equiv to 12"—Only 2⅛" Radius. LAMINATED—Print Stays On! Mult, Div, Sqs, Cubes & Roots, Log, Decimal Equiv Data, Case .... **.98c**
Parallel Rules. Precision Drafting Tool Mfr. BRUNING 6" wide. For Radiomen, Engineers, Students—Unsurpassed for Quick Ckt Diagrams. **SPECIAL ..39c; 3 for $1.00**

TEST EQUIPMENT

Model 102—Pocket multimer features: AC&DC 10 rngs to 3000V, AC current 3 rngs to 600 ma, DC current 4 rngs to 1.2 amps, ohms 2 rngs to 1 megohm. Compact, accurate & durable construction. Std mfgr. **"TAB"** GTD display model.
SPECIAL Post Paid **$13.98**
Model 106—Vacuum tube volt meter. Features include: AC&DC 10 rngs to 1000V, ohms 5 ranges to 1000 megohms, 5 DB ranges. AC freq. response 25 to 100,000 cycles. Designed for field alignment of TV & Radio sets. Std mfgr. **"TAB"** GTD display model.
SPECIAL Post Paid........ **$33.49**
Model 106—In kit form **SPECIAL** Post Paid **$22.98**
Model HVP—30,000 Volt probe for model 106. Display model **"TAB"** GTD.
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Model 206P—Real Mutual Conductance Tube Tester. Checks all latest tubes, Industrial, Radio & TV types. Tests all elements for gas, shorts, opens & leakage. Meter 4½" reads Microhmos, English Scales Reject & Good. Roller Chart. GTD includes Factory Warranty & New Test Information as available. **"TAB"** GTD Display Model. Post Paid **$80.00**
Write For Test Equip Pamphlet

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Horiz Def Output & Hivolts xmfr SIM RCA 211T5, for 15"—16" picture tubes... **$1.98**
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Hivoltage Condenser 500MMF 15KV... **.65**
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ION TRAP permanent magnet type... **.79**
RG59U Cable per ft **.08**; 100 ft **$5.98**
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Laboratory Features. 5 M C Bandwidth, 10MV Sens. PP Horiz & Vert Amp., Cathode Coupled Multi Vib Swp, Int Retrace, Cathode F'lwr Inpt Vert & Horiz Amp, Non-Freq Discrim Gain Cntrl, Cal Compensated Attenuators, Sync Pos or Neg Intrnl or Externl, Inbuilt Cathode F'lwr for Sig Tracing with Phones, Intrnl Calib Voltage. Tech Manual. All Data Diagrams. 13 Tubes. Complete—Incld 3BP1 C'Ray Tube. **Write for Complete Data.**
A "TAB" SPECIAL only $99.50

"TAB" THAT'S A BUY

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3AG: ⅛, ¼, ½ Amp. Ea. **5c**; 100 for **3.98**
3AG: 1, 1½, 2, 3, 4, 15, 20 Amp. Ea. **3c** .... 100 for **2.49**
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4AG: BUSS 10 Amp. Ea. **7c**... 100 for **5.98**
4AG: ¼, ½ Amp. Ea. **7c**... 100 for **5.98**
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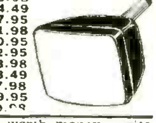
5AG: 35, 80 Amp. Ea. **5c**;... 100 for **3.98**
HOLDER 1075 Littelfuse **20c**;. 10 for **1.75**
HOLDER Dual 3 or 4 AG **15c**; 8 for **$1.00**

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**
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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.

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Pliers 6" Long, Nose & Side Cutters. **89c**
Pliers 6" Side Cutter **89c**
Pliers Linesmans 7" Heavy Duty.. **79c**
All (3) Pliers Listed Above **$2.25**
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Utility Screw Driver Set 3 Standard & 2 Recess Interchangeable Blades. W/Wrap Around Plastic Case... **79c**
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29 Piece Drill Set. 1/16" to 1/2" Vanadium Speed Steel. Std. Length. **$8.69**
Spiral Ratchet Screw Driver & Drill, W/3 Drill Bits & 1 Sd Blade.. **$2.25**

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16MFD/660VAC/3000VDC Intermit't. **7.95**
32MFD/1.2KVDC/23W. Sec. **7.49**
27MFD/1.2KVDC/2KVDC Int. **54W. Sec. 8.95**

TAB "SUN-FLASH" LAMPS

"Tab" No.	Replaces	W-Sec. Max.	Each
U5W	GE FT105	100	$5.98
U10	GE FT114	100	7.25
No. 1	AMGLO 5804X	100	10.98
23ST	GE FT 210	200	9.98
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23MT	FT 214	250	9.98
22ST	FT 110	200	9.98
353GTQ	FT 503	5000	49.98
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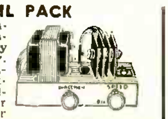
DX	SPRGFA100	150	9.00

Write for Complete "THRIFTLITE" Data Boosterpacks, Ext lites, Units for Focal plane shutters & accessories. We Bu[y], Sell & Swap.

TABOGRAM
WRITE FOR IT
WE STOCK LARGE VARIETY OF COMPONENTS. TELL US YOUR NEEDS. SELL US YOUR TUBES & EQUIPMENT.

"HO" RAIL PACK



0 to 12 VDC/2 Amp. Variable DC supply, uncased and completely built—inpt. 115v/60 cy. Usable LAB supply, filament D. C. plating, battery charging, model railroad, includes voltage or speed control and center off reversing sw. Ideal for two "HO" locomotives .... **$10.95** **2 for $20.00**

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We specialize in Rectifiers and Power supplies to your specifications. Immediate delivery.

Current (cont.)	18/14 Volts	36/28 Volts	54/40 Volts	130/100 Volts
1AMP	1.35	2.15	3.70	7.50
2AMP	2.20	3.60		10.50
4AMP	4.25	7.95	12.95	25.25
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
30AMP	20.00	38.50		
36AMP	25.00	48.50		

Full-Wave Selen Rect & Trans. in Kit Form. All 115V/60 cy inputs
up to 14VDC at 12 amps........ **$18.98**
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18.8—19.2—20.4—21.4Volts/12Amp. $10.98
31—32—34—36Volts/12Amp 2 Kvins. 13.98
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18—12—9—CT—9—12—18V/12Amp. 16.75
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18V/2Amp $2.75; 28-24-20V/4A.. 4.69

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4 Amp .07 Hy	.6	Ohm	$7.95
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10-0-10V (CT) 120 Amp., fan cooled. Replace your old inefficient sulfide rectifier w/new selenium type. SPECIAL .. **$13.75**

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SPST miniature size 115V/60CY 3A contacts **98c**; 3 for **$2.75**
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SPNO 115 V AC, 15A CTS S'Dunn **$2.98**
DPDT & SPNO 12 V DC, 10 A CTS **$2.98**
DPDT Clare SK 5010, Octal Base 18-28V 2Amp Cts, Nitrogen Sld. **$1.49**; 4 for **$5.00**
DPNC & SPNO Clare Telephone Type 115VAC, Octal Base........ **$4.25**

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Made by General Radio. Model 200CU, Rated 0-135 Volts at 5 Amp. Reconditioned, Tested and "TAB" Guaranteed.... **$16.98**
"GR" 100R/0-230V/2KW/9A **30.00**
"GR" 50B/0-270V/7KW/28A **110.00**
Brushes 200CU & 116/116V. 49c; 5 for $2

TOGGLE SWITCHES

SPST GE BKLT CSD 3A/250V .... **25c; 5 for $1.00**
SPDT AHH BKLT CSD 3A/250V .... **35c; 4 for $1.00**
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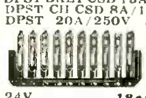
DPST BKLT CSD 15A/125V. **89c; 3 for $2.50**
DPST CH CSD 8A/125V... **65c; 5 for $2.95**
DPST 20A/250V .... **$1.25; 3 for $3.25**



SOCKET ASSEMBLY for 10 slide lamps. Excellent on-off indicator for control panel. As illustrated with lamps. **$2.98**
SLIDE LAMP, type T-2, 24V .... **18c; 10 for $1.50**
SLIDE LAMP, type T-2, 12V **18c; 10 for $1.50**
PILOT LIGHT SOCKET BAYONET with ½" Jewel .... **45c; 10 for $3.49**
PILOT LIGHT SOCKET 1" Jewel, Hi-Polish Finish, **"TAB"** Special.. **75c; 10 for $6.49**
1" LIGHT SOCKET, w/115V 6 Watt Bulb. **85c**

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***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 Guarantee Tubes.**

0A2	.95	6BQ7	1.65	12BH7	1.29	CK538DX	.98
0A3/VR75	1.04	6BY5G	1.45	12BY7	1.35	CK539DX	2.19
0B2	1.37	6CB6	.69	12BZ7	1.25	CK541DX	1.99
0B3/VR90	1.09	6CD6G	1.69	12SA7GT	.69	CK542DX	.99
0C3/VR105	1.15	6D4	2.70	12SC7	.80	CK543DX	.99
0D3/VR150	.90	6J4	6.66	12SF5GT	.72	CK544DX	.99
1B3/8016	.81	6J5GT	.47	12SF7GT	.49	CK546DX	1.99
5R4GY	1.39	6J6	.63	12SG7	.83	CK547DX	1.98
5R4GYW	1.75	6K4A	6.45	12SH7	.63	CK571AX	2.49
5U4G	.69	6L6	2.09	12SJ7GT	.59	CK573AX	3.49
6AG5	.79	6L6G	1.35	12SK7	.72	CK1005	.85
6AG7	1.39	6L6GA	1.35	12SL7GT	.65	CK1027	2.98
6AH5G	1.49	6L6GAY	2.29	12SN7GT	.75	CK1028	1[illegible]
6AH6	1.22	6SA7GT	.63	12SQ7GT	.63	CK1089	2.99
6AJ5	1.40	6SA7GTY	3.37	19T8	1.09	CK1090	2.98
6AK5	.74	6SB7Y	1.19	19V8	1.62	CK5672	1.29
6AK5W	2.98	6SC7	.90	25BQ6GT	1.19	CK5676	1.29
6AK6	1.05	6SD7GT	.80	25L6GT	.69	CK5678	1.89
6AL5	.54	6SF5	.77	25Z5	.79	5687	5.49
6AL7GT	1.29	6SF7	.73	25Z6GT	.99	CK5702	3.49
6AN5	2.90	6SG7	.72	28D7	1.95	CK5703	1.29
6AQ5	.55	6SH7	.61	35Z5GT	.59	Xtal Diodes	
6AQ5W	3.98	6SJ7	.70	50L6GT	.69	1N21A	1.55
6AQ6	.81	6SK7GT	.69	80	.69	1N21B	2.89
6AQ7GT	1.29	6SL7GT	.69	81	1.69	1N21C	21.50
6AR6	2.98	6SN7GT	.70	82	1.19	1N22	1.25
6AS5	.79	6SN7WGT	2.25	82V	1.39	1N23	1.35
6AS6	2.43	6SQ7GT	.63	83	1.45	1N23A	2.20
6AS7G	4.65	6SR7	.65	83V	1.79	1N23B	3.49
6AT6	.63	6SS7	.75	84/6Z4	.99	1N25	4.98
6AU5GT	1.10	6ST7	.98	117L/M7GT	1.59	1N26	8.75
6AU6	.59	6SU7GTY	2.69	117N7GT	1.79	1N27	1.55
6AV5GT	1.29	6V6	1.39	117P7GT	[illegible]	1N29	3.50
6AV6	.49	6V6GT	.57	117Z6GT	1.19	1N32	23.75
6AW6	1.89	6W4GT	.57	117Z7GT	1.49	1N34	.64
6B4G	1.23	12AH7GT	1.45	CK501X	1.26	1N34A	.90
6BA6	.63	12AK5	1.98	CK501AX	2.20	1N35	1.65
6BA7	1.27	12AK5W	[illegible]	[illegible]	1.79	1N38	1.43
6BC5	.63	12AL5	.75	CK502AX	1.49	1N39	4.15
6BC7	1.23	12AT6	.52	CK503AX	1.49	1N44	1.24
6BD5GT	1.65	12AT7	.81	CK505AX	1.79	1N45	1.45
6BD6	.83	12AU6	.72	CK506AX	1.49	1N47	4.00
6BE6	.59	12AU7	.63	CK509AX	1.79	1N48	.55
6BF5	.98	12AV6	.49	CK512AX	1.45	1N51	.45
6BF6	.65	12AV7	.98	CK522AX	1.29	1N52	1.62
6BF7	2.55	12AW6	1.79	CK525AX	1.29	1N54	.89
6BG6G	1.39	12AX4GT	1.20	CK526AX	1.49	1N56	.89
6BG7	1.98	12AX7	.79	CK528AX	1.49	1N57	.89
6BH6	.63	12AY7	2.95	CK529AX	1.79	1N58	1.19
6BJ6	.69	12AZ7	1.49	CK531DX	1.89	1N60	.60
6BK7	2.15	12BA6	.59	CK532DX	1,89	1N61	2.10
6BL7GT	1.45	12BA7	.79	CK533AX	1.29	1N63/K63	2.49
6BN6	1.49	12BD6	1.23	CK534AX	.99	1N64	.69
6BN7	1.69	12BE6	.59	CK536AX	.99	1N67	1.95
6BQ6GT	1.20	12BF6	.85	CK537AX	3.04	1N69	1.19

CIRCUIT BREAKER FUSES

PUSH TO RESET
Amps 3—5—7—10—15—20 Ea. **27c**; 4 for **$1.**; 25 for **$5.**; 100 for .... **$18.**
Circuit Breaker Fuse W/2 Mounting Clips **39c**
3 for $1.00; 20 for **$5.98**; 100 for **$25.**
Fuse is 3AG Size, Operates up to 24 Volts
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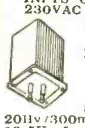

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