MARCH 1954

RADIO-ELECTRONICS

TELEVISION • SERVICING • HIGH FIDELITY

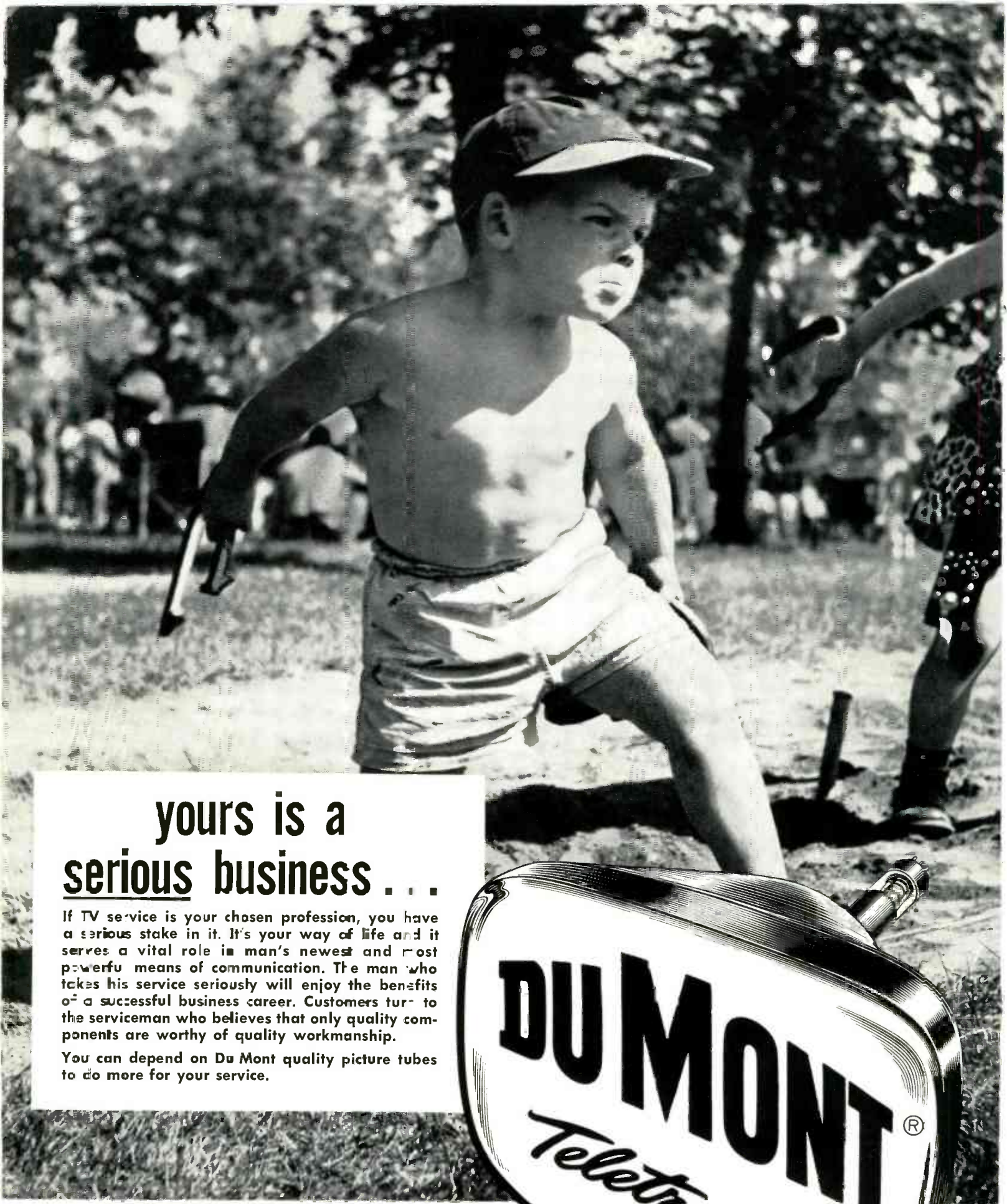
HUGO GERNSBACK, *Editor*

In this issue:

Design Testing U.H.F. and V.H.F. Antennas

(See page 4)

35¢
U. S. and CANADA



yours is a serious business . . .

If TV service is your chosen profession, you have a serious stake in it. It's your way of life and it serves a vital role in man's newest and most powerful means of communication. The man who takes his service seriously will enjoy the benefits of a successful business career. Customers turn to the serviceman who believes that only quality components are worthy of quality workmanship.

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Replacement Sales, Cathode Ray Tube Division
Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

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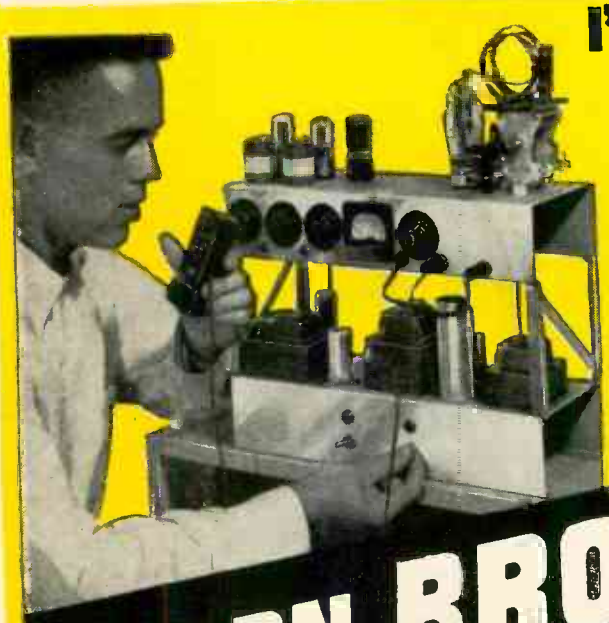

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with parts I send. Use it to get practical experience. Put this station "on the air." Perform procedures required of broadcasting station operators, conduct many experiments, make practical tests.

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YOU PRACTICE setting up code, amplitude and frequency modulation circuits (put voice, music, etc., on "carrier signals" you produce). You learn how to get best performance.

YOU BUILD this Wavemeter and use it to determine frequency of operation, make other tests on transmitter currents.

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Forestry Service Dispatcher
Airways Radio Operator

POLICE RADIO
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Service Technician

AVIATION RADIO
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Airport Transmitter Operator

TELEVISION
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Voice Transmitter Operator
TV Technician
Remote Control Operator

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"I am a technician at WTOP in Washington and I like it very much. Most of my radio knowledge was from N.R.I."—John Britto, Hyattsville, Md.

"A former employer recommended N.R.I. training. Now employed as transmitter operator at WKBO."—Albert Herr, New Cumberland, Pa.

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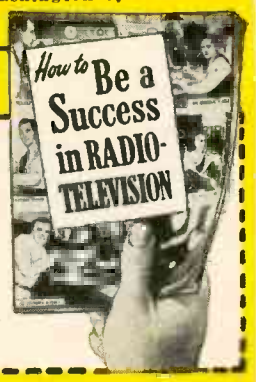

RADIO — ELECTRONICS

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

ON THE COVER *(More details on page 61)*

Measuring the characteristics of a new u.h.f. antenna at the Channel-Master laboratory. In the background, the adjustable test mast, which can hold an antenna in almost any position.

Color original by Avery Slack

CONTENTS — MARCH, 1954

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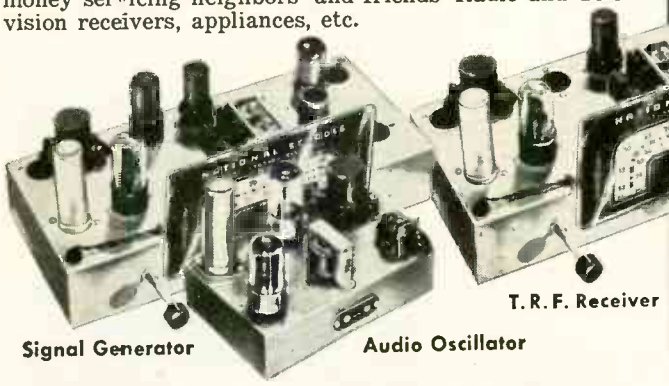
Superheterodyne Receiver



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- Garages: Auto Radio Sales, Service
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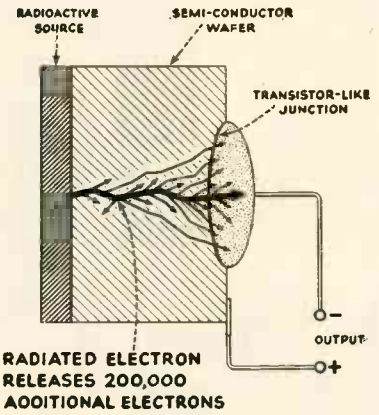
VETERANS: Give Date of Discharge _____

1954 IRE NATIONAL CONVENTION will be held on March 22-25 in New York City. It will take place in two locations, the Waldorf-Astoria hotel and Kingsbridge Armory.

The program, consisting of over 200 technical papers and 600 engineering exhibits, will cover many of the recent advances in the radio-electronics field, including subjects as different as "Engineering Based on Biological Design" and "High Fidelity in Audio Engineering."

RADIO-ELECTRONICS will occupy Booth 452, at the Armory.

ATOMIC BATTERY which makes it possible to convert atomic energy directly and simply into small but usable quantities of electrical energy sufficient to operate a transistor, was announced January 26 by Brig. General David Sarnoff, Chairman of the Board of RCA.



"The RCA atomic battery," said the general, "is now generating sufficient electricity from a minute quantity of strontium-90 to energize a transistor and to produce an audible tone in a telephone receiver." The new experimental battery, as described by Dr. E. W. Engstrom of the RCA Laboratories, consists of a semi-conductor wafer (germanium or silicon), to one side of which has been applied a thin layer of radioactive material (strontium-90 in this case) and to the other side of which an "impurity material" has been alloyed to form a transistor-like junction.

The strontium bombards the wafer with several billion electrons per second. As each of these penetrates the wafer it releases an average of 200,000 additional electrons. (Earlier radioactive generators—RADIO-ELECTRONICS July 1953, page 12—released only about one electron for each bombarding ray.)

These released electrons flow across the wafer's junction, producing a voltage which would cause a current to flow in an external circuit. This electron action within the wafer is known as the electron-voltaic effect, and has not previously been put to any practical use.

The cell delivers 5 microamperes at 0.2 volt. Life expectancy is not known, but the half-life to strontium-90 is 20 years. The cells may be used in series or parallel like other types of batteries.

ELEVEN NEW TV STATIONS have gone on the air since our last month's listing. These are:

KTVU	Stockton, Calif.	36
KOA-TV	Denver, Colo.	4
KSLA	Shreveport, La.	12
WKAR-TV	East Lansing, Mich.	60
WLBT	Jackson, Miss.	3
WCOC-TV	Meridian, Miss.	30
KHOL-TV	Kearney, Nev.	13
WNCT	Greenville, N. C.	9
WFBC-TV	Greenville, S. C.	4
KMID-TV	Midland, Texas	2
WBTM-TV	Danville, Va.	24

This brings the total number of stations on air to 360 (124 of which are u.h.f.) as of January 16, 1954.

The only station shifting channels this month was WRGB, Schenectady, N. Y., from channel 4 to channel 6.

19-INCH COLOR TUBE was demonstrated by RCA late in January. The new tube is a developmental model only. It may be available to manufacturers during the last half of 1954, and then only in limited quantities. The new tube has a picture area of 162 square inches, with the same brightness and definition as the 15-inch tube.

Three major developments in the larger tube are a new electron gun assembly, improved phosphors, and a shadow mask of modified design. The deflection angle of the electron beam has been increased because the larger tube's length is not greater than that of the smaller model.

Explaining that the 19-inch tube, like its 15-inch predecessor, is an interim model, Mr. E. C. Anderson, vice-president in charge of the RCA Commercial Department, told the tube manufacturers that RCA is continuing research and development work on other types and sizes of tubes for color receivers.

"Approximately eight months ago, we demonstrated in these laboratories a color tube—in the research stage—producing a much brighter picture," he said. "That tube employed principles differing from those in the current shadow mask tricolor kinescope.

"We are pressing forward in our research work on that brighter tube and other color tubes." END

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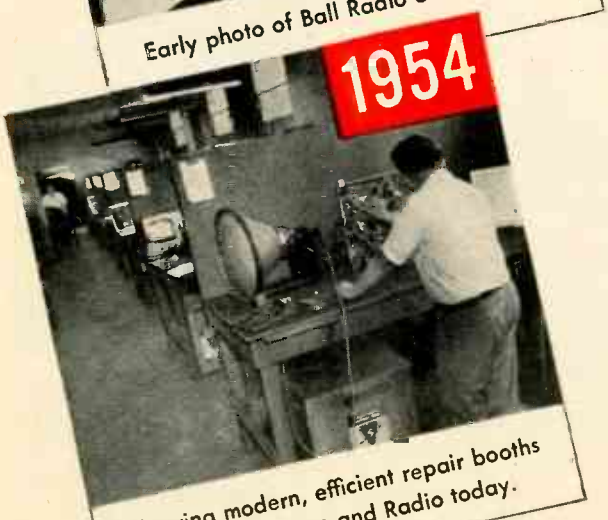
The steady and substantial growth of the Ball Television and Radio Service, from basement shop to the large handsome brick building, shown below, is a tribute to the fair practices and alert policies of the owner, Mr. Ted Ball.

Early photo of Ball Radio Service Shop.



Showing modern, efficient repair booths in Ball Television and Radio today.

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Ted Ball is another important Radio-TV Service Manager that appreciates the quality performance, dependability, and the nation-wide high reputation of Sylvania products.

Mr. Ball also knows about the business-boosting power of Sylvania's promotion and display offers. Find out how Sylvania can step up *your* business. Your friendly Sylvania Distributor is ready and anxious to give you full cooperation. Call him today.

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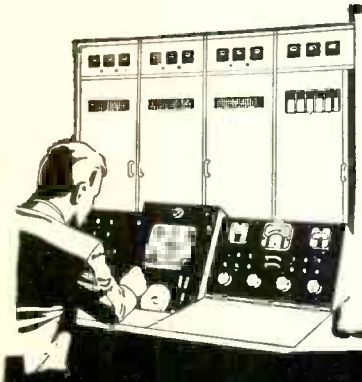

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Harry Clare, 4537 S. Drexel Blvd., Chicago, Ill.

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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Letter from nationally known manufacturer of high quality AM and FM transmitters, "We are very much in need at the present time of radio-electronics technicians and would appreciate any helpful suggestions that you may be able to offer. Salary up to $412 per month to start."

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!

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Francis X. Foerch, 38 Beucler Pl., Bergenfield, N. J.	1st Phone	38
S/Sgt. 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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MAJOR E. H. ARMSTRONG, inventor of our present system of frequency modulation and other basic radio circuits died on February 1 at the age of 63.

His most widely used and renowned development, the superheterodyne circuit, is almost universally used in both AM, FM, and TV receivers. He was the inventor of the superregenerative circuit, and an independent inventor of

regeneration, though the courts—after a 12-year battle—ruled that de Forest had discovered it earlier. Frequency modulation came in 1935.

His most recent development was a system of multiplexing FM broadcasts so that more than one program could be transmitted simultaneously at the same frequency.

His FM station KE2XCC operating on 92.1 mc is known by radio engineers throughout the world. There, Armstrong did much of his FM development, and the station became the prototype of modern FM stations.

Armstrong served in the Army Signal Corps in World War I. In World War II his major contributions were in the field of radar, much of which is still secret.

He also contributed many improvements in radio communications, particularly in short-wave transmission. It was upon his recommendation that the Army adapted FM for mobile radio communication.

During his lifetime Major Armstrong received many honors including the Medal of Honor of the I.R.E. and the Army Medal of Merit, presented to him by President Truman in 1947 with a citation stating that "Maj. Armstrong contributed greatly to the improvement of military communications by his inventions in the field of radio and by his unselfish, patriotic service to the Signal Corps."

At the time of his death, Major Armstrong was professor of electrical engineering at Columbia University, from which he graduated in 1913.

DUOSCOPIC TV RECEIVER which permits two audiences to view two different television programs at the same time from the same screen has been introduced by the Du Mont Laboratories.

The receiver, known as the Du Mont Duoscopic, performs as two separate receivers in one. Looking at the Duoscopic receiver with the naked eye, the viewer sees two superimposed pictures. He eliminates one or the other by looking through polaroid filters (placed on a stand in front of the receiver), or by wearing polaroid glasses similar in appearance to those used to view 3-D films. When the glasses are reversed, the viewer sees the other program.

It is possible to tune in one picture that can be viewed without glasses as in a standard receiver.

Individual earpieces are used to separate the sound portions of the programs. A remote control unit permits the viewer to listen to either of the two programs.

The Duoscopic receiver uses two C-R tubes, a dual chassis, and a twin audio system.

The chief uses of the new receiver are expected to be in stores and public places where it may be used as a crowd-stopper, but it is expected that a number of specialized applications may appear and that it may also solve domestic relations problems in television-divided households.

ELECTRONIC TRANSLATOR capable of turning Russian into English has been demonstrated by IBM.

The mechanical part of the device, which is mostly electronic, is the IBM type 701 electronic data processing machine. The Russian sentences that are to be translated are first coded on punch cards similar to those used for Government checks, and then fed into the machine. Seconds later, an automatic typewriter spells out the translation.

The electronic translator has a 250-word vocabulary covering a broad range. It converts these words into its own binary language and then translates them, using its "stored dictionary" and "syntax."

RADAR SPEED DETECTION was recently upheld in New York State. Monroe County Judge D. J. O'Mara has upheld an auto speeding conviction based on radar evidence. The appellant, who was convicted last June, argued that there was no proof of the accuracy of the radar detector.

TV ANTENNA ACCIDENTS figured prominently in a recent report by the American Mutual Liability Insurance Co. As a result of the current do-it-yourself rage, the report says, approximately 59,000 TV set owners were injured this past year in the process of installing their antennas.

In addition to the accidents definitely attributed to antenna installation, another 47,000 injuries were classified as "roof accidents." No indication was given as to how many of these injuries may have been due to patching the roof after an antenna had been erected by an amateur do-it-yourself installer.

FREQUENCY MODULATION is taking a major role in British broadcasting. To overcome interference to its radio programs by European radio stations, the BBC will build 51 FM transmitters. The estimated construction time is 10 years. END

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The second course quickly reviews the essentials then goes step by step into advanced phases of Radio and Television, including modern methods of installation and repair. Course contains valuable supplementary material. For example, you get a special book giving characteristics of all tubes used in Radio and Television receivers.

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Canadian residents send coupon to International Correspondence Schools Canadian, Ltd., Montreal, Canada. . . . Special tuition rates to members of the U. S. Armed Forces.

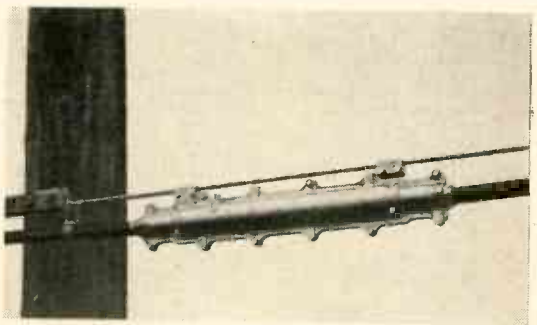
BOLTING VOICES TOGETHER

Adjusting casing over splice in polyethylene cable. Edges and ends are sealed with a new Butyl rubber compound that won't harden, dry out or lose adhesion even in extreme heat or cold.

More than ever, light, flexible polyethylene sheathed cable developed by Bell Telephone Laboratories is providing speedy answers to the demand for more telephone service.

But at thousands of splices, the sheath must be thoroughly sealed against moisture. Laboratories engineers developed a protective casing which is quickly and simply bolted in place. The edges and ends of the casing are *permanently* sealed with a new compound developed by Laboratories rubber chemists.

Now, economical polyethylene cable can be installed much faster and at lower cost. Here is another example of how Bell Laboratories continually finds ways to keep telephone service high in quality, while the cost stays low.



CLOSED CASING IN PLACE

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EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

WANT MORE PAY? MORE SECURITY? A JOB WITH FUTURE UNLIMITED?

VETERANS! CIVILIANS! NO EXPERIENCE NECESSARY!

Go Into TELEVISION

I'll train you at home... in your spare time for better-pay jobs in TV

L. C. Lane, B.S., M.A.
President: Radio-Television Training Association
Executive Director: Pierce School of Radio & Television

LEARN MORE

I give you ALL the practical training you need to qualify for the highest-paid technician jobs in TV.

RADIO-FM-TV TECHNICIAN TRAINING

No experience necessary! You learn by practicing with equipment I send you. It's easy! I give you the same successful guidance that has helped hundreds of men towards a TV career. *Many started with only grammar school training.*

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Saves you months if you have previous Armed Forces or civilian radio experience! Train at home. I give you kits, plus equipment to build BIG SCREEN TV RECEIVER, and FREE FCC COACHING COURSE! Everything AT NO EXTRA COST!

OPTIONAL: TWO WEEKS TRAINING IN NEW YORK CITY AT NO EXTRA COST!

You get two weeks, 50 hours, of intensive Laboratory work on modern electronic equipment at our associated school in New York City — Pierce School of Radio and Television. And I give you all this AT NO EXTRA COST whatsoever, after you finish your home study training in the Radio-FM-TV Technician course and FM-TV Technician Course.

FREE FCC COACHING COURSE!

Important for BETTER PAY JOBS requiring FCC License. You get this training AT HOME and AT NO EXTRA COST! Top TV jobs go to FCC licensed technicians.

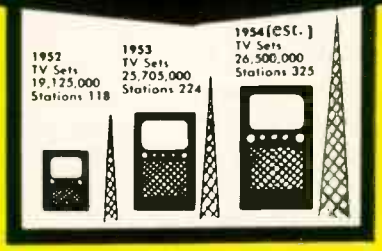
NEW! PRACTICAL TV CAMERAMAN & STUDIO COURSE!

(For men with previous radio and TV training)

I train you at home for an exciting high pay job as the man behind the TV camera. Work with TV stars in TV studios or "on location" at remote pick-ups! A special one-week course of practical work on TV studio equipment at Pierce School of Radio & TV, our associate resident school in New York City, is offered upon your graduation.

VETERANS!

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



P R O O F !

TV NEEDS THOUSANDS OF TECHNICIANS!

TV is coming into practically every community. More than 2,000 *new* TV stations authorized in this country alone! Thousands of new studios being planned and built. All kinds of new equipment coming on the market. Millions of *new* TV-set owners will need servicing. It's the rich field of the future with money-making opportunities NOW . . . if you get in on the ground floor. There just won't be enough TV Technicians to go around. It's your chance of a lifetime for GOOD EARNINGS in a TOP JOB or YOUR OWN BUSINESS!

EARN MORE

MORE MONEY AND A CAREER ARE WAITING FOR YOU HERE!

Earn while you *learn* by repairing TV sets for friends and neighbors. Many of my students make up to $25 a week in spare time . . . pay for their entire training this way . . . start their own money-making service business. When they complete training and go into TV full time, their earnings zoom into big figures! My graduates are now working at RCA, NBC-TV, CBS-TV, DUMONT TV and numerous other TV studios and plants.

GET MORE

Enough equipment to start your own home Laboratory! You learn by *doing*. I give you ALL the equipment. You build and keep a professional GIANT SCREEN TV RECEIVER complete with mammoth picture tube (takes any size up to 21 inch) . . . also a Super-Het Radio Receiver, RF Signal Generator, Combination Voltmeter-Ammeter-Ohmmeter, C-W Telephone Transmitter, Public Address System, AC-DC Power Supply, and more! 15 full Kits! All tubes supplied, too!

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Just by mailing coupon. Try the Sample Lesson. Read how and where you can make big money in TV . . . easily!

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

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- ☐ Radio-FM-TV Technician Course
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VETERANS! Check here for Training under NEW G.I. Bill ☐

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CORRESPONDENCE

I CAN GET IT WHOLESALE

Dear Editor:

I am beginning to see more and more retail selling prices coinciding with wholesale prices. This results in a state of utter confusion. My first experience in this respect was in a Sears Roebuck retail store. A Hallicrafters communication receiver was on display with the same price tag as quoted in a mail-order wholesale catalog.

My second experience was when I picked up a local newspaper and saw a quarter-page advertisement of an audio center showing standard high-fidelity components at wholesale prices.

My third experience occurred when I received a sound catalog from a wholesaler suggesting high-fidelity components be purchased from dealers recommended by him. Those mentioned were recognized retail dealers. What's puzzling me is, at what price is the wholesaler selling the equipment to the retail outlet?

This business of retail and wholesale prices in the radio field has us all spinning. It looks like the expression "retail price" is rapidly becoming merely a reference point from which prices are discounted. That isn't all: how do you price an installation?

For example, suppose we equip a home with a high-fidelity installation; what will govern the price of our job? Will we figure super prices, union rates, private bills, the prevailing wage and list prices, or enter into sealed competitive bidding?

Gentlemen, it's a problem we cannot shelve! The public has a right to know how we do business. If we wish to raise our level, performance must be in accordance with better business practices.

We can borrow from the automotive industry. They set the retail price of an automobile at the factory. The f.o.b. charges to any point in the United States are added to the factory price, resulting in an established retail price for that area. The distributor in the territory conforms with the policy of the auto manufacturer. The only loophole an automobile dealer has in regard to list price is to give you a little extra on a trade-in. If it is as simple as all that for them, there is no reason why the radio industry cannot do the same.

CLYDE D. KIEBACH

Arlington, Va.

(Inquiry has shown the Hallicrafter "wholesaler" to be a large Chicago mail-order *retail* company. There has been considerable confusion between retailer and wholesaler in the electronic field. This confusion has been aided by the retail selling practices of some distributors and a tendency (at least in the past) of some retail mail-order houses to refer to themselves as wholesalers. To discover whether a company is a wholesaler, request their catalog on a plain postcard. If you get it, they are not wholesalers! The question of cut-price selling cannot be so easily resolved, and we would welcome further comment on it from our readers.—*Editor*)

New CBS-Colortron

NOW IN MASS PRODUCTION

Unique photographic process, like photoengraving, uses aperture masks as negatives to print consecutively the red, green, and blue phosphor dots (250,000 of each) on CBS-Colortron screens.

After tri-color screens are printed, aperture masks are temporarily removed and face plates move on to critical inspection for screen imperfections.

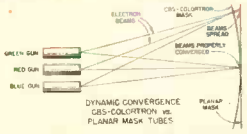
COLOR TV IS COMING . . . faster than you think. The revolutionary new CBS-Colortron . . . a practical color picture tube . . . hastens the day. Already it is in lower-cost, mass production . . . made possible by its simplified, advanced design.

As in black-and-white tubes, the CBS-Colortron's screen is deposited directly onto the inside of its face plate. A unique photographic technique makes this possible. Because each aperture mask serves as a negative to print its tri-color screen, perfect register of mask and screen is automatically achieved and maintained. The rugged, simple, light-weight mask sharply reduces assembly and exhaust problems. And the spherical design of mask and screen simplifies convergence circuitry and adjustment.

The CBS-Colortron is now a 15-inch, round tube. But, as soon as tooling is completed, it will be made in larger sizes. Watch for the new CBS-Colortrons. You'll see plenty of them soon. And you'll be sold on sight by their logical simplicity . . . their superior performance . . . their many advantages.

CBS-Colortron OFFERS MANY ADVANTAGES

Cross-section (face plate, aperture mask, funnel, tri-color electron gun) shows simplicity of CBS-Colortron and its adaptability to low-cost, mass production.



Spherical screen and aperture mask of CBS-Colortron simplify convergence and focus. Electron beams remain in focus over entire surface of screen.

Light-weight (6 oz.), rugged, simple aperture mask of CBS-Colortron minimizes problems of exhaust, handling, and assembly.

COMPLETE CBS-Colortron DATA *FREE!*

Take a look into the future. Write today for complete information on CBS-Colortron 15HP22: Construction . . . operation . . . application . . . installation and adjustment . . . electrical and mechanical data. Four packed pages . . . free!

CBS-HYTRON, Main Office: Danvers, Massachusetts

Manufacturers of Receiving Tubes Since 1921

A Division of Columbia Broadcasting System, Inc.

A member of the CBS family: CBS Radio • CBS Television • Columbia Records, Inc. • CBS Laboratories • CBS-Columbia • and CBS-Hytron

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

CORRESPONDENCE

IONIC OSCILLATOR

Dear Editor:

I was greatly interested in the article "The Ionic Oscillator" in the December, 1953, issue of RADIO-ELECTRONICS. Although it has been well known that fluorescent tubes and gaseous rectifiers create hash throughout the radio spectrum, the fact that gas tubes will oscillate at voltages as low as 22½ is quite a discovery, as is the use of a resistance to vary the frequency of multielement gas tubes. Actually, this principle of oscillation has been known for many years. Frequencies as high as 1,000 mc have been detected in rarified gas discharges. A quotation from the book *Conduction of Electricity Through Gases*, Vol. II, by Thomson, published by Cambridge University Press in 1933, is appropriate. On page 447 appears the following:

"Intermittence in the electric discharge under a constant potential difference seems to have been first observed by Gassiot in 1860. An excellent account of the researches made on this subject down to 1926 has been given by Valle. More recent investigations have been made by Appleton and West, Newman, R. E. Clay, Whiddington, Gill, R. W. Wood, and J. J Thomson. Direct experiments on the oscillations of dense streams of electrons in mercury vapor have been made by Tonks and Langmuir, who estimated the frequency of some of the vibrations they observed to be as high as 10^9 (1,000 megacycles)."

A reference to Gassiot's experiments is given in *Deschanel's Natural Philosophy:*

"By means of a battery of some thousands of cells, discharge in rarified gases can be obtained without the use of an induction coil, and with the advantage of greater steadiness. This has been done by Mr. Gassiot . . ."

A more recent application of this principle was the electrically quenched spark gap of some years ago. (A series of gas-filled cavity resonators.) The discovery of the low-voltage operation may have interesting microwave possibilities.

The articles on the Electronic Flame in RADIO-ELECTRONICS for December, 1952, and February, 1953, also made good reading. While Mr. Conant's explanation of the action taking place in his electro-forming apparatus is undoubtedly correct, I cannot agree with his comparison of the electronic flame to St. Elmo's fire. I believe that the true explanation of this phenomenon is to be found in the cover feature of RADIO-ELECTRONICS, March, 1950. (The dissociation of diatomic gas molecules by means of r.f. energy and the subsequent recombination of the unit atoms with other elements.) This theory could easily be tested by enclosing the electronic flame in an inert gas such as argon or neon.

I find your magazine very interesting —keep up the good work.

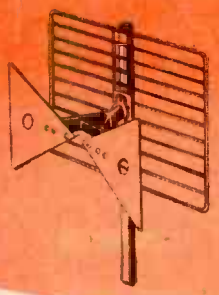
JOHN NOVAK

San Francisco, Calif. END

"LOCAL" UHF BOW TIE KIT

For local and in-town installations, in strong signal areas. Kit complete.

		LIST
No. 9030*	(Series 1 accessories)	$13.95
No. 9034	(Series 2 accessories)	13.95
No. 9038	(Series 3 accessories)	13.95
No. 9042	(Series 4 accessories)	13.95



"FRINGE" UHF TWO STACK BOW TIE KIT

For fringe areas up to 30 miles (depending on local conditions). Kit complete.

		LIST
No. 9031*	(Series 1 accessories)	$16.75
No. 9035	(Series 2 accessories)	16.75
No. 9039	(Series 3 accessories)	16.75
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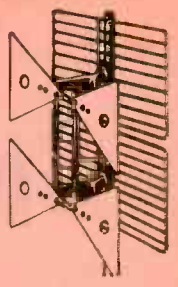

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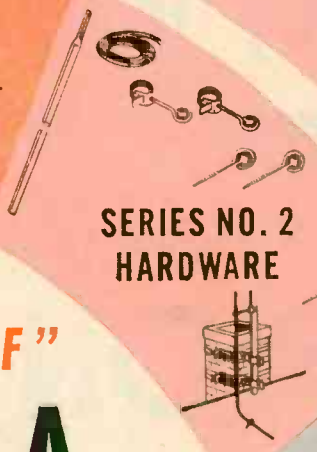

SERIES NO. 2 HARDWARE

UHF

"DO IT YOURSELF"

ANTENNA KITS

CHOICE OF 4 DIFFERENT SETS OF MOUNTING HARDWARE FOR EACH ANTENNA

16 COMBINATIONS TO CHOOSE FROM!

These new TELCO Antenna Kits are just what you need for profitable selling to the "do-it-yourself" market. There's a wide range of styles to meet every requirement . . . with four choices in hardware components for each kit. Your favorite distributor's got them . . . or can get them for you!

"DELUXE" UHF CORNER REFLECTOR KIT

For troublesome areas, or where extra high gain is required. Kit complete.

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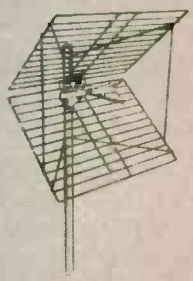

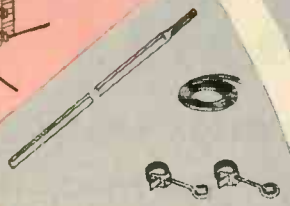

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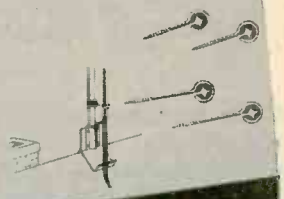

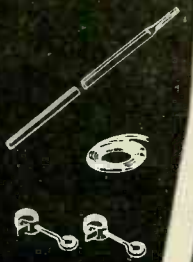

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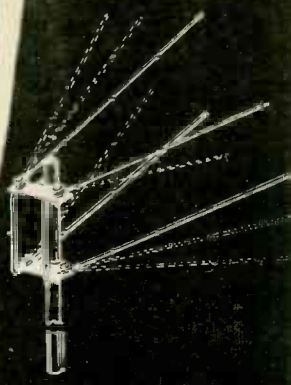

*WHAT EACH TELCO KIT CONTAINS

SERIES 1 ACCESSORIES

Complete Antenna, as shown
1—6 ft. 1¼" Mast
50 ft. Guy Wire
50 ft. UHF Low Loss Line
1—Guy Wire Clamp
4—Screw Eyes
2—Universal Mast Stand-Offs
2—3" Wood Screw Stand-Offs
2—7" Wood Screw Stand-Offs
1—Mast Base

SERIES 2 ACCESSORIES

Complete Antenna, as shown
1—6 ft. 1¼" Mast
50 ft. UHF Low Loss Line
2—Universal Mast Stand-Offs
2—3" Wood Screw Stand-Offs
2—7" Wood Screw Stand-Offs
1—Chimney Mount

SERIES 3 ACCESSORIES

Complete Antenna, as shown
1—5 ft. 1¼" Mast
50 ft. UHF Low Loss Line
2—Universal Mast Stand-Offs
2—3" Wood Screw Stand-Offs
2—7" Wood Screw Stand-Offs
1—All-Purpose Antenna Mast Bracket

SERIES 4 ACCESSORIES

Complete Antenna, as shown
1—5 ft. 1¼" Mast
50 ft. UHF Low Loss Line
2—Universal Mast Stand-Offs
2—3" Wood Screw Stand-Offs
2—7" Wood Screw Stand-Offs
1—Snap-In Wall Mount

AN ANTENNA STYLE AND HARDWARE SELECTION FOR EVERY INSTALLATION — 16 KITS IN ALL!

NOTE — Special kits for particular areas made to order. Write for details!

"DOUBLE V" UHF & VHF ANTENNA KIT

Highly directional and very satisfactory where both UHF & VHF signals are to be received on same antenna. Complete.

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No. 9045	(Series 4 accessories)	14.95

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FREE!
Your new TELCO Catalog. Ask your jobber . . . or write direct.

TELEVISION HARDWARE MFG. CO.
DIVISION OF GENERAL CEMENT MFG. CO.
910 Taylor Avenue Rockford, Illinois

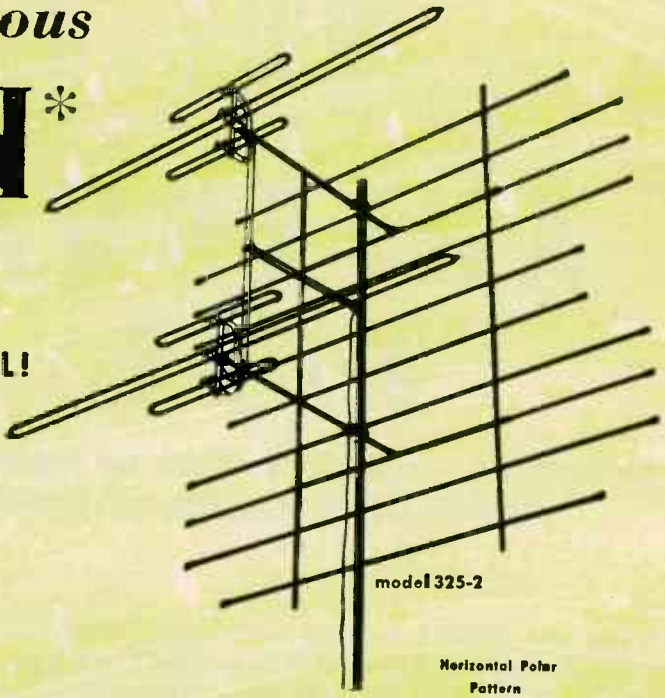
over 100,000 already installed!


model 325-4


model 325

CHANNEL MASTER'S *fabulous*

CHAMPION*


model 325-2

the world's most powerful all-channel VHF antenna —OUT-PERFORMS AND OUT-SELLS THEM ALL!

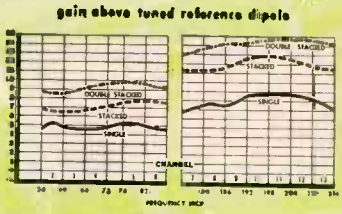
Never before in the history of television has an antenna received such an overwhelming reception. Channel Master's CHAMPION — in a few short months — has rocketed to the top as the nation's most-wanted, best-selling, best-performing VHF antenna!

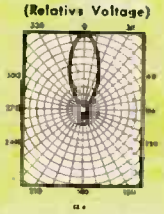
CHAMPIONSHIP Performance: Only the CHAMPION has the unique new "Tri-Pole", a *triple-powered dipole system* in which the Low Band dipole also functions as *three* dipoles tied together, in phase, on the High Band.

All-aluminum. Assembles faster than a 5-element Yagi! The CHAMPION is *another* great contribution of the Channel Master Antenna Development Laboratories.

CHAMPIONSHIP Promotion: The CHAMPION is the antenna America knows best!

- Publicized in leading magazines! • Outstanding dealer Cooperative Advertising Program! • Free newspaper mats, window streamers and TV film commercials!





THE STACKED CHAMPION PROVIDES:

11-13 DB High Band gain

6½-7½ DB Low Band gain

THE STACKED CHAMPION OUT-PERFORMS


this . . .


this . . .


this . . .


or this

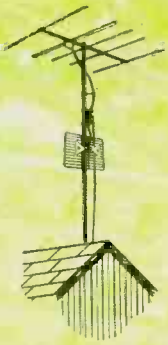
Model No.		List Price
325	Single Bay	$20.83
325-2	2-Bay	$42.36
325-4	4-Bay	$88.89
Separate Stacking Harness		
325-3	2-Bay Harness	$ 2.08
325-5	4-Bay Harness	$ 4.17

CHANNEL MASTER CORP.

ELLENVILLE, N. Y. WORLD'S LARGEST MANUFACTURER OF TELEVISION ANTENNAS

*pat. pending

TIE SEPARATE ANTENNAS TO ONLY ONE TRANSMISSION LINE



CHANNEL MASTER inter-action filters

Only Channel Master filters are permanently sealed in a block of moisture-proof, high melting-point electrical wax, locked in an attractive styrene case.

- Single lead
- No switching
- No signal loss
- No inter-action, effective isolation.

VHF only

New!

TENNA-TIE

model no. 9033-A

Use with leads of any length!

New, specially designed High and Low Pass filters entirely eliminate the need for critical lead lengths! This new, extremely effective circuit makes the TENNA-TIE the most effective filter of its type now available.

— *only* $3.50

VHF-UHF

ULTRA-TIE

model no. 9034

JOINS — separate VHF and UHF antennas for use with a single lead.

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

"Free-space" terminals.

new low price — $3.75

VHF-UHF

TRIPLE-TIE

model no. 9035

Ties together all three TV reception bands:

1. *Low Band VHF*
2. *High Band VHF*
3. *All UHF*

High and Low Pass filters enable the Triple-Tie to adapt all Hi-Lo VHF installations to UHF — quickly and effectively. "Free-Space" terminals for perfect all-weather UHF reception.

new low price — $4.86

THE ANTENNA IN COLOR TELEVISION

by Harold Harris, *Vice President, Sales and Engineering*

Now that color telecasting is a reality, we will see an ever-increasing flow of color sets to the consumer. Although much is being said and written on the subject of color sets, many unanswered questions remain about the role of the television receiving antenna in color television.

Will present antennas work on color?

Will a special antenna be needed?

The results of thorough laboratory and field tests made by engineers of the Channel Master Antenna Development Laboratories show that practically all present TV antenna types will perform satisfactorily on color. Gain variations as high as 3 DB across one channel can be tolerated. When this figure is exceeded blurring or smearing of the picture may occur. Although there are certain antennas on the market which do have excessive gain variation, this is not the case of the vast majority of present installations.

There are also indications that fringe area color reception may be more critical. This may necessitate the use of fringe area antennas in areas closer to the TV station.

In the nation's most advanced television research laboratory, Channel Master antennas have always been designed for full band width and minimum variation in gain on any one channel.

For this reason, every Channel Master antenna which you have installed in the past, as well as the ones you install today, will provide reception of outstanding quality when color TV comes to your area.

Channel Master antennas were the antennas selected for the tests which led to the F.C.C.'s approval of the National Television Standards Committee color system.

Merchandising and Promotion

CBS-Hytron, Danvers, Mass. is offering service technicians four new sales aids in connection with its nationally advertised Certified Quality Service program: an illuminated Plexiglass

sign for indoor use, a metal flange sign, direct-mail postal cards and advertising mats.

Pyramid Electric Co., North Bergen, N.J., is conducting a $5,600 cash prize contest for service technicians. The contest runs from February through April. Contestants must complete the

sentence, "I like Pyramid capacitors because . . ." and send their entry in with the top of a box from a Pyramid dry electrolytic capacitor. J. K. Poff, Pyramid jobber sales manager, announced that duplicate prizes would be awarded to parts distributors from whom winning service technicians made their purchases.

Raytheon Manufacturing Co. Receiving Tube Div., Newton, Mass., reported that about 500 service technicians attended its recent *Service Saver* meetings held in Reading and Wilkes-Barre, Pa. and Hagerstown, Md. Local distributors sponsored the meetings.

Blonder-Tongue Laboratories, Westfield, N. J., developed an attractive new display carton for all its TV accessories.

Cornell-Dubilier Electric Corp., South Plainfield, N. J., and **Radiart Corp.,**

Cleveland, O., are now packaging their CDR rotors in a colorful new shipping carton which also doubles as an "in-stock" box.

Technical Appliance Corp., Sherburne, N. Y., has augmented its field meeting program for TV service technicians. The technical forums, conducted by "Taco" personnel, are held under the auspices of the company's distributors throughout the country.

Radio City Products, New York City, introducted a new test lead counter dis-

play which features a storage compartment in the rear of the display permitting the maintenance of a steady stock on hand.

Hallicrafters, Chicago, awarded MG sports cars to the four winning distributor salesmen in its recent contest.

Hallicrafters J. Mahoney, Adv. Mgr., left, and M. Kelly, TV Sales Mgr.

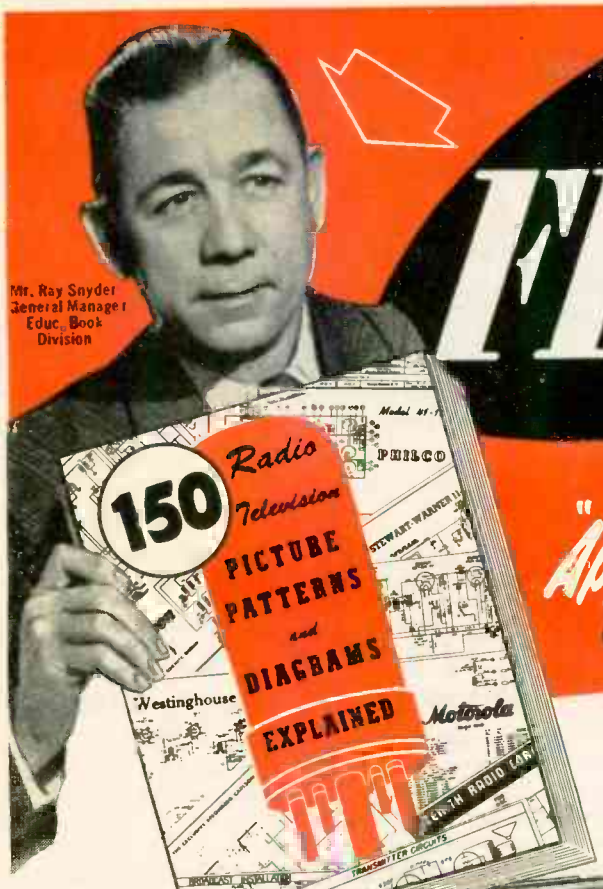
You Get This Valuable Book FREE

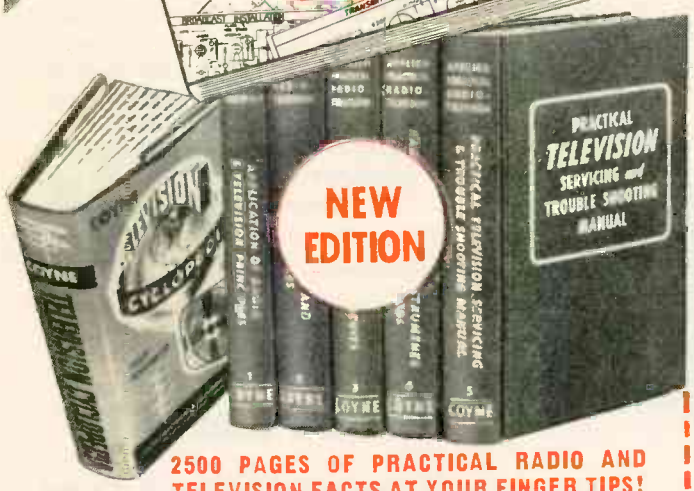
Just for Examining

COYNE'S NEW 6-VOLUME SET

"Applied Practical Radio-Television"

ON 7 DAYS FREE TRIAL!





Now! The most liberal "get-acquainted" offer you've ever seen! Think of it—Coyne gives you this big, new 1954 Edition of book, *"150 Radio-Television Picture Patterns and Diagrams Explained"*, ABSOLUTELY FREE. This up-to-the-minute, practical book gives you complete 11 x 22" Schematic Diagrams covering 170 models Radio and Television Sets. Also analysis of TV Servicing with picture tube patterns including many actual trouble-shooting patterns. Large 8½ x 11" pages. Full instructions show you how to read and use the diagrams. *This valuable book is a FREE GIFT to you,* for just asking to see the great new Coyne 6-book set, "Applied Practical Radio-Television"!

AT LAST! MONEY-MAKING "KNOW-HOW" ON TRANSISTORS, COLOR TV AND SERVICING

You get all the right answers to today's TELEVISION-RADIO servicing problems—and get them quickly—in Coyne's great new 6-volume set. Right at your finger-tips is the TV-Radio knowledge that makes you worth more money! Over 5,000 practical facts and data are fully covered in easy-to-understand fashion in volumes 1 through 5. Every step is completely explained—from principles of radio and television to installing, servicing, trouble-shooting and aligning including full facts on COLOR TV and UHF, adapters and converters. **Also includes latest information on TRANSISTORS.** Hundreds of photos, illustrations, charts and diagrams help you understand quicker. For speedy on-the-job use, I'll also include the famous 762 page Coyne TELEVISION SERVICING CYCLOPEDIA—covering *today's* television problems in easy-to-find alphabetical order. Use this complete 6 volume TV-RADIO LIBRARY FREE for 7 days. Get the valuable Picture Pattern-Diagram Book ABSOLUTELY FREE!

ACT NOW—SEND NO MONEY!

Just mail the coupon for Coyne's 6-volume set on 7 days free trial. I'll include the book of 150 TV-RADIO Patterns & Diagrams. If you keep the set, pay $2 in 7 days and $2 per month until $22.50 plus postage is paid. (Cash price, $20.95.) Or you can return the library at our expense in 7 days and owe nothing. *Either way, the book of TV-Radio Patterns is yours to keep FREE!* Take advantage of this offer AT ONCE!

MAIL COUPON TODAY

2500 PAGES OF PRACTICAL RADIO AND TELEVISION FACTS AT YOUR FINGER TIPS!

Vol. 1. APPLICATION OF TELEVISION-RADIO PRINCIPLES: 300 pages, covers resonance & tuning, amplifiers, oscillators, etc.
Vol. 2. RADIO, TELEVISION & FM RECEIVERS: 403 pages, covers rectifiers, high frequency, short wave, FM, antennas, etc.
Vol. 3. RADIO-TELEVISION CIRCUITS: 336 pages, covers power tubes, de-coupling, distortion, photo-tubes, phase inverters, etc.
Vol. 4. LATEST INSTRUMENTS FOR SERVICING RADIO-TELEVISION: 345 pages, covers all types of testing instruments, their use in service work.
Vol. 5. TELEVISION SERVICING & TROUBLE-SHOOTING MANUAL: 400 pages, practical servicing of all types of TV sets, UHF, boosters, color TV printed in 4 colors, etc.

★ **PLUS TV CYCLOPEDIA!**

A "must" for the TV serviceman. Quick answers to all TV problems in A-B-C order, cross-indexed. 762 pages, fully illustrated; covers hundreds of facts on servicing, installation, alignment, UHF, transistors much more.

COYNE ELECTRICAL & TELEVISION — RADIO SCHOOL
500 South Paulina Street
Dept. 33-TI, Chicago 12, Illinois

FREE BOOK—FREE TRIAL COUPON!

Mr. Ray Snyder, Technical Book Manager
COYNE ELECTRICAL & TELEVISION-RADIO SCHOOL
500 S. Paulina St., Dept. 34-T1, Chicago 12, Ill.

O.K., Mr. Snyder! I'll take advantage of your Get-Acquainted Offer! Send new, 6-book set, "Applied Practical Radio-Television" for 7 days FREE TRIAL per your offer. Include TV-RADIO Patterns & Diagrams Book FREE!

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City ..... Zone ..... State .....
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ANTENNA RESEARCH made it Possible!

the CHANNEL MASTER CHAMPION

2-bay CHAMPION for superior reception in secondary and fringe areas. 4-bay for super-fringe areas.

HIGHEST GAIN ALL-CHANNEL VHF ANTENNA EVER PRODUCED!

WORLD'S MOST POWERFUL ALL-CHANNEL ANTENNA

Out of famous Channel Master Antenna Development Laboratories have come improvements to make the servicemens' job easier—the viewers' enjoyment greater.

Latest development, the CHAMPION antenna, employs a unique Broad Band dipole system, the "Tri-Pole". This is a triple power dipole system in which the low band dipole also functions as three dipoles tied together, in phase, on the high band. The "Tri-Pole" is the heart of the CHAMPION—the secret of its phenomenal performance. Completely pre-assembled, all-aluminum construction—and the mast is WHEATLAND WHETHA-TUBE, hot dip galvanized electric weld tubing.

MASTING RESEARCH made it Permanent!

Rust Resistant!

HOT DIP GALVANIZED ELECTRIC WELD TUBING FOR TV MASTS

WHEATLAND WHETHA-TUBE

Wheatland Tube Company has produced steel pipe for many years. Their research engineers have faced the severest weather and durability problems—in irrigation, oil fields and wherever rigid wear needs arise.

NOW—WHEATLAND introduces WHETHA-TUBE, hot dip galvanized electric weld steel tubing. For the life of your antenna—select this tested tubing that will stand up and insure permanence for your antenna. The hot dip galvanized coating is perfect protection against rust and scratches—inside and out—because it seals out destructive elements.

WHEATLAND WHETHA-TUBE

WHEATLAND TUBE COMPANY • Bankers Securities Building Juniper & Walnut Sts., Philadelphia 7, Penna.

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

But, if you're interested in an honest-to-goodness career in the vigorous young electronics industry, here's how you can step ahead of competition, move up to a better job, earn more money, and be sure of holding your technical job even if the brass is firing instead of hiring.

The "how" is CREI training in radio-television-electronics.

You don't have to be a college graduate. You *do* have to be willing to study—at home. You can do it while holding down a full-time job. Thousands have. Since 1927 CREI has provided alert young men with the technical knowledge that leads to more responsibility, more job security, more money. More than a quarter century of experience qualifies CREI to train you.

What qualified *you* for CREI? If you have a high school education, you're off to a good start. If you have a knack for math, so much the better. If you are currently working in some phase of the electronics industry, you'll get going faster. But remember this: CREI starts with fundamentals and takes you along at your own speed. You are not held back by a class, not pushed to keep up with others who have more experience or education. You set your own pace. Your CREI instructors guide you through the lesson material and *grade* your written work personally. You master the fundamentals, then get into more advanced phases of electronics engineering principles and practice. Finally you may elect training at career level in highly specialized applications of radio or television or aeronautical radio.

How good is CREI training? Here are a few ways to judge. Ask an electronics engineer if you know one. Ask a high-school or college physics teacher. Ask a radio station engineer. Check up on our professional reputation: CREI home study courses are accredited by the Engineers' Council for Professional Development; CREI is an approved member of the National Council of Technical Schools. Ask personnel managers how they regard a man with a CREI "ticket." Look at this partial listing of organizations *that pay CREI* to train their own personnel: All American Cables & Radio, Inc., Canadian Aviation Electronics, Ltd., Canadian Broadcasting Corporation, Columbia Broadcasting System, Hoffman Radio Corp., Machlett Labs., Glenn L. Martin Co., Magnavox Co., Pan American Airways, Atlantic Division, RCA Victor Division, United Air Lines. Finally, ask a CREI graduate to tell you about our Placement Bureau, which currently has on file more requests for trained men than we can fill.

What's the next step? The logical one is to get more information than we can cram into one page. The coupon below, properly filled out, will bring you a fact-packed booklet called "Your Future in the New World of Electronics." It includes outlines of courses offered, a resume of career opportunities, full details about the school, and tuition details. It's free.

NOTE: CREI also offers Resident School instruction, day or evening in Washington, D.C. New classes start once a month. If you are a veteran discharged after June 27, 1950, let the new GI Bill help you obtain resident instruction. Check the coupon for more data.

CAPITOL RADIO ENGINEERING INSTITUTE

An Accredited Technical Institute • Founded in 1927

3224 16th Street, N.W. Dept. 143A Washington 10, D.C.

Send booklet "Your Future in the New World of Electronics" and course outline.

CHECK FIELD OF GREATEST INTEREST

- ☐ Practical Radio Engineering
- ☐ Broadcast Radio Engineering (AM, FM, TV)
- ☐ Practical Television Engineering
- ☐ Aeronautical Radio Engineering
- ☐ TV, FM & Advanced AM Servicing

Name.....

Street.....

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

Check— ☐ Residence School ☐ Veteran

Winners were M. Newman, HSM Distributors, Los Angeles; Al Roth, Minsky Bros., Pittsburgh; J. Morris, Century-Ekon Distributors, Minneapolis; and R. Martin, Cladco, Buffalo.

Brach Manufacturing Corp., Newark, N. J., introduced its new No. 555 antenna designed for color with a life size "cloak and dagger" display in parts jobbers' establishments.

Jensen Industries, Chicago, is featuring a versatile needle container of flexible plastic construction which may be used either as a hanging wall display or a shirt pocket container to be taken out on service calls. It has been nicknamed the Needle Caddy.

Pilot Radio Corp., Long Island City, N. Y., is sponsoring a series of twelve 1-minute spot announcements per week for the next year over station WQXR, New York City, on its high-fidelity components and complete matched systems.

Production and Sales

RETMA reported a record breaking TV set production for the first 11 months of 1953 of 6,765,000, 62% above the 1952 period. Of that total, 1,319,818 TV sets were equipped with u.h.f. tuning facilities. The association also reported radio production of 12,267,441 for the first 11 months of 1952. This was almost 30% better than last year.

Show Notes

The 1954 WESCON (Western Electronic Show & Convention) will be held in the Pan-Pacific Auditorium in Los Angeles, August 25-27. END

NEW

WALSCO *Imperial*

INTRODUCING the greatest advance in Conical antennas ... it's the *all-new* WALSCO *Imperial*. Featuring a new "barrier disc" insulator with 2 inches of air space between the terminals to prevent *shorts*. Soot deposits, dirt, moisture, salt, etc., *cannot* affect this insulator. The WALSCO *Imperial* will therefore maintain *lasting* high gain performance *anywhere*, regardless of weather conditions. Contact surfaces and terminals will *never* rust or oxidize. Front end hardware is *stainless steel* to prevent corrosion losses *permanently*.

Front end elements are pre-assembled to holding plates which are fastened to the insulator with one wing nut. Less than 2 minutes to assemble.

MOST REVOLUTIONARY CONICAL ANTENNA IN 4 YEARS

3 year unconditional guarantee!

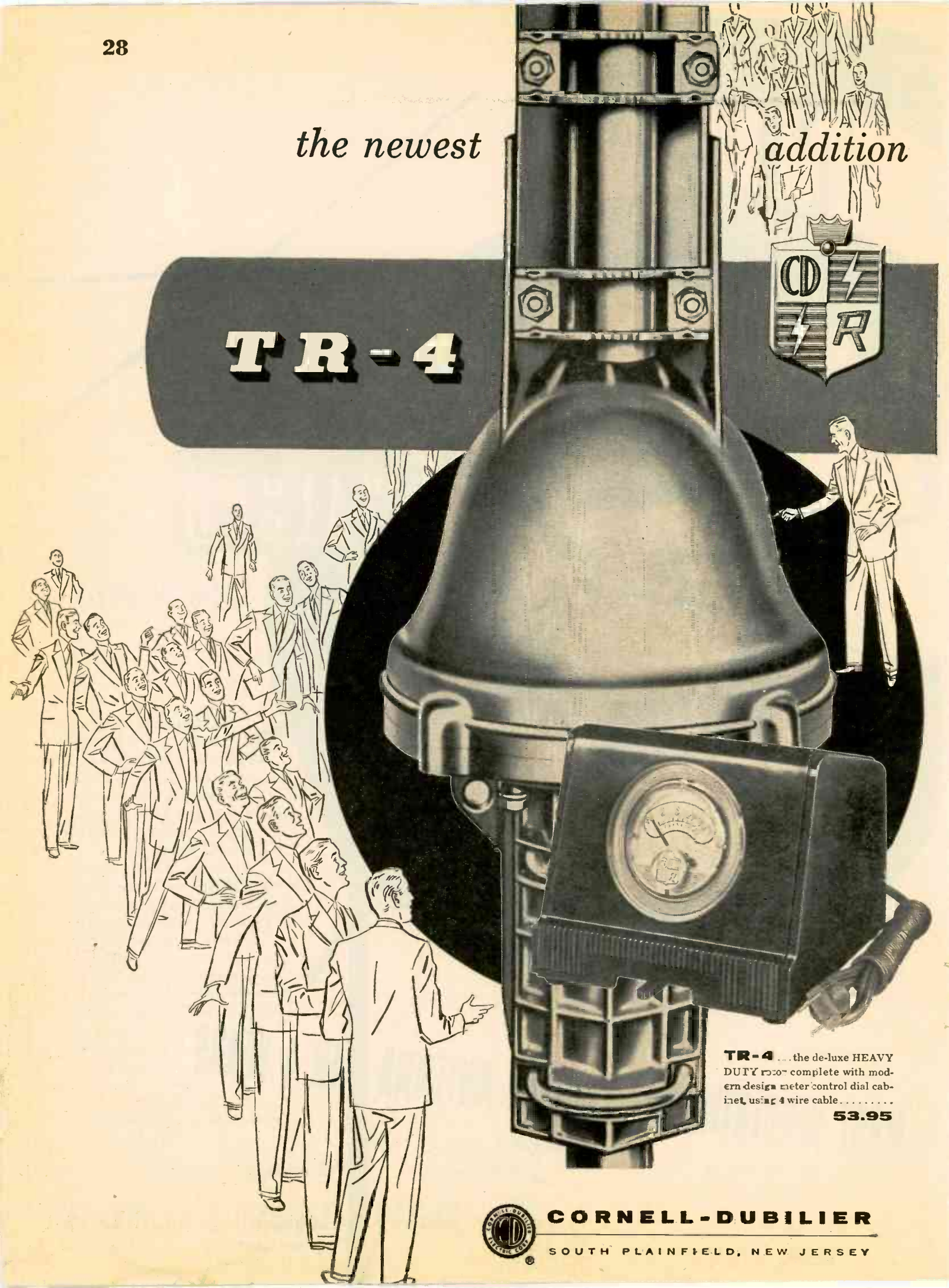
Guaranteed lasting high gain on all VHF channels

WALSCO ELECTRONICS CORPORATION

3602 Crenshaw Blvd., Los Angeles 16, Calif.

the newest *addition*

TR-4



TR-4 ....the de-luxe HEAVY DUTY motor complete with modern design meter control dial cabinet, using 4 wire cable.....
53.95

CORNELL-DUBILIER

SOUTH PLAINFIELD, NEW JERSEY

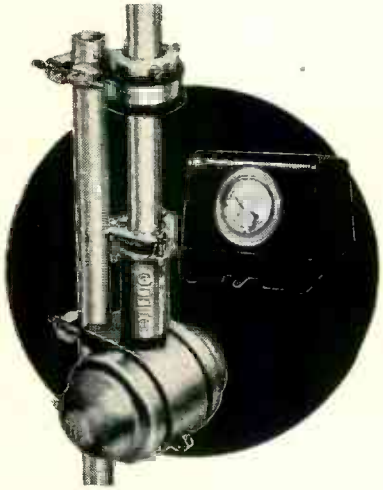
to the family of C·D·R Rotors

C·D·R ROTOR

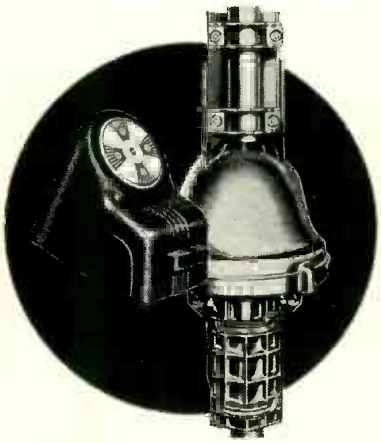
the ultimate in heavy duty Rotors

incorporating all the fine features
that have made the TR-2 outstanding
plus these fine features:

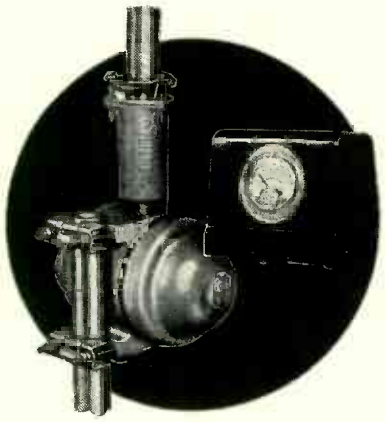
★ **Handsome Meter Dial Cabinet** ★ **Uses 4 Wire Cable**



TR-12 . . . a special combination value consisting of complete rotor, including thrust bearing . . . handsome modern design cabinet with meter control dial, 4 wire cable
47.95



TR-2 . . . . the Heavy-Duty rotor, complete with "Compass Control" cabinet having illuminated "perfect pattern" dial . . .
49.95



TR-11 . . . the all-purpose rotor with handsome modern design cabinet with meter control dial, uses 4 wire cable . . . . . .
44.95

THE **RADIART** CORPORATION
CLEVELAND 13, OHIO

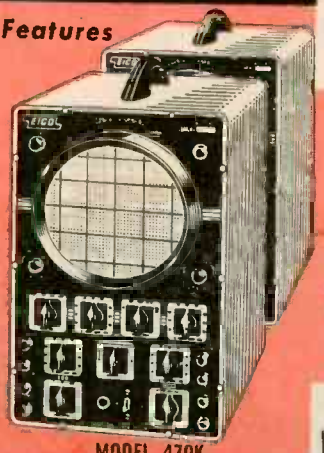
NOW . . . 2 SENSATIONAL EICO SCOPE VALUES!

NEW AMAZING FEATURE PACKED

7" PUSH-PULL OSCILLOSCOPE

Only EICO Has All These Features

- VERTICAL FREQ. RESPONSE: flat ± 2 db 10 cps – 1 mc
- VERTICAL SENS.: .01 volts rms/inch
- HOR. FREQ. RESP.: flat ± 0 db 10 cps – 200 kc, –4 db at 500 kc
- HOR. SENS.: .3 volts rms/inch
- SWEEP RANGE: 15 cps-100 kc
- 3-STEP FREQ.-COMPENSATED ATTENUATOR eliminates freq. distortion, overloading.
- CATHODE FOLLOWER inputs to both amplifiers
- PUSH-PULL outputs in both amplifiers
- RETURN TRACE BLANKING
- INT. VOLTAGE CALIBRATOR
- V & H TRACE EXPANSION & CENTERING: 1.5X full screen without distortion.
- DIRECT CONNECTION to vert. CRT plates.
- PHASING CONTROL of internal 60 cps sine wave sweep.
- AT FRONT PANEL: intensity mod. input; 60 cps, sawtooth outputs.



MODEL 470K

KIT $79.95. WIRED $129.50.

EICO EXCLUSIVE! 5" PUSH-PULL SCOPE, 425K, Amazing feature-packed economy-priced Wired, $79.95. KIT, $44.95.

- PUSH-PULL V & H amplifiers. Sens: 0.5-.1 rms v/in. Useful to 2.5 mc.
- SWEEP: 15 cps-76 kc. Z-axis intensity modulation. Dual trace positioning controls.

SCOPE VOLTAGE CALIBRATOR KIT 495K KIT $12.95. WIRED $17.95.

- Sq. wave output at power-line freq. with full-scale readings of .1, 1, 10 or 100 V. peak-to-peak.
- Accuracy ± 5% of full-scale on each range.

6V & 12V BATTERY ELIMINATOR KIT 1050K KIT $29.95. WIRED $38.95.

- DC output: 0-8 V or 0-16 V.
- Continuous current rating: 10 A at 6 V, 6 A at 12 V.
- Intermittent current rating: 20 A at 6 V, 12 A at 12 V.
- Separate Voltmeter & Ammeter.

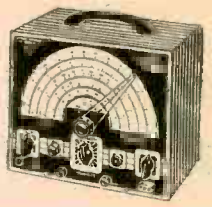
NOW! ONLY EICO KITS & WIRED INSTRUMENTS Gives You LIFETIME SERVICE & CALIBRATION GUARANTEE*

*at less than our cost of handling (See EICO Guarantee Card enclosed with each Kit & Instrument).

221K VTVM KIT $25.95. WIRED $49.95.

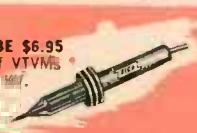
- AC & DC volts: 0-5, 10, 100, 500, 1000 V (30 KV with HVP-1 probe).
- 5 ohm ranges from .2 ohm to 1000 megs.
- DC input Z 26 megs.
- 4½" meter movement in can't-burn-out circuit.
- 1% mult. resistors.

360K SWEEP GEN. KIT $34.95. WIRED $49.95.



- Continuous coverage of all TV & FM freqs. from 500 kc to 228 mc.
- Sweep width variable 0-30 mc.
- Crystal marker oscillator, variable amplitude.

HIGH VOLTAGE PROBE $6.95



- Extends range of VTVMs & voltmeters to 30 KV.

PIX TUBE ADAPTER for Tube Testers $4.50. Checks TV picture tubes while in set.

214K VTVM KIT $34.95. WIRED $54.95.

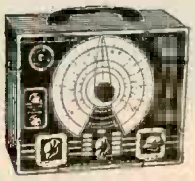
- Large 7½" meter, can't-burn-out circuit.
- AC/DC volts: 0-5, 10, 100, 500, 1000 (30 KV with HV Probe).
- 5 ohms ranges from .2 ohm to 1000 megs.
- DC input Z 26 megs.
- 1% mult. resistors.

625K TUBE TESTER KIT $34.95. WIRED $49.95.

- Illum. gear-driven "Speed Rollchart."
- New lever-action switches for individual testing of every element.
- Tests all conventional & TV tubes.

COUNTER CABINET for above: add $10.00 to Kit or Wired Prices.

CONDENSOR RESIDUAL TESTER WIRED $29.95.

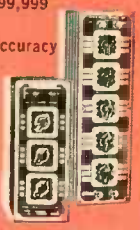


- Measures & tests all resistors; .5 ohm to 500 megohms.
- Every type condenser, 10 mmf to 5000 mfd.
- 0-500 DC voltage source for capacitor leakage testing.

1171K RES. DECADE BOX KIT $19.95. WIRED $24.95.

- Resistance values from 0 to 99,999 ohms with 0.5% precision.
- All resistors have 0.5% accuracy

DECADE CONDENSER BOX KIT 118CK KIT $14.95. WIRED $19.95.

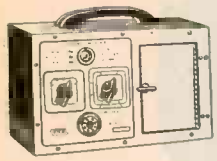


- All capacitors precision silver mica, accuracy ± 1%.
- Range from 100 mmf – 0.111 mfd in steps of 100 mmf.
- Smooth-action positive detent ceramic switches.

Prices 5% higher on West Coast. Specifications and prices subject to change without notice.

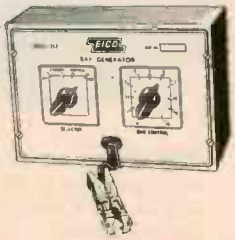
New! EICO SCOOPS!

CATHODE RAY TUBE CHECKER 630K, WIRED $24.95 KIT, $17.95.



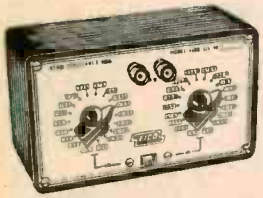
- Checks all types of TV picture and C.R. tubes in the set or carton. Bridge measurement of peak beam current (proportional to screen brightness).
- Detects shorted & open elements.

BAR GENERATOR 352K, WIRED $19.95 KIT, $14.95



- Enabels rapid adjustment of TV picture V & H linearity without hard-to-find station-transmitted test pattern.
- Produces 16 V or 12 H bars. Operates on TV channels 3, 4, or 5.

RTMA RESISTANCE SUBSTITUTION BOX 1100K WIRED $9.95 KIT, $5.50.



- Enables rapid substitution of resistances from 15 ohms to 10 megs in decade multiples of 15, 22, 33, 47, 68, 100 ohms.
- Uses 36 standard 1 watt, ± 10% RTMA resistors.

315K DELUXE SIG. GEN. KIT $39.95. WIRED $59.95.

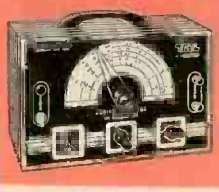
- Covers range of 75 kc to 150 mc.
- 7 calibrated scales: accuracy better than 1%.
- Bandspread vernier tuning.
- 4-step RF shielded output multiplier: constant output Z.

565K MULTIMETER KIT $24.95 WIRED $29.95.

555K MULTIMETER KIT $29.95 WIRED $34.95. (1% precision resistors)

- 20,000 Ω/V; 31 ranges.
- DC/AC/Output volts: 0-2.5, 10, 50, 250, 1000, 5000.
- DC Current: 0-100 ua; 10, 100, 500 ma; 10 A.
- Ohms: 0-2K, 200K, 20 meg.

377K SINE & SQUARE WAVE AUDIO GEN. KIT $31.95. WIRED $49.95.



- Complete sine wave coverage, 20-200,000 cps in 4 direct-reading ranges.
- Complete square wave coverage, 60-50,000 cps.
- Cathode follower output circuit.

145K SIG. TRACER KIT $19.95. WIRED $28.95.

- Audibly signal traces all IF, RF, Video & Audio circuits from ANT to SPKR or CRT in all TV, FM, AM, etc. without switching.
- Germanium crystal diode probe responsive to over 200 mc.
- Integral test speaker.

536K MULTIMETER KIT $12.90. WIRED $14.90.
526K MULTIMETER KIT $13.90. WIRED $16.90.

- 1000 Ω/V; 31 ranges
- DC/AC volts: Zero to 1, 5, 10, 50, 100, 500, 5000.
- DC/AC Current: 0-1, 10 ma; 0.1, 1 A.
- Ohms: 0-500, 100 K, 1 meg.

320K SIG. GEN. KIT $19.95. WIRED $29.95.
322K SIG. GEN. KIT $23.95. WIRED $34.95.

- Fundamentals 150 kc to 34 mc, harmonics to 102 mc.
- 5-step band switching.
- Colpitts audio oscillator generates 400 cps pure sine wave voltage.
- Permits pure RF, modulated RF, or pure AF.

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600,000 U. S. TRANSMITTERS

. . . From the cradle to the grave—the rôle of radio and television . . .

By the Federal Communications Commission

(The well-nigh incredible penetration of Radio and Television into every conceivable human endeavor has now reached hitherto undreamed proportions. This summary of present day radio and television uses, by the FCC, makes spectacular reading—Editor)

RADIO usage extending from the cradle to the grave is encompassed in the flow of applications to the Federal Communications Commission for new or extended radio services.

There are existing radio facilities for calling and otherwise speeding doctors to the homes of expectant mothers as well as other persons requiring medical assistance in rural areas; and in the cities radio-equipped ambulances and other vehicles can bring medical aid.

After the baby arrives, radio-equipped vehicles can deliver milk, pick up and return diapers, and perform other chores in the interest of the newcomer.

Going to the other extreme, radio is being used for dispatching vehicles in connection with the death and burial of the departed. This includes the movement of funeral corteges at a number of large cemeteries.

The Commission's now more than 60 different classes of radio stations—which hold over 250,000 authorizations covering the use of some 600,000 fixed and mobile transmitters—represent a varied and rapidly expanding utilization of this instantaneous communication medium.

The wide extent of the application of radio for communication purposes is indicated here:

Public Communication—Domestic and international communication by telephone and telegraph over radio facilities.

Public Safety—Radio aids to police, fire, highway and forestry protection.

Transportation—Radio navigational, safety and communication aids for ships and airplanes; radio dispatching for railroads, street car systems, taxicabs, intercity buses, and highway trucks.

Industry—Radio communication to control and speed the movement of personnel and material in the production and delivery process.

Entertainment—Programming by commercial AM, FM and TV broadcast stations.

Education—Programming by noncommercial educational FM and TV broadcast stations.

Experimentation—Use of radio in research, and for the development of equipment and techniques.

The diversification of radio's uses is shown by the following miscellaneous examples: To control city and highway traffic systems . . . To direct movement of crews cleaning city streets, water mains, etc. . . . To expedite delivery of food, fuel, building material, etc. . . . To speed repair of home and business office fixtures and appliances . . . To dispatch trucks to pick up garbage, dead animals, and other refuse . . . To route rural school buses . . . To aid beach and other recreation area patrols . . .To contact workers on isolated ranches, etc. . . . To direct the movement of machinery on large farms . . . To look for oil on land and under off-shore waters . . . To spot schools of fish from moving planes and radio their locations to fishing boats . . . To direct motion picture crews on location . . . To aid bank and business protective patrol systems . . . To relay news between reporters on assignment and their newspaper offices . . . To control model airplanes, etc. . . . To send fingerprints and other information from one police department to another . . . To time and photograph the finish of track-racing events.

To communicate between the engine and caboose of long freight trains; between moving trains and wayside stations; and in yard operations . . . To control railroad track switches by the engineer on a moving train . . . To pick up and deliver telegrams by auto . . . To relay telephone and telegraph messages, also TV programs . . . To bridge gaps in disrupted wire lines . . . To transmit pictures and facsimile . . . To control crowds at large regattas, horse shows, golf matches, and other big outdoor events . . . To transmit orders from "car hops" to kitchens of drive-in restaurants . . . To control movement of ships in harbors . . . To page doctors and other persons . . . To determine the position of ships and aircraft, also the proximity of objects . . . To direct firefighters at the scene of a blaze . . . To enable garage and automobile associations to provide emergency road service . . . To send weather and market reports . . . To supervise and control valves, pressures and fluid levels along pipe lines . . . To record sunspot cycles, measure radio propagation, and study planetary reflection . . . Also, to provide emergency communication in time of local, regional and national disaster.

Because of the "housing shortage" in the radio spectrum and the increasing demand for available frequencies by recognized radio services, the Commission is unable to allocate radio space for the exclusive use of—to quote one request—a machine "to take the kinks out of woolly hair." However, electronic hair-removing apparatus does function under rules which govern the technical operation of miscellaneous radiation devices to prevent interference.

Though not used for communication purposes, there is growing use of appliances which emit energy that can disrupt radio services—not only TV and aural broadcast reception, but also services on which the safety of life and property depend. It is significant that the collective power of this group now exceeds the total transmitter power required for all forms of radio communication. Some of these units employ power far in excess of the 50-kilowatt maximum permitted AM broadcast stations.

Industrial, scientific and medical equipment employing radio-frequency energy includes heaters for the quick drying of products used in the manufacturing process, medical diathermy machines used for therapeutic purposes, welding outfits, etc. Specific frequency bands are provided to absorb their radiations and so keep them from straying into the regular communication channels.

Then there are restricted radiation devices, such as phonograph oscillators; garage-door openers and other remote-control gadgets; electronic cook stoves which heat food from the inside out; community antenna systems in areas of poor TV reception which pick up programs and relay them by coaxial cable to the homes of subcribers; and carrier current (closed-circuit) systems which use wire facilities to furnish music, voice and signaling services. The technical operation of these things, too, are subject to rules to guard against unlawful radiation.

Closed-circuit television operation, in particular, is extending into many fields and its possibilities appear to be without end. Present uses include: Demonstrating survey and other medical techniques to doctors and students . . . Instructing several classes of a school or college at the same time . . . Checking signatures, etc., between branches of a bank . . . Watching babies in large nurseries . . . Guarding prisoners in jails . . . Relaying church, concert, entertainment and other programs to overflow or supplemental audiences . . . Demonstrating new products to scattered groups of salesmen . . . Observing planes take off and land at airports . . . Supervising freight car movements . . . Detecting unnecessary chimney smoke . . . Checking documents in different parts of a large filing system . . . Serving industry as a robot eye to follow production and handling processes—such as watching boiler, water-level and other gages from the main control room; detecting delays in the movement of material; and otherwise enabling supervisors to see into several places at the same time . . . "Kibitzing" dangerous operations from a safe distance—such as those involving use of atomic energy, furnace combustion, detonation of explosives etc.

CONTROL UNIT for GOLDEN EARS

Compact and inexpensive, this unit is designed for use with the Junior Golden Ear amplifier, but is highly applicable to any amplifier

By JOSEPH MARSHALL

THE weak spot in most home-built high-fidelity systems is the control unit. It is, in fact, the weak spot of many commercial units. This is not surprising. It is by no means easy to compromise the often conflicting demands of the several jobs a control unit is called upon to do, and especially not easy to do so in a compact and inexpensive form. As an example of the extremes one can go to in trying to approach the ideal, I can cite the present control unit for the Master Golden Ear Amplifier in my own home which uses 5 double triodes (not including the phono preamplifier) and occupies a 7 x 17-inch chassis, and the same sized panel with just about a dozen knobs). Often I have thought that this was surely a case of complication *ad absurdum*; but the fact is that though I designed and built many simpler units, until recently I could not arrive at one which was capable of living up to the standards of the Golden Ear.

For instance, there is the matter of distortion. We take elaborate pains to reduce distortion in power amplifiers to a fraction of 1 percent. Adding a control unit which contributes high levels of distortion would be like throwing away the hard work and expense devoted to the amplifier. And yet it is extremely difficult to hold down distortion in a control unit. For one thing, unless we can afford a to-hell-with-expense attitude, the control unit must be single sided, rather than push-pull, for the simple reason that providing tone equalization in push-pull is a very complicated matter. Thus we are deprived of the distortion-canceling benefits of push-pull configuration. Further, since tone equalizers are included it is also hard to make use of the distortion-canceling properties of negative feedback. Single-sided amplifiers without feedback can produce large amounts of distortion (by high-fidelity standards) even with outputs of 1 or 2 volts.

There is also the matter of satisfactory tone compensation. I don't think anyone will argue with the proposition that a good tone-control circuit should provide direct boosting or attenuation without readjustment of the volume control. There aren't too many good circuits which provide direct boost.

A tone-control circuit should also control the bass or treble but leave the rest of the band unaffected. When you want to bring out the drums, you don't want to change the contralto into a female baritone; nor when bringing up the snares and triangles do you want to change the baritone into a thin tenor. Unfortunately, the simpler tone-control circuits do not fill this specification. Even a reasonable amount of bass boost usually results in a boomy voice.

Finally, when independent bass and treble controls are involved, the two should be reasonably, if not completely, free of interaction. This is far from true in the case of the average control circuits; satisfactory setting of the controls takes considerable skill.

Another important consideration is frequency response. The better high-fidelity amplifiers today have bandwidths of around 13 octaves and even more; and—as I have repeatedly pointed out—this wide bandwidth is essential for faithful, distortion-free reproduction. In contrast, the typical single-sided control unit is flat—in the flat position—from perhaps 30 to 12,000 cycles, with rapid slopes at the extremes. Of course this minimizes the range of the tone-control circuits since part of the boost is needed merely to flatten the response of the control unit itself. Worse yet, however, the slopes produce distortion, especially at low frequencies. And yet, here too, without the benefits of push-pull operation and negative feedback, it is very difficult if not impossible to obtain wide bandwidth.

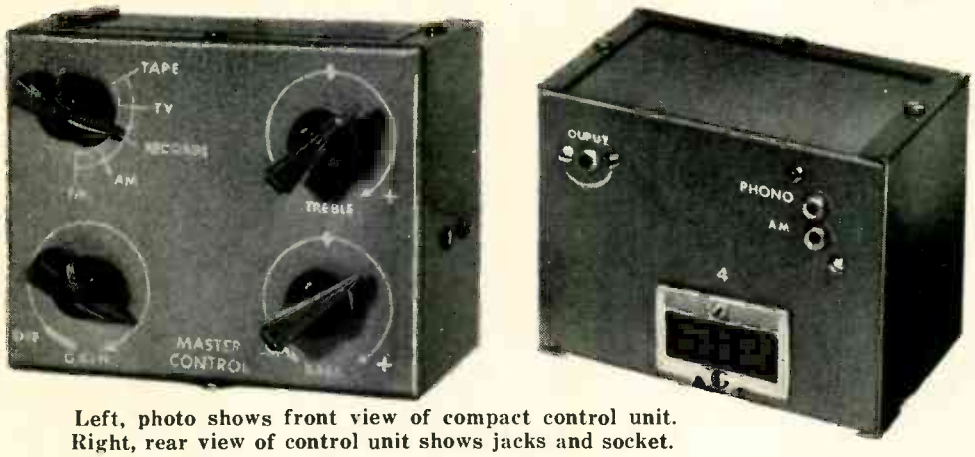
Finally, there is the matter of so-called "loudness control." Without getting into debate in a field already very noisy with argument, we can say that it would be nice to be able to preserve a reasonably good tone balance when changing the volume level. The high-fidelity crank may be perfectly happy to spend two or three minutes adjusting—in proper coordination—the volume, bass, and treble controls, every time he changes the volume level. But his wife—and most people who buy high-fidelity systems—would much prefer to simply turn the volume control up or down and still maintain a reasonably good tonal sound. Much design energy is currently being expended on loudness controls and some are very complicated with their stepped or variable slopes, etc. Even then, most designers confess their failure to solve the problem satisfactorily by including a switch to remove the loudness control from the circuit.

By no means to be disregarded is the matter of physical size and form of the control unit. To meet the infinite variety of installation problems and preferences, the unit should be small, compact, and capable of being inserted in an odd corner of a cabinet, or used by itself in plain sight, of being a part of a single cabinet, or of being used remotely.

A simple and compact job

When—in view of all the above—I present the simple unit pictured and diagrammed here, the reader is entitled to lift his eyebrows high and to look with skepticism at any claims made for it. And I am not going to say that here is the perfect control unit. It is not as good or as flexible as the master outfit mentioned above; but it costs only a fraction as much and occupies less than one-tenth the space. Only one or two people besides myself have noticed any difference, and these were either engineers or high-fidelity cranks. Furthermore, I am the only one in the family who understands the operation of the big unit, whereas all members of the family find this one simple to use properly. I could not conscientiously recommend the master unit except to the very crankiest of cranks; whereas, I do not hesitate to recommend this one even to all cranks. Its performance is good enough to bring out the best qualities of the Golden Ear amplifiers and to me, the proud brain-father, that is adequate praise.

Let us look at the performance of this small handful of gadget to see how it meets the various conditions I have mentioned. The distortion level, though higher than I would like it to be, is



Left, photo shows front view of compact control unit. Right, rear view of control unit shows jacks and socket.

still low enough to take nothing discernible away from the performance of top-quality amplifiers. The IM distortion (60 and 7,000 cycles, 4–1) is under 1% until the output exceeds 1½ volts, and rises to 2% at levels of 3 to 5 volts. The Golden Ear amplifiers are among the least sensitive of all amplifiers, because of the large amounts of feedback they incorporate. However, less than 0.2 volt will produce an output level high enough to drive most women out of the house and to break almost any lease. At this level the distortion is below 0.5%. This is the result of two factors: the smooth and wide frequency response and the very considerable amount of feedback applied to both stages.

Tone compensation circuitry

Now for tone compensation. Recently Britain, which has sent us so many excellent high-fidelity products and circuits, has produced a tone-compensating circuit (introduced by Baxendall) which for a combination of virtue and simplicity is little short of fabulous.

First of all, it is a direct-acting tone-control circuit. Turning either bass or treble controls up or down brings an immediate boost or attenuation with no need to compensate the volume control. Second, it is a circuit in which the turnover on both ends varies with the amount of boost or attenuation. Thus the turnover is below 100 cycles for a boost of 6 db; it rises to about 200 cycles at 12 db; and at maximum boost of some 20 db the mid-frequencies are still relatively unaffected to the ear. The treble turnovers are similarly variable. This results in very pleasant and satisfactory tone compensation; large amounts of boost can be applied to the extremes of the spectrum, with very little audible effect on the mid-frequencies. The total range of control from maximum boost to maximum attenuation at the two extremes of 20 and 20,000 cycles approaches 50 db for the bass and is over 40 db for the treble. This includes the unit as a whole, not merely the tone control unit, and therefore includes all circuit gains and losses. Finally, because this is a feedback circuit, the distortion is minimized except at the points of maximum boost where it becomes the same as that of a similar stage without feedback. However, the maximum boosts are almost unusable with high-fidelity program material; and with any normal amount of boost the distortion is considerably lower than that of an ordinary single-sided stage without feedback. The boost continues smoothly to 10 cycles and perhaps less, on the low end, and at least to 30,000 cycles on the high end. One more thing. Because of the high feedback the output resistance is very low—almost as good as that of a cathode follower—and therefore a long line can be used between control unit and amplifier without serious loss of high-frequency response.

As for bandwidth. By a combination of very low stray capacitance (due to the use of the Vector socket and the method of construction) and of feedback, the over-all bandwidth is flat from about 10 cycles to just over 20,000 cycles, with the volume control half-on. There is a little boost at the low end and a fairly gradual slope beyond 20,000 cycles which can be corrected with just a crack of the treble control to around 30,000 cycles.

The volume control includes a considerable amount of bass boost, amounting to a total of nearly 20 db between maximum and minimum positions of the volume control—and not counting any boost made by the bass control. This is done by the rather novel feedback loop in the first stage where feedback is introduced through a resistor in series with the volume control. The feedback amounts to about 6 db with the volume control at maximum and approaches 30 db at the minimum position of the volume control. The combination of control taper and variable feedback produces a smooth reduction of volume and, because of the R-C constant of the loop, the bass varies as the volume varies. Assuming the control is set at mid-rotation—which would be about the normal home-listening position—the bass boost is about 10 or 12 db. From this position, turning the volume to maximum reduces the level at 20 cycles by 9 db, while turning it to minimum increases it by 10 db. Thus, if the bass control is set for a desired balance at normal listening level, a change in the volume control setting up or down will produce compensation which is pleasant.

It's not perfect

This circuit has one fault: the volume is not completely cut off at the minimum position of the volume control. However, radio and TV receivers will have volume controls which can be set to produce complete cutoff if desired. If the record input is too high to produce an acceptable minimum volume, a resistor of 500,000 ohms or more can be inserted between record input and the appropriate point on the switch to reduce input level to the desired degree. This system could be used with the other inputs, the resistors being selected so that each input source delivers the same input signal. This, however is a small price to pay for the virtues of loudness control and reduced distortion which the circuit yields. (Complete control of volume with somewhat higher bass boost could be obtained by using an IRC type Q17-133X control and returning the feedback to the 25,000-ohm tap.)

Because of the two feedback loops, the control unit is excellent for remote operation. The feedback on the input stage reduces the input resistance and therefore cable losses at high frequencies; the feedback in the output stage reduces the output resistance and therefore losses in cables. As much as 25 or 30 feet of shielded cable can be used with losses moderate enough to be compensated for easily with the treble boost control. The on-off switch on the volume control controls the whole audio system. Two wires in the cable feed one side of the 117-volt line to the switch.

So the circuit does rather better at meeting the specifications for a high-quality control unit than the skeptical might believe possible. Whether the result is measured by ear or by instrument, it is a superior control unit, despite its small size and simplicity. It will not harm the performance of even the most expensive combination of amplifiers, pickups, and speakers; on the contrary, it will work considerably better than most. The over-all performance will in any case belie the cost given in the certified parts list.

Construction details

The unit (shown in Fig. 1) is very simple to construct. It is mounted within a 3 x 4 x 5-inch Flexi-Mount aluminum case to match the phono preamplifier (to be described in a future article). The two units could be combined in a single larger case; but I recommend separate cases for better isolation and a better over-all noise figure, as well as greater flexibility in placement.

There is only one critical part. The treble control should be a 500,000-ohm potentiometer with a *linear* taper and a tap at 250,000 ohms. Only a linear control with a mid-tap will result in

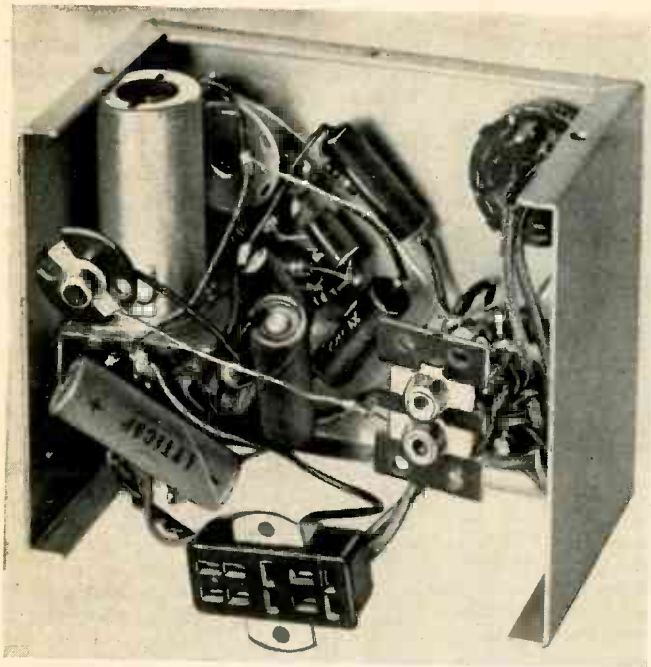


Photo shows internal view of control unit. Thorough shielding includes tubes and wires.

obtaining a flat position at mid-rotation and equal amounts of attenuation and boost. Unfortunately, such units are hard to find. The prototype uses a Mallory UF55-T254. While it is not exactly correct it comes very close to being right. The flat position is a little to the attenuation side of center; but the center position will provide just enough boost to make up for line and program losses beyond 10,000 cycles.

20 cycles useful without instability, and will keep the transient response up to that of fine power amplifiers. All Golden Ears except the Junior provide a V-R tube regulated source of 150 volts for this purpose.

The wiring is done in two steps. The turret socket is wired with the plate and cathode resistors; bypass and coupling capacitors. The rest of the wiring is done on the panel after the

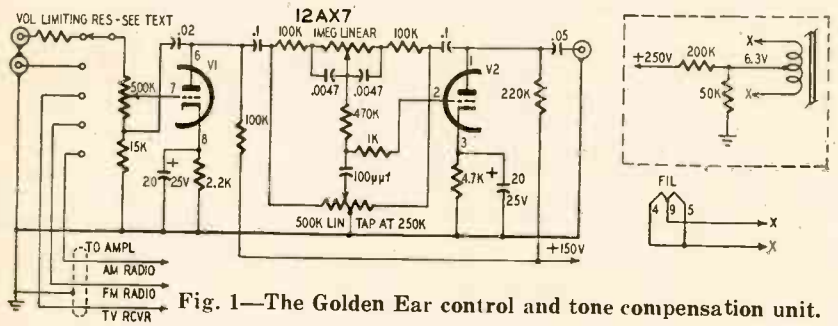


Fig. 1—The Golden Ear control and tone compensation unit.

(Tone control components, dual concentric control and couplate, can be ordered from Centralab—part number C3-300.)

Calibration—centering of the bass control—will be simplified if the two 100,000-ohm resistors are 5% units; in that case, it can safely be assumed that mid-rotation is the flat position. Otherwise the components are not at all critical. Ten or even 20% resistors and good-quality plastic-covered paper capacitors—the smaller in physical size the better—are plenty good enough. For minimum hum the filaments should be fed by a balanced and biased filament supply as diagrammed in the dotted square. Golden Ear amplifiers have such a source and will feed the control unit.

To allow the best use of the wide bandwidth and boost this unit permits, it is highly desirable that the 150-volt B supply come from a V-R tube. This will produce the high degree of decoupling which will make boosting at

controls are mounted. Fig. 2 shows the recommended wiring of the tone-control circuits as viewed from the rear or wiring side. Note that the two coupling capacitors must be connected to the points indicated to obtain clockwise boost. The various resistors and capacitors are supported by the terminals of the controls. Be sure the .0047-μf capacitors are the miniature type specified. Ordinary ones will take too much space. Connection to the second-stage grid is through the 1,000-ohm resistor with spaghetti tubing over the bare wires. The connections to the two plates are through the coupling capacitors, also covered with spaghetti. The vector turret socket is mounted on a small square of aluminum bent to make a bracket and punched with a hole for the socket. This bracket must be positioned precisely with the tube shield in place. There is just room enough to permit the cover to slip on and off, if this bracket is properly placed. Do not leave out the tube shield; the two feedback loops might produce instability without it.

A 5-position single-pole switch of the miniature type permits the choice of 5 inputs. One for the phono-equalizer and another for a tape recorder are phono jacks mounted on the cover of the case. The two radio and the TV input are fed via the cable which brings the operating voltages. Or, rather, this cable consists of two cables strapped together: one is a 3-conductor shielded cable for the audio circuits; the other a 6-conductor unshielded cable for the plate and filament supplies. Although the model pictured has a cable jack and plug, the jack could be dispensed with and the plug used only at the far end, the power supply or amplifier. In that case the cable could enter the cabinet through a grommet.

The only precaution to take in assembling the unit is to make the leads between the parts on the case and points on the cover long enough so that when the cover is slipped on there is enough of a crack or opening to permit easy soldering.

Whether used with Golden Ear or other amplifiers, this control unit will add greatly to the flexibility of performance, and—equally important perhaps for the other members of the household—to the ease and simplicity of operation and therefore to the pleasure the whole family obtains from the high-fidelity installation.

Certified Parts List

1—500,000-ohm potentiometer, audio taper, with switch.
1—1-megohm linear potentiometer.
1—500,000-ohm linear potentiometer with tap at 250,000.
1—12AX7 tube.
1—Vector noval turret socket, 6-lug, 1½-inch.
1—Shield and base for above.
1—Miniature 5-position, single-pole switch.
2—20-μf 25-volt capacitor.
1—.02-μf 200-volt paper capacitor.
2—0.1-μf 200-volt paper capacitor.
1—.05-μf 200-volt capacitor.
2—.0047-μf Aerovox microminiature.
1—100-μμf miniature, mica.
3—Phono style jacks.
2—100,000-ohm 5% resistors ⅓ watt.
7—10%, ⅓ watt resistors: 1—15,000; 1—2,200; 1—4,700; 1—100,000; 1—220,000; 1—470,000; 1—1,000 ohms.
1—Jones socket, 10 contact, type AB.
1—3 x 4 x 5-inch Flexi-Mount case.
4—Knobs.
Total cost of the above, as purchased from a large mail-order house, was $12.09.

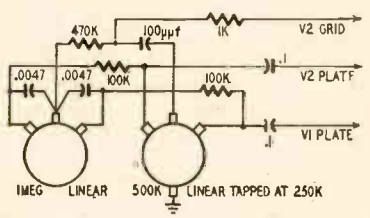


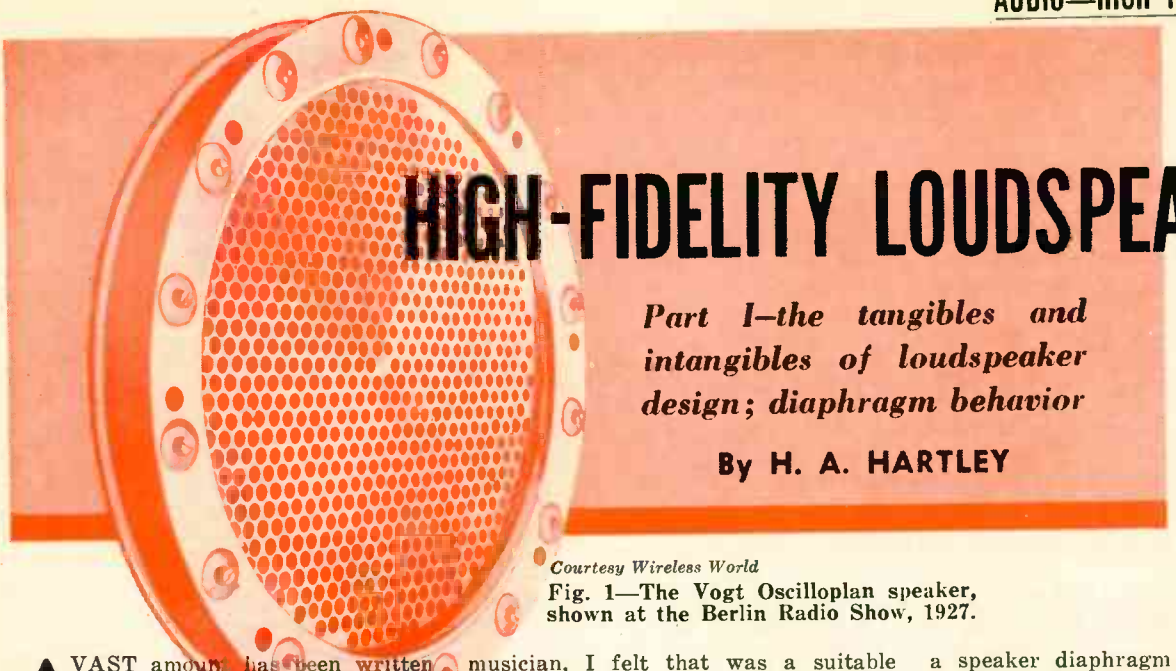
Fig. 2—Wiring of tone-control circuit.

Next Month we expect to present Milady's Golden Ear amplifier, a new version of the Golden Ear configuration using big output tubes, with performance right up there at the top, and a revolutionary method of construction which will hide all clumsy handiwork and mistakes, and produce a piece of equipment which Milady of the household will not object to having in plain view. END

HIGH-FIDELITY LOUDSPEAKERS

Part I—the tangibles and intangibles of loudspeaker design; diaphragm behavior

By H. A. HARTLEY



Courtesy Wireless World
Fig. 1—The Vogt Oscilloplan speaker, shown at the Berlin Radio Show, 1927.

A VAST amount has been written about what we call "high fidelity." Some is original work; much of it has been lifted from standard works, revised, and offered as something new. Old fallacies and errors are repeated, apparently through lack of the necessary technical knowledge, and these sometimes become accepted principles of design.

I believe that I invented the concept of high-fidelity in 1927; at that time I was, as now, seriously interested in music, and it so happened that my job was designing speakers and amplifiers for the phonographs we had in those days. They were not very good and we invariably used some sort of balanced armature speaker with a large paper diaphragm. The moving coil, or dynamic speaker, had been invented a long time previously by the English scientist Sir Oliver Lodge, but nothing very much had been done about making it a practical proposition until the original horn-loaded dynamic speaker of Magnavox appeared in the early 1920's. This sounded better than the other "tin trumpets," but not good enough to compete with the remarkable "Kone" speaker of Western Electric. Then the American designers Rice and Kellogg produced a real dynamic speaker in, I think, 1926 or 1927, and the modern reproducer was born.

The Rice-Kellogg was so good that I thought it had possibilities of becoming better. The hidden meaning of this remark forms the foundation of the whole science and art of reproducing music. Earlier speakers were not even an imitation of music, because they lacked bass and extreme treble. The R-K was not very good above about 5,000 c.p.s. but it reproduced bass of a sort we had never heard before, simply because it had a diaphragm that could move. The sound of this speaker was the first clear signal that electrical gramophones could be designed to give some sort of approximation to an original performance instead of just being a little better than musical toys. Why not, therefore, make them better still? As both an engineer and a musician, I felt that was a suitable question.

I have used the expression "the science and art of reproducing music," and I want to emphasize something that is not generally understood by the layman. It is not possible to define musical appreciation in terms of mathematical equations alone; something must be added. Similarly, the design of audio equipment intended to give a close approximation to an original performance is basically mathematical (amplifier design, for example, is entirely mathematical). But, particularly in the speaker, some design features cannot be computed; they are best thought of as the outcome of inspired hunches.

The best mathematical essay on the mechanics of speaker design is the book "Loudspeakers" (long out of print) by Dr. N. W. Maclachlan. The mathematician will enjoy the elegant treatment, but it is heavy going for the ordinary reader. Maclachlan shows that only the simplest of diaphragm behavior can be analyzed. When the book first appeared, a colleague of mine said that "Mac" had pulled off a remarkable *tour de force*, but it didn't tell us how to design speakers. That was true, but it wasn't Mac's fault. The complete behavior of a speaker diaphragm *cannot* be analyzed; you can only listen to it and hope that it sounds good, and some musical knowledge is required if you desire to criticize it with authority.

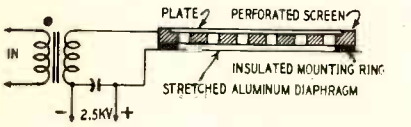
For example, a question often put to me is, "What is the damping factor of your speaker?" The formula for the damping factor at bass resonant frequency can be found in any standard engineering textbook. The factors in the equation include: a figure for the damping resistance equivalent to the combined effect of friction and acoustical loading on the cone; the impedance of the voice coil plus that of the secondary of the output transformer and the connecting leads *and* of the primary related to the secondary; the effective plate resistance of the output stage of the amplifier; the frequency of the bass resonance; and the shunt capacitance of the system. Now I could reply to this question by saying that I can't answer it until he tells me what his output stage is, what sort of output transformer he has (in exact mathematical terms), how long his speaker leads are, what their capacitance is, and at what frequency he wants the figure. Then, if he has the patience to wait while I work out the equation, he can have his damping factor. If this seems poor salesmanship, all I need do is to check up on the damping factors of other speakers and quote a better figure than anyone else; I couldn't be proved wrong, and it would sound impressive. But the honest answer to the question is, "I haven't the faintest idea." And my truth seeker would consider me a fool.

I am pleading for sanity in assessing speakers. A speaker must obviously have a wide and level frequency response; it must be free from intermodulation distortion; it must have a good polar diagram at all frequencies; it must have good "attack" to reproduce transients faithfully, and good damping to avoid hangover; and, most elusive quality of all, it must have absolutely no "personality" whatsoever. A speaker is not a musical instrument, it is a reproducer of musical instruments, and must not add any sort of

This is the first of a series of articles on High-Fidelity Loudspeakers by the British high-fidelity specialist, H. A. Hartley. Having been closely associated with the audio field since its inception as a writer, engineer, and manufacturer, Mr. Hartley has gained world-wide renown as an outstanding authority on audio design in general and loudspeakers in particular. Mr. Hartley is president of H. A. Hartley Co., Inc., formerly Hartley-Turner, Ltd.

coloration to its sound output.

The final article in this series will give some information on testing speakers. This is not easy, except in properly equipped acoustical laboratories. Inadequate testing may lead to erroneous conclusions. I believe that long experience in designing speakers enables one to acquire a fund of practical knowledge of the acoustical behavior of materials and shapes used in speaker design. This enables the expert to make a pretty shrewd guess as to how any speaker will sound just by looking at it. These articles are designed to impart as much of that knowledge to you as possible. They cannot do this with complete success because the written word cannot take the place of experiment and



Courtesy Wireless World

Fig. 2—Oscilloplan speaker circuit.

measurement. But it is hoped that they will prove a reliable guide.

As the writer, I suppose it is inevitable that my own personal "coloration" must appear in the general treatment. I have tried to avoid this. Where my personal *opinion* appears, I'll say so; where I make categorical statements, you may safely assume that practical work proves them. Yet speaker design cannot be entirely a matter of right and wrong. Set two designers to produce a new calculating machine. Working independently, they will likely produce different designs; but the worth of their designs can be evaluated by simply working the machines to see if they give the right answer. Speaker design is not like that, for no one knows what the right answer is. Perfect reproduction is impossible, so assessment of an imperfect result can be only a matter of personal taste.

Direct radiators (baffle speakers)

The two main classes of speakers are the direct radiator type, in which the diaphragm acts directly on the air in front of the baffle or cabinet, and the horn-loaded type. They must be designed differently. It is a good test of design when the direct radiator will not work into a horn, and a horn speaker will not work on a baffle. Many present-day multiple-speaker systems use direct radiators working into what are called folded horns. All this is a contradiction in terms and principles. This point will be discussed further in the design of speaker housings.

Direct radiators can be widely different types—crystal, electrostatic, electromagnetic, or electrodynamic. The last is the only one to survive, so the others will not be considered, except for a few words on the electrostatic—necessary because of talk of new and better speakers coming along, based on electrostatic principles.

An electrostatic speaker is nothing more nor less than a capacitor, one plate of which is a metallic diaphragm. A good early type was the Oscilloplan (Fig. 1) of Hans Vogt, a German designer, in 1927. This had a 12-inch thin aluminum diaphragm tightly stretched across an annular mounting ring. Behind this was a perforated nonmetallic screen, and behind the screen was a plate forming the other electrode of the capacitor. A polarizing voltage (of about 2,500) was applied to the unit to set up a condition of strain, and the speech frequencies were added across the capacitor (Fig. 2). At low frequencies the movement of the aluminum diaphragm was appreciable and the insulating screen prevented short-circuiting. Unfortunately, when the diaphragm was near the screen the polarizing voltage sparked across, with distressing acoustic results, and the frequency response was very uneven. With the arrival of talking films it was thought that a battery of such speakers (they were conveniently thin and light) could be used, spread across the whole projection screen, but extended testing gave little promise of satisfactory results. Other electrostatic speakers were made of pleated metallized paper on aluminum electrodes, but these had no bass response and were feathery at high frequencies. In all types, the polarizing voltage was a nuisance, even dangerous. I have mentioned these to show that there is very little new under the sun. It is very difficult to acquire a valid patent on speakers—all has been done before—and we can look for no great progress until someone invents an entirely new method.

Attention therefore can be directed toward the ordinary dynamic speaker, in which a more or less conical diaphragm carries at its apex a coil of wire which oscillates in a magnetic

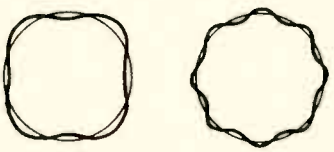


Fig. 3—Front view shows nodes in a straight-sided conical diaphragm.

field. Such a speaker cannot reproduce low frequencies unless it is mounted on a baffle, because as the sound from the front of the diaphragm is 180° out of phase with that from the back, the slower longer sound waves will cancel out each other unless prevented from doing so by an obstruction—the baffle plate. The baffle need not be flat, and its effective size is the total distance from the front of the cone, around the edge of the baffle, to the back of the cone. The most economical baffle therefore will be circular, and the most economical box spherical, considered from the viewpoint of raw materials.

A direct radiator's performance depends on the design of the diaphragm, the voice coil, the magnet system, and the mounting of the whole unit. The last point will be considered under housing design; the other three will be discussed now.

Someone sometime in the past said that it is impossible to design a single diaphragm which will reproduce the whole range of frequencies required for high-fidelity reproduction. I may be the originator of this fallacy, for I produced the first tweeter-woofer combination as far back as 1929, and put it on the market in 1930. I withdrew it in 1931 because I didn't like it. It is difficult to produce a single-diaphragm speaker to cover all frequencies, but it is far from impossible. Another fallacy is that the perfect diaphragm would be an infinitely rigid piston of no mass. I have shown (*Audio Engineering*, January, 1953, "The Great Loudspeaker Mystery") that if such a perfect diaphragm could be made, it could reproduce only one frequency at a time. Loudspeakers do reproduce many frequencies simultaneously, and it is obvious that they can do so only because the cone does not behave like an infinitely rigid piston; in other words, cones "break up." It is the designer's task to see that they break up in a controlled manner, so that the frequency response shall be as level and smooth as possible.

The high frequencies come from the apex zone of the diaphragm; the lows are generated by the cone moving as a whole. The bass reproduction is not affected by the breakup at high frequencies because the movement of breakup is so small that there is no output at other than high frequencies. For a given cone, the harder the material the better the treble response—a cone made of blotting paper would have no top response worth considering. This led to the widespread practice of doping the apex of the cone to make it harder.

On the other hand, for good response

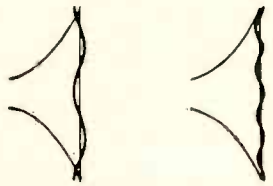


Fig. 4—Diagram shows side view of nodes in an exponential diaphragm.

in the bass, the cone should move as a nearly rigid piston, since the amount of air to be moved at very low frequencies is considerable; it would therefore seem logical to make the cone material harder and stiffer for low-frequency reproduction, and such proves to be the case. A very stiff cone made of high-grade Bakelite-impregnated paper gives cleaner and more powerful bass than one made of molded pulp, the commonly

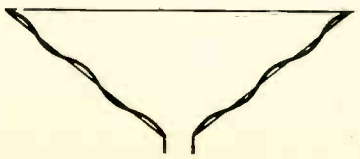


Fig. 5—Low-frequency wave motion.

Fig. 6—The Voigt twin-cone speaker.

Courtesy Wireless World

used material. Molded cones are used because they are cheaper to produce and capable of being made within fairly close limits, but they are too soft for the best bass reproduction. If they are stiffened by being doped, to improve the bass, they will not break up in the desired manner, and the added weight of the dope will impair the treble response as well as the attack, since good transient reproduction depends not only on good frequency response but on low inertia of the moving cone—it must respond almost instantaneously to the kick of a transient wave. This point will be discussed again when I deal with multiple-unit speakers.

Apart from frequency response the diaphragm material affects the "color" of the reproduction. Some organ pipes and musical instruments are made of wood, others of brass or steel, or even silver. These materials are not used haphazardly. Wooden pipes and instruments have a tone color of their own and very distinct from that of metallic sound producers. A speaker is also a sound producer and the vibrating part will have its tone color associated with the material of which the cone is made; but a speaker is primarily a sound *reproducer* and should have no tone color. Metal diaphragms are therefore undesirable, even if they are strong for a given mass. Soft paper is nearly inert, but poor at both the low and the high ends of the frequency scale. If the paper is doped to improve the treble, it must be done in such a way that coloration is not introduced. This can be detected only by ear since it does not show up on a measured response curve.

The size of the diaphragm has an important bearing on the performance of the speaker, but the size is related to the freedom of suspension. For example, if one speaker is fitted with an 8-inch flat diaphragm and another with a 13-inch, for equal inputs the 8-inch cone will have to move about 2½ times as much as the 13-inch to produce the same acoustic output. This is of importance only for low frequencies since the movement at high frequencies is microscopic. Other things being equal, and provided a sufficiently free suspension avoids clipping of the input signal through nonlinearity of output, the size of the cone is no positive indication of bass reproduction capabilities.

But other things are not equal. I have shown that the diaphragm should be rigid for good bass reproduction, and a large cone is not so rigid as a small cone, for a given cone material. With small inputs this is not of great importance, but large cones are used to increase power-handling (since free suspension is a very tricky matter) at low frequencies. If the cone is rigid, its weight will spoil the response in the treble; if it is soft, the bass response will be impaired by *noding* even before the limit of input power is reached. The node pattern is a function of the applied frequency and the phenomenon is not restricted to speaker cones; every suspended system develops nodes when an oscillating force is applied to it.

In a speaker diaphragm, which can be conical or exponential in section, nodes will cause loss of output at fundamental frequencies and introduce harmonic frequencies. If the power input is increased until the limit of movement has been reached, the proportions will be approximately one-twentieth of the fundamental, one-eighth of 2nd harmonic and the rest of 3rd. The strongest cone, for a given mass of material is one with an included angle of 90°, but such a narrow cone causes undue focusing of the highs. If the cone angle is widened to obtain good forward radiation, as is usual, the diaphragm will be weakened radially and nodes will show a flower pattern when the cone is viewed from the front (Fig. 3). The exponential cone was developed to overcome this defect, but it is weak axially and the node pattern can be seen from the side (Fig. 4).

The large cone has a further defect. I have pointed out that cones must break up to reproduce more than one frequency simultaneously. This breakup occurs in concentric waves radiating from the center of the cone. Very short waves (high frequencies) will die out quickly, but the longer waves will continue to the edge of the cone (Fig. 5). Parts of the cone will be out of phase with other parts. In a large cone they may be 180° out of phase. Acoustic measurement with a sine-wave input will show irregularities in the response, but reproduction of music involves the reproduction of complex waves. Phase distortion therefore will be inevitable; the amplitude of the component frequencies *may* be reproduced approximately correctly, except for loss of output at the low frequencies (as explained above), but the lower frequencies will be out of phase with respect to the highs. It is impossible to lay down hard and fast rules concerning design, but in a general way it can be said that this sort of phase distortion is less with small diaphragms.

Attempts to control the cone breakup and remove the defects just described are seen in the use of concentric molded depressions or ridges in the cone. One cannot express any opinion on the value of this by comparing two different speakers, one with rings and one without, for other design features are also present. The only test is to have two identical speakers, one with a plain cone, the other with a ridged cone of exactly the same weight, and make direct comparison measurements between the two under precisely similar test conditions. I have done this and found no noticeable difference in frequency response in the middle register and treble; but molding ridges into the outer zone of an exponential diaphragm increases axial rigidity, reduces the formation of nodes, and improves bass.

A favorite method of trying to overcome the conflicting requirements of treble and bass reproduction in a single diaphragm is to add a tweeter cone to the diaphragm voice-coil assembly (Fig. 6). This method was invented by Voigt in about 1934, and it is beyond argument that the Voigt twin cone had more treble output than a Voigt single cone. But the Voigt was a horn-loaded speaker of unusual electro-acoustic efficiency and required only 1 or 2 watts to produce a very sensible volume. I applied this idea to a direct radiator but without success, although the treble response was improved. A direct radiator is not as efficient as a horn-loaded speaker, and application of 4 or 5 watts to the tweeter cone caused edge flutter, giving a tissue-paper effect to the reproduction. This could be overcome by cementing damping material to the free edge of the tweeter cone, but the added mass destroyed the increased treble output. Some manufacturers have tried to avoid this trouble by molding the small cone into an exponential shape, and it is partially successful, but the apex of an exponential cone is not even a cone but almost a parallel-sided tube, and focusing of the highs is very pronounced.

Other methods of modifying the main cone have been tried, but any departure from the minimum possible area of cone material will increase the mass and decrease the treble response; ideally the designer should try to reduce the mass at high frequencies. This can be done by a special design of voice coil.

(TO BE CONTINUED)

what is OPTIMUM LOAD?

By NORMAN H. CROWHURST

EVERYBODY knows about loads, so we won't start by explaining what a load is—yet. The word "optimum" means "best," but it should be qualified. If someone asked you what is the best tube type on the market, you would need to know what he wanted it for: a low noise level input stage; a high-gain preamplifier stage; a driver stage; or a power-output stage—to name just a few. The same thing is true about the plate load for any given tube. What do you want the plate load to do?

Probably the most common use of the term *optimum load* is in connection with output tubes, where we are interested in getting the maximum power output from a tube without exceeding its plate dissipation rating. In such a case, optimum means the load for giving maximum output without over-driving the tube. But it may not be as simple as that. What kind of output do you want? Square wave? Or something similar to the input wave? Or do you want it to have the lowest possible distortion while still giving close to its maximum output? Another application of output tubes is when a specific output power is required with a minimum of input grid swing. This can be called optimum load for maximum sensitivity. All these objectives cannot be obtained with the same optimum load value for the same tube.

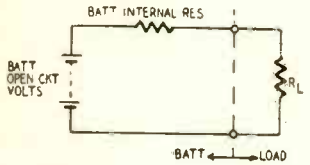


Fig. 1—Equivalent battery circuit.

Leaving tubes behind for the moment, let's assume we have a battery from which we want to operate a heating element. The element can be wound to any specified resistance, but we want all the heat in the element that we can get from the battery. If we make the resistance too high, the battery voltage remains high, there is a small current flow, and little heat is created. If the resistance is too low, the battery voltage drops, and although the battery may get warm the resistance element will not get enough voltage to warm it appreciably. The optimum resistance for the heater is the one that will draw the maximum wattage from the battery—somewhere between these two extremes.

To simplify this problem, the battery is regarded as being made up of two separate components: a perfect battery that gives constant voltage regardless of what is connected to it; and an internal resistance which accounts for the drop in terminal voltage when current is drawn from the battery. Fig. 1 shows this idea. Let's put in some figures. Suppose the battery is a group of small cells giving 24 volts, and having an internal resistance of 12 ohms. The total resistance which determines the current, is the internal plus the external heater resistance. The voltage across the heater can be obtained by Ohm's law and the wattage dissipated by the heater is terminal voltage times current. We can tabulate this for different values of heater resistance. (See wattage table.)

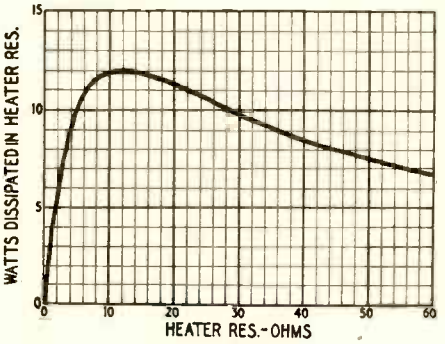


Fig. 2—Varying the load resistance.

Fig. 2 shows heater dissipation plotted against heater resistance. It appears that a 12-ohm heater gives the maximum wattage—12. This is the same resistance as the internal resistance of the battery. This numerical example illustrates an important principle: The *maximum wattage* in the external circuit is obtained by making the external circuit resistance equal to the internal resistance.

Maximum sensitivity

Assume we have a tube connected to the necessary voltages (Fig. 3), and the plate choke-coupled to the plate load, so we can change the plate load without altering the plate voltage. Now apply an audio signal to the grid, well within the maximum swing allowed for the bias used, so that the distortion is small no matter what load we use. If we leave the plate load unconnected, then assuming that the choke does not itself constitute a load, the audio voltage at the output will be the audio voltage at the grid multiplied by the amplification factor of the tube. If we short the output terminals, the voltage disappears, the same as it did with the simple battery. Any amount of plate load we connect will *reduce* the audio voltage at the terminals, according to the load value. This can be explained by regarding the tube as an audio-voltage generator combined with an internal resistance. The so-called internal resistance is the plate resistance of the tube. For the case we are now considering, the maximum wattage in the load occurs when the plate load is equal to plate resistance.

This result is expected, but it doesn't seem to line up with practice, you will be thinking. All the same, it is true for the particular case dealt with. The conditions should be emphasized: Audio signal level at the grid is well inside the maximum swing allowable for the grid bias used, and is restricted to this level; the output variation considered is the power in the plate load as plate load value is varied, using the fixed grid input.

WATTAGE TABLE

Heater resistance (ohms.)	Total resistance (ohms.)	Current (amperes)	Terminal volts	Heater watts
3	15	1.6	4.8	7.68
4	16	1.5	6	9
6	18	1.33	8	10.67
8	20	1.2	9.6	11.52
12	24	1.0	12	12
18	30	0.8	14.4	11.52
24	36	0.67	16	10.67
36	48	0.5	18	9
48	60	0.4	19.2	7.68

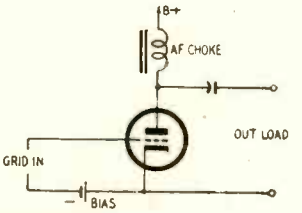


Fig. 3—A basic type output circuit.

If we wanted an output tube to provide its maximum gain in terms of power in the load, we should use an optimum load equal to the plate resistance of the tube. But gain is usually easy to obtain elsewhere. The more difficult thing with power tubes is to get a large audio output with reasonable plate dissipation. So we start at a different place. We assume that whatever grid swing is needed will be found somehow, although it will generally be advantageous to use a tube with a small grid-swing. The problem is to get the biggest possible swing in plate voltage and current at the same time, so the output watts are as high as possible, with little distortion.

Matters are complicated because tube characteristics have boundaries. We have assumed we were well enough within these boundaries so we could ignore their existence. But in each kind of tube there are at least three boundaries that have to be considered. Fig. 4 shows the case for triode types, and Fig. 5 for tetrode or pentode types. In each case dashed lines are used to show how the curves would go in theory if there were no boundaries at all.

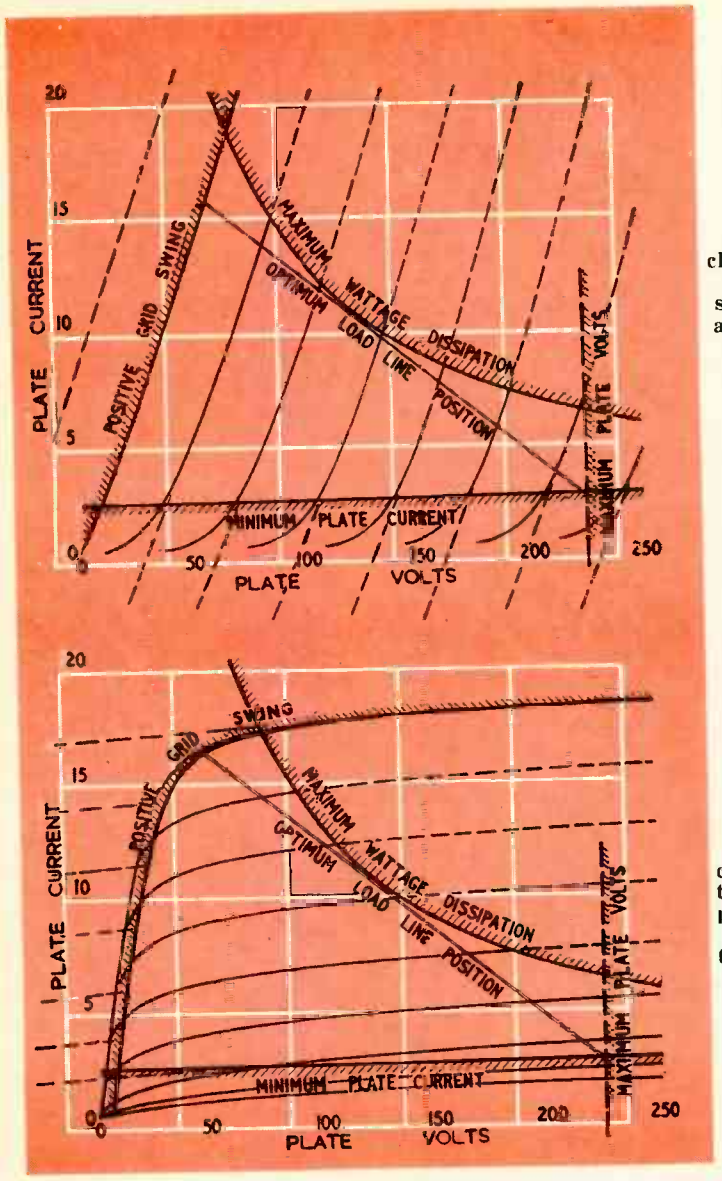


Fig. 4—Tube characteristics of typical triode, showing boundaries controlling optimum load.

Fig. 5—Tube characteristics of typical tetrode or pentode, showing boundaries controlling optimum load.

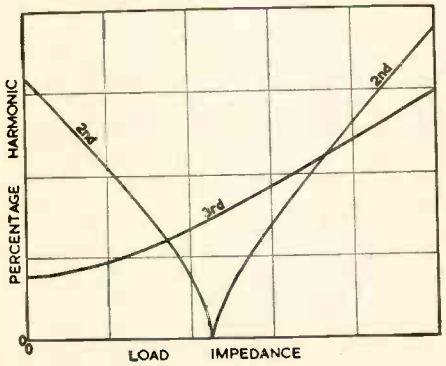


Fig. 6—Harmonic distortion analysis.

The first boundary for a power tube, and for any tube when it is to be operated close to maximum conditions, is the wattage-dissipation curve, a line of points showing maximum plate dissipation (volts × current).

The secondary boundary can be called the positive grid-swing boundary. For the triode tubes, this will usually be the zero grid-voltage curve, unless power is available to supply the grid current that flows when the grid runs positive. In such a case, some specific value of positive grid-voltage curve will determine this boundary. For pentode and tetrodes the zero grid curve applies as boundary above the *knee*, but in the vertical part it is advisable to set the boundary over, as the curves merge here, so that use of the zero grid curve would cause severe distortion.

The third boundary is the line representing zero plate current. Plate current does not normally go into reverse, and before it reaches zero there is a converging of the characteristics that will cause distortion, so the boundary should be set at some minimum value of plate current. This can be called the minimum plate-current boundary.

In addition to these three boundaries that apply every time, there is another that sometimes chips in, while in other cases the three regular boundaries take care of it automatically. This is: maximum permissible plate voltage.

For any given tube the optimum plate load is found by varying the slope of the load line (varying the plate-load resistance) until the product of plate voltage and plate current swings is a maximum. The slope of this line gives a value of optimum load. (Calculation procedures for determining the power output of tubes are given in the RCA Receiving Tube Manual, Technical Series RC 16, pages 17 to 21.)

Load values for triodes are not usually too critical. A value two or three times greater than the rated optimum will not introduce distortion, but the power will be reduced somewhat. In triode output tubes the optimum load is several times the plate resistance—usually three times, and often five or more times. Further increase of plate load improves waveform slightly, increases output voltage swing slightly, but reduces output power, because the current swing is cut down more than the voltage swing is increased. Use of a plate load less than about three times the plate resistance results in distortion, unless the grid input swing is restricted, which limits the output.

For pentode and tetrode tubes, the term optimum load can have a stricter meaning. Working at a level a little below maximum output, variation of the load changes the nature of the distortion. In triodes, all the curvature is in the region of the minimum plate current boundary, which results in 2nd harmonic distortion. In tetrodes and pentodes, curvature is also introduced at the positive grid-swing boundary when the top end of the load line swings below the knee of the curves, representing load values higher than optimum. The higher order harmonics are introduced, and the amount of second harmonic depends on how the two sources of curvature balance one another. It is possible, by selection of load value, to eliminate 2nd harmonics altogether. An analysis of distortion from typical tetrode or pentode tubes is shown in Fig. 6. For some purposes the point where the 2nd harmonic disappears, or the total harmonic is a minimum, is considered the optimum load.

We have assumed that the object is to get the maximum output with minimum distortion. But as in audio work the maximum output is somewhat of an unused figure, reached at only fairly rare peaks, it can be said that distortion is more important at lower output levels. The exact curvature of the characteristic along any given load line follows a rather complicated law. The result can lead to the following kind of experience: Assume that plate load is made adjustable, so that it can be varied. With a harmonic analyzer connected to give minimum distortion at or near full output, turn the level down 10 or 20 db. Readjustment of the plate load will probably reduce distortion at this reduced level. Consequently it is probably better to choose a load value that gives minimum distortion at low levels, even though the distortion at maximum level may be up slightly.

In later articles we will consider frequently asked questions such as: Can feedback modify optimum load? What is optimum load for push-pull circuits? Just what does a cathode follower do and what does it not do? END

HIGH-QUALITY AUDIO

By RICHARD H. DORF*

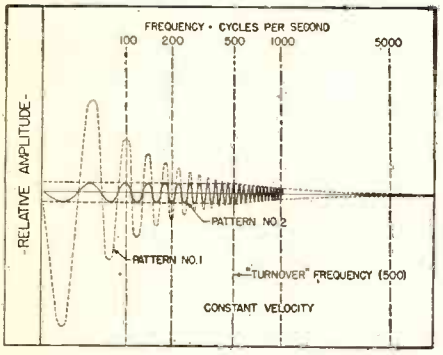


Fig. 1—Chart shows groove variations.

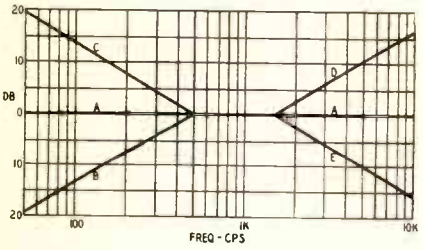


Fig. 2—Frequency characteristic curves.

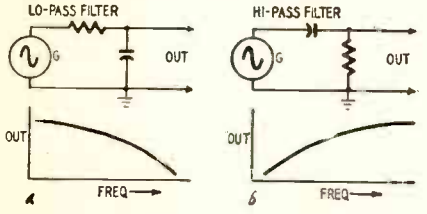


Fig. 3—Two basic equalizer circuits.

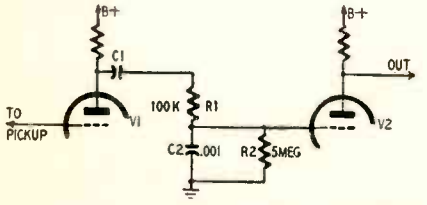


Fig. 4—Preamplifier with equalizer.

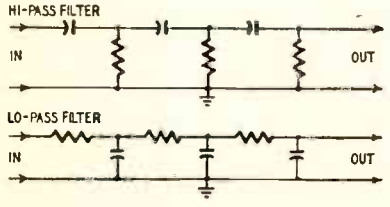


Fig. 5—Equalizers can be cascaded.

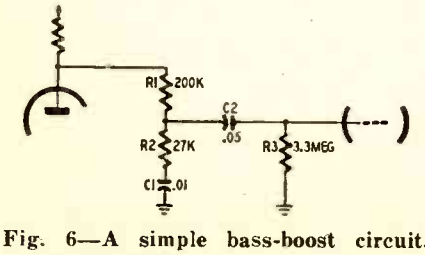


Fig. 6—A simple bass-boost circuit.

Part VII—Bass and treble equalizing circuits can be made to produce ideal playback characteristics

MAGNETIC-TYPE pickups are used in most high-quality audio systems today. To understand the equalizing circuits that must be used with them, we must treat groove-width *vs* output a little differently from the way we think when crystal or other constant-amplitude pickups are used.

Last month we showed how records are made when, as is always the case commercially, magnetic cutters are used to engrave the groove. Let us briefly refresh our memories with the aid of Fig. 1, a chart showing groove width against frequency for constant-voltage input to the recording cutter.

Pattern 1 shows what happens when an unequalized magnetic cutter is used. The groove becomes wider as frequency decreases and narrower as frequency increases. This is exactly offset by the ideal unequalized magnetic pickup, which produces more output for a given stylus movement as frequency rises and less output as frequency decreases. Since the two devices—cutter and pickup—are complementary, let us lump them together and consider only the transfer characteristic between the input of the cutter and the output of the pickup. If we do that, we find that the pickup output is exactly proportional to the voltage input to the cutter, regardless of frequency. Let us, furthermore, become parties to the convention common in the record industry that says, "The frequency characteristic of a record is always shown as if it were to be played back with an ideal unequalized magnetic pickup." Thus, regardless of the actual fact that with constant input to the cutter the groove width decreases with rising frequency, we show the frequency characteristic or curve of a record as simply the voltage input to the cutter (usually translated to decibels) against frequency.

If we make a record without equalization, then curve A of Fig. 2 will show the frequency characteristic. The flat line means that between 50 and 10,000 cycles the record follows the constant-velocity magnetic characteristic.

Now look at Fig. 1 again. With the constant-velocity cut of pattern 1, the low-frequency grooves are so large that the spiral would have to be very widely spaced. Not only would we get very little playing time, but the cutter would have to be built so that the cutting stylus could describe very wide swings, a great mechanical difficulty. So we insert an equalizer in the recording system which attenuates frequencies below a certain frequency (let us assume it is 500 cycles) at the rate of 6 db per octave. This means that by the time the audio signal reaches the cutter terminals, the voltage is directly proportional to frequency below 500 cycles.

With the magnetic cutter, the cutter itself makes a groove whose width is *inversely* proportional to frequency. With our equalizer in the circuit, the equalizer and the cutter's own characteristic exactly offset each other. The result is that the groove width remains constant below 500 cycles, as shown in pattern 2 of Fig. 1. With the groove width restricted, we can wind a much closer spiral.

But in adding this equalizer during recording we have made a change in the record frequency curve. Instead of curve A (Fig. 2) being flat throughout its low-frequency end, we have curve B, which shows attenuation of the low frequencies at the 6-db-per-octave rate. This means that an unequalized ideal magnetic pickup will play back the record with a gradual loss of bass. If we want the pickup to reproduce sound as it originally was before being changed by the recording equalizer, we must add an equalizer of exactly opposite or complementary effect to the playback system. The playback equalizer must have the low-frequency characteristic shown by curve C. It must give the playback system an output which rises with falling frequency below 500 cycles. It is exactly opposite in effect to the recording equalizer and cancels it out, producing once again the flat characteristic of curve A.

Referring again to Fig. 1, we see that in pattern 2 the high frequencies are still very small in groove width; so small, in fact, that the audio variations compare in size to the random variations caused by disc surface irregularities and dust particles which create noise. To make the audio far greater than the noise, we insert a second "equalizer" in the recording equipment to boost the treble. The treble recording equalizer may have the characteristic of curve D in Fig. 2. But again, we have created a deviation from the ideal constant-velocity characteristic.

So, to offset the treble recording emphasis we must have a treble equalizer in the playback system. Again, it must have an effect exactly opposite to that of the recording equalizer. Its effect is shown by curve E. Since curves D and E are exactly complementary, they can-

* Audio Consultant, New York

Fig. 7—Pickering 230 H preamplifier.

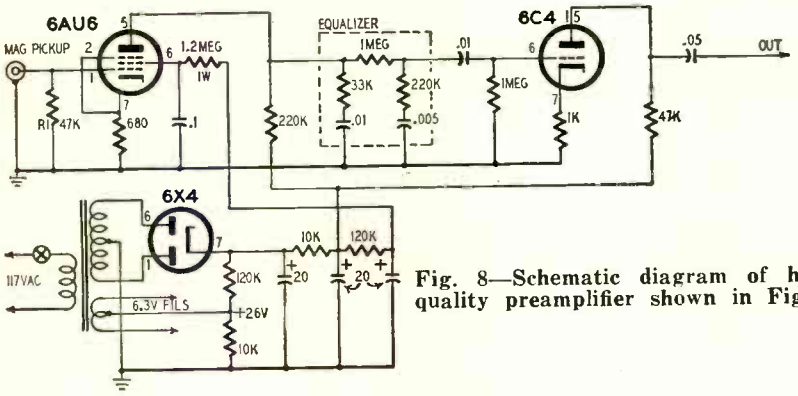


Fig. 8—Schematic diagram of high-quality preamplifier shown in Fig. 7.

cel, and once again we have the flat sound transfer between microphone and loudspeaker of curve A.

Suppose we sum up. We could have had a perfect frequency characteristic by omitting all equalizers and using ideal magnetic cutter and pickup. Instead, we have inserted a bass equalizer to give more playing time and a treble equalizer to reduce noise, together with complementary equalizers in the playback system. As a result, we again have a flat frequency characteristic but with longer playing time and quiet records. The whole scheme smacks just a little of Rube Goldberg, but since equalizers are inexpensive and easy to make, it is highly practical.

Equalizer circuits

Unfortunately, the different record manufacturers have failed to standardize on the amount of equalization included in their records. Some start the bass equalization at about 200 cycles, others at 500 cycles or more. Some use a straight 6-db-per-octave bass cut, others modify it. There is a similar lack of standardization in the treble equalization. To add to the confusion some record makers have changed their equalization standards from time to time, so that an old record may have been equalized differently than a late release from the same company. Because of this lack of standards, the home reproducing system must provide a flexible system of playback equalizers to match the various equalizing characteristics used by record manufacturers.

Equalizers used for home phonograph reproduction are simple; they are composed of resistors and capacitors. In addition, the general scheme of designing them is easy to remember.

Fig. 3 shows the two basic equalizer circuits. In each case generator G represents the pickup or tube supplying the audio signal. In circuit A, the output attenuates high frequencies and passes low frequencies; in circuit B the lows are attenuated while the highs pass. The theory is simple: In circuit A the resistor and capacitor constitute a voltage divider. While the resistor opposes all frequencies equally, the capacitor presents a greater impedance at low frequencies than at high. Therefore, if output is taken across the capacitor, the output voltage will increase as the frequency decreases. In circuit B the exact opposite is true.

Either equalizer can be estimated with very little calculation. For circuit A, output decreases at the rate of 6 db per octave above the frequency at which resistance and capacitive reactance are equal. For circuit B, output decreases at the rate of 6 db per octave below the frequency at which R and X_c are equal. In both cases, at the frequency of equal impedances (usually called the turnover or crossover frequency) the attenuation is 3 db, while the rate of attenuation does not reach the full 6 db per octave immediately, being rather a gradual increase of attenuation. The sharp changes of line in Fig. 2 are ideal curves only; actual characteristics of records are really curves.

Circuit A is useful for playback equalization of the treble. To produce the characteristic of curve E, for example, in Fig. 2, the circuit of Fig. 4 could be used. The diagram shows a two-stage preamplifier with equalizer R1-C2 between stages. The reactance of C2 equals the resistance of R1 at 1,500 cycles. From that frequency upward the voltage to the grid of V2 decreases at about 6 db per octave. C1 is a large-value blocking capacitor, while R2 is a grid resistor high enough to avoid affecting the impedance of C2.

These equalizers can be cascaded, as shown in Fig. 5, when greater attenuation is required, but that is rarely necessary in record playback systems.

Fig. 6 shows a simple bass-boost circuit used in a G-E preamplifier. The voltage divider has R1 as the upper or series leg, with the combination of R2 and C1 as the shunt leg. At high frequencies the reactance of C1 is insignificant. But beginning at around 500 cycles, the reactance of C1 becomes large enough to be important (27,000 ohms at just below 600 cycles) and it begins to make the shunt leg larger as frequency decreases. This equalizer never does reach the rate of 6 db per octave, but it comes close enough for general use.

The playback equalizer characteristic must exactly complement the equalizers used in making the record. Only by using the right equalizers for both bass and treble can the loudspeaker produce sound with the same tonal balance as existed at the original microphones.

Commercial units

Magnetic pickups require some preamplification to bring the output up to the 0.5- to 2-volt level of a tuner so that it can be switched to the input of the main power amplifier. Most preamplifiers include bass equalization adjusted to a crossover frequency somewhere between 500 and 1,000 cycles.

An example of the better standard preamplifiers is the Pickering type 230H shown in Fig. 7 and diagrammed in Fig. 8. This preamplifier has enough gain to give normal records an average output of from 1 to 2 volts with the Pickering pickup. R1 is chosen to terminate the Pickering pickup but can be changed to suit manufacturers' recommendations for other pickups. The bass equalizer is shown within a dashed box. Two sections similar to that of Fig. 6 are used to get excellent equalization, down to a satisfactorily low frequency.

It is important to determine before buying a preamplifier (or an amplifier with built-in preamplifier) that its bass equalization gives the full 6-db-per-octave rise, for some do not.

Few preamplifiers contain any but bass equalization so the treble equalizer must be provided for elsewhere, unless, as in the case of some pickups, a satisfactory treble rolloff can be provided by terminating the pickup in a certain resistance. A unit such as the Pickering type 132E record compensator is suitable for this purpose. The pickup cable is plugged unto a jack on the side of the compensator (see Fig. 9) and a cable from the compensator goes to the preamplifier. Six switch positions provide for six different treble characteristics to match various records.

Records cannot be equalized successfully with the tone controls found on some amplifiers. These tone controls (which many people, including the writer, believe ought not to exist) are —theoretically—to compensate for room characteristics, but are actually for people who like to fiddle with controls. Ordinary living rooms are sufficiently dead acoustically not to add anything undesirable to the sound coming from a good speaker system. On the other hand, the controls cause an uncomfortable feeling because the listener never can

Fig. 9—Left, the Pickering type 132E record compensator.

Fig. 10—Right, the Brociner preamplifier-equalizer.

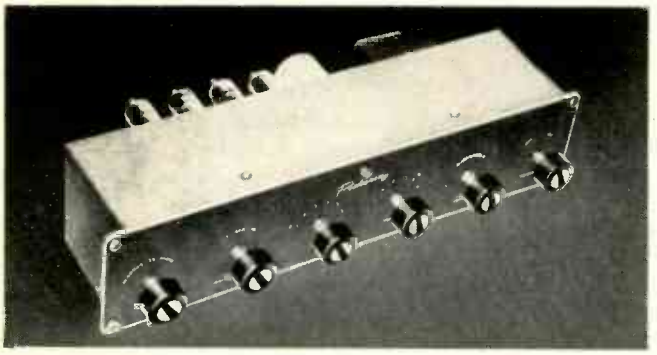


Fig. 11—Left, the Pickering type 410 audio input system. Fig. 12—Right, Childs model 352 preamplifier-control.

decide whether he has the right setting, which, in fact does not exist. The only legitimate function of a tone control might be to add some bass at low volume settings; but again it is impossible to do the job right with continuously variable controls.

Several manufacturers offer preamplifier-equalizers which include a variety of bass and treble equalizer combinations for obtaining correct compensation for all kinds of records. Such a system is the Brociner unit pictured in Fig. 10. The Pickering type 410 audio input system shown in Fig. 11 is more complete in that it also includes switching for various inputs—record, tuner, etc.—as well as three variable record equalizers and a volume and power control.

The Childs preamplifier-control unit (Fig. 12) is an especially interesting device of this type. It has high- and low-frequency equalizers giving 20 different calibrated equalization curves to match any of the various recording characteristics now in use (AES, Columbia, London ffrr, etc.), a four-position input selector, and a power switch and pilot for the main amplifier.

The Childs unit is shown in the circuit diagram of Fig. 13. Both high- and low-frequency equalization is controlled by negative feedback loops with frequency-selective transfer characteristics. The feedback loop is between the plate of the second stage and the cathode of the first. Bass boost is brought about by passing the feedback signal through a 1.8-megohm resistor in parallel with one of five selectable capacitors. The combination is in series with a 51,000-ohm resistor. The capacitor and the 1.8-megohm resistor have equal impedance at a frequency just below the

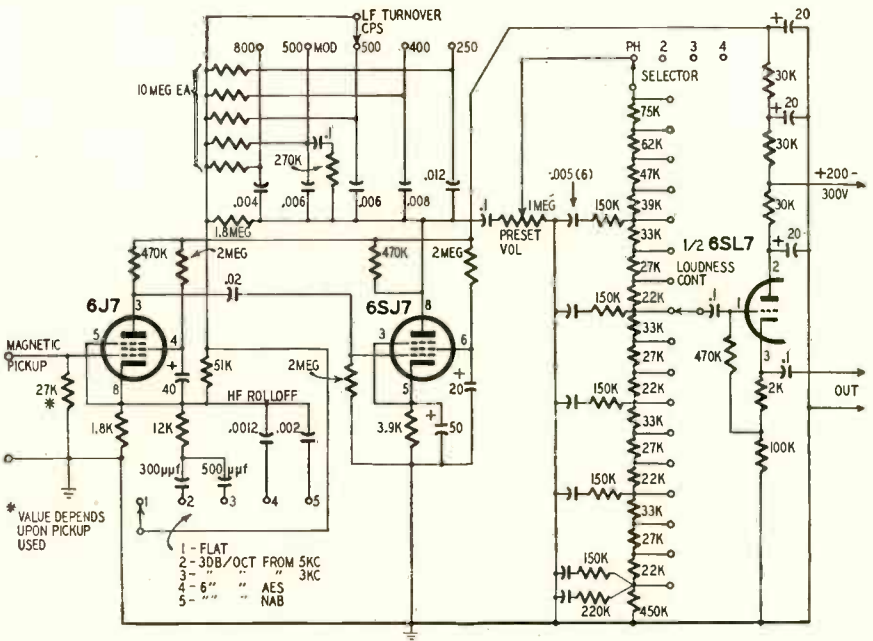


Fig. 13—Childs control-preamplifier model 352; all controls are indicated.

desired audio range; therefore the capacitance, whose reactance becomes smaller as frequency rises, causes more feedback signal transfer with rising frequency until the turnover frequency, at which it is equal to the resistance of the 51,000-ohm resistor, and at which time response flattens off. Since the feedback loop is negative, the preamplifier as a whole gives a complementary curve, which is precisely the desired 6-db-per-octave bass rise with selectable turnovers.

The 51,000-ohm resistor is paralleled by one of four capacitors selected by the high-frequency rolloff switch, giving a rising characteristic above a selected turnover frequency. This becomes a rolloff, again with precisely calibrated characteristics. In addition to precise equalization, the negative feedback, even at frequencies where it is lowest, is sufficient to give the usual feedback advantages of improved linearity and signal-to-noise ratio. The loudness control is a 17-point switch with R-C networks to add the bass compensation required by the ear at low volumes.

Having discussed the primary source of sound in high-quality systems—records and pickups—we shall inquire next month into the other main source, the radio tuner.

(TO BE CONTINUED)

SERVICING HIGH FIDELITY AUDIO EQUIPMENT

Part II—*Particular attention must be paid to balance, feedback and hum*

By JOSEPH MARSHALL

IN THE servicing of high-fidelity equipment, circuits are tested to an extent almost unthinkable in conventional audio amplifiers. Typical of this testing is that for unbalance in push-pull stages. The low distortion in high-fidelity amplifiers is in considerable part due to the use of distortion-canceling properties of push-pull driver and output stages of amplifiers. The distortion cancellation depends on maintaining balance. The circuit of a typical high-quality audio amplifier is shown in Fig. 1.

Output stages should be balanced to 1 or 2%. R-C-coupled voltage amplifier, driver, and phase-inverting stages, should be balanced to at least 5%. To check the d.c. balance, connect a high-resistance d.c. voltmeter from plate to plate of the push-pull stage. A completely balanced stage will show zero voltage. Many high-fidelity amplifiers have provision for balancing the output stage with an adjustable resistor in the cathode circuit. Adjust this resistor until the plate to plate voltage is as close to zero as possible.

If the unbalance is considerable, or if balance can be obtained only by a marked difference in bias voltages, both the tubes and the circuit components should be checked. The plate loads and d.c. resistances on the two sides must be as nearly identical as possible. Good output transformers provide loads equal to 1 or 2%.

Plate-load resistors in voltage amplifying stages and phase inverters (R_K), should also be matched to 1 or 2% but seldom are, except in the highest-quality amplifiers. However, if measurement shows that the difference is much greater than 5%, one resistor should be replaced. Choose one whose resistance is equal within 1 or 2% to that load resistor which comes closest to the specified value. Be careful, when wiring, not to overheat the resistor; this may very easily change its value permanently.

If the two sides of the stage use different cathode resistors (R_K), check these for balance also and replace if one is more than 5% higher or lower than the other. Except in the case of output-power stages, grid resistors R_g are not critical. However, they should match at least to 10%; and in output stages which may draw grid current, it is important to preserve balance in the grid resistors.

An open coupling capacitor C_c can produce serious unbalance, and can be spotted with the headphones. If the phones show a much stronger signal on one grid than the other, check and replace the capacitor.

If the reactance of one capacitor is considerably higher than that of the other, there will be unbalance at low frequencies and harmonic distortion may not be completely canceled out. The harmonic distortion of bass tones is not in itself as noticeable or annoying as distortion at higher frequencies. However, it leads to increased intermodulation distortion. The situation is aggravated because in most high-fidelity installations there is considerable boosting of the low frequencies in the preamplifier or control unit; therefore, succeeding stages are driven harder and produce more distortion not only within the low-frequency range but also in the mid- and high-frequency ranges.

To check capacitors for balance or to match them, feed a 60- to 100-cycle tone into the amplifier. If no audio generator is available, use the 6-volt filament circuit. Connect a meter capable of reading such a low frequency between one of the grids and ground. Adjust the input volume control to obtain a reading of 1 or 2 volts. Transfer the meter to the opposite grid without changing the volume level. The meter should give nearly identical readings at both grids. (We are assuming that the previous stage is delivering equal signals to both sides. This can be checked by measuring the voltage on the plate side of the capacitor. We also assume that the grid resistors are fairly closely matched.)

If there is more than one push-pull stage, measurements should start from the first one, to check balance all along the line.

When a push-pull stage uses a common cathode resistor, the resistor should be by-passed by a high capacitance, otherwise the odd harmonics will feed back in phase to increase by addition or even multiplication. Always check this bypass capacitor. If its d.c. resistance is too low, it should be replaced because the low resistance in parallel with that of the cathode resistor will reduce the bias voltage. This can be checked by measuring bias voltage with the capacitor connected and disconnected.

Positive feedback, parasitic oscillation, or improper operation of feedback network:

High fidelity amplifiers invariably use from 12 to 30 decibels of inverse feedback through one or more loops. Serious distortion may result if the feedback loop operates improperly. Under certain circumstances the feedback can turn positive and result in parasitic oscillation. This oscillation may occur at supersonic frequencies. There are two simple checks for such inaudible oscillations. Turn on a broadcast-band radio and tune it slowly. If the amplifier is oscillating at frequencies above 20kc, harmonics will beat with the stations in the radio receiver. If the beat disappears when the amplifier is turned off, the amplifier is generating parasitics. Another way is to break the B plus lead to the output transformer and insert a milliammeter. Momentarily disconnect the feedback loop; if the plate current drops, you can be sure that parasitic oscillation is taking place.

Commercial amplifiers are designed to prevent parasitic oscillation. If it occurs after a period of use, a component failure or deterioration can be safely assumed. First, change the tubes. Tetrodes used as triodes usually have 100 to 1000-ohm series resistors in the grid and plate circuits; check to see if these are O.K. Check the value of the series-feedback resistor R_{fb} and the

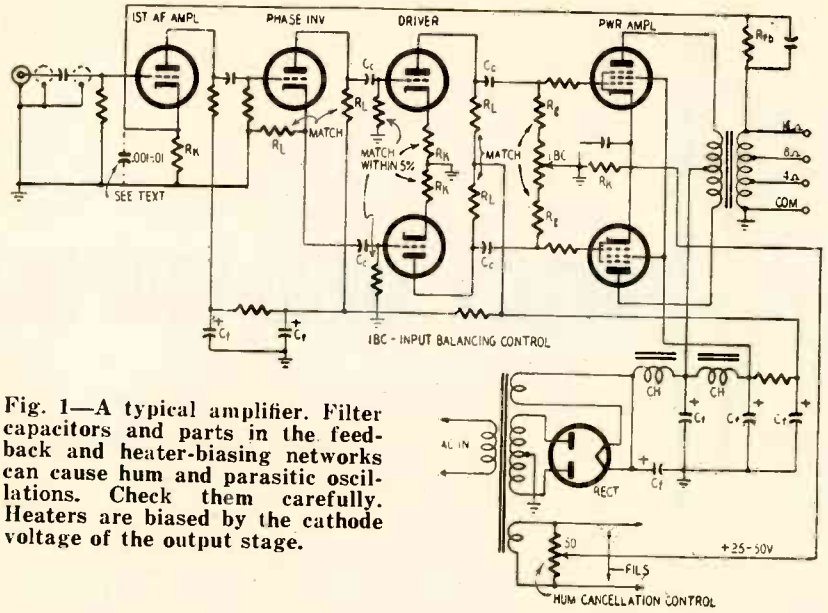


Fig. 1—A typical amplifier. Filter capacitors and parts in the feedback and heater-biasing networks can cause hum and parasitic oscillations. Check them carefully. Heaters are biased by the cathode voltage of the output stage.

resistor across which the feedback is applied. (Usually a cathode resistor in an early stage.) If the series resistor is lower than specified, or the other resistor is higher, the feedback has been increased over that of the original design. Replace one or both. If replacing tubes and feedback resistors does not cure the parasitic oscillation, it may be necessary to reduce the feedback by replacing the series feedback resistor with one of higher value. Increase the resistor value only if absolutely necessary and then only as much as necessary to kill the parasitics; further increase may not produce enough cancellation of distortion for optimum performance. Another expedient is to bypass the cathode resistor to which feedback is applied with a capacitor of around .01 to .001 μf; the smaller the better. This has the effect of reducing the feedback at frequencies above 20,000 cycles without affecting the feedback at lower frequencies. It should be used only when new tubes and restoring the circuit to design values will not get rid of the parasitics.

Critical amplifiers may be triggered into oscillation. This usually occurs at very low frequencies and is at least as much the fault of poor decoupling in the B plus supply loop as of the feedback loop. If this form of instability occurs, the decoupling capacitors should be checked and replaced with larger capacitances if necessary. (Or a V-R tube can be inserted in the input stage or stages. See RADIO-ELECTRONICS March, 1953.)

Distortion can also be produced in the tuners or phono-pickups. Tuner distortion in AM receivers is usually due to the diode detector circuit. If the diode load is shunted with too low a resistance, distortion on peaks may be very serious. In FM receivers, distortion is usually the result of poor alignment or too narrow a bandpass in the i.f. stages. The narrow bandwidth can be caused by regeneration.

A worn needle can produce very serious distortion from phonograph records. Sapphire needles are by no means as permanent as once advertised. Only a few hundred sides will produce sufficient wear to seriously increase distortion. In some instances, misalignment of the needle or cartridge, misadjustment of the tracking angle, or dirt between the needle and coils or poles may cause serious distortion. Clean the needle and gap with a fairly stiff brush.

Hum

Commercial high-fidelity equipment is designed to have a very low hum level and *any sudden increase* in hum should be due to one or more of following: (1) failure of power-supply filtering (chokes CH and capacitors C_f); (2) failure of cathode by-pass capacitors; (3) tube heater to cathode leakage; (4) failure of feedback loop; (5) serious imbalance of output stage; (6) failure or imbalance in heater-biasing circuit; (7) failure of shielding, or grounding in preamp tubes; (8) pickup by connecting cables; and (9) excessive bass boosting. The first three causes are the familiar ones common to radios.

Inverse feedback not only reduces distortion but reduces hum; the failure of the feedback loop may therefore result in increased hum.

Power-output tubes, usually fed with less-filtered plate voltage than earlier stages, depend on balance of the push-pull circuit to cancel the hum. Balance the output stage for minimum hum.

In many amplifiers, all or part of the heater chain is biased with a positive voltage of anywhere from 25 to 50 volts d.c. This voltage is applied to the center-tap of the filament winding or to a low value potentiometer which shunts the winding—adjust it for minimum hum.

In some amplifiers, the parallel-connected heaters are biased positive by connecting the center of the heater line to the high side of the output cathode-biasing resistor. If the heater winding is center-tapped, the bias may be applied to this point. Otherwise, it can be connected to the center of two identical low-value resistors or to the arm of a hum-balancing potentiometer connected across the heater winding as in Fig. 1. Fig. 2 shows how the bias voltage can be obtained from a

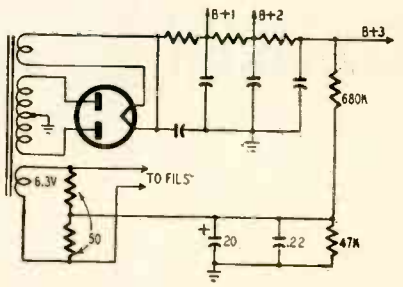


Fig. 2—Heater string is biased by drop across 47,000-ohm resistor in bleeder.

B plus voltage divider.

Examine the shielding and grounding of preamps and control units if these are independent of the main amplifier. Also check their location. If located too close to a phonomotor or to the power transformer on an adjacent chassis, they may be within the magnetic field and picking up hum this way. Check the grounding of the plugs of shielded interconnecting cables. Frequent removal and reinsertion may have loosened contact between plug and jack, or dirt may have increased the resistance of the grounding contacts. Interconnecting cables may be too close to power transformers, phono motors, etc. If the main amplifier, control unit, tuners, etc., have separate power supplies, try reversing the a.c. plugs. Hum is easily traced by removing the tubes in the string one by one, starting with the preamp and working toward the speakers.

It should be possible with good equipment to limit the hum to a level so low that it is audible only very close to the woofer under no-signal conditions and with bass controls flat.

Adjustment of hi-fi equipment

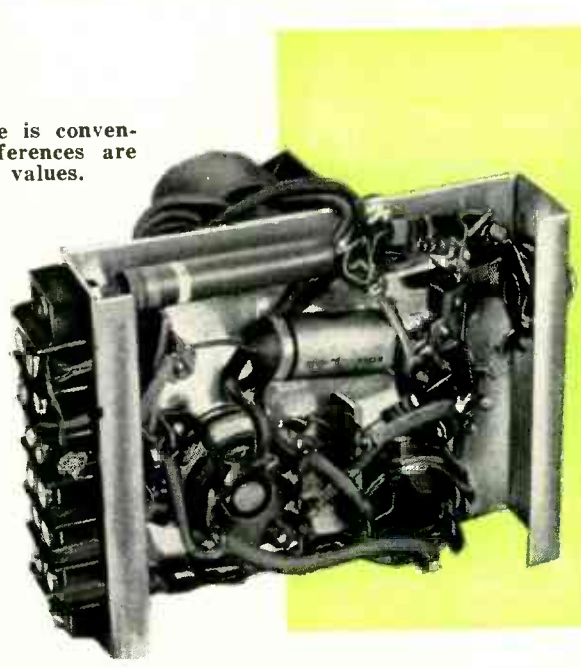
When a repair is made correcting the immediate defect, always adjust the equipment for peak operation. This is not difficult even without instruments. Follow these steps:

1. Check all tubes.
2. Check operating voltages and replace filter capacitors if they show deterioration.
3. Check the balance of the output stage.
4. If the unit has a hum-canceling control (see Fig. 1), adjust it for minimum hum.
5. Check the interconnecting cables for good contacts, especially for low-resistance grounds.
6. Check the various tuners, record players, etc. Tuners may need realignment. Phono needles may need replacement. Record changers may need new drive wheels or adjustment for proper cycling.

(TO BE CONTINUED)

ULTRA HIGH GAIN STARVED-CURRENT AMPLIFIER

By PAUL S. LEDERER



Appearance is conventional. Differences are in resistor values.

The amplifier looks exactly like the more standard models.

FOR conventional circuits, a gain of about 250 for a resistance-coupled pentode stage is usually the maximum obtainable. Transformer coupling will give more gain, but at the cost of increasing price, volume and weight.

But there is a way of achieving extremely high gain with only a few inexpensive, conventional components.

The method was described in a paper entitled "Ultra-High-Gain Direct-Coupled Amplifier Circuits" by Dr. Walter K. Volkers, and read before the 1950 IRE National Convention in New York. He stated that by lowering the screen voltage of pentodes below 10% of their plate supply voltage, and by increasing the resistance of their plate load 10 or more times beyond conventional values, the amplification factor of tubes so "starved" is greatly increased in spite of a decrease in mutual transconductance.

Following this principle, I built a two-tube amplifier using only five resistors, two capacitors, and an output transformer.

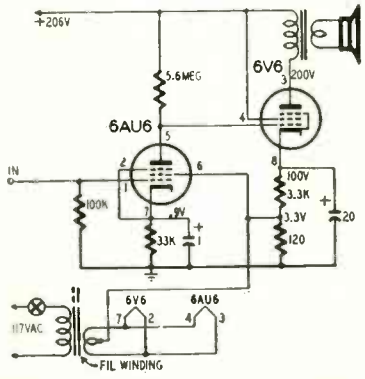
This amplifier delivers 0.1 watt output with an input of 2 millivolts, a power gain of about 92 db.

The circuit uses a 6AU6 "starved" pentode with a gain of about 750, direct coupled to a 6V6 power amplifier. Direct coupling is important, for only by working into the practically infinite input resistance of a negatively biased stage can the extremely high gain of the first stage be retained. The plate supply delivers 26 ma at 200 volts.

As we have all found out, one cannot get something for nothing. To get high gain, frequency response must be sacrificed. This circuit is therefore *not* recommended as a preamplifier for variable-reluctance pickups or other high-fidelity uses. However, there are many occasions where a 3-db response from about 180 to 2,500 c.p.s. is sufficient and even desirable. Possible uses: a very sensitive and compact signal tracer; a sensitive null detector for audio frequency impedance bridges; a lower-power modulator for communications equipment, or a general-purpose crystal mike amplifier. Used as a mike amplifier with an inexpensive crystal microphone, I obtained a very clear output at so-called "room level" when I *whispered* at the mike from a distance of about five feet.

To get more output, a higher plate-supply voltage is necessary. This will require some experiment to determine the proper values of load and cathode resistance for the 6V6. A 0.1-megohm volume control may be substituted for the 0.1-megohm grid resistor of the first stage.

When first constructed, the amplifier had a large amount of hum. This was almost entirely eliminated by connecting the center-tap of the filament transformer to the screen of the 6AU6, thus biasing the filament at about plus 3 volts with respect to ground. END



Circuit of starved-current amplifier.

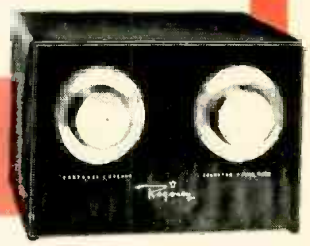
Parts for high-gain amplifier.

Resistors: 1—33,000, 1—100,000 ohms, 1— 5.6 megohms, ½ watt; 1—120 ohms, 1 watt; 1—3,300 ohms, 5 watts.
Capacitors: 1—1 μf, 100 volts, paper; 1—20 μf, 150 volts, electrolytic.
Tubes: 1—6AU6, 1—6V6.
Miscellaneous: 1—3 x 4 x 1-inch chassis; 2—tube sockets; 1—output transformer (10,000-ohm primary); 1—filament transformer; 1—6-terminal barrier strip; assorted hardware, etc.

2 REMOTE TV CONTROL UNITS

With viewer comfort in mind, these units permit tuning, volume, and contrast control from a remote point

By ROBERT F. SCOTT
TECHNICAL EDITOR



REMOTE controls for TV sets seem to come and go in cycles of two to three years. A number of 1951 TV sets were designed with remote viewers. Several others were available with electromechanical accessories which could be added to turn the set on and off, select channels, and adjust volume and contrast from a remote point. (See "Remote Controls for TV Promote Viewer Comfort" in the November, 1951, issue.) Now, after nearly two years during which there was no noticeable activity in this field, remote controls for TV sets are booming again. A number of manufacturers are including at least one remote-control TV receiver in their 1954 lines. Design features of these will be covered in an early issue. Gonset and Regency have recently introduced remote-control TV tuners which can be used in modernizing sets which do not include this feature.

The Gonset and Regency remote-control tuners permit full control over tuning, volume, and contrast from a remote point. The Standard Coil cascode tuner, used in both units, often provides enough gain to eliminate the booster required with some sets in fringe areas. The removable channel strips permit u.h.f. strips to be installed, making a converter unnecessary in areas where the total number of v.h.f. and u.h.f. stations does not exceed 12. The remote-control units have built-in transformer type power supplies and are available for sets with 21- or 40-mc i.f. amplifier systems. Power to the TV receiver is controlled through a receptacle across the power primary on the remote-control unit.

The Gonset unit is designed to replace the tuner in the receiver. Its installation is simple; it can be connected to most sets without removing the chassis from the cabinet. Added features are a headphone jack and a switch for muting the speaker. When the unit is attached to the TV set, the original tuner is deactivated, so all tuning operations must be made at the remote unit.

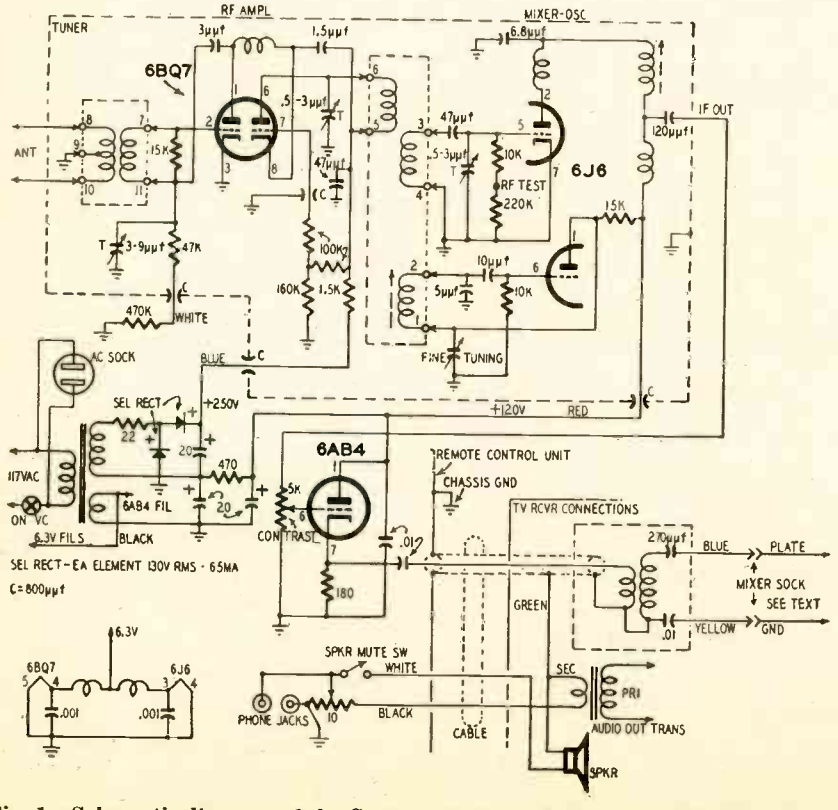
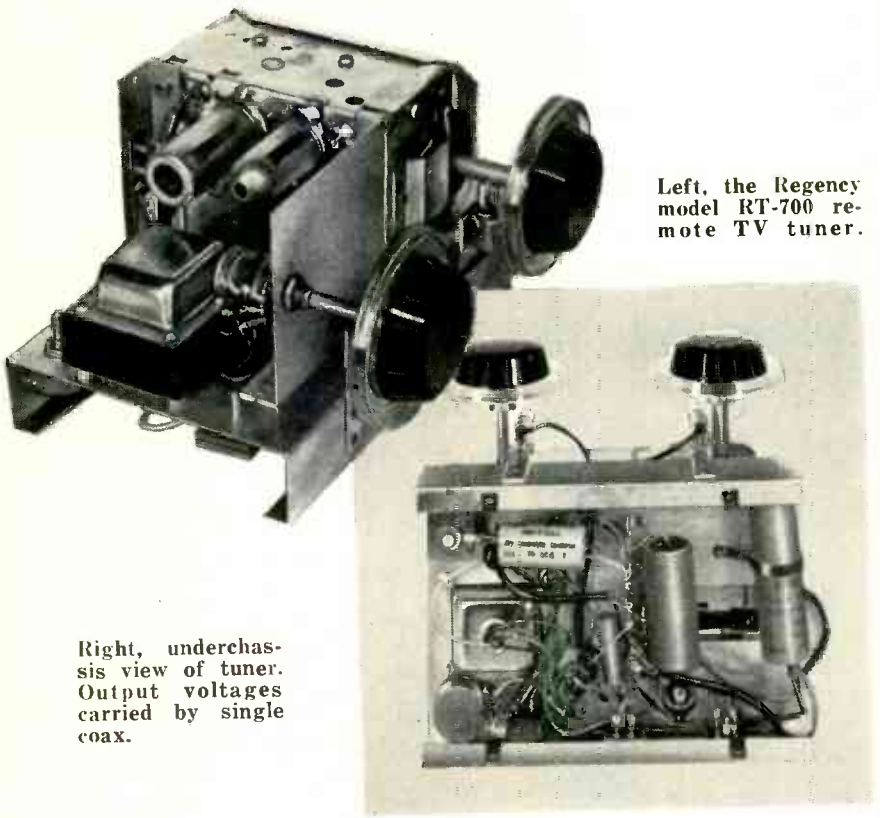


Fig. 1—Schematic diagram of the Gonset remote-control model 3050 (21 mc i.f.).

The Gonset remote control

The circuit of the Gonset remote-control unit is shown in Fig. 1. The antenna is connected to the control unit. The signal is amplified and heterodyned to the intermediate frequency in conventional manner. The 21- or 40-mc i.f. output of the 6J6 mixer is capacitance-coupled to the grid of a 6AB4 cathode follower. A 5,000-ohm potentiometer controls the signal fed into the grid, thus controlling the contrast. The output of the cathode follower is fed to the receiver through a shielded cable. This cable terminates in an i.f. coupling transformer. The secondary leads of the transformer are fitted with pins which fit into pin jacks of a miniature button-base tube socket.

When installing the unit, all tubes are removed from the original tuner and the transformer secondary leads are plugged into the plate and cathode pin jacks on the mixer-tube socket. In a few tuners, the mixer cathode is hot (above ground for r.f.), and better results can be had by connecting the yellow transformer lead directly to ground. If one side of the heater line



Left, the Regency model RT-700 remote TV tuner.

Right, underchassis view of tuner. Output voltages carried by single coax.

is grounded, the yellow transformer lead can be plugged directly into the grounded heater terminal on the mixer socket.

Both leads of the i.f. coupling transformer have series-blocking capacitors which eliminate the possibility of short-circuits when connecting to some types of tuners.

Volume is controlled at the remote point by a 10-ohm potentiometer that is connected in series with the speaker voice coil through the speaker muting switch and a 2-wire line enclosed in a cable with the shielded lead carrying the i.f. signal. Headphones can be plugged into tip jacks across the remote volume control, and the speaker may be silenced by opening the muting switch. The switch can be used also to open the speaker circuit during commercials or when answering the telephone. High-impedance magnetic phones provide sufficient volume for persons with normal hearing. Low-impedance phones of about 600 ohms are recommended for hard-of-hearing persons.

In some instances, a strong signal may overload the tuner and make it impossible to reduce contrast sufficiently to obtain a normal picture. In such cases, the manufacturer recommends that a 1,200-ohm, ¼- or ½-watt resistor be soldered across the two outside terminals on the r.f. strip for the channel that overloads.

Photo shows the Gonset model 3050 for remote control of TV receivers.

The Regency RT-700

The Regency model RT-700 remote TV tuner in Fig. 2 illustrates entirely different solutions to the problem of controlling volume and contrast from a remote point. The i.f. signal, contrast, and volume control voltages are all carried by a single length of RG-122/U coaxial cable between the tuner and receiver chassis. The coaxial line terminates in a potted matching unit (M6 on the diagram) and coupling and decoupling networks to the audio and a.g.c. circuits.

The potted terminating unit is mounted on the chassis close to the first i.f. amplifier socket. The i.f. grid lead connects to the grid pin of the first i.f. amplifier and the if. grid return goes to the ground point for the first i.f. stage.

Contrast-control circuits

Contrast is controlled from the remote tuner by supplying a variable d.c. bias voltage to the a.g.c. line in the set where the a.g.c. voltage is obtained by rectification of the video signal. When the set uses keyed or amplified a.g.c., the control bias is applied to the grid of the a.g.c. keyer or amplifier tube.

Two auxiliary controls are provided in the RT-700 for ease of operation of the contrast-control circuit. Approximately 50 to 60 volts of bias is developed across R2, the COARSE BIAS ADJUSTMENT. The polarity of the output voltage developed between the arm and one side of R2 can be reversed by switching the white lead from one end of the control to the other. (The need for reversing bias polarity will be discussed shortly.) The voltage output of the bias supply is applied across the contrast control R1.

The second auxiliary control is the local-distance switch. Operating bias for the 6BQ7 cascode r.f. amplifier in the tuner is developed across the series-connected 150- and 47-ohm resistors in the negative leg of the B plus supply. When the switch in set to LOCAL, full bias is applied to the cascode amplifier to prevent overloading by strong signals. Throwing the switch to DISTANT reduces the grid bias to the point where the tuner operates with maximum gain and lowest noise.

Fig. 3 shows how the contrast control is connected to receivers with simple rectified a.g.c. The circuit in Fig. 3-a is used when the a.g.c. filter resistor in the receiver is 1 megohm or higher. When the filter resistor is less than 1 megohm, the a.g.c. line must be cut and the 470,000-ohm resistor R18 spliced across the break as in Fig. 3-b.

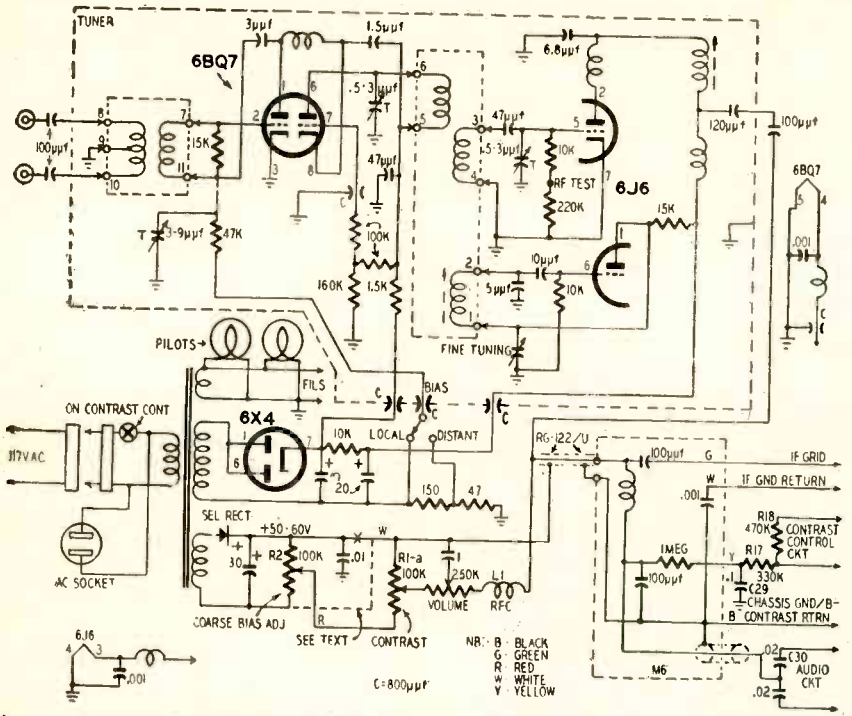


Fig. 2—Schematic diagram of the Regency model RT-700 remote TV tuner.

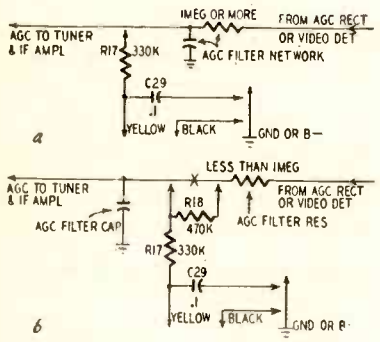


Fig. 3—Contrast control connections.

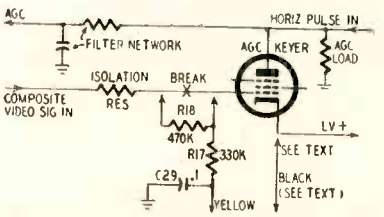


Fig. 5—Diagram of keyed a.g.c. circuit.

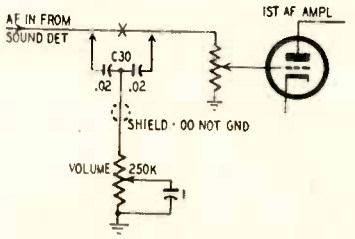


Fig. 6—Regency RT-700 volume control.

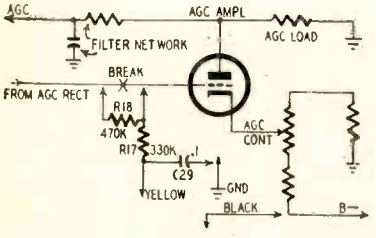


Fig. 4—An amplified a.g.c. circuit.

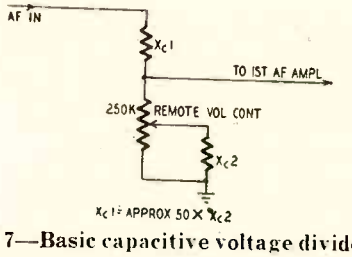


Fig. 7—Basic capacitive voltage divider.

The bias supply circuit delivers a negative voltage to the contrast control. The voltage at the arm of the control is applied to the a.g.c. line through the inner conductor of the coaxial line. The positive side of the bias supply connects to the receiver chassis through the outer conductor.

Fig. 4 illustrates the contrast-control connections for receivers using amplified a.g.c. In this circuit, the a.g.c. amplifier plate is grounded through the a.g.c. load resistor, and its cathode is supplied from a point on a B minus voltage divider. The contrast-return line must then be connected to B minus (not ground). This B minus point must be bypassed to ground by 10 μf or more.

In keyed a.g.c. circuits, the contrast-controlling bias voltage is applied to the control grid of the a.g.c. keyer as in Fig. 5. The contrast-return (black) lead is shown connected to the cathode of the a.g.c. keyer. If there is a point in the receiver B plus circuit that is 10 to 20 volts less positive than the a.g.c. keyer cathode, connect the contrast-return line to it and bypass it to ground with at least 10 μf. If this B plus tap is not adequately bypassed, sync buzz is likely to occur and it may be impossible to exercise full control over the volume at the remote tuner.

Keyed a.g.c. circuits require a positive voltage from the bias supply in the tuner. This is obtained by transferring the white lead to the opposite end of the bias adjustment control.

Remote volume control

The volume control in the RT-700 uses a resistance-capacitance voltage divider circuit as in Fig. 6. The audio lead from the sound detector is broken just ahead of the volume control, and two series-connected .02-μf capacitors (C30 on the diagram) are inserted. The inner conductor of the coaxial cable is connected to the junction of the two capacitors. At the remote-control unit, the shielded conductor is connected to a 250,000-ohm volume control. The arm of the control is grounded through a 1-μf capacitor.

A basic circuit of the capacitor voltage divider is shown in Fig. 7. X_c1 and X_c2 are reactances of the left-hand .02-μf capacitor and the 1-μf unit, respectively. Moving the arm of the control varies the resistance in the lower leg of the voltage divider and controls the proportion of the total developed voltage that is applied to the input of the audio amplifier. The r.f. choke L1 (Fig. 2) isolates the i.f. signal from the remote volume control and prevents the i.f. signal level from varying with the setting of the volume control.

Installation and adjustment

To make the initial adjustments on the RT-700, set the local-distance switch to DISTANT, turn the remote contrast control to the minimum position, and set the receiver's contrast control to maximum. Set the remote channel selector to the strongest TV channel in the area and rotate the tuner on the set to another channel. Set the bias adjustment control R2 for a weak picture with good sync stability. If stable sync cannot be obtained, throw the area switch to LOCAL and reset the bias adjustment control and back down on the set's contrast control until the remote contrast control operates properly. When using the remote-control tuner, the receiver's contrast control should be returned to the position used in the initial adjustments.

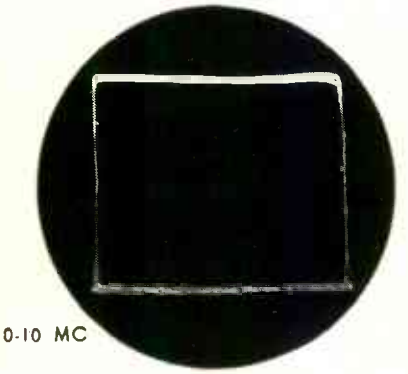
The volume-control circuit is set up with the remote control set to the maximum position and the receiver's volume control set slightly higher than normal. The remote control then permits the volume level to be varied from the preset maximum to a barely perceptible minimum.

The receiver can be operated with its built-in controls by removing the line plug from the rear of the remote-control tuner and plugging it into an a.c. receptacle and setting the remote volume control to maximum. END

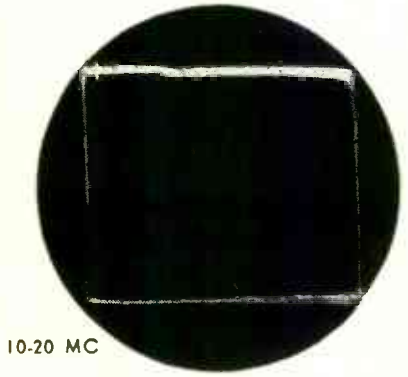
TESTING VIDEO AMPLIFIERS

Obtaining frequency response curves for the video amplifier requires careful selection and use of generator and probe.

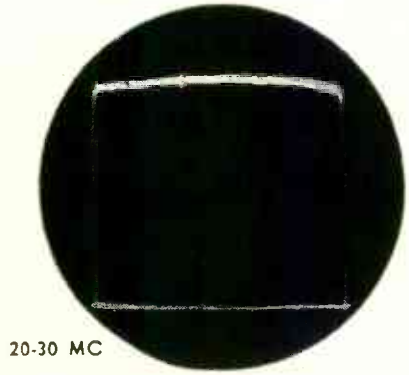
By Engineering Department, Scala Radio Co.



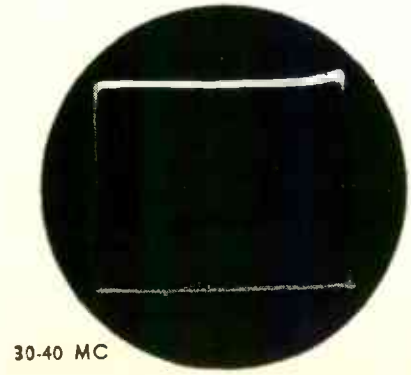
0-10 MC



10-20 MC



20-30 MC



30-40 MC

THE most common check of video-amplifier response is through use of a frequency-response curve. This method is undoubtedly best for preliminary checking, as major defects in circuit operation can be seen by a frequency-response curve.

However, the experienced technician finds that the phase characteristic of a video amplifier is even more important than its frequency characteristic. And although the phase characteristic can be approximately determined from an analysis of the frequency-response curve, few technicians have the desire to perform such an analysis. It is more practical to check phase characteristics in a more direct manner, by making a square-wave check of the amplifier. Obviously the equipment used for such tests must have a better response than the video amplifier to be tested. This rules out much of the run-of-the-mill test equipment.

Test setups for video amplifiers must meet rigid requirements concerning input and output impedances. Unless the video amplifier sees a suitable source resistance, and unless the amplifier works into a suitable capacitance, the test results may be misleading.

The output from the video sweep oscillator should be flat, as shown in Fig. 1. Unevenness will produce distortion of the response curve. For example, when the output level varies over the swept band as shown in Fig. 2, the middle portion of the reproduced response curve will appear to be abnormally high. The curvature in Fig. 2 indicates crystal probe resonance, or improper operation of sweep generator. Some crystal probes resonate at the high harmonic frequencies present in the output of some sweep generators. In the course of circuit adjustment, the technician would misadjust the circuit in order to compensate for the unevenness in the instrument output.

The output from the video sweep oscillator should also be free from strong interfering impulses and harmonics which can develop confusing markers on the response curve. The small markers seen in Figs. 1 and 2 are such markers. As the desired markers are tuned along the curve, the undesired markers may run either forward or backward. In most cases, unwanted markers, if present, are distinguishable from desired markers upon the basis of size because the unwanted markers are usually the result of cross beats, interharmonic beats, or both which do not involve fundamental or beat-fundamental voltages.

Most video sweep generators can be tuned to sweep through zero beat, and to develop a video response curve on either side of zero beat. The output on either side of zero beat should be flat. However, there is some lower frequency, as the beat oscillators approach each other, at which pulling takes place, with the frequency of one oscillator pulling ahead to take the same frequency as the other oscillator, and the frequency of the second oscillator pulling back to take the same frequency as the first oscillator. This pulling action makes the video output meaningless at frequencies below 100 kc, even in instruments having good buffer action between the two beating oscillators. The typical output from a video sweep oscillator when sweeping through zero beat is shown in Fig. 3. (A shows a sweep 5 mc to either side of zero frequency; B shows a sweep through zero frequency, with the sweep width reduced to a few kilocycles; C shows a sweep through zero frequency, with the zero-frequency point moved to the right-hand end of the zero-volt reference line.) Commercial instruments eliminate pulling of the beating oscillator by adequate buffering between the two beat oscillators, and elimination of stray coupling.

The horizontal linearity of a video sweep oscillator can be checked by placing markers upon the swept output. As

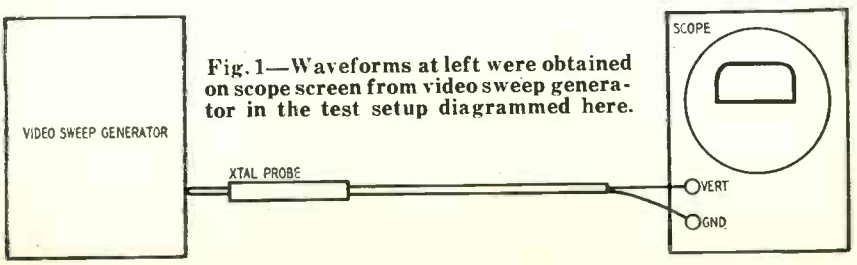


Fig. 1—Waveforms at left were obtained on scope screen from video sweep generator in the test setup diagrammed here.

in i.f. alignment, horizontal nonlinearity does not harm the accuracy of the alignment as long as the technician determines his frequency points along the response curve with markers.

To become familiar with the types of correct video response curves found in present-day TV receivers, the reader should refer to receiver service manuals. The video response curve should be essentially flat, with a slight amount of high video peaking. Such a video response curve, adjusted for a bandwidth of 4 mc, provides maximum picture quality. Some receiver manufacturers believe that a video-response curve should not always be flat, but may be more acceptable if there is a substantial amount of high video peaking. Some receivers provide a *picture control* or similarly named device which varies the amount of damping resistance across a series peaking coil, or varies the amount of bypass capacitance shunted across a video-amplifier cathode resistor. Such devices permit the viewer to vary the video-response curve.

In some receivers, the control for high video peaking is automatic, and operates with the contrast control, as shown in Fig. 4. The compensated contrast-control circuit is located in the output of the video amplifier. It can maintain a constant video-response curve as the picture contrast varies, or it can select any desired amount of high video peaking at low contrast levels. Without such compensating circuits, the high-frequency end of the video-response curve falls off as the signal-output level is reduced. The amount of high video peaking which appears on the response curve is determined by the internal resistance of thet video detector. This resistance is nonlinear, as shown in Fig. 5. This is the internal resistance of the diode only, and is not the resistance presented to the driving i.f. circuit. The internal resistance of the detector tube varies from one tube to another. For this reason, changing the video detector tube often serves to greatly improve the quality of the picture.

To obtain video-response curves, a crystal probe at the output of the video amplifier should be used. The probe should have the same input capacitance as the grid of a picture tube, so that the video amplifier is normally loaded. Excessively high input capacitance to the probe will cause the high-frequency response of the video amplifier to fall off. On the other hand, excessively low input capacitance may increase the high-frequency response. The probe used must rectify video sweep frequencies from 100 kc to 4.5 mc, and pass the envelope frequencies of the sweep output. The envelope of the sweep output may be considered as a 60-cycle square wave. In other words, the probe must demodulate the carrier component of the modulated wave (sweep output), but must develop the 60-cycle square-wave modulation envelope on the scope screen without appreciable distortion. A typical demodulator probe suitable for this application is shown in Fig. 6.

The crystal diode type used for video-sweep demodulation may be a matter of concern, as a relatively high peak voltages may be encountered during video-amplifier testing. The normal output from a video amplifier is approximately 50 volts peak-to-peak. But when the amplifier is overdriven, as it frequently is, 75 to 100 volts peak-to-peak

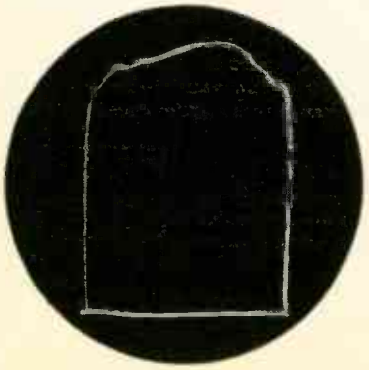


Fig. 2—Photo shows varying output.

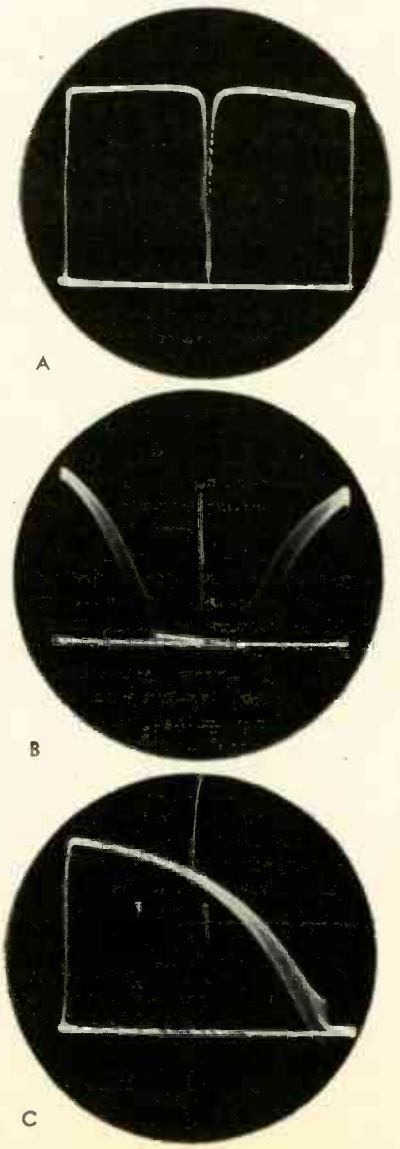


Fig. 3—Sweeping through zero beat.

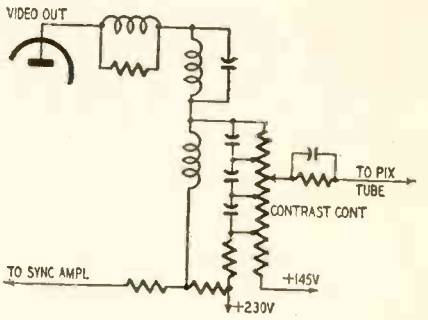


Fig. 4—Compensated contrast control.

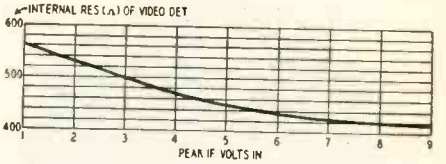


Fig. 5—Video detector resistance.

can be developed. In such a case, crystal diodes of the less rugged type will become damaged. However, there are several types that are quite rugged. See Chart.

The crystal diode in the probe must be able to withstand double the applied peak voltage of the signal. Of course, this is true only of symmetrical waveforms, such as sine waves and square waves. For nonsinusoidal signal voltages, the crystal diode may have to withstand nearly double the peak voltage, more or less.

The manner is which these considerations tie in with commercially available crystal diodes is shown in the chart. The continuous reverse working voltage is not applied to the crystal in normal testing, but the peak back voltage may be taken as the peak-to-peak output voltage from the video amplifier when the crystal diode is used in a standard crystal probe. Most of the types in the chart may be used without extra precaution, although there are a few types that could be damaged by the high temporary transients which are often found when connecting the equipment. Crystal diodes used with video detectors have become damaged by high peak surges caused by sweep leads being dressed too close to the detector leads. Fig. 7 shows that the back current of the crystal diode increases at a rapid rate in the region of maximum back voltage. Detailed test arrangements and procedures on what has been discussed will appear in a future article.

High on the list of important considerations is the subject of square-wave response of video amplifiers. A square-wave check of video-amplifier response is especially useful, because the phase characteristic of the amplifier is given directly, as well as the frequency response. The phase characteristic is important, because nonlinear phase shift (unequal time delay at various frequencies) causes the reproduced square wave to tilt, which may show up in the picture as smear, or as

TYPE	1N34	1N35*	1N38	1N39	1N40**	1N41**	1N42**	1N54	1N55	1N56	1N57	1N58
Description	General Purpose Diode	Matched Duo-Diode	100-Volt Diode	200-Volt Diode	Plug-In Voristor	Lug-Type Varistor	Plug-In 100-Volt Varistor	High Back Resistonce Diode	150-Volt Diode	High Conduction Diode	80-Volt Diode	100-Volt Diode
Continuous reverse working voltage (volts max.)	60	50	100	200	25	25	50	35	150	40	80	100
Peak back voltage for zero dynamic resistance (volts min.)	75	75	120	225	75	75	120	75	170	50	90	115
Forward current at +1 volt (ma min.)	5.0	7.5	3.0	3.0	12.75 (@ 1.5 volts)	12.75 (@ 1.5 volts)	12.75 (@ 1.5 volts)	5.0	3.0	15.0	4.0	4.0
Average anode current (ma max.)	40.	22.5	40.	40.	22.5	22.5	22.5	40.	40.	50.	40.	40.
Recurrent peak anode current (ma max.)	150	60	150	150	60	60	60	150	150	200	150	150
Instantaneous surge current (ma max., 1 sec.)	500	100	500	500	100	100	100	500	500	1000	500	500
Reverse current (μa max.)	50@—10v 800@—50v	10 @—10v	6 @—3v 625 @—100v	200 @— 100 volts 300 @— 800 volts	50 @—10v	50 @—10v	6 @—3v 625 @— 100 volts	10 @—10v	300 @— 100 volts 800 @— 150 volts	300 @—30v	500 @—75v	800 @— 100 volts
Shunt capacitance (μμf.)	1 μμf. nominal for all types											
Ambient temperature range (°C)	—50° to +70° for all types											
Average life (hours)	More than 10,000 hours for all types											

*Units are matched in the forward direction at +1 volt so that the current flowing through the higher resistance unit is within 10% of that in the lower resistance unit. Ratings shown for each diode.

**Consist of 4 specially selected and matched germanium diodes whose resistances are balanced within ±2.5% in the forward direction at 1.5 volts. For additional balance, the forward resistances of each pair of varistor crystals are matched within 3 ohms. Ratings shown for each diode.

—*Courtesy Sylvania Electric*

Chart 1—Voltage and current ratings for crystal diodes used in typical oscilloscope probes.

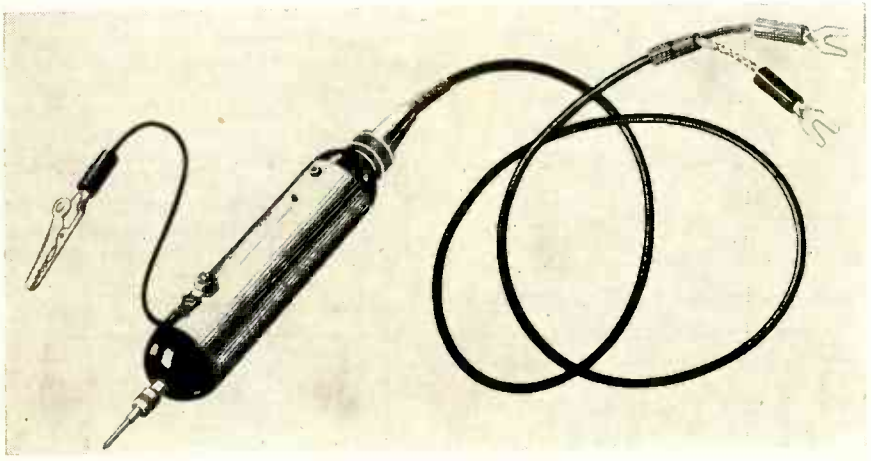


Fig. 6—Photo shows crystal probe.

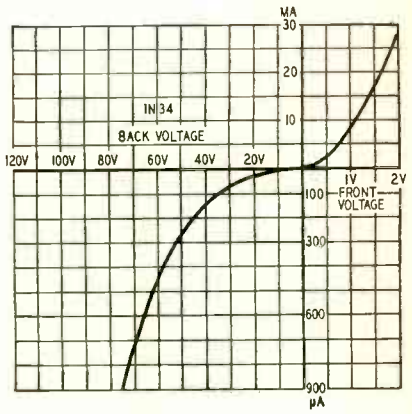
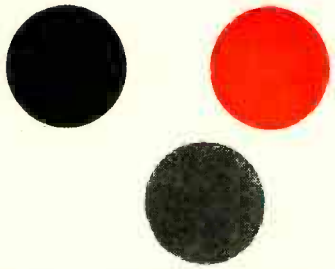


Fig. 7—Voltage-current relationships of three germanium crystal diodes.

a false change in picture shading from the top to the bottom of the raster.

The elements of picture (video) signals are essentially square waves of various frequencies. Typical distortions suffered by square waves in passing through defective video-amplifier circuits consist of tilt, curvature, overshoot, and ringing. These distortions, of course, are in addition to attenuation of the amplitude of the square wave due to poor amplifier gain at the test frequency. Tilt occurs when the top of the square wave is not level, but slopes uphill or downhill. Such tilt is the result of phase shift. There is always some phase shift when a signal passes through an amplifier, but the phase shift should be proportional to frequency. Curvature in the reproduced square wave is caused by frequency distortion or frequency discrimination. Curvature may show up along the entire top of the reproduced square wave, or only at the corners of the wave. All four corners of the wave may be affected, or diagonal corners only may be rounded. When the peaking coils are underdamped, the leading edge of the wave overshoots its final voltage. If underdamping is severe, a ringing follows the initial overshoot. END

BASIC COLOR TV



Part III—Transmitting the color subcarrier; detecting and separating the color difference signal

By D. NEWMAN* and J. J. ROCHE*

IN PART II we discussed the ways bandwidth requirements of the color television signal can be reduced.

It was pointed out that the brightness and color information can be separated and handled as individual signals, making it possible for black-and-white receivers to operate using the brightness (Y) signal. We also covered briefly the problem of transmitting the relatively narrow bandwidth color-difference signals within the 6-mc channel occupied by the brightness signal.

To transmit the color information within the same channel as the brightness signal, several new techniques are used.

The color subcarrier

In the previous article, it was shown that in addition to the brightness (Y) signal, two color-difference signals are needed to produce the color picture. The third color component (green) does not have to be transmitted separately, since it can be obtained at the receiver by adding the two color signals and subtracting their sum from the brightness signal. Due to the characteristics of the average eye, only those video frequencies up to approximately 1.5 mc are needed for the red color-difference signal, and only frequencies up to approximately 0.6 mc are needed for the blue color-difference signal.

Let us assume that we wish to transmit only one of our color-difference signals along with the brightness signal, and that the color signal is the blue one (B-Y).

If we modulate the video r.f. carrier simultaneously with the brightness and blue color-difference signals, there will be cross-talk between the two signals. The blue color-difference signal consists of frequencies between 0 and 600 kc, and the cross-talk will occur primarily at these frequencies. Since these frequency components represent the relatively large areas of the picture, the visible interference will be coarse and objectionable.

This problem can be minimized by shifting the blue color signal to the region around 3.6 mc. Cross-talk between the brightness and color signals will still be present, however, since the interference is taking place at much higher video frequencies, representing extremely small areas of the picture, the interference pattern will be fine in structure and much less noticeable to the viewer.

We see therefore that it is desirable to shift the color signal to the higher video-frequency region of the television channel. Now, let's see how this can be done.

Fig. 1 is a block diagram showing how the frequency of the color signal can be shifted to the desired portion of the channel. For purposes of explanation we will confine ourselves to the 3.6-mc oscillator and will assume that only the narrow-bandwidth color-difference signal (1) is involved. Later we will discuss the second one.

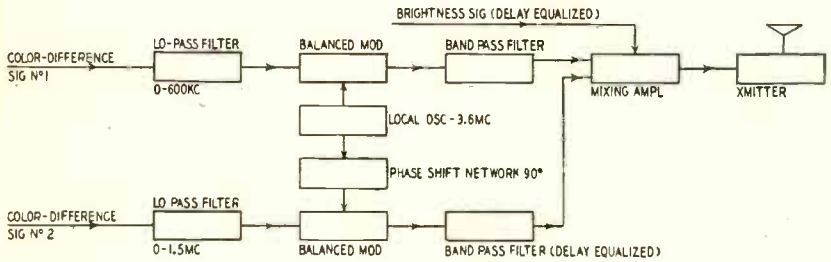


Fig. 1—Block diagram shows layout of transmitter color-handling circuits.

The color-difference signal is first fed to a low-pass filter which removes all frequency components above approximately 600 kc. The output of this low-pass filter is applied to a circuit called a *balanced modulator*.

At the same time, a locally generated signal, or subcarrier, of approximately 3.6 mc is fed to the input of the balanced modulator. In this stage, the 3.6-mc subcarrier signal is modulated by the color-difference signal.

In the output of the balanced modulator, only the sidebands produced by the color-difference signal appear while the subcarrier is eliminated or suppressed.

The output of the balanced modulator is fed to a mixing amplifier along with the brightness signal as shown in Fig. 1. The output of the mixing amplifier—which consists of both the brightness and color signals combined—is then used to modulate the transmitter.

Fig. 2 shows the frequency relationship of the color-difference signal to the brightness signal in the transmitter output. The narrow-bandwidth (0 to 600-kc) color-difference signal has now been shifted to the region around 3.6 mc. Upper and lower sidebands extending

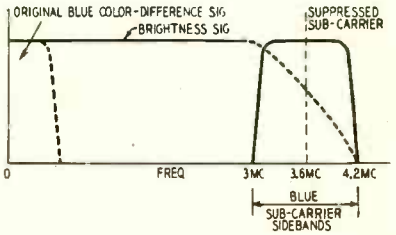


Fig. 2—How color signal is shifted.

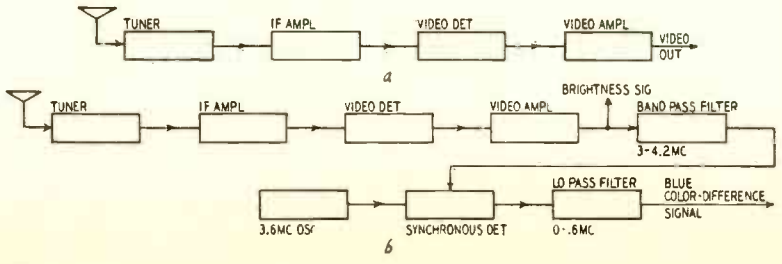


Fig. 3—How circuits are added to separate and detect the color signal.

*Allen B. DuMont Laboratories, Inc.

from 3 to 4.2 mc are present, having been generated in the balanced modulator circuit.

We have now produced and transmitted a combined brightness and color signal within a 6-mc channel. At the receiver, we must separate these signals.

Separating the signals

Fig. 3-a is a block diagram of the video channel of an ordinary black-and-white television receiver. The composite brightness and color signal is fed to the video detector, and its modulation envelope is obtained in the usual manner. The output of the video detector is fed through regular video amplifiers to the cathode-ray tube to produce a black-and-white picture.

Of course, the color signal is still superimposed on the high-frequency portion of the detected video signal, but as we have seen previously, the interference pattern will be very fine and not too objectionable. Later we will see how the visibility of this interference pattern is further reduced.

Fig. 3-b shows a similar receiver with several circuits added to separate and detect the color signal.

The composite video signal (consisting of both color and brightness information) at the output of the video detector, is applied to a bandpass filter which passes only frequencies between 3 and 4.2 mc. Most of the brightness signal is eliminated in this process.

The color (chrominance) signal is then fed to a special type detector, called a synchronous detector. In this circuit, the chrominance signal is combined with a locally generated signal of exactly the same frequency and phase as the originally transmitted unmodulated subcarrier. The sidebands of the chrominance signal combine with the local oscillator signal and produce the original 0-to-600-kc color-difference signal we desire.

Fig. 4 is a simplified diagram of one

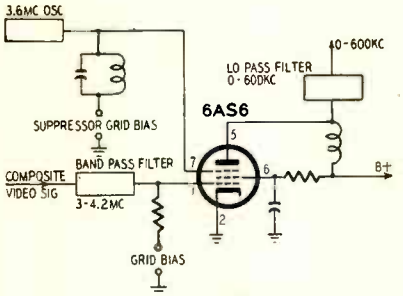


Fig. 4—Typical synchronous detector.

type of synchronous detector. A 3.6-mc local oscillator signal is applied to the suppressor grid. The chrominance signal is applied to the control grid, after being passed through a 3–4.2-mc bandpass filter.

The signal at the plate contains a number of frequency components. Among these are the difference frequencies between the locally generated 3.6-mc signal and the chrominance signal. A low-pass filter (0–600 kc) in the plate circuit removes the undesired signals and permits only the desired color-difference signal to pass through.

To recover the color-difference signal without distortion, the locally generated 3.6-mc signal which is applied to the synchronous detector must be of exactly the same frequency and phase as the original subcarrier frequency used at the transmitter, as will be explained later.

Two color-difference signals

Up to this point, we have assumed for purposes of explanation that there was only one color-difference signal to be transmitted and received. The signal we used in the explanation was the color-difference signal whose bandwidth extends from 0 to approximately 600 kc (signal 1 in Fig. 1).

Actually we must also transmit *another* color-difference signal, whose bandwidth extends from 0 to approximately 1.5 mc (as was explained in the previous article). This is signal 2 of Fig. 1.

We have learned that it is possible to insert the narrow-band color-difference signal in the same channel as the brightness signal, and recover each separately at the receiver. The problem now is to insert a third signal (the wide-band color-difference signal) as well.

This is done by using *two* separate subcarriers at the transmitter instead of one. These subcarriers are *identical in frequency* but *90° out of phase* with one another. The two subcarriers are obtained as shown in the block diagram of Fig. 1.

Subcarrier 1 is obtained from the 3.6-mc local oscillator. Subcarrier 2 is obtained by passing the output of the same oscillator through a 90° phase-shifting network.

Subcarrier 1 is modulated by one of the color-difference signals in a balanced modulator. Subcarrier 2 is modulated by the other color-difference signal in a second balanced modulator. The outputs of the balanced modulators are passed through filters to remove undesired frequency components.

The filter outputs are then combined with the brightness signal in a mixer amplifier and fed to the transmitter. In passing through the low-pass filters, the color-difference signals are delayed, due to the phase shift which takes place in the filters. The narrow-band color-difference signal is delayed more than the wide-band color-difference signal, because of the differences in filter characteristics. To equalize the delays of the three signals (brightness and two color-difference signals), additional delay is provided in the brightness and wide-band-color channels.

Fig. 5 shows the vector relationships of the unmodulated and modulated subcarrier signals. Fig. 5-a shows the unmodulated sub-carrier signals which are applied to the balanced modulators. Note that these subcarrier signals are 90° out of phase with each other.

The outputs of the balanced modulators are shown in Fig. 5-b. In each case the subcarrier has disappeared, while upper and lower sidebands have been generated for each corresponding color-difference-signal frequency component. (In the process of modulation, sideband pairs are generated for each frequency component in the modulating signal as in an audio signal, for example. For simplicity, only a single pair of sidebands is shown in Fig. 5, for each of the color signals.)

Fig. 5-c shows all of the sideband components which form the chrominance signal when the outputs of the balanced modulators are combined. In the illustration, all the sideband components are shown separately. Actually, since any signal can have only one amplitude and one phase at any instant, these sideband components combine to form a *resultant* signal.

Fig. 6-a shows this total resultant chrominance signal which is produced when the sideband components in Fig. 5-c combine. Vector addition by "completing the parallelogram and finding

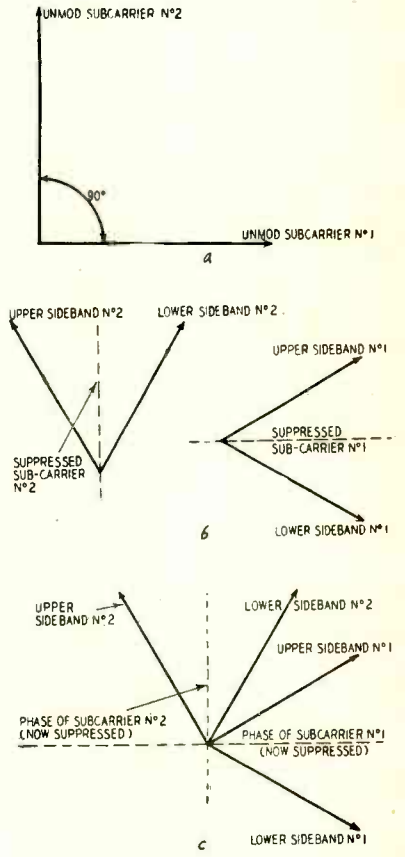


Fig. 5—Subcarrier phase relationships.

the diagonal" is shown, to clarify the process. This is the signal that is actually transmitted. Fig. 6-b shows how this resultant is affected when either of the sideband pairs is altered. Note that the total resultant chrominance signal changes in both *amplitude* and *phase* when this occurs. When both sideband pairs are altered, the total chrominance signal again changes in both amplitude and phase as in Fig. 6-c. Thus we see that the total chromi-

nance signal as transmitted is constantly varying in both amplitude and phase in accordance with the modulating signals. However, it is important to remember that all the sideband components are always present in the chrominance signal.

At the receiver, we must separate and recover the two color-difference

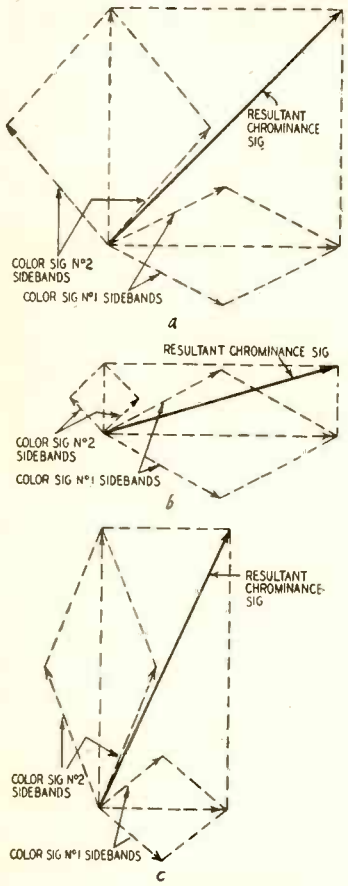


Fig. 6—Vector addition illustrates composition of chrominance signal.

signals. This is done by using two separate synchronous detectors as shown in Fig. 7.

To operate the synchronous detectors, two subcarrier signals are generated in the receiver for reference purposes. The composite video signal, consisting of the chrominance and brightness signals, is applied to separate bandpass filters which eliminate most of the brightness signal.

The outputs of the filters are applied to separate synchronous detectors. The subcarrier signals applied to the synchronous detectors are identical in frequency and phase to the original subcarrier signals at the transmitter.

These subcarrier signals are obtained in much the same way as at the transmitter. One signal is obtained from the output of a local 3.6-mc oscillator; the other by passing the oscillator signal through a 90° phase-shifting network.

The synchronous detectors operate exactly as was described in the case of the single color signal. However, the output of each detector contains only one of the desired color-difference signals. Only one signal appears in the output of each detector because the phase of the reference subcarrier applied to it is chosen to cancel the sideband components representing the other color signal.

From the above, we can see that the frequency and phase of the subcarrier reference signals generated in the receiver must be identical to those of the original unmodulated subcarriers used in the transmitter, if reproduction of the original color signals is to be true. In other words, the frequency and phase of the subcarriers at the receiver must be *synchronized* with those in the transmitter.

The two subcarriers are synchronized by transmitting approximately 9 cycles (burst) of a 3.6-mc reference signal, at horizontal scanning rate intervals. This reference signal is inserted on the back porch of each horizontal blanking pulse, as shown in Fig. 8.

One of the primary reasons for locating the burst on the back porch of the horizontal blanking pulse is to avoid affecting the normal operation of the horizontal sync circuits in both black-and-white and color receivers.

The burst occurs during horizontal retrace time, when the receiver screen is normally blanked out by the horizontal blanking pulse. Also, since the burst occurs after horizontal retrace has started, it has no effect on synchronization of the horizontal sweep circuits.

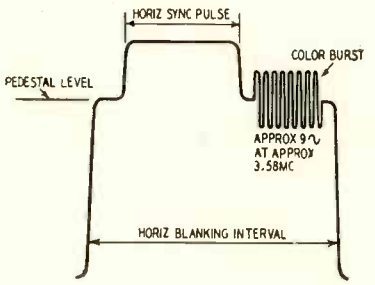


Fig. 8—Inserting color sync burst.

Having seen how the color-difference signals can be transmitted and detected, we can now turn our attention to the refinement of, and reduction of interference in the system.

(TO BE CONTINUED)

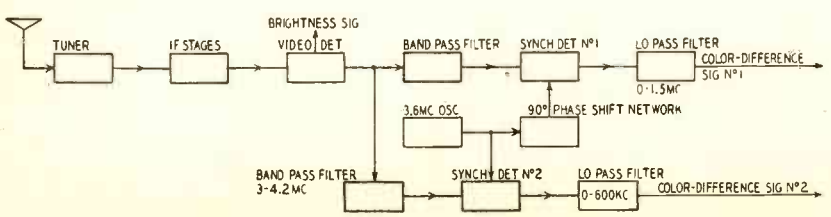


Fig. 7—Two synchronous detectors separate the color difference signals.

tv dx IN MARCH

IN THE more southerly parts of the country, at least, March will mark the beginning of another TV dx season. Some sporadic-E dx is usually seen in the Deep South each year before the month is over. In these same latitudes, too, warming weather increases the viewers' chances of picking up some good tropospheric dx. This will be particularly true of the Gulf States.

Farther north there will be only a very slight upturn in general reception, unless we get a stretch of unseasonably warm weather that sometimes breaks out toward the end of the month. March is generally a good aurora month for the Northerners, though TV reports from this medium have thus far been few and far between.

Some real u.h.f. dx

It hasn't happened often, and very likely it never will become anything like the dx we experience on channels 2 through 6, but once in a blue moon an alert viewer will come up with a u.h.f. dx prize that defies explanation. A few such were listed in the 1953 TV dx summary published last month, and now we have another.

Observer R. J. Walker, Daytona Beach, Fla., reports a 10-second flash reception of KSTM-36, St. Louis, Mo., at 2:55 pm, December 13. This is a time of day and season of the year when tropospheric dx is highly unlikely. And it is generally thought that ionospheric propagation is impossible above 150 mc or so. What was the medium of propagation, then? Well, we'd like to know, too! When we've collected a few hundred such observations, perhaps we can make a guess.

New quarterly department

Beginning with the next issue, TV dx information (forecasts and reports) will be carried on a quarterly basis. It is hoped to be able by this means to present a more balanced column, as each one will span all or part of a particular type of seasonal phenomena. It is hoped, also, to be able to present outstanding dx reports regularly.

To achieve the latter aim we need the full co-operation of TV dx enthusiasts. If you catch anything unusual, report it *at once*. Don't wait until the end of a season and mail in a complete log. Reports several months old are satisfactory for long-term study, but they don't rate as news.

Interesting things are happening almost daily in the TV dx field. Can we count on your assistance in reporting them?

END

ing television receivers. In adjusting an antenna with this type of mounting, start with the V in a horizontal plane. After the other adjustments have been made, readjust the angle the arms make with the horizontal.

For the service technician, an adjustable-V antenna used in combination with an outdoor type in difficult locations often can produce nearly ghost-free reception to an extent that cannot be obtained with any practical single outdoor or indoor antenna. This combination was devised by the author to solve a ghost problem which had resisted several types of installation by different technicians, but the scheme probably is not original. It consists simply of connecting an adjustable-V indoor antenna in parallel with the outdoor one, as shown in Fig. 3, and adjusting the indoor V to cancel out the ghost. With an arrangement of this type, the owner of an intermittently haunted TV set has something to do which is more constructive than complaining to his service technician. The indoor antenna need not be adjusted nor even connected if the received picture is satisfactory without it.

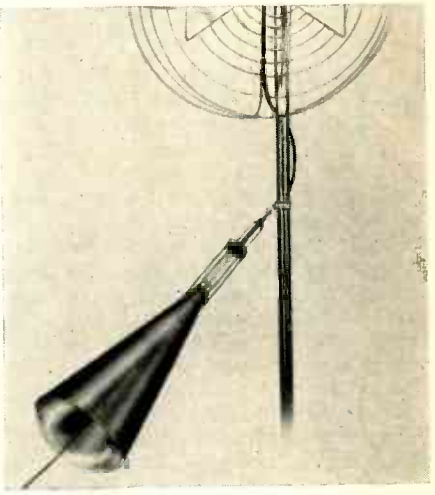
Impedance mismatch when the two antennas are thus connected together will not necessarily give trouble. In fact, the auxiliary antenna may be adjusted to correct a mismatch between the receiver and the outdoor antenna system. If a mismatch does exist when the two antennas are otherwise properly adjusted, it can be corrected by the usual means, but I have not found a case where it was necessary to do so.

Since an indoor antenna alone may not give sufficient signal pickup some distance from a station, it may be thought that such an antenna could not pick up enough ghost signal to cancel out that from the outside antenna. Actually, good results have been obtained 50 miles from a station.

If you never have used an indoor antenna, try it sometime! END

G-LINE

The *launcher* (from the antenna) and the *catcher* (at the window) match the G-line to the 300-ohm lead. *Photos courtesy of David Bogen Co., Inc.*



ONE of those fantastic scientific conceptions that seem fitted only for expression in long strings of mathematical calculations has come down to (or near) Earth, and may soon be seen on rooftops carrying u.h.f. TV antennas.

The new science-fiction-like apparatus is the G-line being made and sold as u.h.f. lead-in by Bogen. To all appearances, it is a single wire ending in a horn-like device at each end. (See photos and Fig. 1.) But radiomen know that u.h.f. does not travel readily on a single piece of wire. It tends to radiate off the wire into space, so little gets to a point any distance along the wire. For u.h.f., very special twin-line, coaxial or other types of transmission lines are needed, and even their losses go up rapidly with frequency. Is this new line some special kind of wire?

The *G-line*, so called after its inventor, Dr. George Goubau (RADIO-ELECTRONICS, May, 1950, and June, 1951) is a very special piece of wire. The ultra-high-frequency currents travel, not in the wire itself, but in the insulation around it! (To be more exact, they are confined to the area around the wire by the difference between the dielectric value of the insulation and that of the air around it.)

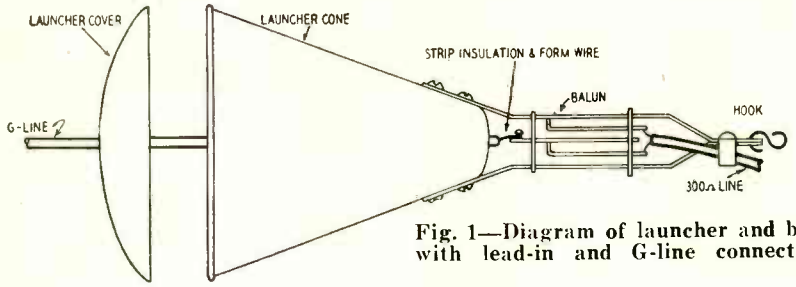


Fig. 1—Diagram of launcher and balun with lead-in and G-line connections.

This is not as hard to understand as it may seem. We are all familiar with coaxial cable. At higher frequencies, the center conductor of the cable may be removed, and we have a waveguide. We know that u.h.f. current can be piped down waveguides without trouble. The G-line, in effect, removes the outer conductor, using only the inner one. The only difficulty is that we might expect the u.h.f. to radiate out in all directions from the wire, and that little would reach the end. This is just what does happen on an ordinary piece of wire.

As the waves spread outward from the wire of the G-line, they are reflected back toward it again by the boundary between the insulation and air. The short waves (3–30 mc) are similarly confined to the area near the surface of the Earth by bending due to the thinning out of the atmosphere. Waves which are not too near vertical are reflected back toward the Earth, instead of going on into space.

Thus, in the G-line, signals travel much as in the exaggerated drawing of Fig. 2. The signals are picked up by an ordinary antenna with a balanced impedance of about 300 ohms. Therefore they must be launched onto the single (unbalanced) line. The launcher includes—at the narrow end, a *balun* (balance-unbalance transformer) and a gradually widening horn. The signals which may at first be inclined to treat the wire-horn combination as a new kind of coaxial finds the impedance rapidly going up as the horn widens, so that more and more of it follows the center conductor. A similar unit at the end where the lead enters the house transforms the signal back to a balanced one and puts it on a standard 2-conductor 300-ohm line. The two matching units contribute a loss of only ½ db each, and the line itself has a loss of 1 db per hundred feet. Radiation and noise pickup are very low because of the self-contained nature of the line, and it has an almost complete cutoff below 300 mc.

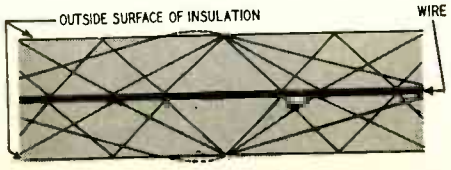


Fig. 2—Exaggerated illustration showing r.f. traveling between wire and surface of the insulation on G-line.

Insulation presents a problem. While the field falls off rapidly with distance from the surface of the wire, anything approaching it closely would cause severe losses. Therefore the line is supported wherever necessary by loops of nylon cord stretched between the ends of a small bracket, so that a minimum of solid material is brought near the line. Similar brackets are used wherever a bend is made, as the line must not have sharp turns, and 3 supports are needed for a 90-degree bend.

The new line will be especially useful wherever long runs have to be made. It will also be valuable in bad-weather and industrial areas and salt-air installations, since moisture, soot, or salt do not increase its losses. END

the "BEST TEACHER"

By HENRY FARAD

"Experience is the best teacher, but she keeps a dear school"

HE DRIFTS into my TV repair shop two or three times a year. He's a different individual each time, but his problem is always the same. He has studied TV theory until it's running out of his ears; what he needs now is on-the-job experience to make that theory worth something in terms of dollars and cents. He is up against a problem as old as civilization—he hasn't been able to find a job because he has no experience; he can't get any experience because he can't find a job!

I can't help him directly. I'm a small-bore operator on a side street; my shop is in front of my home. You know the setup: in slack season not half enough work for one man; when things get snowed under, a few 12- or 14-hour days clear the decks. I get by, which is just fine. But hired help I can't use.

However, I can explain how I got *my* experience after I'd run up against the identical problem. Like many others, I learned my TV theory at home in my spare time; making a living occupied most of my daylight hours. My only teachers were books, magazines, and a study course.

Inevitably, as does every student, I reached a point where the books began to blur. I'd absorbed all the wordage I could handle for the time being. I needed actual contact with TV sets—preferably in bad order.

I could have gotten that contact in a residential TV school, but I had a family to support and no rich uncles. A job as a helper or apprentice in a TV shop was another possibility, but a shop helper's pay is too low and his progress not fast enough for any but single, unburdened individuals. I solved the problem by creating my own experience. The method is simple and relatively cheap; it can be duplicated anywhere. It can supply any student —as it supplied me—with experience at exactly the right pace; never too fast, never too slow; whenever he wants it—evenings, week-ends, any time.

My first step was to become what amounted to a part-time dealer in TV junk. This was simple enough. I inserted a classified ad in a local paper, offering to buy old TV sets—any size, shape, or condition for cash. You don't have to be a big dealer to do this. I put a $50 maximum on my offer, thus side-stepping big stuff; I never paid more than $30 for any of the ten-inch clonkers I dragged home. $30 was my top a couple of years back—a $20 maximum would be more in line with today's situation.

Having dragged a relic home, I proceeded to restore it to working condition, which frequently took a little doing. As might be expected, there was something badly amiss with every one of my prizes. Some produced neither raster nor sound; some made with fearful planing-mill noises. Others were

inhabited by gremlins or some of the many ailments common to TV sets. Sad cases every one, but you don't learn TV repairing by working with sets in good order. Assuming a receiver hasn't suffered a major burn-up (sniff well before buying), and hasn't been robbed of tubes, then the worse its condition the better for the student seeking experience.

The actual, hard-rock experience I gained in repairing those boxes was only part of the program. My next stop was to twist every nonoperating control I could find, with the idea of getting everything as far out of kilter as possible. Then I restored everything to normal, sometimes repeating the process several times. The further I progressed the bolder I became; the deeper I dug into my clonkers. I introduced defects and observed the symptoms. I practiced signal-tracing and alignment, to mention just a few of my earlier experiments. Then, after I'd milked a chassis dry of information I sold it down the river, as detailed a little later.

In one corner of my over-sized garage I fought first one piece of junk back into working order and then another—and another. A v.t.v.m. with a couple of probes, a tube tester, and some early printings by Rider and Photofact made up my equipment, plus the usual hand tools.

It's no fun—not at the start. Not for the student completely on his own, with not a soul to give him a lift when he gets stuck in the mud, which is often. It's not the most efficient method in the world, either; it involves frustrated hours of doing things the wrong way, stupid mistakes, wrong approaches, errors of both omission and commission. There were times when I'd have sold out for a fraction of the inventory.

But you can say this about the method—it works! It produces real, valuable experience. Moreover, it sticks with you, as does anything acquired the hard way; there's no time wasted simply memorizing. Another advantage is that you have neither employer nor impatient customer breathing down your neck—a handicap which can make even an experienced mechanic sometimes black out.

I started out in my garage loaded with theory but inclined to go numb from the neck up the moment I removed the back of a defective TV set. The first time I pulled one out of a cabinet and turned it over I recall sitting there for half an hour, just gawking, with a gone feeling at the pit of my stomach, wondering why I'd ever started this. The first few times I compared a schematic with a chassis I got lost so fast it was worse than pitiful. No fun at the start.

Little by little, however, stage by stage, I acquired competence and confidence, a backlog of experience. I discovered head-on attacks don't pay off in TV repairing. Strategy is the key to the jackpot; knowing when to attack a repair job via the *dynamic* approach, checking a.c. components with a v.t.v.m.

or scope, and knowing when to use the *static* approach, routinely checking socket voltages, capacitors or resistors. It means knowing when to use a tube-tester and when to rely entirely on substitution. The difference between the strategic and the head-down approach is the difference between minutes and hours in wrapping up a repair job.

The strategist is always changing pace. He hangs onto an idea or a deduction just so long, then if it fails to pan out he dumps it. This is an attitude of mind to be cultivated. Let me illustrate the disadvantages of not having this attitude, by using a hypothetical Joe Doakes. Confronted with a fairly tough case of TV trouble, Joe looks the situation over and makes a quick deduction as to the probable cause. So far so good. However, Joe's test gear promptly reports that everything is under control in the suspected area. This is where real trouble starts.

Instead of changing pace and developing a second deduction, Joe stubbornly makes another pass at the original target. When this gets him nowhere, he promptly goofs off. Two hours, three hours later you may find him still working over the same group of components. Meanwhile in the process of checking and re-checking it's quite possible Joe's test gear has indicated the cause of the trouble. But because Joe is operating strictly under Condition Goofoff, he pays no attention to what the test gear tells him. He ignores it, knot-headedly continuing his original line of attack.

After lunch or possibly the next day, he'll come to, kick himself, and proceed to repair the TV set in a normal manner. I goofed off like this more than once. Others far more competent than I have done exactly the same thing.

The calm, cool, and collected attitude is about twenty-five percent of the top-drawer technician. It increases output and accuracy, it inspires that precious gem, customer confidence. Move slowly and deliberately; it will reduce the number of chassis unnecessarily pulled, and the number of 6AU6's popped by forgetting to return the filament knob on the tester back from 12.6. In short, the less haste the more speed.

I once pulled a chassis and fought with it for an hour, trying to discover the reason for no-sound. I was knee-deep in gear and half-strangled with test leads when I noticed at long last that the record-player switch had somehow been snapped over to PHONO.

Then there was that memorable Philco on which I wasted more than half a morning trying to find out why the over-all bandwidth had decreased to about 2 megacycles. (Yes, I checked and re-checked the tubes.) The trouble, it eventually developed, grew out of the fact that a 12AU7 and a 12AV7 were planted side by side in the front end—and someone had swapped them! Later I discovered the owner had taken some of his tubes downtown for testing before calling me in, which shows to go you—never take anything for granted.

When nothing produces results within a reasonable time, start taking wild shots in the dark. I am reminded of a certain series-filament conglomeration wherein all the symptoms of an open grid circuit in the C-R tube were produced by a heater-to-cathode short in the damper! Then there was that frightful case of horizontal nonlinearity which was caused by trouble in a 6SN7-GT horizontal oscillator which checked perfectly in my tester. In this case and as an added unattraction, the horizontal drive capacitor had insanely taken over the function of a horizontal centering control!

Anyway, and as I started to say some time back, little by little, stage by stage, headache by headache, I acquired competence and confidence at my garage workbench. If I've made it sound rough, I can only say it is indeed rough—at the start.

In the end, I no longer crept timidly up to each sour TV set, wondering whether this one would be my Waterloo as I began to probe its inards.

Oh, sure, you get thrown for a loss every so often by some box tougher than you, but repairing the vast majority of TV sets is so simple—even for a halfway competent technician—that it sometimes seems a shame to take the money(?).

I bought a lot of clonkers, but my actual inventory at any one time was seldom more than one TV set. As soon as I milked one dry, it was promptly sold.

I'd have a really good story here if I could say these transactions showed a nice profit, but not so. I had to price those boxes low enough to insure prompt disposal, and I had to get cash. The prices I got were anything but fancy. Considering the cost of advertising, mileage, replaced tubes and components, I lost something on every deal—around $7.50 per box.

Holding on for higher prices could have showed a profit possibly, but I wasn't necessarily trying to make money; my objective was getting experience. Keeping a constant supply of TV cadavers coming my way was the all-important item.

I started my project with a v.t.v.m. and a tube-tester; eventually I acquired a scope, sweep and marker generators, 1,000-kc crystal marker oscillator, grid-dip meter, wattmeter, capacitance-bridge, short wave receiver to monitor WWV, complete set of service manuals, and trimmings. You don't have to be a big dealer to do this. I bought my gear one item at a time, in kit form wherever possible, because I couldn't afford ready-made gear. Moreover the purchases were spread out over a considerable period of time—a year or so all told.

Slow work? Well, acquiring electronic know-how is a slow process. The TV student in a hurry is licked before he starts; never less than a year and often two years must elapse before he gains enough ground to tackle general repair work.

Also pretty well licked before he starts is the TV student who expects to draw a salary while he gets his practical experience. Students pay considerable sums to acquire theory, and without protest. However, the thought that practical experience must also have a price tag is something which seldom occurs to them. But that's what it amounts to when the inexperienced technician—sharp though he may be in theory—tries to hire out in Slowblow's TV shop.

Apprentice training works out well enough in some occupations, where other services may be rendered while the student learns.

Simply observing a TV repairman at work is of little value to the novice, assuming the repairman is not doubling as instructor. Ninety-nine per cent of the effort is quite invisible, consisting of mental processes.

If Slowblow takes him as a *bona-fide* apprentice or learner, the novice will be in Slowblow's way for a long time; he's only half a technician. Slowblow would be forced to make up his deficiencies. Slowblow must spend many hours *teaching* the novice the techniques he needs; inevitably the novice will make numerous and sometimes expensive mistakes. In short, he'll be a student drawing wages for being instructed!

The only practical way Slowblow can hire the student is on the basis of shop helper. Most of the time he will put up aerials, pull chassis, act as general man-of-all-work. Thus the student earns his wages, but acquiring experience is strictly hit-or-miss, at a woefully slow rate.

Hence, unless he's exceptionally lucky, or unless he can manage to take a residential course in a TV trade school, the average Joe must buy his experience—and the only visible method is along the general route I've been outlining. The cost of buying experience this way is never more than a few hundred dollars, with payments spread out over a rather long period.

Even if the student does not plan to go into business for himself, buying all this test gear is actually a necessity. Considering the strong economic position enjoyed by the experienced, competent TV service technician, a few hundred dollars represents a trivial investment indeed. END

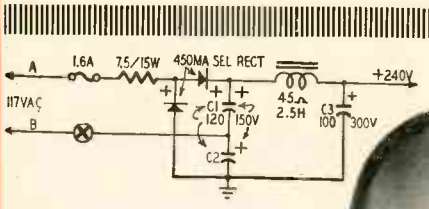


Fig. 1—Schematic diagram of voltage doubler used in Philco model 52-T2110

Fig. 2—Insufficient low-voltage supply.

THE increasing use of selenium rectifiers in television receivers has resulted in our receiving many queries regarding symptoms which appear when rectifiers go bad. Readers have also asked about replacement precautions and data.

In most instances when selenium rectifiers replace vacuum tubes in low-voltage power supplies, a voltage-doubling circuit is used to get an output of between 200 to 250 volts. In most instances the voltage-boost system of the damper tube contributes an additional 100 to 200 volts for circuits requiring B voltages in excess of 300.

When troubles develop in such voltage-doubling circuits, the fault may not always be the selenium rectifiers. Often a defect is due to other circuit components, because the voltage-doubling circuit is critical with respect to part values.

A typical circuit is shown in Fig. 1 and is used in many current Philco receivers. Two selenium rectifiers are used, each having a 450-ma rating. These, in addition to the two 120-μf capacitors, form the voltage-doubling circuit.

A 1.6-ampere fuse is in series with one leg of the a.c. line, and a 7.5-ohm limiting resistor is also used to prevent excessive current peaks. When one-half of the a.c. cycle causes the input terminal A to be positive, the top selenium rectifier conducts and charges capacitor C1 to the peak value of the a.c. voltage. During the second half of the a.c. cycle the lower rectifier conducts and charges C2. The *sum of these charges* is double the input voltage.

The efficiency of the circuit depends on the conduction of the selenium rectifiers, plus the ability of C1 and C2 to maintain their charges. If these capacitors become leaky or change value, the voltage doubling will be seriously affected. Likewise, leakage of filter capacitor C3 can load down the circuit by drawing excessive current. A current drain in excess of what the circuit is designed for results in draining off the energy from C1 and C2 at a faster rate than they can be charged, thus decreasing the voltage output.

In a television receiver, decreased output from the low-voltage supply can result in a shrunken picture which cannot be expanded by the width and height controls, corner shadows, poor picture quality, unstable synchronization, and low audio output. The degree to which these symptoms are present depends on the amount of voltage decrease in the power supply. Fig. 2 shows symptoms of vertical and horizontal shrinkage, as well as corner shadows caused by a decline in selenium-rectifier output.

When the rectifiers are at fault, they should be replaced with units having the same (or higher) current ratings. The 450-ma rectifiers shown in Fig. 1 can be replaced with 500-ma units, thus assuring somewhat longer life. The only factor to consider is whether or not the new units will fit in the same space used by the old units.

If possible, filter capacitors should be checked with a capacitor checker so that the power factor (leakage) can be read. Do not bridge old capacitors with new ones, as this does not eliminate any leakage. Also check the value of any series resistors and replace with values recommended in the service notes. Electrolytic capacitors used with selenium rectifiers require special consideration. Since the selenium rectifier has no warmup period, the capacitors will be subjected to high initial surge voltages. (See "Electrolytic Capacitors", February, 1954, issue.)

With respect to filter capacitor replacements, use the same values given in the receiver schematic. The values shown in Fig. 1 are only for the receiver mentioned. Other receivers may use lower-current rectifiers, or higher doubling capacitors. (Crosley chassis 411, for instance, uses 200-μf capacitors in both the doubling circuit and the filter section.)

Selenium rectifiers have the advantage of requiring no filament voltage and are fairly rugged. Their life may be as short as six months or as long as several years. Often their emission declines gradually, so that it becomes necessary to advance both the height and width controls every few months to keep the picture filled out. Eventually both controls are at their maximum and shrinkage can no longer be corrected except by rectifier replacement. By this time picture quality is also down, and the new rectifiers (and perhaps new filters also) will do much to give the set new life and sparkle. Don't forget to reduce those height and width controls, or your customers will be complaining about the tops of heads being chopped off, or never seeing the performer's feet!

Blanking differences

On some channels, the picture in a Transvision A-4 receiver lacks full width, while on other stations the picture fills out completely. What could cause this? I would also like your opinion regarding fine detail. Do you believe that excessive sharpness is possible?—R. Z., Eagle Lake, Texas.

There is a difference in the transmitted width of some stations. This is caused by a difference in the blanking duration; unfortunately all stations do not adhere to standards in this respect. You will also find that some stations fill out the mask to a greater extent than others do. A contributing cause in the receiver could be insufficient high voltage which will cause blooming for differences in contrast and brightness levels. The high-voltage system should be checked and brought to maximum efficiency by tube replacement.

With respect to fine detail, the correct procedure would be to align the tuner and video i.f. stages so that a 4-mc bandpass is obtained. This gives the sharpest picture. Excessive high-frequency peaking will cause repeat lines to be visible at the edges of sharply defined objects. Sometimes this is caused by incorrect peaking coils in the

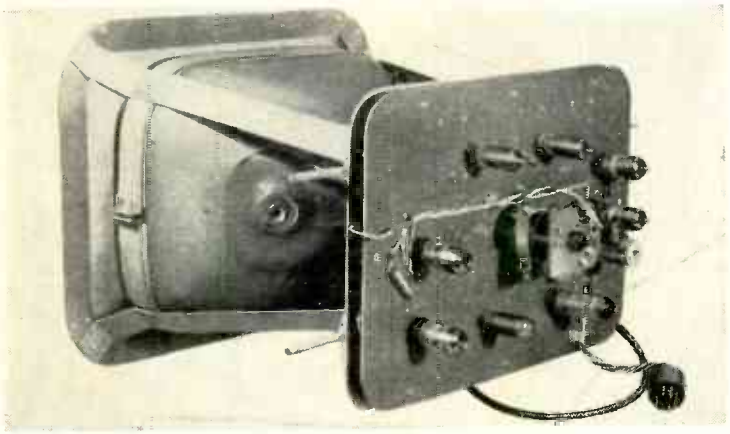
*Author: Mandl's Television Servicing

C-R tube wrap-around deflection coils.

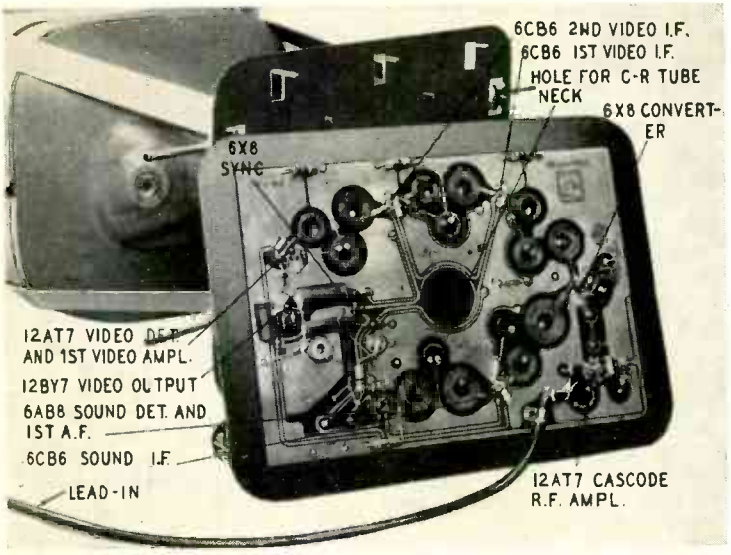
PRINTED CIRCUIT TV RECEIVER

French TV receiver may be sign of things to come

By M. BONHOMME
Editor-in-chief *Toute La Radio* (France)



Tubes and printed circuit are mounted over neck of C-R tube.

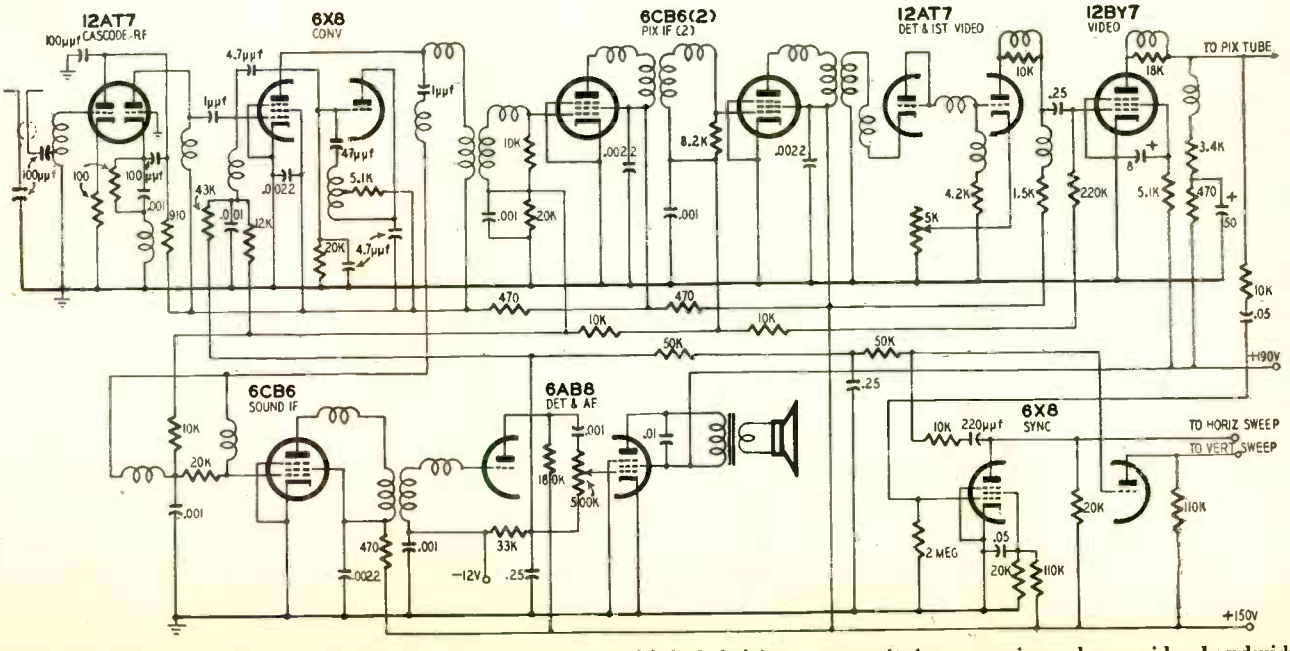


Layout shows combination of printed circuits and standard parts.

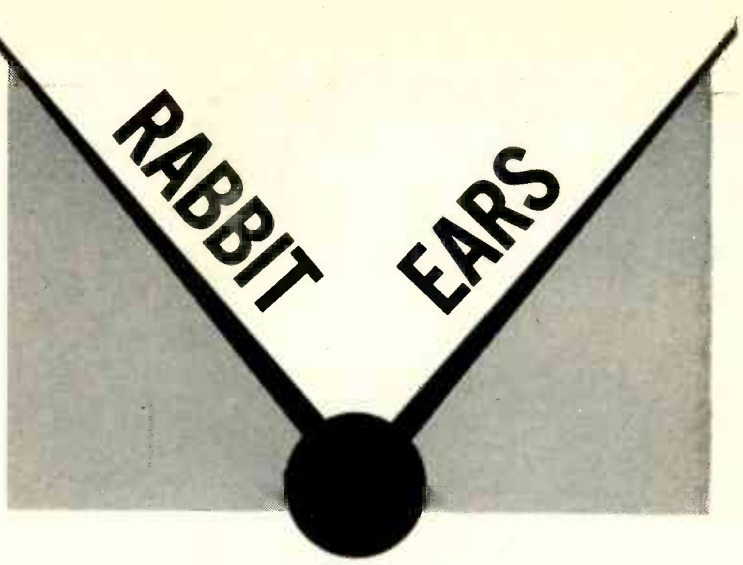
PRINTED circuits are by no means a novelty, and more than one receiver on the market is partly or entirely constructed with the help of photo-engraving techniques. Not so in television. Kaye-Halbert have announced an at least partly printed-circuit televiser, and Sanders Associates of Nashua, N. H., have demonstrated an experimental receiver constructed with the modular system of *Project Tinkertoy* (RADIO-ELECTRONICS, December, 1953, page 59) which uses printed circuits in conjunction with plug-in connections. For this reason the accompanying illustrations of a French television receiver made by the French firm Visseaux is particularly interesting.

All the connections and all the inductances are made by engraving (printed-circuit) techniques. The resistors in the earlier models are standard miniatures, though the Visseaux technicians state that this is a temporary step.

The illustrations here show the printed part of the equipment (the power supply still follows tradition). Nine tubes are used, five of which are dual-function types. The set is intended to receive a single station at 174.1 mc. Bandwidth is 8.5 mc to accommodate the French high-definition 819-line transmissions. Unquestionably the simpler demands of one-station reception have made it much easier to design and manufacture such a receiver. END



Schematic diagram shows printed circuits. Used for high-definition transmission, receiver has wide bandwidth.



GETTING THE MOST FROM

Indoor type antennas need not be "substitute" antennas; proper use makes them highly effective

By JOHN K. FRIEBORN

WHETHER you are a set-owner or a service technician, the adjustable-V type indoor antenna offers advantages which often are overlooked. This type of antenna is usually regarded as a mere substitute for an outside installation. Actually, an indoor antenna often can give you a satisfactory picture when an outdoor type cannot. Unless you can place an outdoor antenna high enough to eliminate the possibility of reflections ever occurring on any channel, you cannot be sure of obtaining ghost-free reception under all conditions, except with an extremely elaborate installation. The amount of signal pickup generally is less with an indoor antenna than with an outdoor one, but the greater ease of adjusting the indoor type makes it possible to eliminate ghosts more consistently.

To obtain maximum benefit from an indoor antenna, you should have one with as many adjustments as possible and adjust it whenever the picture indicates the need. Many set-owners feel that simply paying for a receiver and its installation should be enough to entitle them to perfect television reception. However, for many locations the service technician cannot obtain good reception at all times, and the set-owner who does some additional work will be well repaid for his efforts. In many cases, the most effective thing a set-owner can do to improve the quality of his picture is to have an adjustable antenna, and adjust it when necessary.

The set-owner usually is told to "adjust for the best picture," but that is not much help in making the many adjustments possible with some antennas. Any method is satisfactory as long as the adjustments are performed in a definite order and repeated if necesary. For example:

1. Extend each arm about halfway;
2. Adjust each arm to an angle of about 45° with the horizontal;
3. Rotate the antenna for the best picture;
4. Adjust the length of each arm individually (holding the insulators at the ends, not the metal parts of the arms);
5. Adjust the angle of each arm individually;
6. Re-check rotation, lengths, and angles, until changing any adjustment does not produce any improvement;
7. Try the antenna in different locations.

If you adjust the arms individually, often you will find that an unsymmetrical configuration of the antenna is the best one. I have found that the best picture sometimes is obtained with a position like that in Fig. 1. This may not look right to you, and it doesn't look right to me, but it seemed to suit the signal. Incidentally, the higher-frequency channels (7 through 13) do not necessarily require that the antenna arms be shorter than those for the lower channels; an antenna does not have to be one-half wavelength. In adjusting your antenna, forget oversimplified theories about what it should look like and just give the incoming signals a chance to try all the different sizes, shapes, and positions your antenna can offer.

Even with the five adjustments which are available in the standard adjustable-V indoor antenna, still another would be desirable. In fact, a different type of antenna mounting would produce better results than the present one, both theoretically and practically. With present commercial indoor antennas, the V formed by the arms is always in a vertical plane. Better results usually would be obtained with the V in a horizontal plane, since the best direction for a V-type antenna is in the plane of the V, and television signals are received along an approximately horizontal line. (See Fig. 2.) The plane best for the antenna in a particular case usually is one tilted slightly up from the horizontal. In a number of actual cases where it has been tried by the author and others, changing the plane of the V from vertical to approximately horizontal resulted in improved signal strength so that the amount of snow was reduced, and often, a persistent ghost was removed.

To make an added adjustment possible, you must have an antenna base or mounting with some type of universal joint. Until such an antenna is manufactured, anyone wishing to experiment with it must build his own. Several devices which could be adapted for experimental mountings are available. Rubber-covered clamps with universal joints, for holding cameras and lights, are sold in photographic supply stores. Mirrors, similarly mounted, are available through radio and television supply distributors, for use in adjust-

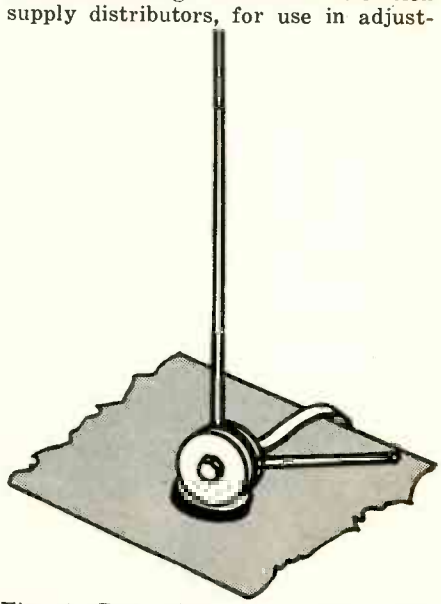


Fig. 1—Best pictures are often obtained with unsymmetrical arrangements.

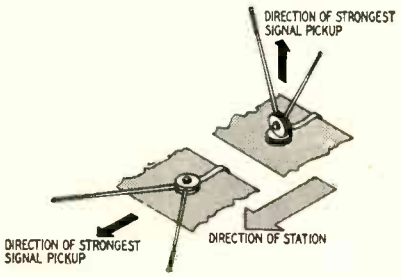


Fig. 2—Horizontal positioning of V.

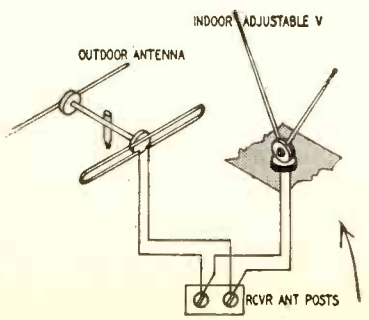


Fig. 3—Layout for eliminating ghosts.

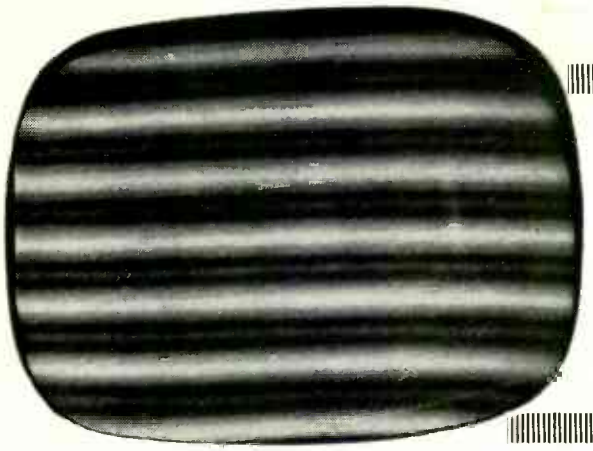


Fig. 3—Screen shows horizontal bars.

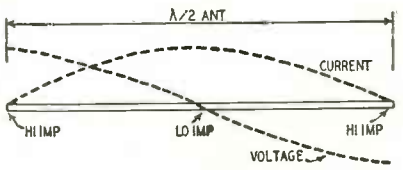


Fig. 4—Antenna impedance distribution.

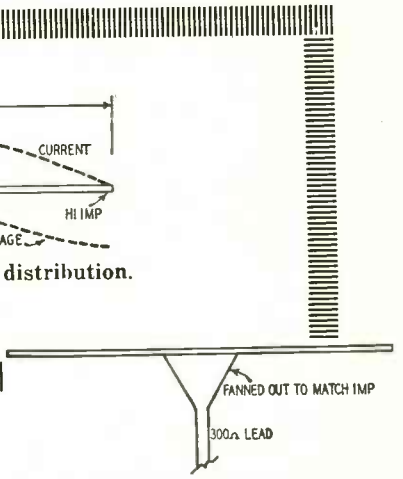


Fig. 5—Obtaining impedance match.

video amplifiers, as well as by improper alignment. It is preferable to have a clear and sharp picture without such repeat lines, which indicate abnormal high-frequency response.

Sound bars

In an RCA 21T176 there are a number of horizontal bars on the screen. (Fig. 3.)

I have tried new tubes and have made other checks but cannot find the trouble.—N. F., Milwaukee, Wis.

You mentioned having checked all tubes, but did not state whether or not you have adjusted the sound traps. If these check all right, the trouble may be caused by a.g.c. overload which causes one of the stages to go into oscillation. The a.g.c. control should be adjusted to see whether or not it makes a difference in the interference. If not, try replacing the crystal detector.

Another cause for this condition could be improper video i.f. alignment. When the alignment is overpeaked, stages may become critical, with possible oscillations. The same holds true for improper peaking coils in the video-amplifier section, as well as for defective component parts.

Capacitor failure

A Hallicrafter model 17825 receiver had excessive brilliancy and I replaced a shorted .01-μf capacitor (C138) in the brightness control circuit. The set worked well for three weeks and the same trouble occurred. I replaced the same capacitor and made extensive voltage and resistance measurements, and checked the brightness control for any intermittent shorts. After another month the same trouble reappeared. Have you any suggestions as to why this capacitor would short out after a short period of time?—J. G., Brooklyn, N. Y.

The fact that the .01-μf capacitor which you replaced to correct the trouble has again become defective does not necessarily indicate a circuit defect. Since the receiver operates well for several weeks before the capacitor becomes defective it may indicate that the replacement capacitors were defective or not of the proper voltage rating. Try another replacement, using a 600-volt rating. It is possible that you have used a 400-volt rating; if so, the capacitor will be short-lived.

Uhf-vhf delta match

I would like to have an explanation of the principle involved in using a delta-match Yagi antenna for u.h.f. or v.h.f. I want to try one of these units and I understand no insulator is needed. —G. C., Saskatchewan, Canada.

In a half-wavelength antenna the voltage is high at each end and therefore the impedance is high. At the center the voltage is zero and therefore the impedance is low. (See Fig. 4). When no insulator is used, the transmission line ends can be fanned out for an increasing impedance. Thus, a perfect match can be obtained by fanning out the line for the proper distance (Fig. 5). This is established when best reception occurs. The principle can be used for either u.h.f. or v.h.f. antennas. Since the match is for a narrow frequency span the system is best adaptable to Yagi antennas.

17BP4A to 21EP4

I have a Westinghouse H658T17 which contains a 17BP4A picture tube. I wish to substitute a 21EP4. Both tubes are identical as to focus coil, deflection angle, etc. Can this be done without change to the circuit or components?—J. J. B., Sumter, S. C.

Since both tubes are identical with respect to deflection angle, etc., you could make the change without altering the circuits or additional components. Make sure the vertical and horizontal output tubes are operating at peak efficiency, and that the high-voltage system is also giving maximum output. If these components are not giving peak performance, you may not get sufficient size or brilliancy for the larger tube.

Transmitted linearity

When I set the linearity controls to get a perfect circle for one local station, I find the picture has bad left-hand stretch on another channel. I can't understand how the receiver would change linearity for a different station, and I assume the trouble is in the transmitted pattern of one station. Am I right in this assumption? W. O., Chicago, Ill.

There is often considerable variation in station-pattern linearity for the sev-in stations in any one locality. Linearity at the station (as in the receiver) must be adjusted carefully or the transmitted picture will be distorted. For most accurate results check the linearity adjustments on your receiver with a cross-bar generator. END

ON THE COVER: ANTENNA TESTING METHODS

With the scenic Catskill mountains as a background, engineer Julius Green of Channel Master, Ellenville, N. Y., is seen testing the Ultra-Bow antenna.

The experiment in process consists of measuring the characteristic impedance of the antenna. The girl, Barbara Watson, is recording standing-wave ratios as measured on a Lecher wire and is taking signal generator and voltmeter readings.

The large wooden mast behind them is used for field testing. The tower mounted on the mast can be pivoted in a vertical plane. The tower and mast represent the receiving section of a transmit-receive setup.

At the end of the tower is mounted the antenna to be tested; in this case it is the 2-bay Champion. The antenna can be rotated 360° by a selsyn motor mounted on the tower and can be controlled from a nearby laboratory. The antenna under test is rotated at a speed of 2 r.p.m. while the receiving pattern is automatically recorded. END

TELEVISION . . . it's a cinch

By E. AISBERG

Ninth conversation, first half—Forming the electron image; photoelectric cells

In the land of the microseconds

WILL—I've got news for you, Ken!

KEN—Go ahead!

WILL—This talk about time bases and deflection circuits has got me fed right up to the neck. Can't we change the subject for a while?

KEN—It just happens I was thinking the same thing myself. We should now be able to attack the main principles of television—we've pretty well cleared up the preliminaries. How about starting to learn something on how images are transmitted, as well as received?

WILL—I do know a little about that already. For instance, I've just been reading how a TV studio has to be so brightly lighted that the actors get sunburned and . . .

KEN—That's what you get for picking up back-number magazines! All that was out long ago! Nowadays TV camera tubes are as sensitive as the human eye, so they don't have to burn the skin off the actors with lighting, as they did in the early days. Color TV needs a little more illumination, of course, on account of the optical filters in front of the cameras.

WILL—Then they've been making photoelectric cells more sensitive?

KEN—No, the progress wasn't made in that direction. What they've done is learn to use more of the cells, and for more of the time. Instead of lighting the cells for short instants. . . .

WILL—Huh?

KEN—Remember the mechanical Nipkow disc we talked about a long time ago? And how each small element of the image could reflect its light onto the photocell only for the instant the hole in the disc was directly between the picture element and the tube? If you were to use a system like that for a standard 525-line scan, each of the picture elements would project its light on the cell only about a tenth of a microsecond..

WILL—That means that at 30 frames a second, each element would have a chance to get in front of the camera only about 3 microseconds out of each second. About 3-millionths of the time!

KEN—So you see that a system that could see *all the light* from the picture *all the time* would be much more sensitive—in theory at least.

WILL—Yes, over 300,000 times as sensitive—as many times as 3 microseconds is contained in a second.

KEN—Well, you can't actually get anything like that in practice. But you could get something like 25,000 times more sensitivity.

WILL—That ought to help a little! But how are you going to illuminate every part of your image—and get it picked up by a photocell—continuously?

KEN—Why use one photocell, Will? Why not use millions instead? Then each tiny image element would have half-a-dozen photocells for itself.

WILL—Now you're kidding! That's impossible, of course!

KEN—Nothing impossible about it at all! But before I show you how to use millions of photocells, let's take just one and see how it works. Look at this hookup. When light falls on the photosensitive cathode, it emits electrons. They are attracted by the positive anode, and from there go back to the battery, B1. Meanwhile, the upper plate of capacitor C, connected to the cathode, is charged . . .

WILL—. . . more or less positive, because of the negative electrons the cathode has lost.

KEN—Now, switch S turns 30 times a second, and—for a very short instant—connects the negative terminal of the high-voltage supply to the cathode. What happens?

WILL—Capacitor C's top plate gets back the lost electrons from the negative end of the high-voltage supply (battery B1).

KEN—Exactly! But, as the electrons from the battery neutralize the positive charge on capacitor C's upper plate, a corresponding negative charge is released from the lower plate. These electrons go to the positive pole of the battery through resistor R.

WILL—I see what happens. The current through resistor R is bigger or smaller according to the amount of light that falls on the photocell. And of course it produces a voltage drop across the resistor. So if we connect the control grid of an amplifier tube, as in the layout, its output will vary with the amount of illumination. But haven't you got a pretty heavy positive bias on that grid?

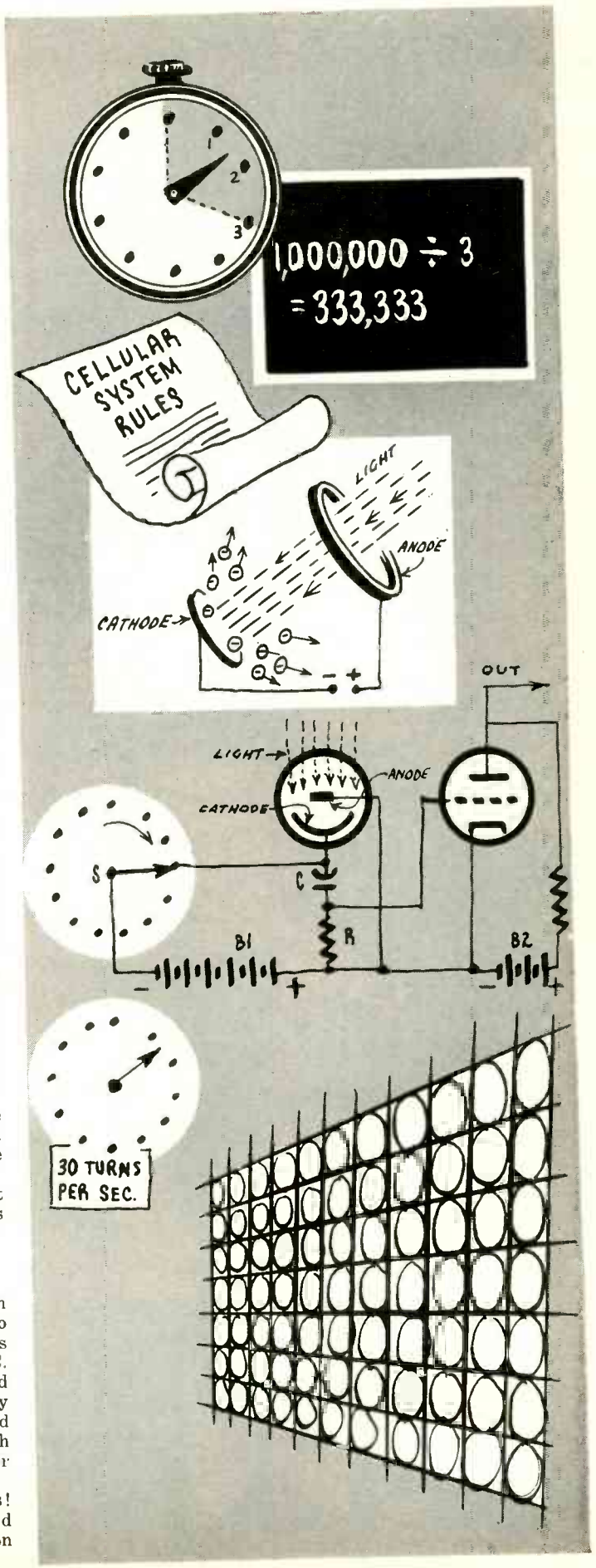
KEN—No. You're looking at the photocell battery. The amplifier is interested only in battery B2, its own supply. Both cathode and grid return are connected to B2's negative terminal. Standard hookup, no?

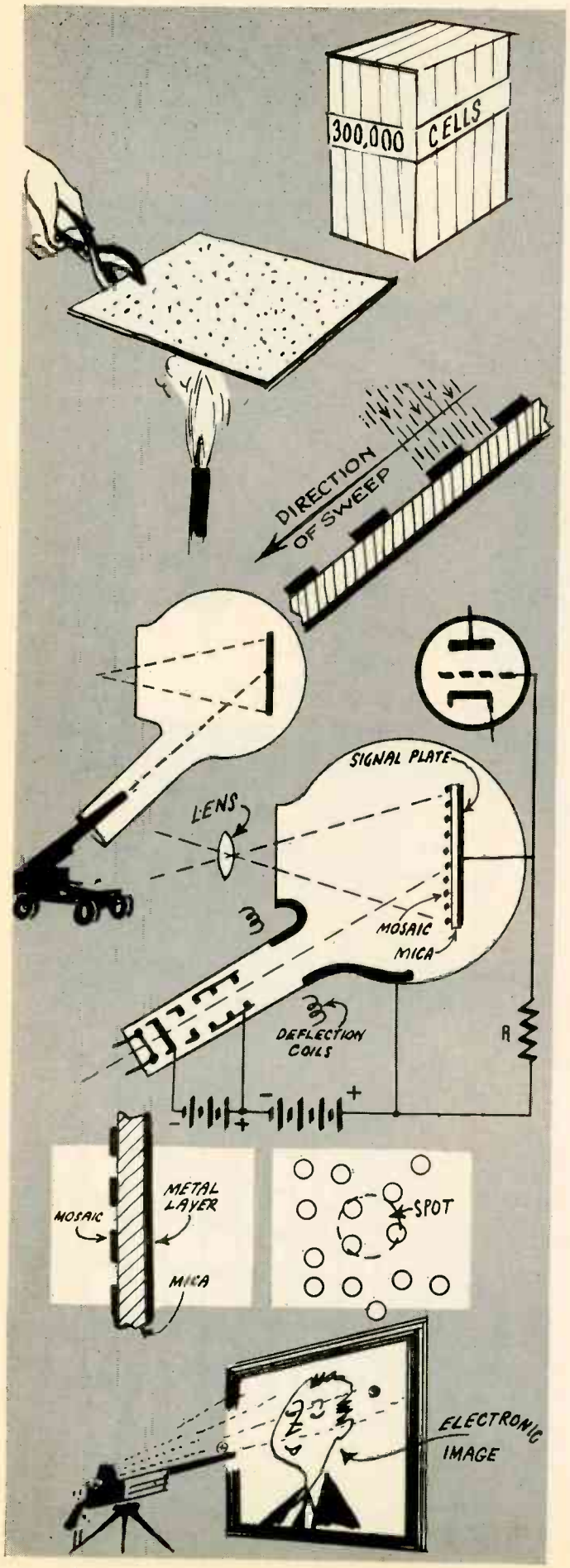
WILL—Sorry. I missed that one. But what I still can't see is how you're going to capture all those image elements with your photocell.

Millions of cells—Impossible!

KEN—Try to imagine a surface completely covered with photocells like this one. Their cathodes are all connected to contacts. The switch passes over all these contacts 30 times a second. Each cathode is also connected to its capacitor C. The lower plates of all these capacitors could be connected together—or you could use a common lower plate, like they show in the diagram of a multiple-section electrolytic—and you would need only one resistor R for all the cells. Each cell now takes its turn putting its voltage on the amplifier grid. Now if we illuminate all these cells together . . .

WILL—. . . your system will work—in theory, that is! You're saying that there'll be a voltage on the amplifier grid—at any given instant—proportional to the light falling on the photocell connected to the switch at that instant.





KEN—Your mental pickup is good today! Now keep in mind that the light is falling on *all* the photocells *all* the time, so the voltages are the results of an *accumulation of charge* for the thirtieth of a second between two discharges.

WILL—But all this is ridiculous! How are you going to assemble your panel of 300,000 photocells? And where are you going to get a switch that will make and break 9,000,000 contacts a second? It can't be done!

Nothing is impossible

KEN—But it is done—on the photosensitive mosaic of the *iconoscope*, which is what I've been leading up to.

WILL—Photosensitive mosaic . . . ?

KEN—Yes. It's a thin layer of silver deposited on a sheet of mica. After the silver is deposited, the sheet is heated. That makes it expand and cracks the silver layer up into millions of little bits, each separated from the others by a gap of insulating mica. Then cesium vapor is deposited on them, making each of these little silver islands a photocell.

WILL—I know about heating paint on metal cabinets to get a crackle finish. But crackle-finished silver is a new one on me. So that's how you get your millions of photocells!

KEN—That's how. Or at least it's how we get the most important part of the cells—the cathodes. And you only need one anode for all of them, so that's no problem.

WILL—But how about the capacitors in the cathode circuits.

KEN—Very easy—just plate a thin layer of metal on the other side of the mica sheet. Then each cathode forms one plate of a capacitor and the metal on the other side of the mica becomes the common lower plate we've been talking about. You understand, of course, that the cathodes don't have to be regular or symmetrical, because there are several of them in the space we've been allotting to one picture element. The capacitance of each of these tiny capacitors is proportional to its size, so the voltage induced on the common capacitor plate is the same for the same amount of light on the picture element, whether it's represented by two or three larger islands or a half-dozen smaller ones.

WILL—Wonderful! And now I begin to see that the switch to contact each of these tubes is going to be the electron beam in a cathode-ray tube.

KEN—I suppose watching me draw this diagram of an iconoscope didn't help you any?

WILL—Well, it *is* a funny shaped thing.

KEN—That shape is highly functional. You have to put the photomosaic where it can be swept by the electron beam and at the same time be exposed to the light from the scene you are televising. One face of the tube has to be flat so that a lens can form an image of the televised scene on the photomosaic. To keep it out of the way of the light, the electron gun is mounted in a cylindrical tube at an angle of about 45° from the mosaic. And the common anode for all the cathodes is a metallic film deposited over part of the inside of the glass.

WILL—It looks as though the beam is focused electrostatically and swept magnetically.

KEN—Doesn't matter. You could do it the opposite way and it would still be an iconoscope. What *is* important is that *all* the cells of the mosaic are *continuously* being illuminated by the rays of light from the corresponding points on the televised scene. That is, the positive charges on each cell—due to loss of electrons as the light strikes it—keep on increasing as the light keeps on jarring more electrons loose.

WILL—And what happens to the electrons?

KEN—They are attracted by the anode. But we're more interested in the positive charges. As they accumulate on the mosaic they form a veritable *electronic image* of whatever you are televising. Then the electron beam sweeps over each cell 30 times a second; replaces the lost electrons and wipes out the image. Of course that releases the negative charges on the other side of the mica dielectric, and produces a current that travels through resistor R and sets up a voltage across it . . .

WILL—. . . which depends on the amount of light on the element of the image the beam is passing over at the instant! Why, the iconoscope is really very simple! (TO BE CONTINUED)

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The new Sprayberry "package" plan includes many big kits of genuine, professional Radio-Television equipment. You perform over 300 demonstrations, experiments and construction projects. You build a powerful 6-tube 2-band radio set, multi-range test meter, signal generator, signal tracer, many other projects. All equipment and lessons are *yours to keep* . . . you have practically everything you need to set up your own profitable Radio-Television service shop.

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All your 10 months of training is IN YOUR HOME in spare hours. Keep on with your present job and income while learning. With each training "package" unit, you receive extra plans and "Business Builder" ideas for spare time Radio-Television jobs. New television stations everywhere, open vast new opportunities for trained Radio-Television Technicians—and those in training. If you expect to be in the armed forces later, there is no better preparation than practical Sprayberry Radio-Television training.

YOU BUILD the Television set and the powerful superhet radio receiver shown above. IN ADDITION to the other test units shown here (many are not shown because of lack of space). All equipment I send you is YOURS TO KEEP.

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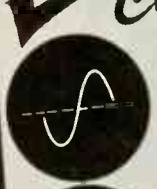
City..... Zone..... State.....

THE MOST *Outstanding* OSCILLOSCOPE IN HEATHKIT HISTORY

NEW MODEL O-9

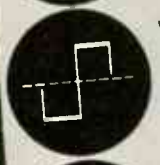
OSCILLOSCOPE KIT

Check THESE FEATURES

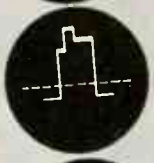


Voltage regulated for rock steady traces—complete freedom from bounce and jitter.

Built-in 60 cycle sweep and phasing control—a necessity for TV service work.



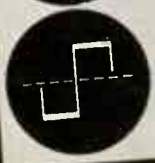
Wide band width down only 6 db at 3mc—reproduces 500 kc square wave and up to 10 mc sine wave.



New production 5UP1 CR tube by RCA gives finest trace available for complex, hard-to-see wave forms.

Acts as peak-to-peak vacuum tube voltmeter—measures directly on calibrated screen—built-in calibrator voltage.

Properly compensated cathode follower vertical input controls trace reproduction at any input level.



Retrace blanking amplifier eliminates confusion and gives clear concise picture of viewed wave form.

New ready formed and laced wiring harness eliminates unsightly and time consuming work of assembly.

MODEL O-9

$59.50

SHIPPING WT. 28 LBS.

Announcing the newest addition to a brilliant series of Heathkit Oscilloscopes, the outstanding new model O-9 instrument. This Oscilloscope features a brand new 5UP1 cathode ray tube for really fine hairline focusing, good intensity and freedom from halation.

NEW FEATURES

Efficient voltage regulation system maintains rock steady trace stabilization. New retrace blanking amplifier circuit—amplifier band width further extended through efficient circuitry. Calibrated 1 volt peak-to-peak reference — wiring simplified by ready laced and formed wiring harness—new phasing control.

GOOD DESIGN

Terminal board for quick access to deflection plates—provisions for Z axis input—astigmatism control—balanced push-pull deflection amplifiers—internal sync on either positive or negative peaks.

VERTICAL AMPLIFIER

High impedance input with 6AB4 cathode follower, twin triode 12AT7 Cascade amplifier, 6C4 phase splitter and 12AT7 push-pull high gain deflection amplifier. Sensitivity .025 volts per inch.

HORIZONTAL AMPLIFIER

Five position input switch for choice of external input—line sweep—line sync—internal sync and external sync. Uses 12AU7 input stage, half as triode phase splitter driving 12AT7 push-pull high gain deflection amplifier. The remaining half of the 12AU7 used as retrace blanking amplifier.

POWER SUPPLY

New heavy duty internally shielded 100 milliampere power transformer. Efficient high voltage filtering system—voltage regulation completely eliminates trace bounce or jitter.

The Heathkit O-9 is the ideal general purpose oscilloscope for educational and industrial use. Radio and TV servicing and any other application requiring the instantaneous reproduction and observation of actual wave forms.

Heathkit LOW CAPACITY PROBE KIT

No. 342

$3.50

SHIP. WT. 1 LB.

Oscilloscope investigation of high frequency, high impedance or broad band width circuits requires the use of a low capacity probe. The Heathkit Low Capacity Probe features a variable capacitor to provide the necessary degree of instrument impedance matching.

Heathkit SCOPE DEMODULATOR PROBE KIT

No. 337-B

$3.50

SHIP. WT. 1 LB.

In applications such as trouble shooting TV, RF, IF and video stages, the frequency ranges encountered require the demodulation of signals before oscilloscope presentation. The Heathkit Demodulator Probe will fulfill this function and readily prove its value as a service accessory.

Heathkit VOLTAGE CALIBRATOR KIT

The Heathkit Voltage Calibrator provides a convenient method of making peak-to-peak voltage measurements with an oscilloscope. Peak-to-peak voltages are read directly on the calibrated panel scales in the range of .01 to 100 volts peak-to-peak. A convenient "signal" position on the panel switch can be used to by-pass the calibrator and apply the signal directly to the scope input.

MODEL VC-2

$11.50

SHIP. WT. 4 LBS.

Heathkit ELECTRONIC SWITCH KIT

The basic function of the Heathkit S-2 Electronic Switch kit is to permit simultaneous oscilloscope observation of two separate traces which can be either separated or super-imposed for individual study. Continuously variable switching rates in three ranges from less than 10 cps to over 2000 cps. Individual gain controls for each input channel and a positioning control.

MODEL S-2

$23.50

SHIP. WT. 11 LBS.

HEATH COMPANY · Benton Harbor 20, Mich.

Heathkit IMPEDANCE BRIDGE KIT

MODEL IB-2

$59.50

SHIPPING WT. 15 LBS.

Features

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

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

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

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

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

Heathkit AUDIO WATTMETER KIT

MODEL AW-1

$29.50

SHIPPING WT. 6 LBS.

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

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

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

Heathkit LABORATORY GENERATOR KIT

MODEL LG-1

$39.50

SHIP. WT. 16 LBS.

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

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

HEATH COMPANY · Benton Harbor 20, Mich.

Heathkit VACUUM TUBE VOLTMETER KIT

MODEL V-6

$24.50

SHIPPING WT. 6 LBS.

Features

- New 1½ volt full scale low range
- 1,500 volt upper limit DC range
- Increased accuracy through 50% greater scale coverage
- High impedance 11 megohm input
- Center scale zero adjust
- Polarity reversal switch
- 1% precision resistors
- Clearly marked db scales

The beautiful Heathkit Model V-6 VTVM, the world's largest selling kit instrument, now offers many outstanding new features in addition to retaining all of the refinements developed and proven in the production of over 100,000 VTVM's. This is the basic measuring instrument for every branch of electronics. Easily meets all requirements for accuracy, stability, sensitivity, convenience of ranges, meter readability, and modern styling. It will accurately measure DC voltages, AC voltages, offers tremendous ohmmeter range coverage, and a complete db scale for a total of 35 meter ranges.

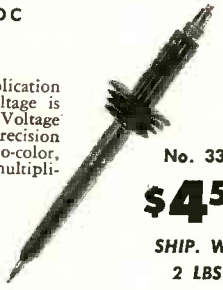
New 1½ volt full scale low range provides well over 2¼" of scale length per volt. Upper DC scale limit 1,500 volts. DC ranges 0-1.5, 5, 15, 50, 150, 500, 1,500 volts full scale. AC ranges 0-1.5, 5, 15, 50, 150, 500, 1,500 (1,000 volts maximum). Seven ohmmeter ranges from .1 ohm to 1,000 megohms. For added convenience a DC polarity reversing switch and a center scale zero adjustment for FM alignment.

The smartly styled, compact, sturdy, formed aluminum cabinet is finished in an attractive gray crackle exterior. The beautiful two-color, durable, infra-red, baked enamel panel further adds to the over-all professional appearance.

Top quality components used throughout. 1% precision resistors — silver contact range and selector switches — selenium rectifier — transformer operated power supply. Individual calibration on both AC and DC for maximum accuracy. DB scale printed in red for easy identification, all other scales a sharp, crisp black for easy reading. A variety of accessory probes shown on this page still add further to over-all instrument usefulness.

Heathkit 30,000 VOLT DC PROBE KIT

For TV service work or any similar application where the measurement of high DC voltage is required, the Heathkit Model 336 High Voltage Probe Kit will prove invaluable. A precision multiplier resistor mounted inside the two-color, sleek, plastic probe body provides a multiplication factor of 100 on the DC ranges of the Heathkit 11 megohm VTVM. The entire kit includes precision resistor, two-color plastic probe, tip connector spring, test lead, phone plug panel connector, and complete assembly instructions.



No. 336

$4.50

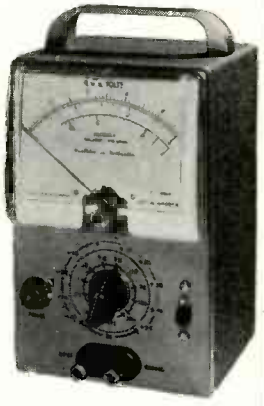
SHIP. WT. 2 LBS.

Heathkit AC VACUUM TUBE VOLTMETER KIT

MODEL AV-2

$29.50

SHIPPING WT. 5 LBS.



The new Heathkit AC VTVM that makes possible those sensitive AC measurements required by laboratories, audio enthusiasts, and experimenters. Especially useful for hum investigation, sensitive null detection, phono pick-up output measurements, making frequency response runs, gain measurements, ripple voltage checks, etc. Low level measurements are easy to make because of the complete voltage coverage of the instrument and the one knob operation.

The large 200 microampere Simpson meter has clearly marked and easy to read meter scales. Ten voltage ranges covering from .01 rms full scale to 300 volts rms full scale, with frequency response ± 1 db from 20 cycles to 50,000 cycles. Instrument input impedance 1 megohm, ten db ranges from −52 db to +52 db. For stability and good linearity characteristics the meter bridge circuit features 4 germanium diodes. Attractive instrument styling, a companion piece for the popular Heathkit VTVM and the new AW-1 Audio Wattmeter.

No. 338-B

$5.50

SHIP. WT. 2 LBS.

Heathkit PEAK-TO-PEAK PROBE KIT

Now read peak-to-peak voltages on the DC scales of the Heathkit 11 megohm VTVM. Readings can be directly made from the VTVM scale without involved calculations. Measurements over the frequency range of 5 kc to 5 mc. Use this probe to extend the usefulness of your VTVM in radio and TV service work. The Peak-to-Peak Probe Kit features the new polished aluminum housing with two-color polystyrene probe ends. Detailed assembly sheet including instructions for probe operation.

Heathkit RF PROBE KIT

The Heathkit RF Probe used in conjunction with any 11 megohm VTVM will permit RF measurements up to 250 mc, ± 10%. A useful, convenient accessory for those occasions when RF measurements are desired. The RF probe body is housed in the new, smartly-styled polished aluminum probe body featuring two-color polystyrene probe ends and a low capacity flexible shielded test lead. The kit is complete with all necessary material and a detailed assembly sheet as well as instructions for probe operation.

No. 309-B

$3.50

SHIP. WT. 2 LBS.

HEATH COMPANY • Benton Harbor 20, Mich.

CHECK THESE *Features*

- 20,000 ohms per volt DC sensitivity, 5,000 ohms per volt on AC
- Polarity reversal switch
- 1% precision multiplier resistors
- 50 microampere 4½" Simpson meter
- Meter ranges for service convenience
- New resistor ring-switch assembly
- Total of 35 meter ranges
- New Modern cabinet styling

NEW *Heathkit*

MULTIMETER KIT

MODEL MM-1

$26.50

SHIPPING WT. 6 LBS.

The most important Heathkit announcement of the year, the new 20,000 ohms per volt Heathkit Multimeter, Model MM-1. The universal service measuring instrument, accurate, sensitive, portable, and completely independent of AC line supply. Particularly designed for service use incorporating many desirable features for the convenience of the service man. Full 20,000 ohms per volt sensitivity on DC ranges — 5,000 ohms per volt sensitivity on AC —polarity reversal switch, no bothersome transferring of test leads — 1% precision multiplier resistors — large 4½" recessed non-glare 50 microampre Simpson meter — conveniently slanted control panel — recessed safety type banana jacks — standard universally available batteries — rugged practical sized cabinet with plastic carrying handle, and a total of 35 calibrated meter ranges.

RANGES

Voltage ranges selected entirely for service convenience. For example 1½ volt full scale low range for measuring portable radio filament voltages, bias voltages, etc., 150 volt full scale range for AC-DC service work, 500 volt full scale range for conventional transformer operated power supply systems. Complete voltage ranges AC and DC, 0-1.5—5—50—150—500—1,500—5,000 volts. DC current ranges, 0-150 microamperes—15 milliamperes—150 milliamperes—500 milliamperes—15 amperes. Resistance measurements from .2 ohms to 20 megohms x 1 x 1,000 x 10,000. DB coverage from —10 db to +65 db.

CONSTRUCTION

Entirely new design permits assembly, mounting and wiring of precision resistors on a ring-switch assembly unit. The major portion of instrument wiring is completed before mounting the ring-switch assembly to the panel. No calibration procedure is required, all precision resistors readily accessible in event of replacement.

CABINET

Strikingly modern cabinet styling featuring two piece construction, durable black Bakelite cabinet, with easy to read panel designations. Cabinet size 5½" wide x 4" deep x 7½" high. Good cabinet physical stability when operated in vertical position.

The Heathkit MM-1 represents a terrific instrument value for a high quality 20,000 ohms per volt unit using all 1% deposited carbon type precision resistors. Here is quality, performance, functional design, and attractive appearance, all combined in one low priced package.

Heathkit

BATTERY TESTER KIT

MODEL BT-1

$8.50

SHIP. WT. 2 LBS.

The 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. Operation is extremely simple and merely requires that the test 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, accurate meter movement, and a three deck wire-wound control, all mounted in a portable rugged plastic cabinet. Checks portable radio batteries, hearing aid batteries, lantern batteries, etc.

Heathkit

HANDITESTER KIT

MODEL M-1

$14.50

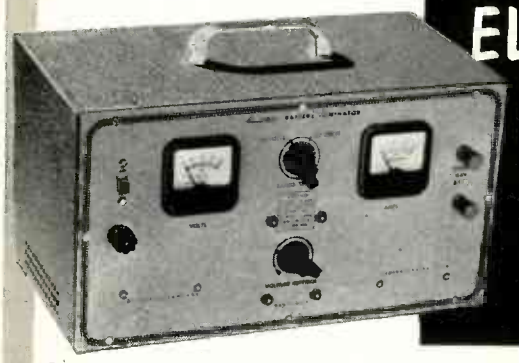
SHIPPING WT. 3 LBS.

The Heathkit Model M-1 Handitester readily fulfills major requirements for a compact, portable volt ohm milliammeter. Despite its compact size, the Handitester is packed with every desirable feature required in an instrument of this type. AC or DC voltage ranges full scale, 0-10—30—300—1,000—5,000 volts. Two ohmmeter ranges, 0-3,000 and 0-300,000. Two DC current measurement ranges, 0-10 milliamperes and 0-100 milliamperes. The instrument uses a Simpson 400 microampere meter movement, which is shunted with resistors to provide a uniform 1 milliampere load on both AC and DC ranges. Special type, easily accessible, battery mounting bracket — 1% deposited carbon type precision resistors — hearing aid type ohms adjust control. The Handitester is easily assembled from complete instructions and pictorial diagrams. Necessary test leads are included in the price of this popular kit.

HEATH COMPANY · Benton Harbor 20, Mich.

New *Heathkit* 12 Volt

BATTERY ELIMINATOR KIT



MODEL BE-4

$31.50

SHIPPING WT. 18 LBS.

CHECK THESE *Features*

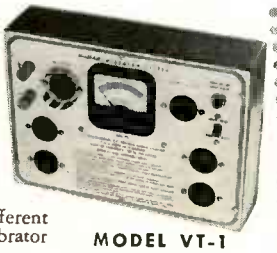
- Either 6 or 12 volt operation
- Continuously variable voltage output
- Constant ammeter and voltmeter monitoring
- Automatic overload relay — self-resetting
- Two 10,000 mf condensers
- New 18 disc split type heavy duty rectifier unit
- Fuse protection

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

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

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

Heathkit VIBRATOR TESTER KIT



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

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

MODEL VT-1

$14.50

SHIPPING WT. 6 LBS.

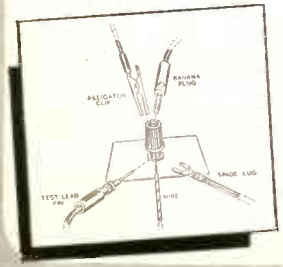
NEW *Heathkit* VARIABLE VOLTAGE ISOLATION TRANSFORMER KIT

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

MODEL IT-1

$16.50

SHIP. WT. 9 LBS.



Heathkit BINDING POST

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

Heathkit TECHNICAL APPLICATION BULLETINS

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

HEATH COMPANY • Benton Harbor 20, Mich.

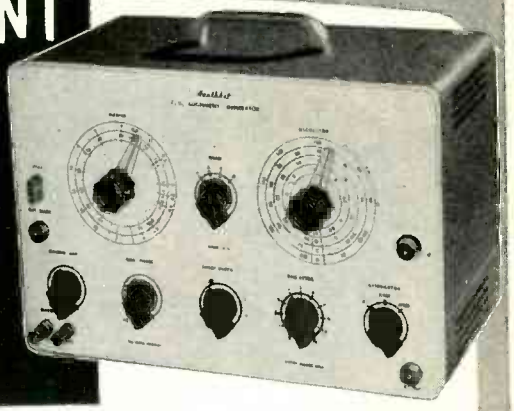
NEW *Heathkit*

TV ALIGNMENT GENERATOR KIT

MODEL TS-3

$44.50

SHIPPING WEIGHT 18 POUNDS



CHECK THESE *Features*

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

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

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

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

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

NEW *Heathkit*

SIGNAL GENERATOR KIT

MODEL SG-8

$19.50

SHIPPING WEIGHT 8 POUNDS

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

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

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

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

NEW *Heathkit*

BAR GENERATOR KIT

MODEL BG-1

$14.50

SHIPPING WEIGHT, 6 POUNDS

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

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

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

HEATH COMPANY • Benton Harbor 20, Mich.

NEW *Heathkit* TUBE CHECKER KIT

MODEL TC-2

$29.50

SHIP. WT. 12 LBS.

CHECK THESE NEW *Features*

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

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

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

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

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

New HEATHKIT PORTABLE TUBE CHECKER KIT

MODEL TC-2P

$34.50

SHIP. WT. 14 LBS.

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

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

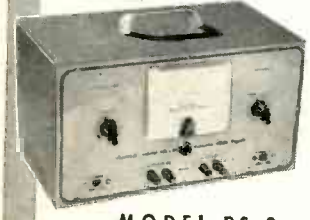
No. 355
Ship. Wt. 1 Lb.

$4.50

Heathkit TV PICTURE TUBE TEST ADAPTER

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

Heathkit POWER SUPPLY KIT



MODEL PS-2

$33.50

SHIPPING WT. 17 LBS.

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

LABORATORY AND SERVICE SHOP BOOKLETS

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

HEATH COMPANY • Benton Harbor 20, Mich.

CHECK THESE *Features*

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

Heathkit VISUAL-AURAL SIGNAL TRACER KIT

MODEL T-3

$23.50

SHIPPING WEIGHT 10 POUNDS

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

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

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

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

Heathkit DECADE RESISTANCE KIT

MODEL DR-1

$19.50

SHIP. WT. 4 LBS.

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

Heathkit DECADE CONDENSER KIT

MODEL DC-1

$16.50

SHIP WT 4 LBS.

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

Heathkit RESISTANCE SUBSTITUTION BOX KIT

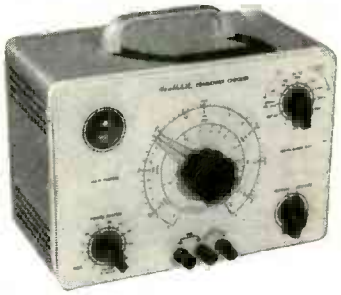
MODEL RS-1

$5.50

SHIP. WT. 2 LBS.

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

Heathkit CONDENSER CHECKER KIT



MODEL C-3

$19.50

SHIPPING WT. 8 POUNDS

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

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

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

HEATH COMPANY • Benton Harbor 20, Mich.

Heathkit AMATEUR TRANSMITTER KIT

MODEL AT-1

$29.50

SHIPPING WEIGHT 16 POUNDS

CHECK THESE NEW Features

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

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

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

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

NEW Heathkit ANTENNA COUPLER KIT

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

MODEL AC-1

$14.50 SHIP. WT. 3 LBS.

Heathkit ANTENNA IMPEDANCE METER

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

$14.50 SHIP. WT. 3 LBS.

MODEL AM-1

Heathkit COMMUNICATIONS RECEIVER KIT

MODEL AR-2

$25.50 SHIP. WT. 12 LBS.

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

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

RECEIVER CABINET

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

IMPROVED Heathkit GRID DIP METER KIT

$19.50 SHIP. WT. 4 LBS.

MODEL GD-1B

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

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

HEATH COMPANY · Benton Harbor 20, Mich.

CHECK THESE *Features*

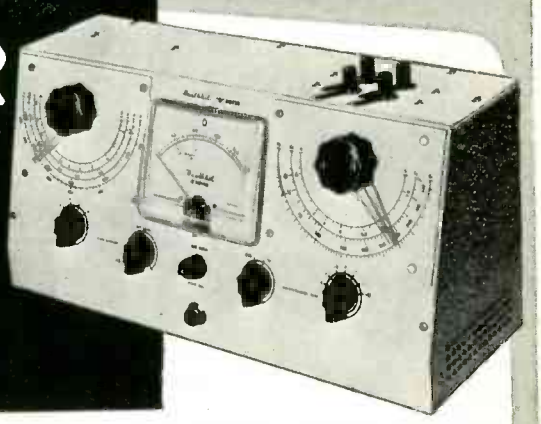
- First popular priced Q Meter
- Reads Q directly on calibrated scale
- Oscillator supplies RF frequencies of 150 kc to 18 mc
- Calibrate capacitor with range of 40 mmf to 450 mmf with vernier of ± 3 mmf
- Measures Q of condensers, RF resistance, and distributed capacity of coils
- Many applications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

Heathkit "Q" METER KIT

MODEL QM-1

$44.50

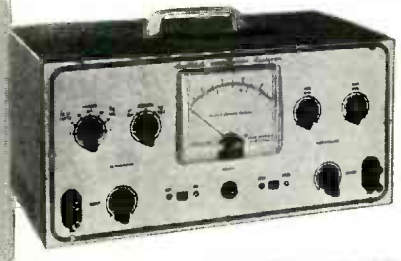
SHIPPING WT. 14 POUNDS



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

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

Heathkit INTERMODULATION ANALYZER KIT



MODEL IM-1

$39.50

SHIPPING WT. 17 POUNDS

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

Heathkit AUDIO GENERATOR KIT

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

MODEL AG-8

$29.50

SHIP. WT. 11 LBS.

Heathkit AUDIO OSCILLATOR KIT

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

MODEL AO-1

$24.50

SHIP. WT. 11 LBS.

Heathkit AUDIO FREQUENCY METER KIT

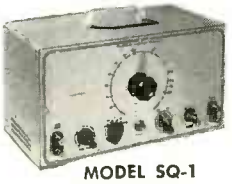
MODEL AF-1

$34.50

SHIP. WT. 12 LBS.

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

Heathkit SQUARE WAVE GENERATOR KIT



MODEL SQ-1

$29.50

SHIP. WT. 12 LBS.

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

HEATH COMPANY · Benton Harbor 20, Mich.

Heathkit
WILLIAMSON TYPE
AMPLIFIER KIT
MODEL W-2

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

$69.50

PRICES OF COMBINATIONS

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

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

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

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

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

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

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

NEW *Heathkit* 20 WATT
High Fidelity AMPLIFIER KIT
MODEL A-9A

$35.50

SHIP. WT. 18 LBS.

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

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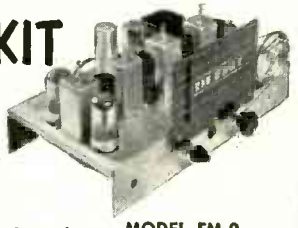

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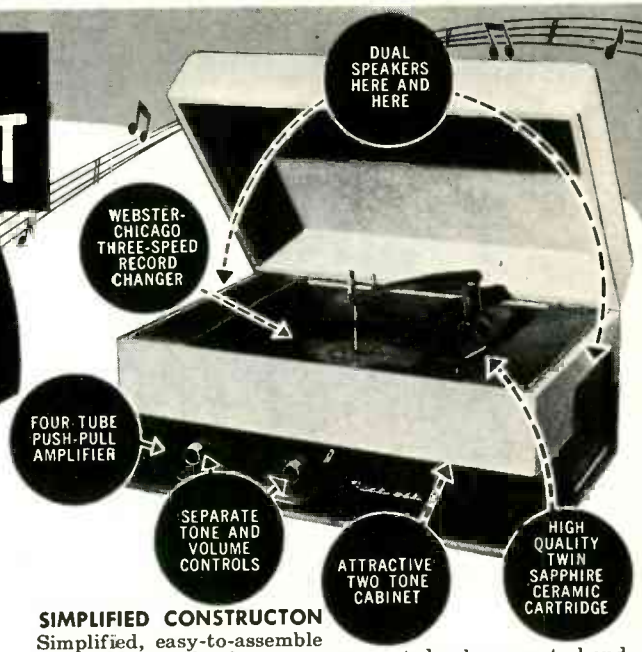

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Transistor Code Practice Oscillator

By A. L. CLELAND, K2ADS*

Front view of the miniature transistorized code-practice and a.f. oscillator.

THE point-contact transistor is a natural for a code-practice oscillator. It requires no warmup time and it can deliver enough output to drive a speaker or several headsets on a fraction of the power input required by a vacuum tube. Its circuitry is much simpler and more compact.

The fact that a transistor has no filament to heat up before the circuit can operate is a decided advantage in a code-practice oscillator because no power is consumed when the key is open, and the circuit starts oscillating the instant the key is closed. The saving in filament power greatly increases the efficiency of the circuit.

By taking advantage of the characteristics of the 2N32 point-contact transistor we can even eliminate entirely some of the usual oscillator-circuit components. This simplifies the layout, and the fact that the point-contact transistor operates on smaller B voltages and currents than a vacuum tube means that the remaining components can have very small voltage and power ratings. This reduces size and cost, and is a big step toward miniaturization. All these favorable factors were utilized in the design and construction of the experimental audio oscillator described here.

Built-in feedback

The effectiveness of the point-contact transistor as an oscillator is due partly to its built-in feedback circuit. As shown in Fig. 1 the collector and the emitter have a common coupling impedance (R_b) in the base lead which feeds a part of the output back into the input circuit in the correct phase for oscillation. Only a small additional impedance is needed in the base arm to overcome the effects of the external components in the emitter and collector circuits.

(Emitter and collector currents flow in opposite directions in the base lead. Collector current I_c is larger than emitter current I_e in point-current transistors, so the resulting base current I_b is the difference in the two currents flowing in the same direction as the collector current. I_b flows through R_b to produce a voltage at point A that is in phase with the emitter signal. Thus we have the positive feedback required for oscillation.)

The schematic of the oscillator is shown in Fig. 2. A 2N32 point-contact transistor is connected in a relaxation oscillator circuit. The output waveform is a modified pulse having a pleasing tone quality. (A sine-wave oscillator was tried, but gave much less output than that obtained from the relaxation-oscillator circuit.)

The output-transformer primary is the external base-circuit impedance which provides the additional feedback needed to sustain oscillation. The oscillator is keyed by opening and closing the 22.5-volt battery circuit. When the key is open there is no current drain and no power is consumed. This eliminates the need for an on-off switch. The current drain on the battery is determined by the external resistance in the emitter circuit; with the values shown this drain should be less than 5 ma, and in normal use even a hearing-aid battery should last approximately 6 months.

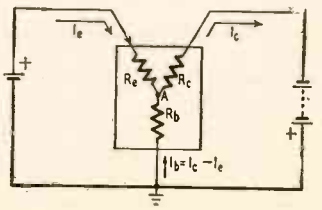


Fig. 1—Diagram showing current flow in equivalent circuit of a transistor.

The external resistance in the emitter circuit affects not only the collector current but the oscillator frequency as well. Reducing the value of this resistance *increases* the collector current and *decreases* the frequency. In this

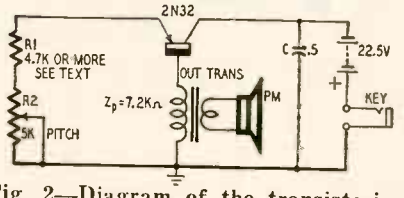


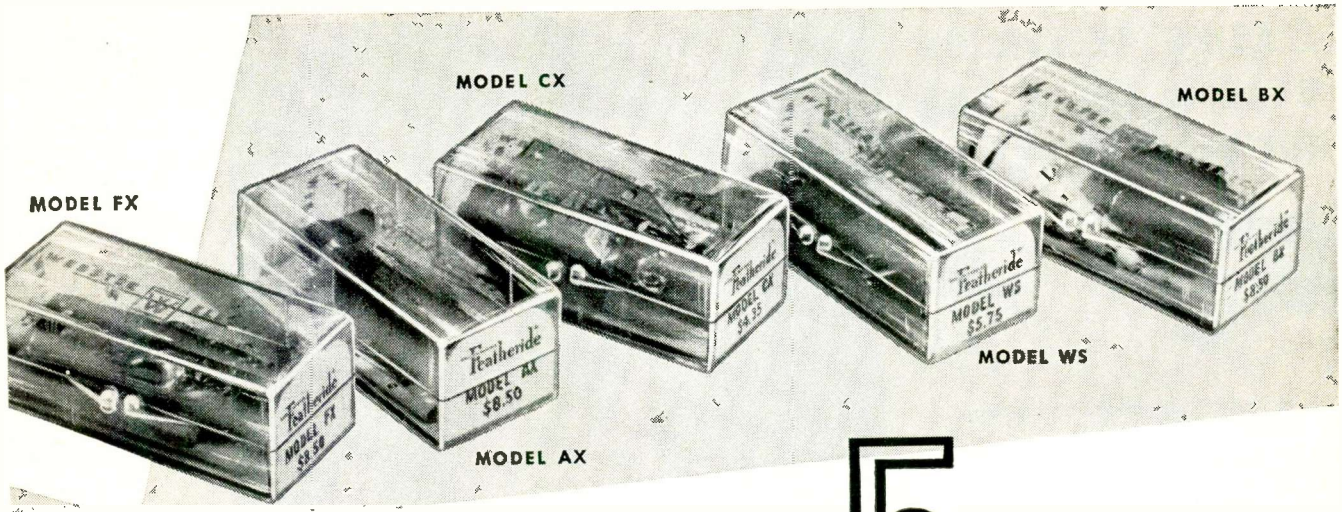
Fig. 2—Diagram of the transistorized code or experimental a.f. oscillator.

circuit R1 (which should not be less than 4,700 ohms) limits the collector current to a value which will not damage the transistor; R2 controls the frequency of oscillation.

The only critical values in this circuit are the resistor R1 and the battery voltage. Almost any output transformer designed to couple a pentode or beam-power tube to a speaker voice coil will do. The speaker itself can be any size. The voltage rating of capacitor C is not important so long as it is rated for at least 22.5 volts. The parts used in this oscillator were chosen for their small physical size.

The fairly wide variation in the internal characteristics of transistors of the same type may call for some experimenting with R1 to obtain the de-

* Tube Department, Radio Corporation of America, Harrison, N. J.



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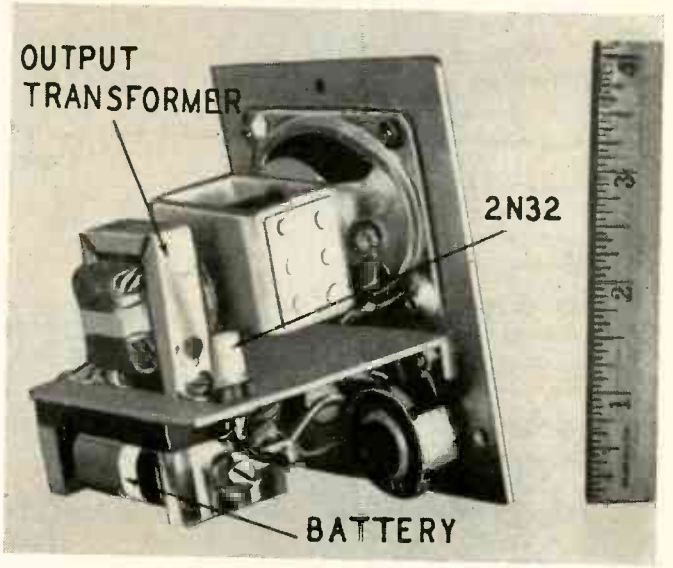
Under side of the novel code oscillator.



Rear view of the transistor oscillator.

sired frequency range, but in no case should R1 have a value less than 4,700 ohms. *Do not allow the circuit to oscillate below 200 cycles*, or the transistor may be damaged by excessive collector current.

Construction hints

The writer has access to complete shop facilities; therefore, the mechanical construction of the unit illustrated may seem quite elaborate to the average experimenter. However, almost any housing and component layout can be used, and there are no shielding problems. Lead lengths are not critical.

The battery mount is probably the biggest mechanical problem. A fairly simple and easily constructed mount for an RCA VS084 or similar battery is shown in Fig. 3. Screw a pair of ½-inch angle brackets to a rectangular base of bakelite or similar insulating material. Recess the mounting holes in the bottom of the base so that the heads of the screws cannot short against the metal cabinet. Soldering lugs under the nuts provide good electrical contact. Solder a 6-32 brass nut over the inner face of the hole in the upright of each bracket so the two 6-32 contact screws are parallel to the base and in line. File the tip of each screw to a 60° point to fit the small hole in the terminal of the battery. Adjust the screws to hold the battery firmly between them and tighten the lock-nuts on the outsides of the brackets to keep the screws from loosening. This mount provides adequate mechanical support for the battery and good electrical contact to its terminals. When wiring, watch the transistor terminals carefully. Hooking a transistor up wrong will ruin it as quick as will putting B voltage across a tube filament; and transistors are more expensive than most tubes. Of the three leads coming out of the transistor's base, the collector is the one most widely sepa-

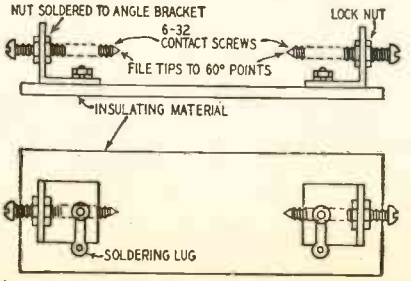


Fig. 3—Details of the battery mount.

rated from the other two. The base is the next one, and emitter the third. So the rule is that the collector and emitter are the outside leads, and that the base is nearer the emitter than the collector.

Alternate circuit

The size of the speaker and output transformer dictate to a large extent the physical size of the oscillator. For

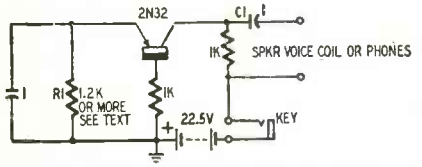


Fig. 4—The alternate circuit diagram.

those who may wish to miniaturize the oscillator even more, the circuit shown in Fig. 4 eliminates these two large components. It has the advantage of reducing cost as well as size, but these advantages are obtained at the expense of power output.

In the modified circuit a 1,000-ohm resistor replaces the primary of the output transformer as the external feedback impedance that keeps the circuit oscillating. Output is taken from the collector through C1. This gives a very poor impedance match because almost any headset or speaker which may be used will have relatively low internal impedance compared with the internal impedance of the collector. This poor match accounts for the comparatively low power output because maximum power output is obtained only when the source and load impedances are matched. This circuit is also affected more by the variations among transistors than is the circuit of Fig 2, and considerable experimenting may be required to obtain the desired results. Vary the value of R1 for the desired tone and the best operating characteristics.

The unit in Fig. 2 and the photographs lends itself quite readily to group or class practice, as well as to private or mobile requirements, and has sufficient power output to be used with a class of 15 to 20 persons. Its self-contained power supply gives it the advantage of portability, and its use is not limited to locations where power lines are available. Not only is this oscillator useful to anyone interested in amateur radio, but it affords an excellent opportunity for one to become familiar with transistors and their associated circuitry.

The author wishes to acknowledge the advice of R. M. Cohen and R. E. Kleppinger on the electrical design of the oscillator and the advice of Ed Milavec and Don Beaulieu on the mechanical design.

END

Materials for code oscillator

Miscellaneous: 1—2N32 transistor; 1—4,700-ohm resistor, ½ watt; 1—5,000-ohm potentiometer; 1—0.5-µf paper capacitor; 1—miniature output transformer 7,200-ohm primary (approximate), secondary to match speaker voice coil; 1—2 x 3-inch PM speaker; 1—22.5-volt hearing-aid battery, RCA VS084 or equivalent; chassis, cabinet, hookup wire, and hardware.

TRANSISTORIZED WRIST-RADIO

The transistor wrist-watch receiver is a regenerative, capacitance-tuned set.

TECHNICAL details on the transistorized wrist radio designed by Lt. Paul Cooper and Joseph O'Brien at the Signal Corps Engineering Laboratories, Fort Monmouth, N. J., have been released by the Signal Corps. The radio was built to demonstrate the feasibility of constructing a small radio receiver with transistors. This printed-circuit model, was fabricated by Harry French of the laboratory. The reduced power requirements of transistors as compared to vacuum tubes made it possible to use a very small battery which is included in the wrist case.

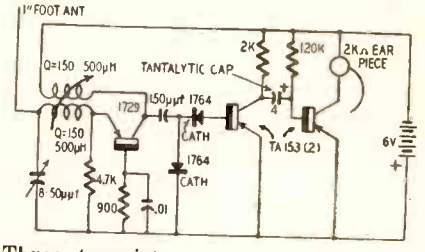
The receiver (see diagram and photo) uses three transistors; one as a regenerative r.f. stage and two as audio amplifiers. A point-contact transistor (type 1729) is used in the regenerative stage. Regeneration is controlled by varying the coupling between the two coils. A miniature capacitor is used for tuning. The audio is amplified by two p-n-p junction transistors (type TA-153). A bead diode (type 1764) is used as a detector and another one is used as a d.c. return. (Information on the exact commercial equivalents of the transistors and diodes was not available but we understand that the 1729 is similar to the 2N25, the TA-153 is similar to the 2N34, and the diodes (1764's) are roughly equivalent to 1N84's—*Editor*)

The power supply is a 6.5-volt battery (½ x ⅝ inch) consisting of five 1.3-volt RM-412 mercury cells. Battery drain is about 20 milliwatts and battery life about 10 hours. Although in strong-signal areas no antenna is needed, usually a 1-foot wire should be used. The 2,000-ohm earphone is a small Telex hearing-aid type. The transistors can be replaced without making any circuit adjustments.

The receiver tunes from 1000 to 1600 kc; it has sharp selectivity, and a sensitivity of 50 microvolts. A number of New York stations (35 miles from Fort Monmouth) can be heard quite satisfactorily. When the receiver is in the vicinity of radiators, such as telephones, the reception is improved to the extent that signals from the set can be heard 30 feet from the earphone.

In the evolution of the receiver, it was found that with a 60-foot outside wire antenna, only one regenerative stage was needed to hear New York City at Belmar, N. J., 45 miles from New York. With the addition of a single audio stage and an output transformer, a loudspeaker could be used. Two stages of audio were needed to compensate for the elimination of the antenna. In metropolitan areas the coils alone will pick up sufficient signal. In the wrist version, the antenna can be built into the strap.

When the receiver is held near the body both the tuning and regeneration are affected by body capacitance. The regeneration should be checked for each tuning adjustment. Regeneration can be more easily controlled electronically than by moving a coil. One method is to insert a small 2,000-ohm potentiometer in series with the collector coil. Another is to use a trimmer capacitor for feedback from collector to emitter. In this case, the collector coil can be replaced with a resistor.



Three transistors are used in the set.

The selection of a power source was primarily determined by the point-contact transistor which operated best with 6 volts. Junction transistors, however, can be satisfactorily operated from a 1½-volt source. With minor modifications, the power requirements can be reduced by a factor of 2.5; and by replacing the point-contact transistor in the regenerative stage with a junction type the requirements can be reduced considerably more. END

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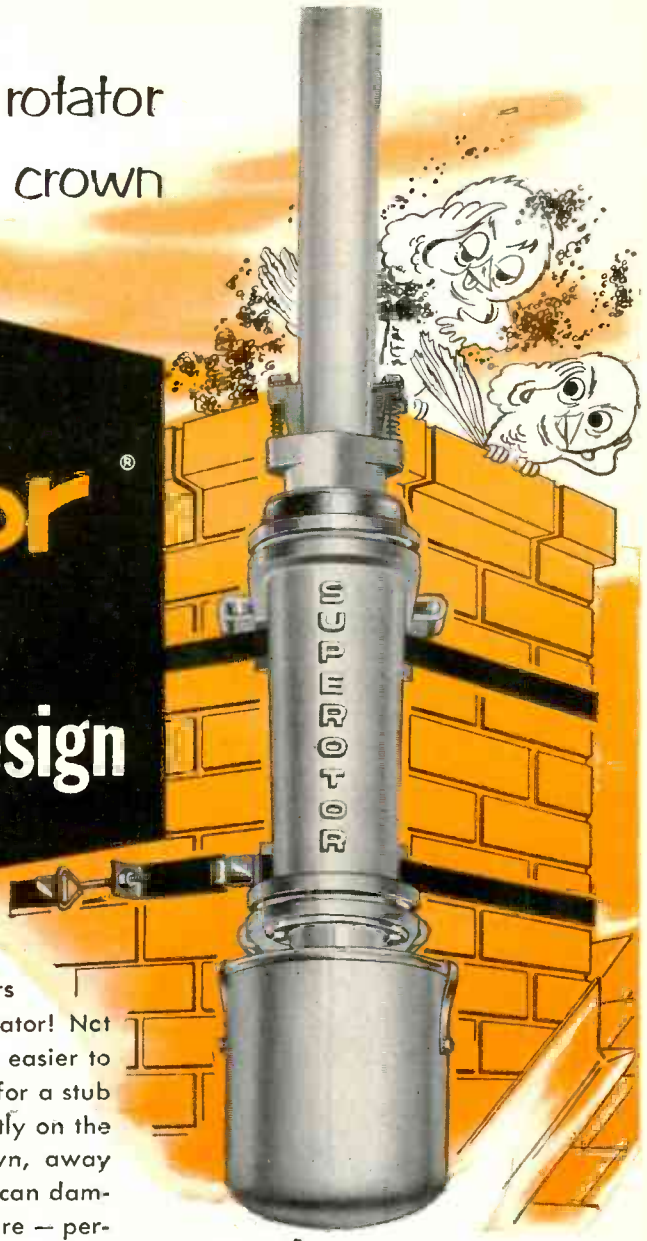

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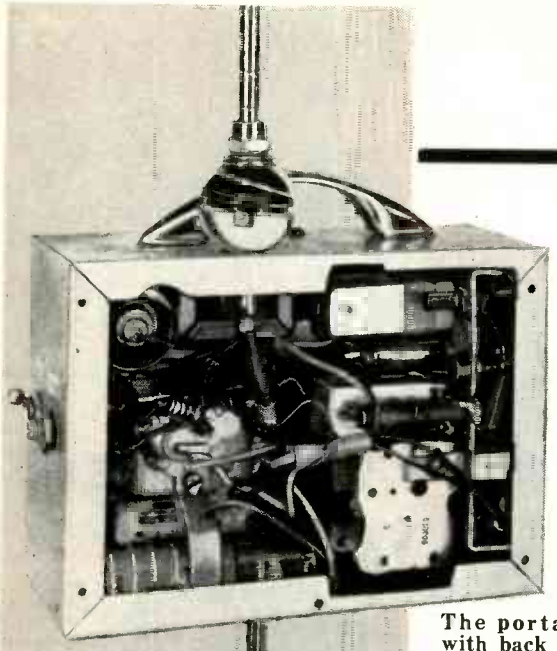
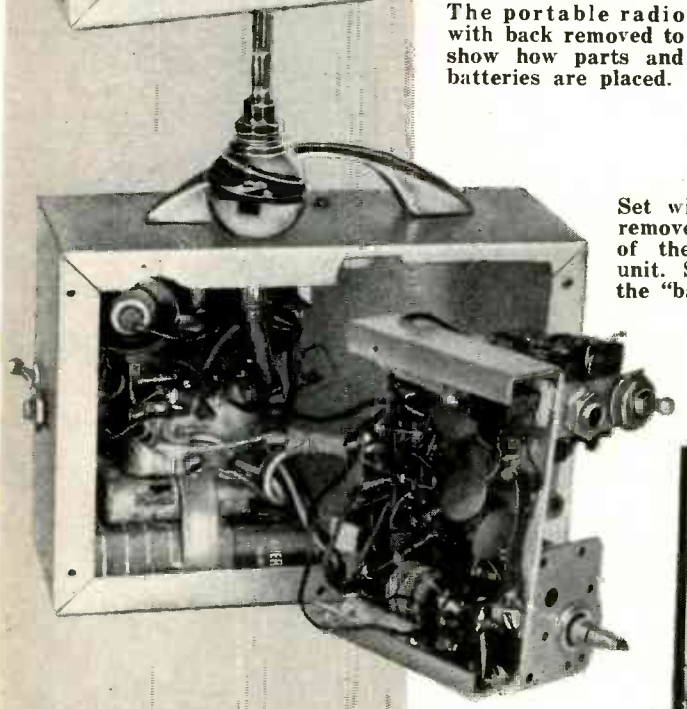
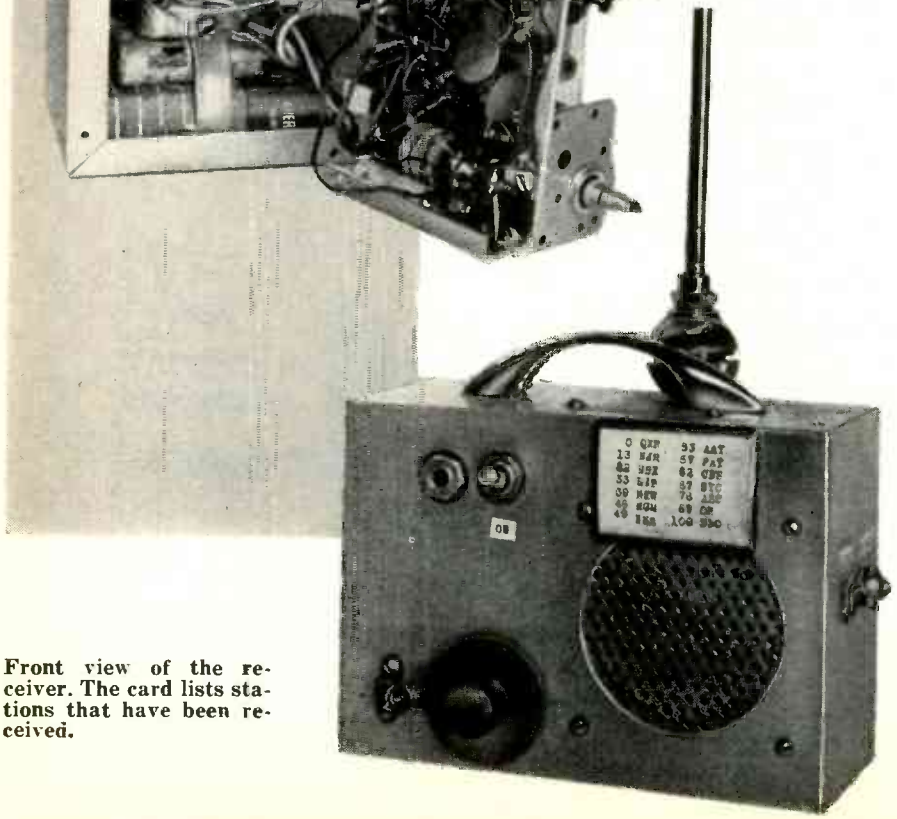


The portable radio with back removed to show how parts and batteries are placed.



Set with the subchassis removed, giving a view of the wiring of that unit. Switch at side is the "battery-saver."



Front view of the receiver. The card lists stations that have been received.

WHEN anybody mentions "portable radio," most of us think immediately of the entertainment it can provide. The set can go with us on picnics, vacation trips, and boat rides. We can enjoy ball games, national events and all our favorite programs while we work, play, and travel. But there is a serious side to this matter. In these days of H-bombs and supersonic jets, a portable radio might mean the difference between life and death. If that terrible day should ever come when air-raid sirens wail for real, the Conelrad system will go into effect. If worst comes to worst, if power goes out and wires down, civil defense messages and other essential communications will continue. In such an emergency, a portable radio can become a very important item.

The design of a radio for portable and emergency use is largely a compromise. Due to limitations of space, weight, and power supply, we cannot include all desirable features. At the outset we must decide: do we prefer to have high gain, loudspeaker volume, selectivity, low drain, compactness, simple tuning, high fidelity, low cost, etc. Which of these will we simply have to do without?

The standard portable circuit, with its four or more tubes, gives excellent results, but uses too much current to be practical in emergency periods when a set might have to be left running most of the time and when batteries might well be unobtainable. The little one-tube (usually duo-tube) receivers use less current, but have low gain. Two- or three-tube regenerators feeding headphones can be made with high gain, but are usually tricky to tune, and are intermediate in their power requirements. Ultra-compactness is also out, as it implies small batteries, with a limited

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life and presumably limited availability in emergency periods.

The receiver described here gives good speaker volume on all local stations and some distant ones. For the more distant, headphones are provided. The set has very high gain and selectivity, permitting operation in skyscrapers, while walking along the street, even in a cellar or subway. It has sufficient selectivity to separate high-power local stations, and pick up stations 500 miles or more away. It tunes with a single dial and is contained in an aluminum box only 3 x 5 x 7 inches; batteries, speaker, and all. The receiver carries its own whip antenna which can be collapsed to 18 inches, or extended to almost 5 feet.

Last but not least, the battery drain is amazingly—almost unbelievably—low. The maximum A battery drain is 80 ma, but we get satisfactory results with about 50 or 60 ma from a single type 950 cell. This means that you can use a cell after it has been discarded as too old for a flashlight or buzzer! As for the B supply, we use a 45-volt battery. When the radio is set to maximum gain, this battery has to supply *about 1.6 ma.* For local reception this is reduced to about 500 microamperes. Obviously batteries are not a problem here. Reception is satisfactory long after the batteries are too old to function in other portable radios.

How can we combine such high gain with such low drain? The secret is in the use of *junction transistors as well as tubes.* The lineup includes 2 subminiature tubes, 2 transistors and a crystal detector. We have mentioned the power supply for the tubes. The transistors need, in addition, 3 penlight cells. The current consumption is so low that these cells will last a long time.

The schematic is shown in Fig. 1. It is a superheterodyne circuit using tubes in the r.f. and i.f. stages. The audio is handled by the two type CK722 transistors. The detector is a 1N34 crystal. In an experimental hookup I tried to eliminate the crystal, using a transistor for detection-amplification. Results were not satisfactory. Using the separate detector requires a second audio transformer, but it is well worth it.

The high-frequency portion of the circuit is conventional in most respects. The tubes are subminiature types. They are rated at 40 ma at 1.25 volts each, but they function very well with much lower currents. A 20-ohm potentiometer (rheostat) is used to reduce filament voltage to 1.25 or less. This unit can also act as volume control to some extent. When the cell gets really old, this potentiometer can be turned down to zero resistance for maximum volume. With a new cell, it should always be turned up for low drain and filament protection.

The antenna coil is the well-known Vari-Loopstick. I cut off the 13-inch enameled wire lead from it and connected its terminal to the auto whip antenna. Tune this coil with the whip extended to its most commonly used length. I have done this with only a single section since this is the length we ordinarily use. The whip is extended to its full length only when needed to overcome the most unfavorable listening conditions.

The oscillator coil is a Miller universal type (unshielded). It is mounted *below* the small chassis which measures only 4 x 2½ x 1 inches. All other coils, including the i.f. transformers, are mounted above the chassis. Disregard the taps on the grid winding of the oscillator coil.

The variable ganged capacitor is a conventional but small superheterodyne unit. It measures about 2 inches along each dimension. The mail-order catalogs show a capacitor that is even smaller than ours by about ½ inch along each dimension. Inquiry in several radio stores failed to locate one, however. Since this capacitor is the largest unit on the chassis, it pays to obtain the smallest you can find.

The i.f. transformers are Miller K-Tran type. The first is an input, the second an output. We found that they need careful adjustment with a nonmetallic screwdriver. Try not to press down while you are rotating the screw setting, since this changes the tuning.

The r.f. alignment is as usual. Tune the Vari-Loopstick for maximum signal on a station near 600 kc. Then adjust the trimmer on the antenna section of the dual capacitor while tuned near 1400 kc.

The 1N34 detects the signal and generates a d.c. component in this circuit. On powerful stations the current may go as high as 80 microamperes. During alignment, a microammeter may be inserted in the test jack. Every change in tuning, antenna length, or location of the set will show up by a corresponding increase or decrease in meter reading. This is a great help in getting maximum performance from the set.

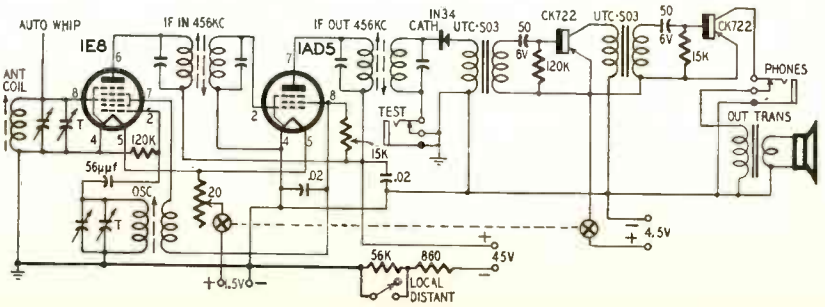

Fig. 1—Schematic diagram of the high-gain, low-drain portable radio receiver.

An alternative detector circuit is shown in Fig. 2. This one permits the use of a v.t.v.m. (at the test point) for measuring signal intensity In this case a pin jack may be used instead of the phone jack.

The transistors are coupled by tiny transformers; UTC type SO3 subouncers. The high-impedance windings connect in the collector circuit in each case. Subminiature "in-line" sockets are used for the CK-722 transistors. The transistor supply is 4.5 volts from penlight cells. This part of the circuit should offer no difficulty. However, for maximum sound output and minimum distortion, you may experiment with the values of each base resistor.

A 3½-inch speaker is used for this set. Smaller sizes are manufactured and could be used. However, it is doubtful they are as efficient and they probably do not reproduce as well. The matching transformer is a type designed for a 6K6 pentode. I was unable to find a miniature type so settled for the smallest conventional unit that could be found.

During experimental work on this circuit a sad accident ruined the tubes. After this, I inserted a 860-ohm resistor in series with the plate battery. This resistor protects the tube filaments by limiting current from the B battery. It was left in permanently after I discovered that it didn't affect the set performance. It drops the B voltage by about 1 volt.

After using this set a short while I soon discovered that it overloaded on some of the stronger local stations. Several of these are located about 5 miles from me. To eliminate overload, I inserted a large resistance (56,000 ohms) in series with the plate battery. This reduces power input to the tubes by dropping the B voltage to about 25 volts. Due to lower gain, distortion is greatly reduced. Of course, this also cuts down battery drain to a fraction of 1 milliampere, and greatly extends battery life! A toggle switch shorts out the 56,000-ohm resistor when high gain is needed.

This portable is easy to assemble, convenient to carry about, and is a source of much entertainment. It may be played for long periods continuously without worrying about battery costs, so it is ideal for children to play with.

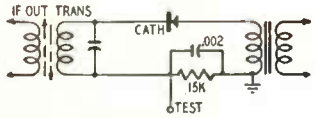

Fig. 2—Alternative detector circuit.

Like other portables, results may vary sharply from one location to another. For example, one local station came in consistently poor when the receiver was set on a table in my room. I was surprised one day to find that moving the receiver only a few feet away made a world of difference. In many cases, I found that performance is improved when the metal box is grounded. Indoors, this is done by setting the box on a metal cabinet, a radiator, or a grounded appliance. Outdoors, I auto-

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matically ground the set by holding it or carrying it.

Because of the high gain, this radio is an excellent trouble-shooting device. It can pick up noise from a fluorescent lamp from 10 feet or more. Motors, intermittent joints, and other sources of interference may be located by the noise it generates.

Materials for portable

Resistors: 1—860, 2—15,000, 1—56,000, 2—120,000 ohms, ½ watt; 1—20 ohm, potentiometer.
Capacitors: 1—56 μμf, 2—.02 μf, ceramic; 2—50 μf, 6 volts, electrolytic.
Batteries: 1—950 or equivalent; 3—penlight cells; 1—45 volts, XX30 or equivalent.
Miscellaneous: 1—1E8, 1—1AD5, 2—CK722; sockets for tubes and transistors; 1—1N34; 1—i.f. input transformer (456 kc); 1—i.f. output transformer (456 kc); 1—2 gang superhetrodyne capacitor; 1—antenna coil; 1—oscillator coil; 1—test jack; 1—phone jack; 1—s.p.s.t. toggle switch; 1—d.p.d.t. toggle switch; 2—interstage transformers (subouncer UTC SO3); 1—output transformer; 1—loudspeaker; 1—auto whip antenna; 1—chassis; 1—cabinet.

I have made tests to determine the end-point to which batteries are still usable. Good reception is possible with a B voltage of about 20 volts and an A supply less than 0.9 volt! At these potentials, the current drain is very small indeed.

This set requires batteries whose total cost is under $1.75, yet they outlive batteries for conventional portables by a factor of 10 to 1 or more. Over a period of many months, or years, this set should prove much more economical than less expensive sets that consume batteries in a relatively short time. END

MEASURING COIL CAPACITANCE

The formula for frequency is $f = \frac{1}{6.28\sqrt{LC}}$. L is the inductance of the tank coil and C is the capacitance across it. This equation is correct if L has negligible capacitance itself. If the coil is closely wound or has many layers, its self-capacitance, C_s, will be considerable. In that case C_s must be added to the capacitance across the coil to make up the total tuning capacitance C.

Probably the easiest way to measure C_s is as follows. Use a calibrated tuning capacitor to resonate the coil at some frequency f and note the tuning capacitance, say C1. Now tune to the second harmonic (2f) and record the new value of capacitance as C2. The basic frequency formula shows that *doubling frequency* is equivalent to *dividing the LC product by 4*. When we measured with frequency f, the inductance-capacitance product was $L(C_s + C1)$. When the circuit is tuned to the second harmonic the product $L(C_s + C2)$ is one-fourth the first product.

Therefore we write

$$\frac{L(C_s + C1)}{4} = L(C_s + C2)$$

$$C_s + C1 = 4C_s + 4C2$$

$$C1 - 4C2 = 3C_s$$

$$C_s = \frac{C1 - 4C2}{3}$$

Therefore if we know C1 and C2, we can easily determine C_s. END

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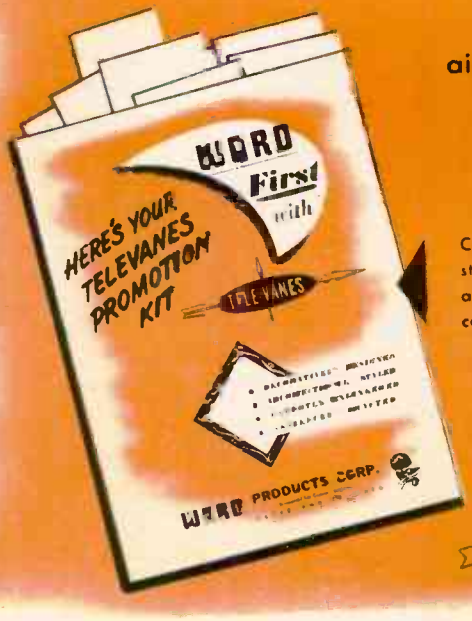

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THE FUND REACHES $11,341.09

HELP-FREDDIE-WALK FUND

We here at RADIO-ELECTRONICS find it heart-warming to read the many letters of good wishes and encouragement that are written regularly to little Freddie Thomason, armless and legless son of Herschel Thomason, radio technician of Magnolia, Arkansas. Most of these letters accompany contributions to the Fund, and through the generosity of our readers, the Help-Freddie-Walk-Fund has climbed to over $11,300.

Mr. Thomason writes in appreciation: ". . . this is more than we ever dreamed of, and we appreciate every penny of it. Freddie is still going to kindergarten and likes it a lot. All of the kids seem to get a kick out of him coming, and they will do anything for him." He has promised to keep us informed of Freddie's progress.

We would like to make special mention of the following donations:

$85.00 from W. Austin, and $10.50 from Van Ferguson, RADIO-ELECTRONICS authors who turned their checks over to the Fund.

$1.00 from Bruce Tanner, a boy with cerebral palsy, and Mrs. Lois Roberts, the woman who cares for him, who saw the story about Freddie in the Buckboard Review, official paper of "Little Princess" Ranch.

$19.50 from the Men's Fellowship Class of St. John's Methodist Church, Memphis, Tennessee.

$6.00 from Carleton C. Long, who writes: "Yesterday my family discussed their own good fortune relative to Freddie's, and as a result, the children gave me, jointly, a dollar to send to Freddie's Fund. To this I am adding $5.00 of my own . . ."

For five-year-old Freddie to live a normal and productive life, it will be necessary to fit him with mechanical appliances which will enable him to walk and take care of himself. All these cost money—thousands of dollars. Won't *you* send in your donation whenever you can? No amount is too small to receive our sincere thanks and acknowledgment by letter. *Make all checks, money orders, etc., payable to Herschel Thomason.* Address all letters to:

HELP-FREDDIE-WALK FUND
c/o RADIO ELECTRONICS Magazine
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FAMILY CIRCLE Contributions	$ 602.50
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Construction of Honeycomb Inductances, by Hilbert R. Moore

An Experiment with Wave Motion, by L. A. Bartholomew END

AN R-C BRIDGE TEST UNIT

Easy-to-build instrument measures resistance and capacitance with a high degree of accuracy

By ALAN G. SORENSEN

THIS test bridge is an extremely useful instrument for the service bench. It measures the exact values of a wide variety of capacitors and resistors to 1% accuracy. Capacitors of all types can be tested. The operation is quick and simple.

The basic circuit of the resistance section is a Wheatstone bridge, shown in Fig. 1. R_x is the unknown resistor, R_d is the variable resistor (dial), R_s is the resistance standard, and R_r is the range resistor. The generator is an audio transformer that delivers 60-cycle a.c. to the bridge. When the arms are balanced there will be no voltage between points A and B. This is a null condition. On either side of this condition voltage will appear, due to the unbalanced condition of the resistance arms.

A similar arrangement is used to measure capacitance. The bridge circuit of Fig. 2 is almost the same as that of Fig. 1 except that two arms contain capacitors instead of resistors. C_x is the unknown capacitor, C_s is the standard. R_s balances out the resistive component of C_x. These circuits combine nicely since R_d and R_r are the same in both bridges. A d.p.d.t. switch is used to change from one circuit to the other.

The complete schematic is shown in Fig. 3. A 1:3 audio transformer provides the 60-cycle bridge voltage. The secondary is the high-impedance side and provides a voltage step-up. To increase the impedance of this source, resistors R2 and R3 are inserted. Resistor R1 loads the transformer and reduces the no-load voltage to about 200. The source voltage should be poorly regulated so that with a small resistance across the terminals the voltage will be reduced to a safe value. At times there may be as little as 5 ohms in the circuit.

The calibrated dial of R13 serves for both resistance and capacitance measurements. This potentiometer should have a linear taper and should be wirewound. Another bridge, ohmmeter, or resistors of known accuracy should be used to calibrate the dial directly in ohms. This should be done before R13 is connected into the circuit. The accuracy of the completed bridge is dependent upon this calibration, so every effort should be made to obtain an accurate dial marking.

R4 through R10 are 1% tolerance, 1-watt resistors. In the author's instru-

Front view of R-C test bridge. Main dial must be carefully calibrated.

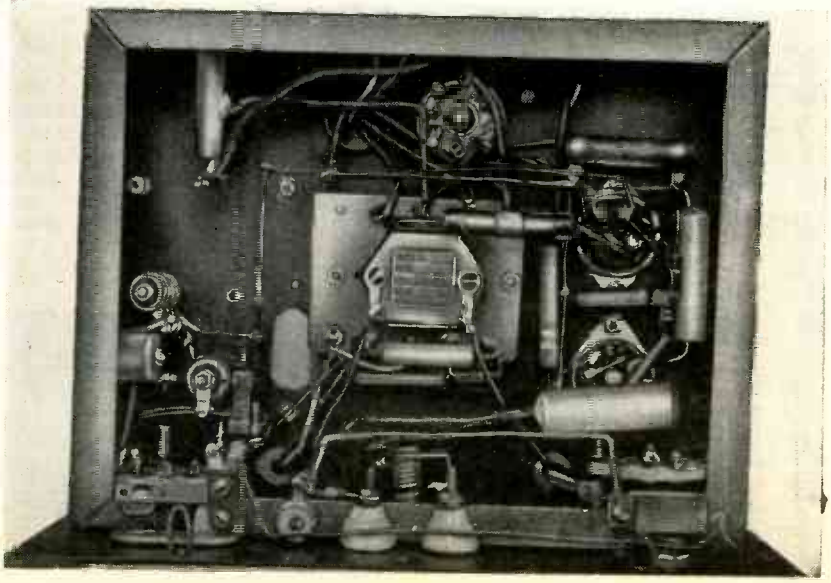
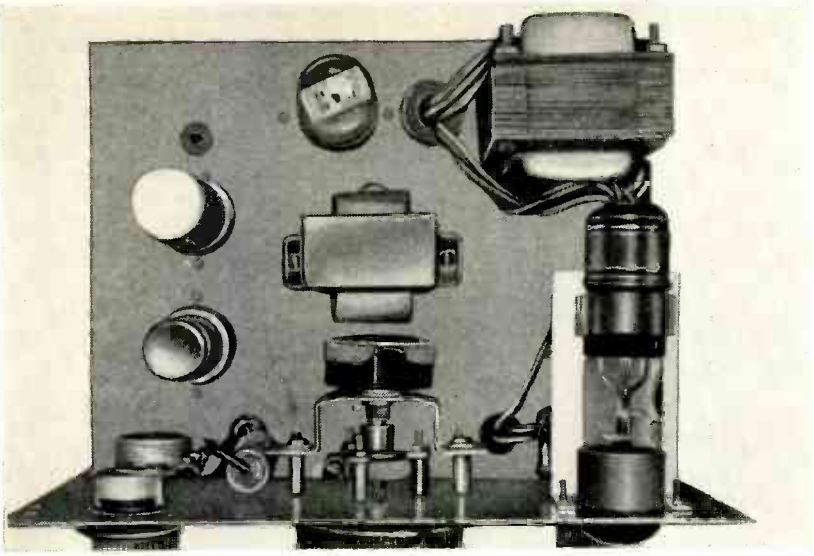


Photo shows underchassis view of bridge. Layout of parts is not critical.



Top view. 6E5 tuning-eye and assembly are conveniently mounted at right.

ment R4 and R5 were IRC *Precistors*. The lower values were wire-wound resistors. R11 is the resistance standard and should also be 1% or better. Capacitor C1 is the capacitance standard and must be within 1%.

R12 is the power balance or power factor control. In most commercial bridges this control is calibrated in power factor percentage. However, for a general-purpose unit, there is no real need for this, and a 0–10 knob was used. If the constructor desires, a dial may be attached and calibrated directly in ohms and the power factor obtained from it.

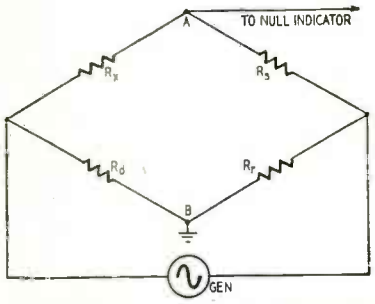


Fig. 1—Diagram of basic Wheatstone bridge used to measure resistance.

A switch and jack were provided so that the amplifier and tuning-eye null indicator might be used with an external inductance bridge.

Construction

The construction is simple and straightforward. A heavy wire should be used for the bridge itself and stray capacitance should be kept to a minimum. Parts placement is relatively unimportant; most any layout could be used. An ICA 3926 grey cabinet, National knobs, and a chrome stripe for decoration (ICA 3513) were used to provide a matching and neat-appearing instrument.

The terminals are small ceramic feedthrough insulators to reduce stray capacitance which would otherwise appear in parallel with the capacitor under test. These were later replaced with the new General Radio 938 terminals. The stray capacitance across the terminals in the original instrument was 3-μμf. This must be subtracted from the dial reading when measuring small capacitors. The final requirement is to very accurately calibrate the main dial directly from R13 in ohms.

Operation of the completed bridge is quite simple and quick. After a couple of minutes warmup, the null eye glows a bright green, and the instrument is ready.

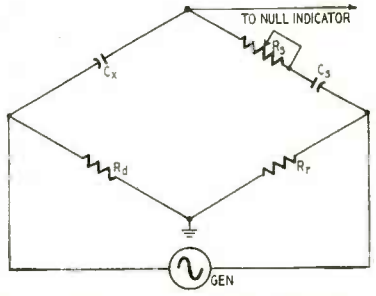


Fig. 2—Diagram of basic Wheatstone bridge used to measure capacitance.

Resistance:

1. Set the function switch to RES.
2. Set the range switch to a range that will include the resistor under test. If the resistor under test is unknown, try all ranges one by one.
3. Connect the unknown resistor to the instrument terminals. A pair of very short test leads may be used.
4. Advance the AMPLIFIER GAIN control slightly so that the tuning eye will show only a small wedge of black.
5. Slowly turn the main dial and watch for an eye opening. When the eye is at its widest point the bridge is at null. The AMPLIFIER GAIN control may then be adjusted for the sharpest null. By reading the value shown on the main dial and multiplying it by the RANGE switch setting, the value of the resistor under test, in ohms, may be determined.

Capacitance:

1. Set the function switch to CAP.
2. Set the RANGE switch to a range that will include the capacitor under test. If the approximate value is unknown, try all ranges one by one.
3. Connect the unknown capacitor to the instrument terminals. A pair of very short test leads may be used.
4. Advance the AMPLIFIER GAIN control slightly so that the tuning eye will show only a small wedge of black.
5. Slowly turn the main dial and watch for an eye opening. When the eye is at its widest point the bridge is at null.

Materials for Test Bridge

Resistors: 1—1,000, 2—1,200, 1—22,000, 1—270,000, 1—470,000 ohms, 2—1 megohm, ½ watt; 1—1, 1—10, 1—100, 2—1,000, 1—10,000, 1—100,000 ohms, 1—1 megohm, 1 watt, 1%; 1—2,500 ohms, 10 watts, 1—15,000 ohms, 10 watts; 1—100,000, 1—500,000 ohms, potentiometer; 1—10,000 ohms, 3 watts, potentiometer.

Capacitors: 1—.01 μf, 1% mica; 3—0.1 μf, 400 volts; 1—20-20-20 μf, 450 volts, electrolytic.

Miscellaneous: 1—power transformer, 500 volts c.t. at 40 ma, 6.3 volts at 2 amp; 1—1:3 step-up audio transformer; 1—6SJ7, 1—6E5, 1—5Y3-GT, tubes; 1—off-on power switch; 1—d.p.d.t. switch; 1—s.p.s.t. toggle switch; 1—tuning-eye assembly; 1—pilot light and assembly; 1—1-amp fuse and holder; 2—test terminal (General Radio 938); 1—cabinet 8 x 12 x 8-inches (ICA 3926); 1—chassis 7 x 9 x 2-inches; 1—jack; 1—calibrated dial; knobs; sockets; line cord; hardware, wire, etc.

6. At null, adjust the POWER BALANCE potentiometer to broaden the null and reduce any fuzziness. Readjust the main dial for the sharpest null. The AMPLIFIER GAIN control may have to be readjusted.
7. The value of the capacitor may be

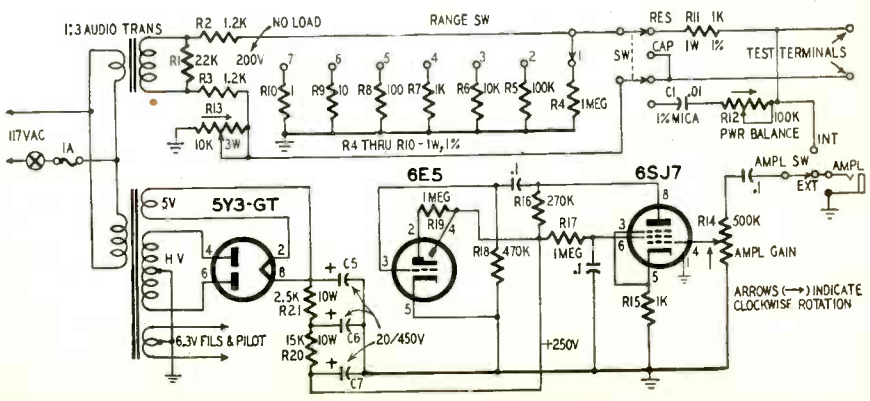


Fig. 3—Diagram of R-C test bridge. Arrows indicate clockwise rotation.

taken from the main dial and the RANGE switch.

RANGES COVERED BY TEST BRIDGE

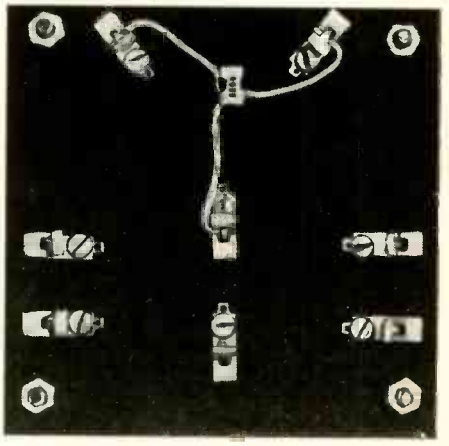
Position	Resistance	Capacitance
1	1 ohm to 10 ohms	10 to 100 μμf
2	10 ohms to 100 ohms	100 to 1000 μμf
3	100 ohms to 1,000 ohms	.001 to .01 μf
4	1,000 ohms to 10,000 ohms	.01 to .1 μf
5	10,000 ohms to 100,000 ohms	.1 to 1.0 μf
6	100,000 ohms to 1 megohm	1.0 to 10 μf
7	1 megohm to 10 megohms	10 to 100 μf

The table shows the ranges covered by the instrument. END

TRANSISTOR LAYOUT BOARD SAVES EXPERIMENTING TIME

When experimenting with transistor circuits you will find that this breadboard layout will save you hours of work. After wasting many hours soldering and unsoldering connections, I figured that there must be an easier way. There is.

Cut a 4-inch square from sheet bakelite, 3/16 or 1/4 inch thick. Drill eight holes for the Fahnestock clips and four holes for the mounting feet. The holes for the transistor mounting clips are 120° apart on the circumference of a circle having a radius of 7/8 inch. Assemble the clips and feet as shown in photograph. This panel provides for



straightforward wiring. In a matter of seconds you can change any part of the wiring. By reorienting the socket you can change the basic circuit from grounded-base to grounded-collector or grounded emitter. Transistor socket leads should be spaced 120 degrees apart so that they will fit directly into the clips. I used General Cement No. 6302 clips, 3/4 inch long. Fahnestock No. 533 clips are the same size and may be used. If you have larger clips on hand, you can use them on a little larger panel.

If you have ever experimented with different circuit arrangements, you will appreciate this layout. With transistors becoming more available, new applications will be developed requiring experimentation.—*J. R. Steen*

DISPLAY IN ELECTROTHERAPEUTICS

The scope display gives the surgeon immediate visual information

By F. J. G. VAN DEN BOSCH, D. SCI.*

AT THE International Congress of Anestiology held in Paris during 1951, there was a discussion on the apparatus for the automatic application of anesthesia developed by Dr. R. G. Bickford at the Mayo Institute. (See "Brain Waves Control Anesthesia" in the November 1950, issue of RADIO-ELECTRONICS.) This apparatus is based on the use of the electrical activity of the brain. By this is meant the frequency and amplitude of the electroencephalographical waves. Dr. Bickford's equipment is an important development in the use of the electroencephalograph (EEG) as a powerful instrument for neurologists.

*Chief of physical and electronic laboratories
Fondation Sheid
Berchem-Antwerp, Belgium

The apparatus described by Dr. Bickford (Fig. 1) consists of a 3-stage capacitance-coupled symmetrical amplifier. Its output is fed into a 6AG5 pentode that is biased to cutoff so it acts as a rectifier and amplifier. Potentiometers in the screen and cathode circuits adjust the cutoff point and one in the grid circuit regulates the amplitude of the input. A 0–1-ma meter in the plate circuit measures the average current and indicates the average electrical level.

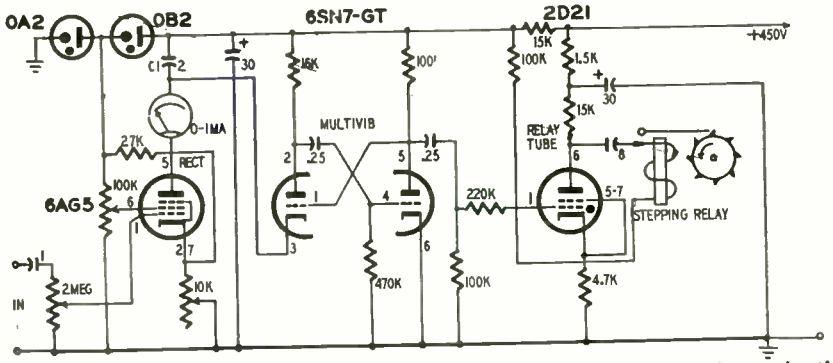


Fig. 1—Control unit for automatic anesthesia. The energy level of the patient's brain waves fires the thyratron periodically and triggers the stepping relay.

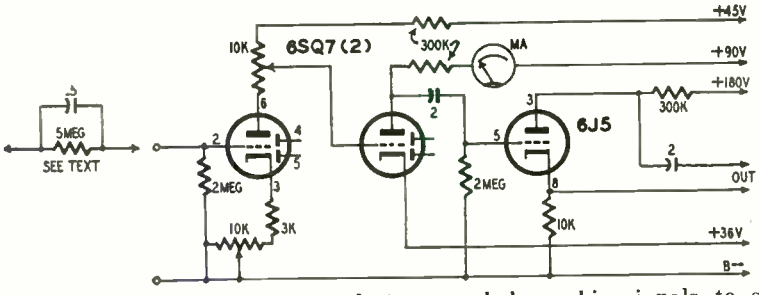


Fig. 2—Preamplifier for feeding electro-encephalographic signals to scope.

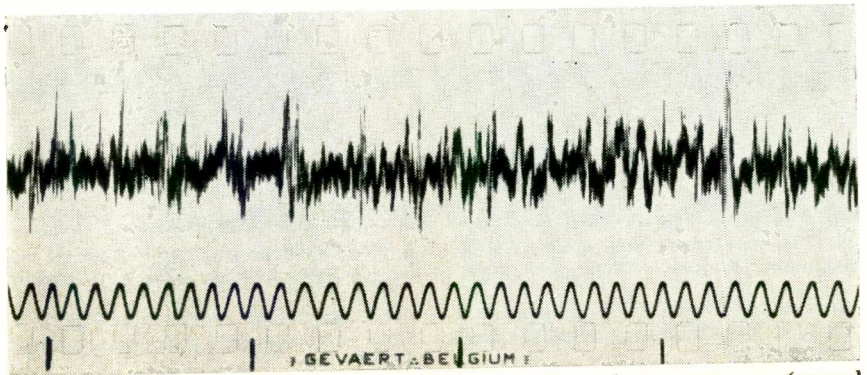


Fig. 3—The upper trace shows a small portion of an electromyogram (record of a muscle's electric activity). A 50-cycle reference marker is shown below.

When the 6AG5 is conducting. C1 charges until its potential is high enough to unblock the 6SN7-GT one-shot multivibrator. The multivibrator discharges C1 and produces a pulse which fires the 2D21 thyratron. Thus the electrical energy level of the brain is transformed into a series of pulses that increase in frequency as the energy level increases.

When the thyratron fires, it conducts momentarily and produces a pulse in the coil of the stepping relay where it is integrated and shifts a wheel a fraction of a turn. This wheel controls the syringe mechanism used to administer the anesthetic. Since the brain-energy level decreases with the depth of anesthesia, it is possible to regulate the instrument to stabilize anesthesia to the desired level, and keep it there as long as needed.

EEG (electroencephalographic) readings show that before the application of anesthetic, the average brain-wave frequency is about 20 cycles, with a relatively small amplitude; with the onset of anesthesia the amplitude increases while frequency decreases. As anesthesia progresses the frequency settles at about 2 cycles per second and amplitude diminishes gradually with the anesthesia. When a waveform no longer appears on the recorder or scope, it corresponds to a grave inhibition of the brain. It appears that no electrical activity corresponds to death.

When my attention was called to the Mayo and Bickford publications, I was very much interested, as I had already done some work with electronic equipment for operating theaters. Recently I used with considerable success a visual and acoustical aid for display of electrical activity of the heart muscles (electrocardiograms) during a surgical operation. The apparatus was

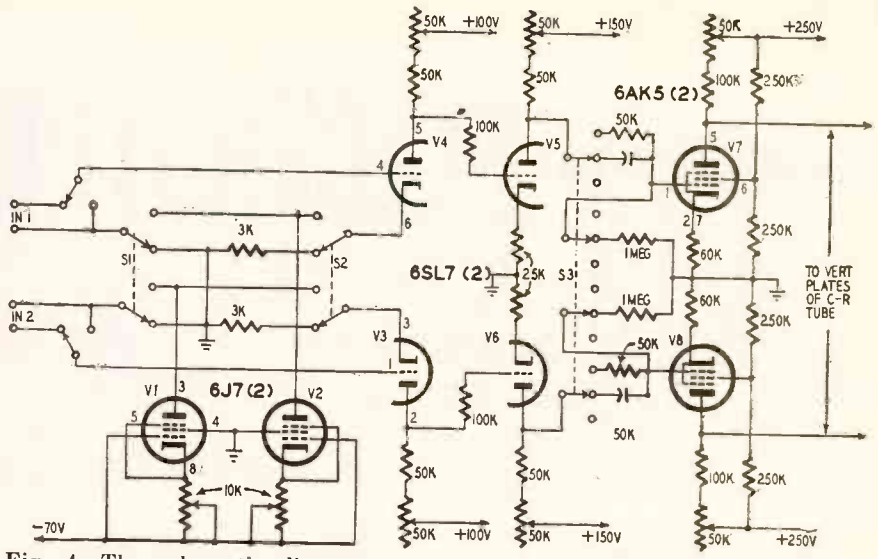


Fig. 4—The schematic diagram shows circuits used in vertical amplifier for a scope for electrocardiograms and electro-encephalographic displays.

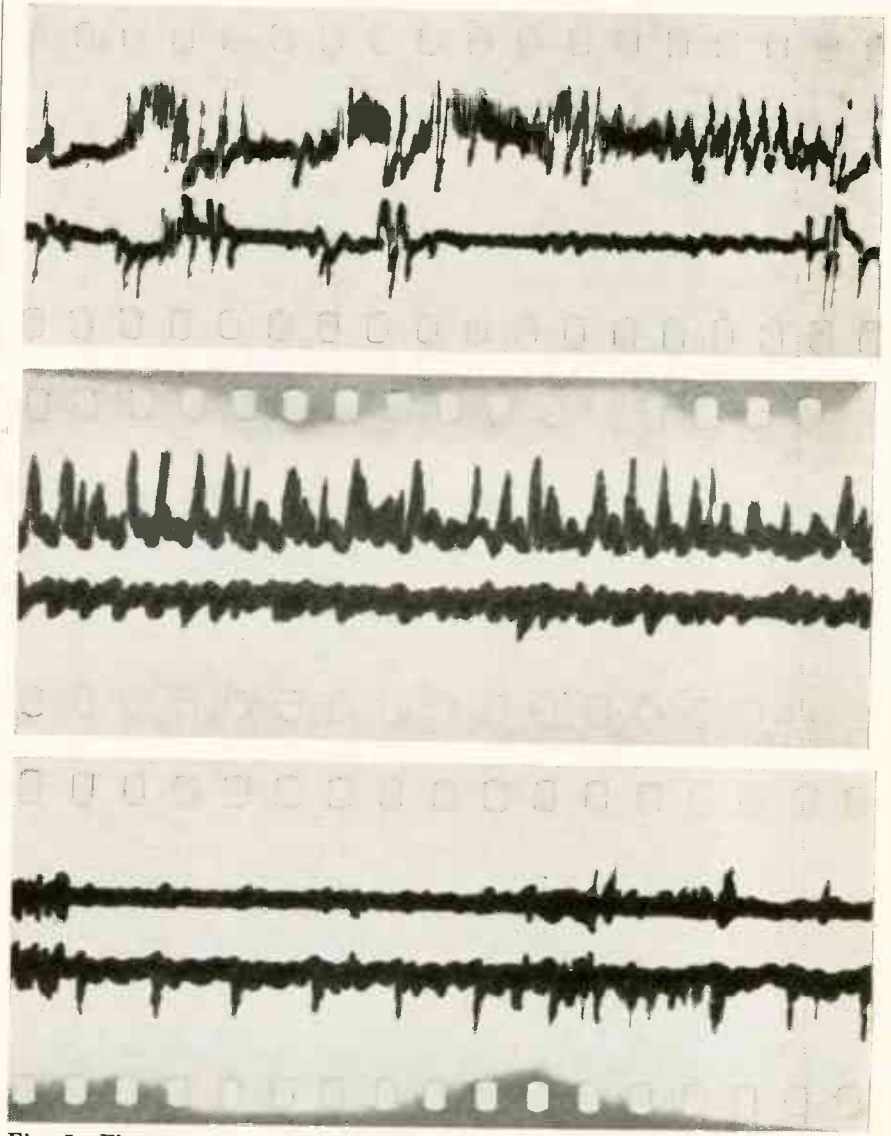


Fig. 5—Electrocardiographic (EKG) and electroencephalographic (EEG) recordings. The EKG traces are shown in the top rows and the EEG's are below.

a Cossor type 1049 oscilloscope paralleled by a low-frequency amplifier with a loudspeaker.

Both these were fed from a preamplifier that I designed for the purpose. Its circuit is shown in Fig. 2. The first two stages are direct-coupled 6SQ7's, and the third is R-C coupled and uses a 6J5. When used with the Cossor oscillograph it is advisable to

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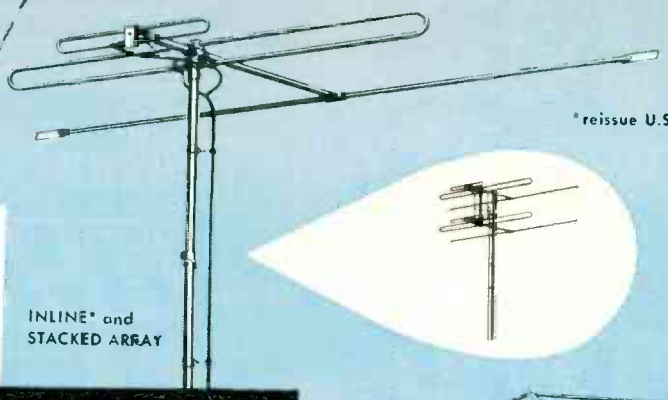

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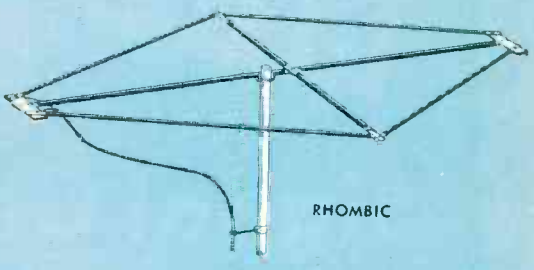
*reissue U.S. Pat. 23,273



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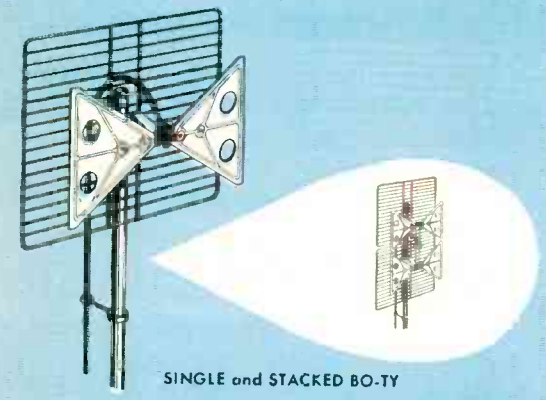

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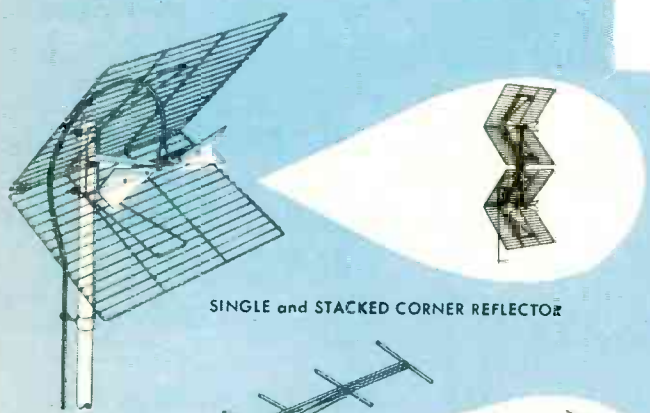

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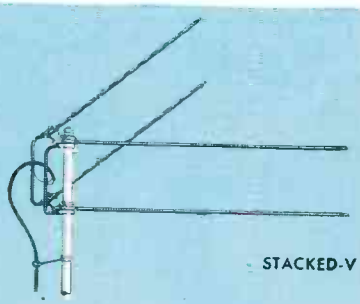

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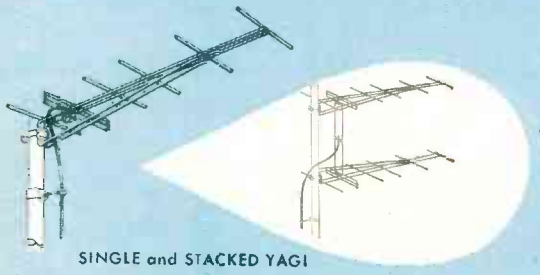

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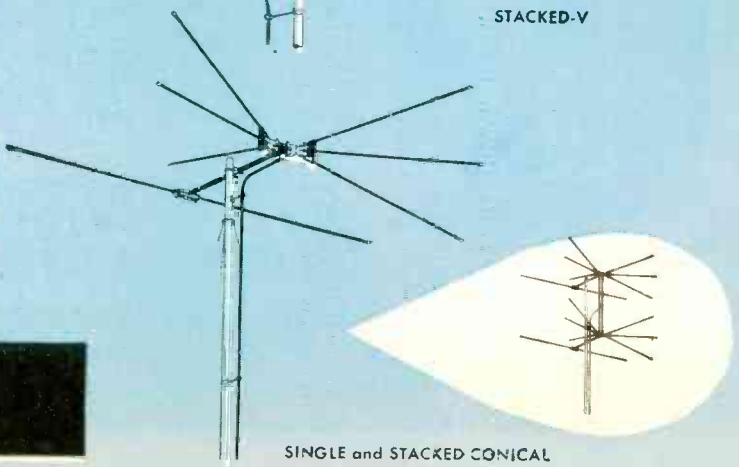

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use the capacitor shunted by a resistor in the input lead from the electrocardiograph.

Interference and artifacts

I could not see how, in the Bickford apparatus, it would be possible to cut out all the unwanted voltages produced by radiations, bad grounds and noisy power lines. I had been greatly troubled by various types of electrical interference and artifacts during the operations I had assisted in with my equipment. By grounding all apparatus, as well as the operating table, and by using coaxial as input leads, I was able to get trouble-free electrocardiograph recordings *when the patient was at rest and no one was touching him* (that is: before the actual operation began). Fig. 3 is a small portion of an electromyogram (recording of electric muscle activity) taken on a patient before being anesthetized or operated. It was of the left arm muscle. At the bottom appears as a reference marking, the 50-cycle line frequency.

Having experienced interference even with the anesthetist, I applied grounding techniques to him. But when the surgeon started operating, there was a kind of interference that varied according to whether he was only touching the body, shifting organs, or cutting into them. In my view this kind of interference cannot be avoided.

On several occasions during surgical operations I have been able to ascertain that nerves continue to react in a normal manner though the patient is under a heavy anesthetic. It is quite logical that, for example, nerve cells and fibers dealing with pain will continue to act—if situated on a healthy part of the body—and transmit their messages to the brain. There these messages will be detected and the brain —although under anesthesia—must produce some electrical reaction. And this reaction will certainly translate itself on the EEG. This is apart from the fact that the surgeon may manipulate nerve fibers and thus induce spurious voltages whose peaks will certainly drown out the EEG.

With all this in mind I was anxious to see what use we could make of the equipment designed by Dr. R. D. Bickford. The first step was to build a suitable cathode-ray oscilloscope with two equally balanced amplifiers, to enable me to get on one trace the EEG and on the other trace the ECG (electrocardiogram) as a control. The double trace would be obtained with a multivibrator switch.

The circuit of the amplifier is shown in Fig. 4. The first two tubes (V3, V4, V5, V6) are two 6SL7's. They are followed by a 6AK5 on each side. Switches S1 and S2 enable V3 and V4 to have 6J7's as cathode bias resistors. Switch S3 allows insertion of a capacitor to provide the necessary time-constant.

I followed several operations and show in Fig. 5 three of my recordings. These were selected for their interferences, but since the recordings were taken at a rate of 6 cm per minute

they involve quite sufficient time for a device like Dr. Bickford's integrator to administer too much anesthesia.

No EEG waves can be seen (the recordings were taken at too low a speed) and only the amplitude is shown as one thick line. Frequency can be followed, however, if displayed visually the same as the variation in amplitude of the EEG, but I made the recording at a very low speed to show the length, continuity and degree of interference which would make it difficult—or impossible—to work any equipment automatically from pure EEG activity during a surgical operation.

What we found however was that we had a very good visual aid to guide the anesthetist in administering anesthesia, just as the electrocardiograph helps the surgeon greatly with its acoustical aid, once he has trained himself to use its various sounds to ascertain not only the cardiac and respiratory condition, but also the traumatic condition of his patient. The EEG displayed on a cathode-ray tube is also a good indication of the patient's narcotic condition.

Friends have suggested that—to reduce interference—I might even "ground" the surgeon. That would present almost unsurmountable difficulties and would not eliminate interference. From my own experience, I fail to see how Dr. Bickford's apparatus—though an ingenious device which certainly has its uses—could be operated efficiently during a surgical operation, since interference (or artifacts, if you prefer the term) would dominate the voltages developed by the EEG. I have come to believe that it would be unwise to try to design *automatic* electronic devices which work with voltages produced by the patient during surgical operation for use in the operating theater.

Display needed

Indicating electronic devices are sadly lacking and no doubt will render immense service in the future, and in my opinion, research and development in the physical and electronic field should—at this stage—be directed toward indicating instrumentation rather than the operative apparatus.

I am still of the opinion that certain techniques applied by electronics in other fields should be applied to the medical field. For example, in the early days of radar, all the display then considered necessary was a cathode-ray tube as indicator; display had a *controlling* effect on radar by the end of 1945. Similarly what is required in medicine is display. As a start why not have all the different EEG channels displayed at once on a single C-R tube? That should present no difficulty to a good electronic engineer. With a 10-way electronic switch controlling the tubes which supply the vertical plates (there must be one final tube for each channel) while at the same time controlling the input tubes, it should be possible to present 10 channels simultaneously. This can be achieved with a frequency of about 20

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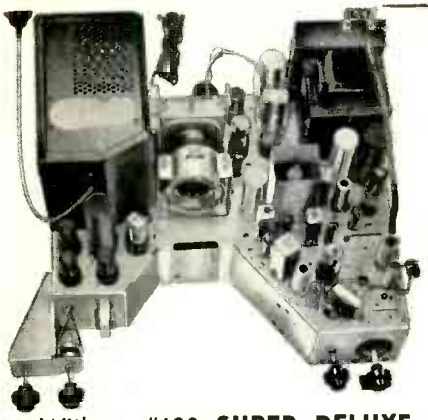

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- #K4C TV CHASSIS for 16" to 21" CRT's $149.50
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STANDARD BRAND PICTURE TUBES

NEW in Factory Sealed Cartons—With a Full Year Guarantee

17"—#17BP4A	$29.63
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CUSTOM-BUILT CABINETS FOR #630 AND ALL OTHER TV SETS — from FACTORY to YOU

5 LEADING STYLES in genuine mahogany or walnut (blond 10% extra) • Ready drilled for any #630 TV chassis and cutout for any 14", 17", 19", 20" or 21" picture tube at no extras in price • Also supplied with undrilled knob panel for any other TV set • EVERYTHING NECESSARY for an easy perfect assembly is included • Each cabinet is delivered complete as pictured with mask, safety glass, mounting brackets, backboard, backcup, hardware and assembling instructions • Each cabinet is shipped in on air cushioned carton from FACTORY to YOU!

The VOGUE
Most Popular Table Model

H-25", W-26", D-22"

$39.89

VOGUE also available for 24" or 27" picture tube

H-31", W-27", D-23"

$62.54

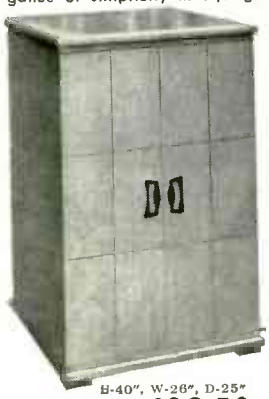
The MANHATTAN
Style, Quality, Price

H-41", W-25", D-23"

$59.37

MANHATTAN for 24" or 27" CRT
H-46½", W-27¾", D-24" **$86.22**

The MAYFAIR
Exquisitely modern, with an elegance of simplicity in styling.



H-40", W-26", D-25"

$98.56

The PLYMOUTH
Choice of interior Decorators, truly superb in every detail.

H-40", W-27", D-23"

$105.48

The TOWN & COUNTRY
Patterned after the popular credenza.
Available for all size picture tubes **14" to 27"**

H-42", W-36", D-24"

For 14", 16", 17", 19" 20", 21", 24" or 27" C.R.T.'s **$109.62**

PARTS FOR #630 TV SETS

TV WIRE & SOLDER KIT, for any Set	$ 1.49
630-KIT, screws, nuts, rivets, washers, etc.	1.69
PUNCHED CHASSIS PAN, cadmium plated	4.87
UNIVERSAL CRT MOUNTING BRACKETS	6.97
STANDARD CASCODE TUNER, incl. tubes	22.49
POWER TRANSFORMER, 295ma. 201T6	9.97
VERTICAL OUTPUT TRANS. 204T2	2.69
VERTICAL BLOCKING TRANS. 208T2	1.32
HORIZONTAL OUTPUT TRANS. 211T5	3.98
FOCUS COIL, 470 ohms, 202D2	3.42
DEFLECTION YOKE, Cosine 70°	3.98
COMPLETE SET OF KNOBS, incl. decals	1.34
SOUND DISCRIMINATOR TRANS. 203K1	1.12
1st PIX I.F. TRANSFORMER, 202K2	1.08
2nd PIX I.F. TRANSFORMER, 202K3	1.08
1st or 2nd SOUND I.F. TRANS, 201K1	1.02
HORIZONTAL DISCRIM. TRANS. 208T8	1.49
FILTER CHOKE, 62 ohms	1.47
CATHODE TRAP COIL, 202K4	1.08
WIDTH CONTROL COIL, keyed AGC IR4AG	.79
ION TRAP BEAM BENDER, double 203D3	.98
ION TRAP BEAM BENDER, single 203D1	.79

STANDARD CASCODE TUNER

Complete with tubes, and Brooks **CASCODE MANUAL** with step-by-step instructions and all extra parts needed. **$22.94**

PULSE KEYED AGC KIT

Finest, most accurate and the easiest Kit to install in a #630 or in any other make TV receiver. Improves performance, and insures a steady picture on all channels.

COMPLETE SET OF PARTS Including 6AU6 tube & Instructions **$4.59**

#630 PARTS IN COMPLETE SETS

TV WIRE & SOLDER KIT, for any Set	$1.49
VIDEO AND I.F. KIT, 19 items	7.84
VARIABLE CONTROL KIT, 9 controls	5.83
CARBON RESISTOR KIT, 107 resistors	6.98
WIREWOUND RESISTOR KIT, 4 resistors	2.31
BRACKET AND SHIELD KIT, 18 items	8.63
ELECTROLYTIC CONDENSER KIT, 6 cond.	7.37
TUBULAR CONDENSER KIT, 38 condensers	4.28

AM SUPER RADIO FOR #630 or other TV

Complete ready to install including tubes & instructions (lists for $24.95)

only **$7.89**

Brooks LIFE-SIZE TV INSTRUCTIONS for building any #630 Receiver. Postpaid **$2.49**

HINTS FOR BETTER PERFORMANCE on your #630 TV receiver. Postpaid **$1.00**

Brooks CASCODE MANUAL, how to install Cascode Tuner in any make TV set. Postpaid **50¢**

BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N. Y.

kilocycles on the electronic switch.

All the electrocardiograph channels should be displayed simultaneously on another C-R tube screen, and on a third screen several independent channels of electromyograms should be displayed. A fourth scope should display various and appropriate gland-action potentials. The neurologist would then have an "electrical activity" picture of the patient before him. This would certainly facilitate diagnosis. I am convinced that the day physicians are able to present a complete and correct physical picture and interpretation of the central nervous system, medical science will enter a new era where guesses will be unknown.

It is essential that medical men should obtain the services of an experienced physicist in the early stages, to get acquainted with the various waveforms displayed and the interpretation of all possible artifacts. And to those who would enter the field of medical electronics: remember that medical men as a group regard electronic devices with suspicion. Their training has left them without sufficient equipment to enable them to grasp even the meaning of electronic apparatus. Clinicians are too much inclined to look upon electronic and physical apparatus to *confirm* their diagnosis rather than to use it with an open mind; and without prejudice to look at such pieces of equipment as they mostly are: *perfect indicators!*

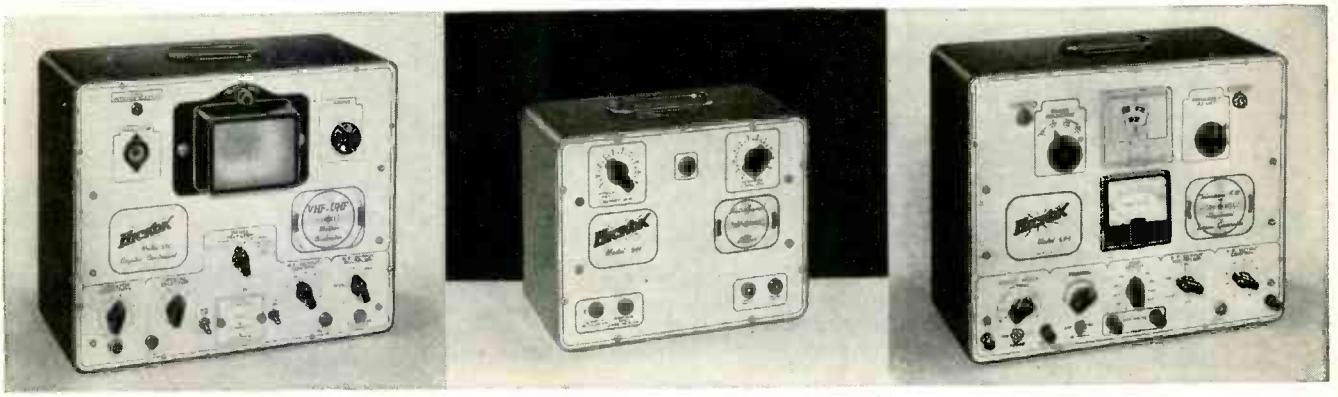
The medical profession as a whole is beginning to recognize the importance of electronics, and electronic engineers or physicists are gradually being added to the medical staff in most important institutions. Electronic engineers thus engaged should always bear in mind that, while in industrial electronics mistakes will affect only relative production, in medical electronics one deals with human lives. The responsibility is very much greater indeed, and the greatest possible care and caution is therefore recommended.

Finally permit me to express my gratitude to my numerous medical friends who so kindly assisted me with their advice and help, as well as to Gevaert Photo-Products, Ltd., of Antwerp, who kindly assisted me on the photographic side. END

"Gramps getting interested in binaural sound. He bought another ear trumpet."

"BEST FREQUENCY • STABILITY • ACCURACY"

SUMS UP ALL FIELD COMMENT ON THIS LATEST HICKOK TELEVISION ALIGNMENT EQUIPMENT



This entirely new and advanced alignment equipment represents the latest HICKOK achievement in offering a complete, fast and accurate solution to TV alignment.

Many leading TV engineers have tested this new equipment and highly compliment its practical design for individual unit use or compatible set use.

The stability frequency and accuracy of this new equipment plus its ease of use make the 690 - 691 - 695 today's best tools for a more profitable TV service business.

Model 690
Marker Generator

Crystal controlled. High .25 volt R.F. output. Provides dual markers with any TV sweep generator. This unit features another HICKOK First by incorporating a Non-Parallax shadow type dial. In conventional type dials, error generally is introduced in setting frequencies since the hairline or indicator is at a slight distance from the scale. This distance, however slight, can introduce error if the scale is not viewed directly at right angles.

In alignment of any type of receiver, the marker generator is the unit that is to be relied upon and must therefore be consistently accurate in frequency settings. The Hickok Non-Parallax dial can be viewed from any angle without introducing error. The 45 inches of dial can be self calibrated to within crystal accuracy (.05%) since the unit includes a self contained crystal calibrator

Leading features of this unit are:

(1) The simple and time saving method employed in calibration of the dial—there is no counting of beats—no interpolation —no remembering of frequencies.

(2) Provision for calibrating any other signal generator to crystal accuracy.

(3) Complete R.F. coverage up to and including channel 83. All channels have picture and sound settings marked directly on the scale—this eliminates checking on these values when they become applicable

(4) The marker can be modulated by a self contained 400 cycle signal. This is especially valuable in stage - by - stage alignment and eliminates the introduction of another instrument.

(5) Position for adding two other crystals is provided in addition to the 2.5 Mc crystal which is included.

(6) It is possible to view two markers at once on the response curve. This will include the main marker and a marker corresponding to the crystal value selected. For instance, a 4.5 Mc crystal may be used to obtain two markers with a 4.5 Mc separation. This will greatly speed up alignment procedures since it is not necessary to re-set dials to check response curve width.

(7) Both an electronic-eye tube and a headphone jack are available for either visual or audible indications of zero beat.

(8) Attenuation is controlled by both a step attenuator and vernier to attain complete regulation of output.

(9) The unit is completely double shielded to assure a minimum of leakage.

(10) All frequencies are covered on fundamentals with the exception of U.H.F. channels. There are no spurious or confusing beats or frequencies generated by the unit. It is an all around instrument in view of its very complete R.F. coverage. 3.57 mc crystal is available. (Frequency of color burst)

Model 691
Heterodyned Marker Adder

This unit, in conjunction with the Model 695 Sweep Generator and Model 690 Marker Generator provides the utmost in television alignment techniques. It takes the guesswork out of receiver alignment and eliminates any errors previously introduced by overloading due to markers.

The 691 provides a marker visible at all times (including trap points) and will not change in amplitude or distort the response curve what-so-ever. This feature, in addition to the accuracy and minimum leakage of the other units (690 - 695), will greatly simplify any alignment.

The outputs of the sweep generator and marker generator are heterodyned and applied to an oscilloscope in such a manner that the marker signal will never pass through the receiver itself—therefore cannot cause overloading.

In short, we can say that we are calibrating the oscilloscope with a marker which is visible at all times—even on the base line.

The 691 is specifically designed as a companion to the HICKOK 690 Marker and 695 Sweep Generator; however, it will work well with any of your present equipment that has an output of 50,000 microvolts or more.

Many leading TV engineers have tested this new Hickok equipment and highly compliment its frequency, stability and ease of use in offering today's fastest, most complete and accurate solution to TV alignment tasks. See your jobber today or write factory direct for complete technical information.

Model 695
Sweep Generator

This is a completely new electronic sweep generator that will exactingly fill top requirements of the professional TV serviceman or lab. There are no moving parts to produce vibration or to wear out. This unit, although moderately priced, features a sweep signal that is absolutely linear and without amplitude modulations.

This unit has technical advantages over other sweep generators because:

(1) The unit is completely triple shielded to insure that there is as little leakage from the unit as is engineeringly possible. It is possible to attenuate the signal down to 3 microvolts, and the unit has a maximum output of 300,000 microvolts.

(2) A bias voltage, variable from 0 to 12 volts, and metered directly by the voltmeter on the front panel, eliminates the usual time-consuming method of obtaining bias voltage from dry cells. Since this bias voltage is variable with continuous tuning, one can determine more accurately the effects of bias on the overall response curve and can align sets to more sensitive for "fringe area" reception or align them to prevent "overloading" when the station signal is very powerful.

(3) Three RF oscillators provide complete VHF coverage (Channels 2 - 13) on fundamentals and hetrodyned output IF frequencies 0 - 50 Mc. This assures a strong signal necessary for aligning "front ends."

(4) Continuous tuning and an easy-to-read scale marked off in channels literally provides the serviceman with a foolproof method of alignment.

(5) An internal method of "retrace blanking" provides a reference base line and eliminates confusion sometimes brought about by retrace curves.

(6) Even though the sweep width is varied, it will not be necessary to readjust the phasing control.

(7) As is common to all Hickok Signal generators, a Standby position is incorporated in which the plate voltage is removed from all the tubes leaving filament voltage alone to keep the unit at a constant temperature and ready to operate the moment the Range Selector Switch is rotated.

(8) The instruction manual accompanying the unit gives complete, detailed and easy-to-follow instructions on correct alignment procedures, uses of the instrument, and a thorough understanding of alignment.

All of these features have been developed with the TV serviceman in mind.

HICKOK

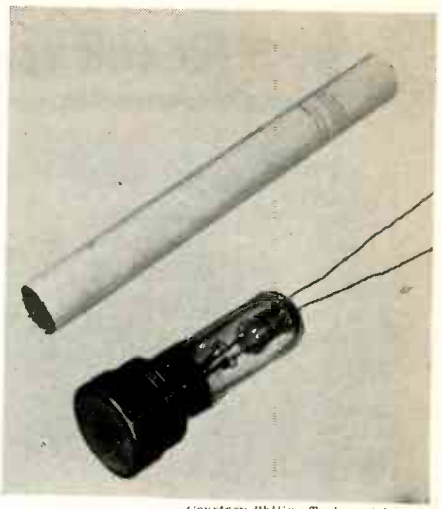
THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10531 Dupont Avenue • Cleveland 8, Ohio

See your parts jobber or write direct for technical details.

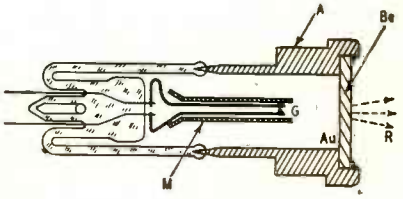
SMALLEST X-RAY TUBE

Probably the smallest X-ray tube ever made, the KT, is now being used for superficial therapy and biological research. The KT tube is so small, it can easily be held between two fingers of one hand. The maximum tube voltage is 25,000 and maximum current is 200 μa. The plate can dissipate 2.5 watts continuously.



Courtesy Philips Technical Review

Photo shows size of midget KT tube.



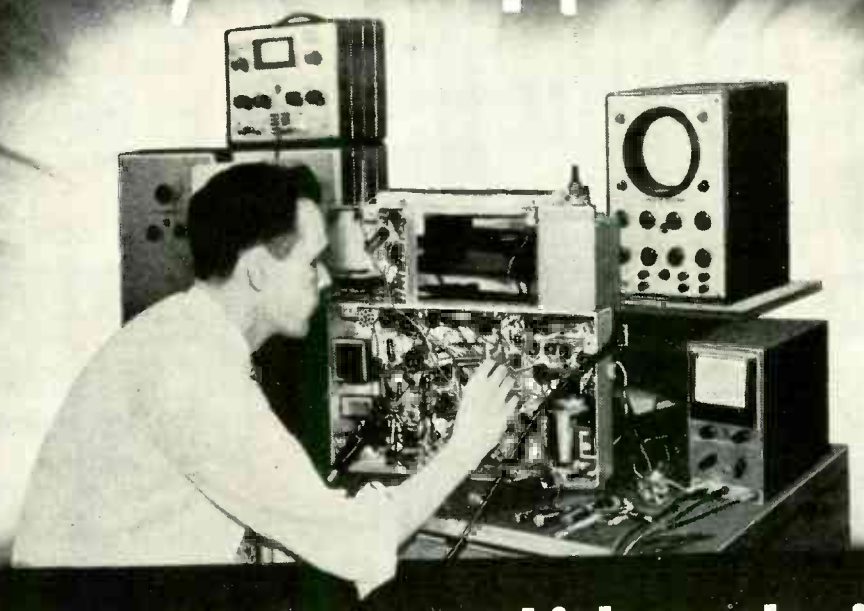
Cross-section of the KT tube (approximately ⅜ x 1¼ inches). A—anode can; Be—beryllium plate; Au—gold layer; G—filament; M—metal cylinder; R—effective X-ray beam.

The KT can be used for making radiographs for research and teaching purposes, where a very soft radiation is required and extremely small power is sufficient. At present, the KT tube is finding much use in therapeutic irradiation.

END

"and is that husband of yours still tinkering around with electronics?"

Here's your Opportunity



to prepare for a good job or a business of your own in TV SERVICING

ARE YOU SATISFIED with the position you now hold? Do you feel you're worth more money? Are you pleased with yourself, your work, your associates . . . and your future? What does the next year hold for you . . . and the year after that?

Are you content merely to plod along through the best years of your life . . . or do you want to get into more pleasant work . . . hold a well-paid job . . . perhaps establish your own business?

If you are looking for a REAL opportunity . . . If you want to GROW with a GROWING INDUSTRY . . . If you want to grasp the success that should be yours, *then we say to you, study TV Servicing.*

Everyone knows that Television is the fastest growing industry today. Opportunities are going begging for men who have the training and ability to grasp them. *Now is the time to start on the road to success in TV Servicing.*

Study at Home in your spare time

The RCA Institutes Home Study Course in TV Servicing is easy to learn. You progress rapidly, step by step, as you learn the procedure of servicing and trouble-shooting TV receivers and installing TV antennas. Hundreds of pictures and diagrams help you understand the how-it-works information and the how-to-do-it techniques.

A Service of Radio Corporation of America

The RCA Institutes TV Servicing course was written and planned by instructors with years of specialized experience in training men. You get up-to-the-minute information, too, because you study right at the source of the latest developments in Television. Your lessons are carefully examined and accurately graded by competent teachers who are interested in helping YOU to succeed.

RCA Institutes is licensed by the University of the State of New York . . . an affiliate member of the American Society for Engineering Education . . . approved by leading Radio-TV Service Organizations . . . approved by Veterans Administration.

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RCA Institutes makes it easy for you to take advantage of the big opportunities in TV Servicing. The cost of the TV Servicing Home Study Course has been cut to a minimum. You pay for the course on a pay-as-you-learn unit lesson basis. *No other home study course in TV Servicing offers so much for so little cost to you.*

RCA Institutes conducts a resident school in New York City offering day and evening courses in Radio and TV Servicing, Radio Code and Radio Operating, Radio Broadcasting, Advanced Technology. *Write for free catalog on resident courses.*

SEND FOR FREE BOOKLET—Mail the coupon—today. Get complete information on the RCA INSTITUTES Home Study Course in Television Servicing. Booklet gives you a general outline of the course by units. See how this practical home study course trains you quickly, easily. Mail coupon in envelope or paste on postal card.

MAIL COUPON NOW!

RCA INSTITUTES, INC., Home Study Dept. RE354
350 West Fourth Street, New York 14, N. Y.

Without obligation on my part, please send me copy of booklet "RCA INSTITUTES Home Study Course in TELEVISION SERVICING." (No salesman will call.)

Name_____
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Address_____

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THE SERVICE RUNAROUND

RADIO-ELECTRONICS will be happy to print future contributions similar to the ones below, giving personal experiences of radio and television technicians. We shall pay $10 for each contribution used by this department. The contribution may be either serious or humorous, but should be an actual experience encountered by a service technician.

Address all contributions to:

Editor, THE SERVICE RUNAROUND
% RADIO-ELECTRONICS
25 West Broadway
New York 7, New York

A DOCTOR'S APPOINTMENT

Our doctor-customer was angered by the nonperformance of his video set and was too busy to make an appointment so that a service technician could see the set. He berated us and the receiver we'd sold him. Meantime his warranty was running out and we didn't want to be put in a position where we might be suspected of delaying repairs till a set was out of warranty.

Finally we had one of our men, who was unknown to the doctor, call him up as a patient and make an appointment.

When the repairman got to see the medic, he told him he was there to look at the set, and asked him how much time he allotted a patient and what his office fee was.

The doctor said he generally figured on 20 minutes to a patient, so our technician went to work and luckily spotted the trouble in the allotted time. He handed the doc the regular fee, but the doctor handed it back with a smile and complimented our man on his novel approach.—*Harvey Muller*

RUNNING WATER

This opus could be called "The Case of The Running Water." It happened in the East End of Montreal.

During the freezing months of winter we received a call from a customer. Our repairman who answered their plea for assistance was one of our more highly skilled technicians, as the customer's home was some distance from the shop and we didn't particularly relish a return engagement, nor was it practicable at that time. Upon arrival, the technician inquired of the trouble and was told the set "hissed" (which we thought was not unusual, considering the programs it was receiving), but try as he might, the thing just would not hiss and he left. Several days later the hissing returned and there came another complaint.

The set was under guarantee but the expiration date was close at hand and we thought it possible that the customer was conjuring up faults as a device to have his set thoroughly checked. But he had never been a nuisance before and we couldn't falsely accuse, so we trod our way back through another snowstorm. Of course, upon arrival the cupboard was bare. No hissing, no boiling, no nothing. Just a clear, sweet picture. "But it hissed at eight o'clock last night," he protested, "and it did it the

Now a COLOR TELEVISION HOME STUDY COURSE by RCA Institutes

"Color Television is here—not around the corner, or in the developmental labs, but here! The big question now is . . . Are YOU ready for Color TV?

"You may now have a successful TV servicing business. When color sets come to your bench for servicing, will you be able to handle them?

"Color Television is a vast new field, embodying entirely new concepts . . . principles of light and vision, radically new circuitry."

First Home Study Course in Color TV

Now is the time to prepare. Now, for the first time, you can train yourself for the opportunities in this brand-new field. The just-announced RCA Institutes Home Study Course is the *first* home study course covering all phases of color television. Offered only to those already experienced in radio-television servicing, it explains the "why" of basic theory, as well as the "how-to-do-it" of servicing techniques.

Planned and written by RCA instructors, the entire course is based on the practical experience of RCA engineers—the men who have pioneered in the research and development of color television since the very first color experiments, many years ago.

Remember when black-and-white television first became a reality? Overnight, the demand for men who knew television grew. Even now, a shortage of qualified servicemen exists. Think, then—of the even greater demand for servicemen who will understand the many additional problems of color reception!

Costs so little to gain so much

RCA Institutes makes it easy for you to prepare yourself now for color television. Not only is the cost of the home study course for qualified servicemen extremely low, but you pay for the course on a pay-as-you-learn basis.

RCA Institutes conducts a resident school in New York City offering day and evening courses in Radio and TV Servicing, Radio Code and Radio Operating, Radio Broadcasting, Advanced Technology. *Write for free catalog on resident courses.*

Send for FREE Booklet—Mail the coupon, today. Get complete information on the RCA INSTITUTES Home Study Course in Color Television. Booklet gives you a general outline of the course lesson by lesson. See how thoroughly you can learn Color TV.

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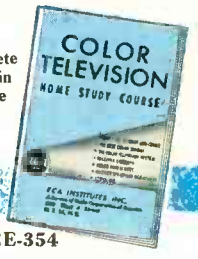

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night before!" We decided to remain until eight o'clock, nine o'clock, ten o'clock . . . and then came eleven o'clock. No hiss tonight.

We became rather fond of the customer (he always served beer during our visits). We felt if the set really were hissing, then to maintain our professional reputation the trouble must be eliminated.

We therefore removed the set, installed it on the test bench in the shop and instructed the shop personnel . . . "Make this set hiss!" We neglected to ask our customer if he could somehow represent the sound of the hiss, either with his mouth or some instrument. So we amended our foolish error by telephoning him and asking that question. Yes, if we would turn the water tap open and let the water run slowly, then we would have an exact reproduction. We turned on several taps, and finally found one that sounded like a perfect corona discharge. "O.K., boys, look for a corona discharge," we said. But sad to relate, no corona.

We crossed our fingers, and without calling for an appointment drove to the customer's home with the set. (We may as well mention it was again snowing.) When we arrived his wife apologized for the condition of the kitchen where the set was normally installed. "Just cannot dry in the snow you know . . . gotta dry all the kid's diapers in the kitchen . . ."

"Ha, ha! So your television set has been hissing, eh?" we asked. "Well lady, you can grow orchids in your kitchen with *this* humidity . . ."

And so ends our tale. It was so hot and humid that the insulation broke down within the set and caused a perfect corona. Naturally it didn't hiss while we were there; she was proud and didn't want us to see diapers strung all over the kitchen, so she refrained from washing at the times of our service calls. Hence no humidity.—*J. S. Bremner*

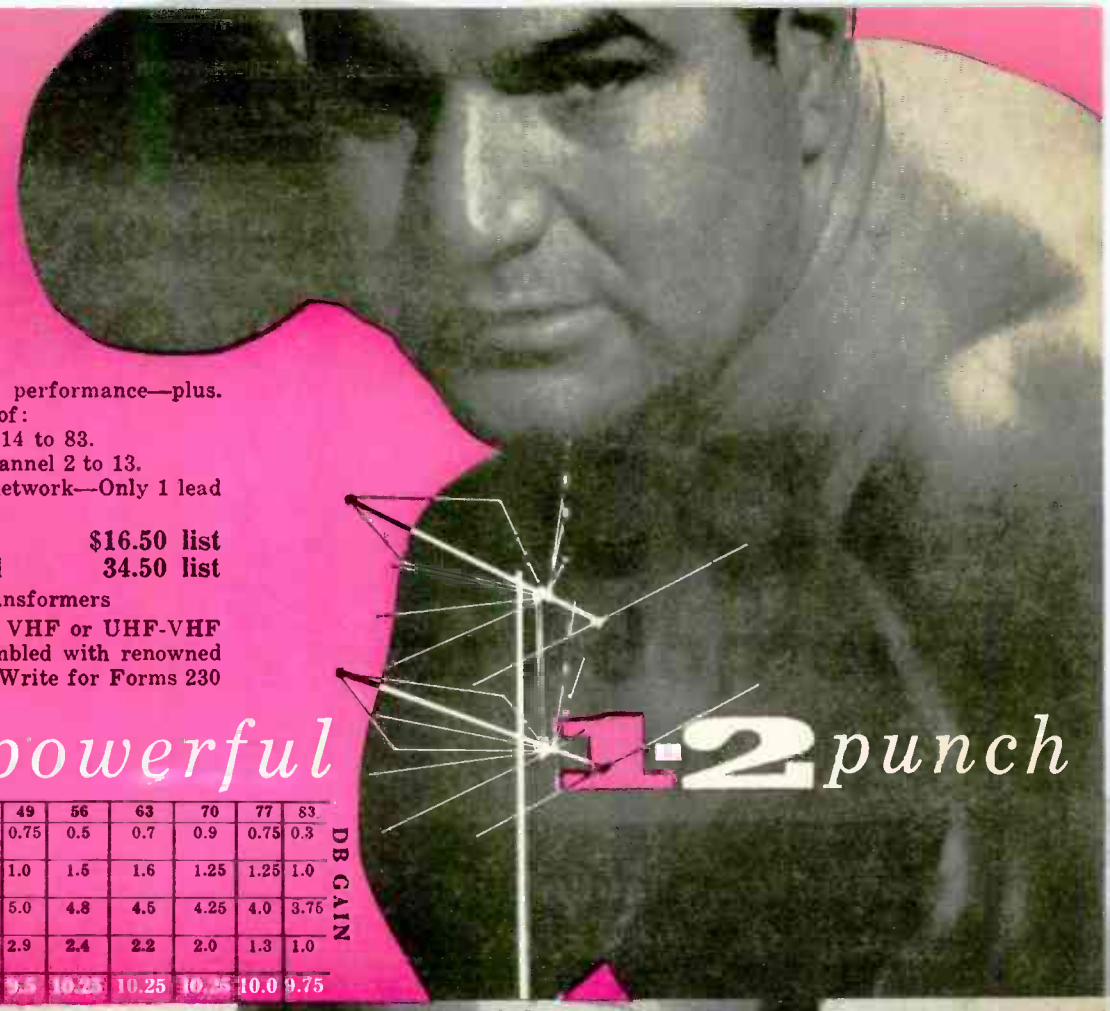
MERRY CHRISTMAS

During the Christmas season a customer phoned and complained that the set was going on and off. I went out on the call and sure enough, just like the tick of a clock, the set went on and off. I suspected a bad connection and listened carefully for peculiar sounds like intermittent arcing. I did not detect anything unusual, so I connected an a.c. voltmeter across the a.c. interlock socket. Sure enough, up and down went the meter pointer. This was a new one on me.

I had been admiring the flashing ornamental lights on the Christmas tree when I suddenly noticed that they flashed on and off *with the receiver*. Then it hit me! I checked the set's line cord and found that it was plugged into the light flasher! We had a good laugh, then I cleared up the trouble and left.—*Harold F. Palmer*

A MEATY ONE

During World War II, a lot of old receivers with 24-A's were dragged out



JFD JeTOMIC

Produces brilliant deep fringe UHF performance—plus.
Produces heretofore unachieved gain of:
Stacked* UHF Rhombic on Channels 14 to 83.
Stacked JeT conical on every VHF Channel 2 to 13.
Featuring exclusive no-loss isolation network—Only 1 lead to set.

Model JeT 454 Single $16.50 list
Model JeT 454 S* Stacked 34.50 list

* complete with stacking transformers

Guaranteed to out-perform any other VHF or UHF-VHF antenna. Both units factory pre-assembled with renowned Jet-action all-aluminum construction. Write for Forms 230 and 241.

the most powerful 1-2 punch

Channels	14	21	28	35	42	49	56	63	70	77	83
Competitor A Conical with Bowtie (2 stack)	4.0	3.25	2.0	1.0	1.0	0.75	0.5	0.7	0.9	0.75	0.3
Competitor B Bedspring with UHF	0.75	0.75	0.9	1.0	0.8	1.0	1.5	1.6	1.25	1.25	1.0
Competitor C Conical with V (2 stack)	3.0	3.3	4.0	4.6	4.9	5.0	4.8	4.5	4.25	4.0	3.75
Competitor D Filter type with attached "V"	2.0	2.0	2.5	2.75	2.9	2.9	2.4	2.2	2.0	1.3	1.0
JFD JeT 454 S	7.0	7.25	7.4	8.5	9.0	9.5	10.25	10.25	10.25	10.0	9.75

DB GAIN

JFD SUPER-JeT

Delivers Spectacular Deep fringe VHF performance—plus.
Packs Unprecedented gain of:
Single 10-Element VHF Yagi on each channel from 2 to 13.
Stacked UHF Bowtie-Reflector off side lobes on Channels 14 to 83.

Model JeT 213 Single $20.75 list
Model JeT 213 S* Stacked 42.50 list

* complete with stacking transformers

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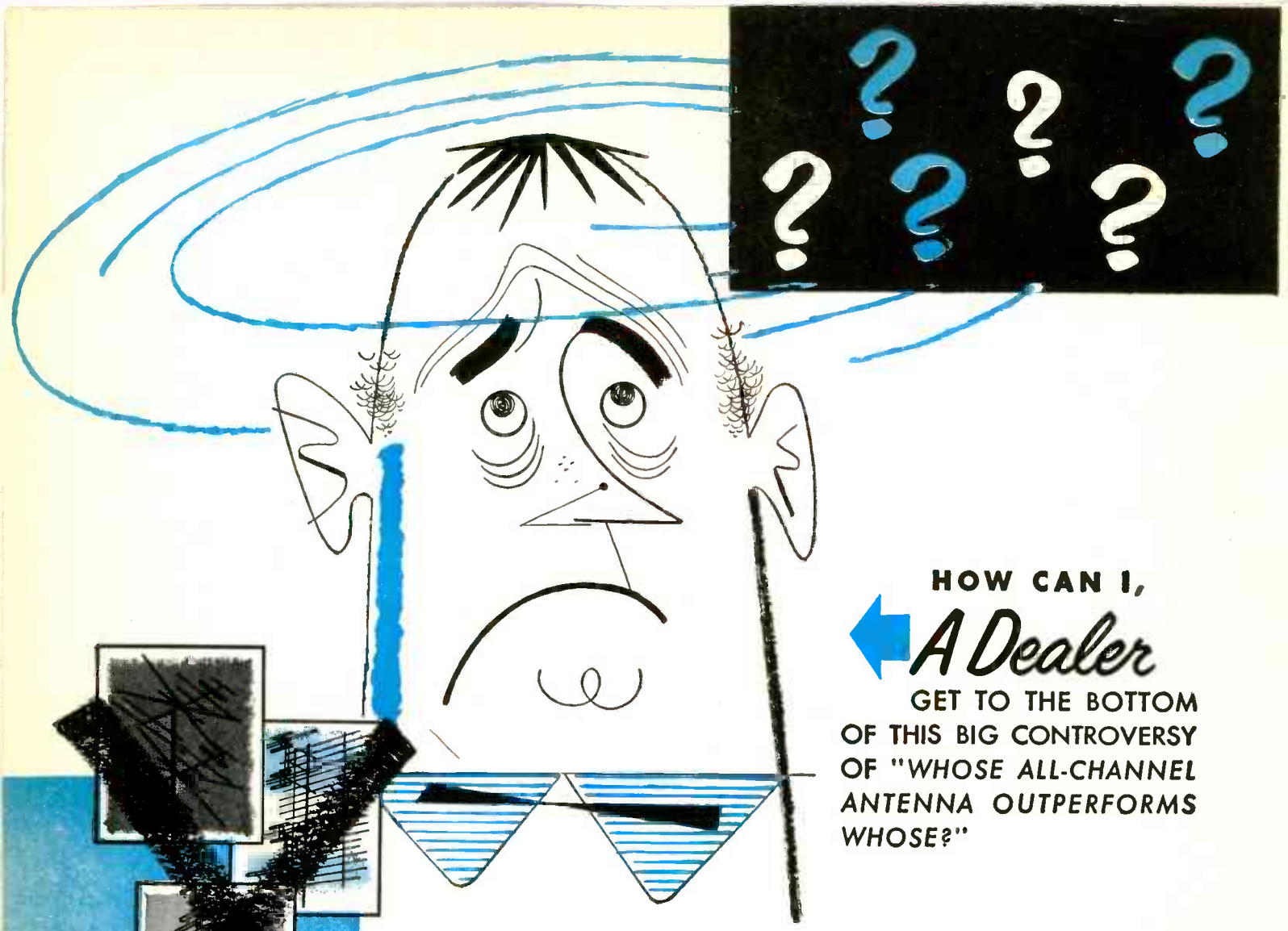
in antenna history!

CHANNELS	2	3	4	5	6	7	8	9	10	11	12	13
Competitor A Mattress (4 Stack)	4.0	5.0	7.0	6.25	5.0	5.25	6.0	5.25	7.25	9.25	6.5	7.0
Competitor B Radar Screen Type A	0.0	3.0	4.0	3.25	3.0	4.5	7.0	7.0	8.0	10.0	10.0	9.0
Competitor C Radar Screen Type B	0.75	3.25	4.5	3.5	3.5	6.0	7.0	6.5	7.75	8.0	7.5	6.0
Competitor D CHS 2-13 YAGI	4.50	5.00	5.75	3.00	2.50	3.50	1.00	0.0	.875	.875	.50	.75
JFD JeT 213 S	6.0	7.5	8.75	7.75	6.75	10.0	9.0	7.0	9.0	10.0	11.0	9.75

DB GAIN

	1" Square Crossarm	Completely Preassembled	LIST PRICE
Competitor A	NO	YES	$55.00
Competitor B	NO	NO	$34.95
Competitor C	NO	NO	$47.50
Competitor D (2 STACK)	NO	NO	$65.90
JFD JeT 213 S	YES	YES	$42.50

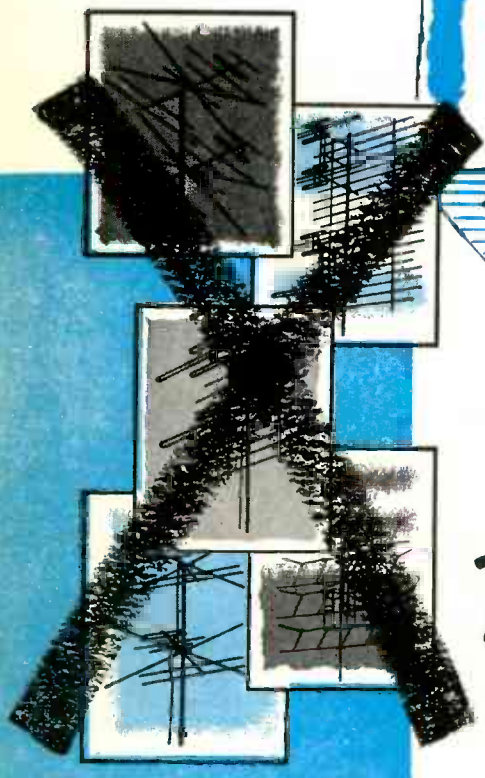
World's largest manufacturers of TV antennas and accessories.



HOW CAN I,

A Dealer

GET TO THE BOTTOM OF THIS BIG CONTROVERSY OF "*WHOSE ALL-CHANNEL ANTENNA OUTPERFORMS WHOSE?*"



DO AS THOUSANDS OF OTHER DEALERS ARE DOING...

Test the super "KATYS" Yourself!

Find out for yourself, in your own area, why KAY-TOWNES can honestly guarantee that a super "KATY" will outperform any other all-channel TV antenna on the market today!

If we were in your shoes, with a local Dealer-Service reputation to protect . . . *and add to* . . . we would do exactly as you *should do!* WE WOULD RUN OUR OWN PERFORMANCE TESTS ON THE SUPER "KATYS"!

In the next few months, many of our competitors are going to attempt to copy the "KATYS" . . . just as they did our "BIG JACK". We have already taken the necessary steps to stop them . . . *and to protect our dealers.* This is the price forced upon us, because of our recognized leadership in the field of "fringe area" antenna design.

When you stop to think, it is easy to understand why KAY-TOWNES is so far ahead of the pack. While the others have been busy "commercializing" strictly on production to satisfy the huge demand, KAY-TOWNES has been working toward the "*reception perfection*" demanded by today's more cautious buyers of Television!

4½ YEARS OF DEVELOPMENT, with our resources and energies trained upon the objective of designing and engineering the world's finest TV antenna, has produced the SUPER "KATYS". What the SUPER "KATYS" will do toward the betterment of Television enjoyment is a foregone conclusion.

Look for KAY-TOWNES' big consumer ads appearing in *Life Magazine* . . . *Country Gentleman* . . . *Progressive Farmer* . . . and many other of the leading home publications!

The combined readership of all these publications will add up to more than 30,000,000 individual readers in the most productive "fringe areas" in America! *Think what this means in terms of selling help for you!*

It's a fact...

The amazing, "long-distance", photo-clear reception performance of the KAY-TOWNES SUPER "KATYS" makes all other all-channel antenna designs as obsolete as the 7-inch screen!

THE SUPER "KATYS" WILL PROVE . . . THE BEST SET IS ONLY AS GOOD AS ITS ANTENNA!

WHO CAN I BELIEVE

Who IS TELLING THE TRUTH ABOUT TV ANTENNA PERFORMANCE... *and who isn't!*

WE CAN ONLY ANSWER FOR OUR OWN ANTENNAS . . . *AND THEN LEAVE THE ENTIRE QUESTION UP TO YOUR OWN GOOD, QUALIFIED JUDGMENT!*

***THE NEW,* KAY-TOWNES SUPER "KATYS" ARE *POSITIVELY GUARANTEED* TO OUTPERFORM ANY OTHER ALL-CHANNEL ANTENNA ON THE MARKET TODAY!**

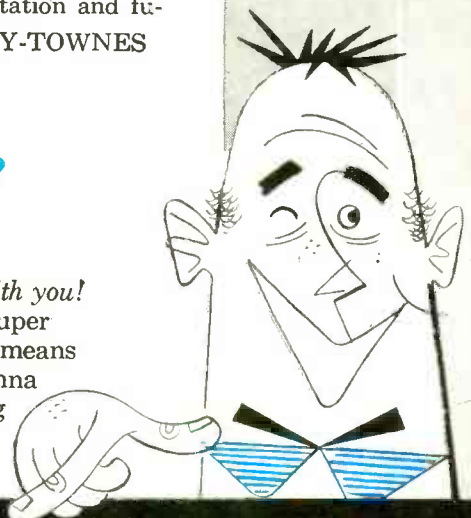
This is an absolute fact, and not simply an advertising statement! In our search for a perfect All-Channel Antenna design we have, in the past 4½ years, developed countless arrays *with ability to perform as well and often better* than any competitive design available. We didn't stop there!

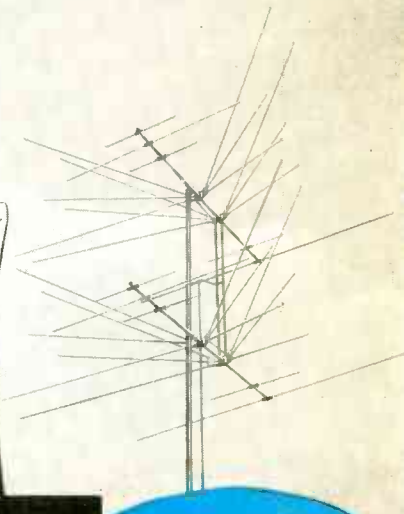
The more we probed into the secrets of TV reception, the more convinced we became that with the *right research and study*, the *right engineering and experimentation* we could finally develop a truly amazing and outstanding TV Antenna. We didn't stop until we did just that!

We've crossed and recrossed our engineering trails many times. We've made every test and check possible. We stake our reputation and future on the positive GUARANTEE we make for the KAY-TOWNES SUPER "KATYS"!

What does this Guarantee mean to You... a Dealer?

First of all, it means that we are absolutely sincere with you! It means that we are willing to stand behind the Super "KATYS" with all the resources at our command. It means that you can finally SELL an All-Channel TV Antenna you can depend on to do the best possible receiving job for any installation!





KAY-TOWNES
ANTENNA COMPANY
ROME, GEORGIA
Recognized leaders in the field of fringe area antenna design

and put back into service. These tubes (remember?) had large, conspicuous grid caps.

One day I got a call from a woman who complained that her radio was very weak. Also she noticed that by putting her finger on the grid cap she could increase the volume. This she said, was very tiresome while trying to listen to her favorite programs.

When our technician arrived he found that her inventive genius had gone into action and she had removed about two pounds of sirloin steak from the refrigerator and wired it to the grid cap! Only after she found that the meat somehow did not attract the radio waves did she decide to have the set repaired. —*Ralph C. Lippert*

BATH-NIGHT BREAKDOWN

The customer who had bought one of our best television receivers called to complain that *every time someone took a bath,* his set went out completely. (The set was not in the bathroom.)

We checked every component to no avail; then the antenna and lead-in came in for a microscopic examination.

Sure enough, the plastic 300-ohm lead was almost rubbed bare of insulation from close contact with the hot-water pipe that ran from the boiler. The pipe was copper and when a continuous stream of hot water ran through it for a time, it expanded just enough to short out the wires in the worn plastic! —*Henry Josephs*

OPPORTUNITY KNOCKS

Street and house numbers in our area are being changed, and this has led to considerable confusion, especially since many street signs and house markers have already been painted out pending the assignment of the new numbers.

When I called at a house recently to deliver a repaired radio, the lady who answered the door-bell turned out to be the wrong one on the wrong street. But this gave me an opportunity to identify myself and tell about our service, and not only did I get two radios for repair, but she promised to come in to see our line of television receivers.—*Harry J. Miller* END

"Would you mind trying channel 9 now?"

NO INTEREST!!

Buy on our radically new

Time Payment Plan

NO CARRYING CHARGES!!

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 7.5/15/75/150/750/1,500/7,500 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

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.

The Model 670-A comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions.

$28.40 NET

Superior's new Model TV-11

TUBE TESTER

SPECIFICATIONS:

★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Peanut, Bantam, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.
★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary.
★ The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.
★ Free-moving built-in roll chart provides complete data for all tubes.
★ Newly designed Line Voltage Control compensates for variation of any Line Voltage between 105 Volts and 130 Volts.
★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

The model TV-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover

$47.50 NET

EXTRA SERVICE — The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

Superior's New Model 660-A **AN AC OPERATED**

SIGNAL GENERATOR

PROVIDES COMPLETE COVERAGE for AM-FM & TV Alignment

SPECIFICATIONS:

● 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—68E6 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.

$42.95 NET

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. B-94, 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked. I am enclosing the down payment with order and agree to pay the monthly balance as shown. It is understood there will be no carrying, interest or any other charges, provided I send my monthly payments when due. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

Name.....

Address.....

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

☐ MODEL 670-A .....Total Price $28.40 $7.40 down payment. Balance $3.50 monthly for 6 months.
☐ MODEL TV-11 .....Total Price $47.50 $11.50 down payment. Balance $6.00 monthly for 6 months.
☐ MODEL 660-A .....Total Price $42.95 $12.95 down payment. Balance $5.00 monthly for 6 months.
☐ I enclose $.....as down payment.
☐ Ship C.O.D. for the down payment.

WITH THE TECHNICIAN

JOINT SERVICE PROJECT

Philadelphia's WFIL and WFIL-TV are joining with the Council of Radio and TV Service Dealers and Service Technicians' Associations to conduct an intensive public service campaign stressing proper care and maintenance of home radio and television receivers.

David Krantz, chairman of the Industry Relations Committee for the Council, announced that more than 2,500 service technicians from Eastern Pennsylvania, New Jersey, and Delaware will participate in this campaign. Through interviews conducted on programs over WFIL and WFIL-TV, and spot announcements throughout the stations' schedule, listeners and viewers will be constantly alerted to the need for expert care and service for their sets.

In announcing the stations' participation in the public service campaign, general manager Roger W. Clipp said, "Along with constant efforts to improve programs, we cannot lose sight of the millions at home who receive these programs and of the qualified service technicians who keep their sets operating at a high level of efficiency. This campaign, undertaken in co-operation with the Council of Radio and Television Service Associations, will familiarize our audience with the objectives and Code of Ethics of the group, and help our listeners and viewers to keep their sets in good working order."

NATESA ISSUES AWARDS

Joining with other branches of the electronics industry and with the mayor and Chamber of Commerce of Indianapolis, the National Alliance of Television and Electronic Service Associations honored Howard W. Sams with its "Friend of Service Management" award, January 7. Chief speakers at the event were Mayor Clark, of Indianapolis, and Frank Moch, president of NATESA, who stated that the award was presented to Sams for his efforts in behalf of the service business and his contributions to the training of service personnel.

A similar award was presented to John T. Thompson of General Electric's tube department, in which the G-E tube department was cited for the second year, "for outstanding service to television service management in creating better customer relations." A wreath was voted to Sylvania, to be added to the plaque previously awarded that company.

MOCH AGAIN HEADS TISA

Frank J. Moch was re-elected president of the Television Installation Service Association, Chicago. Also re-elected were John Cecich as vice-president, Jerome Mann as treasurer, and Rubin Saxner as secretary. Newly elected officers are Ralph Friedman, second vice-president, and Russ Havill, sergeant-at-arms.

TISA's membership is stated to have gained approximately 20% during the past year, and now numbers about 75 service companies.

FACTS NOT JUST CLAIMS

FACT- 53 CLAIMS GRANTED IN 5 UNITED STATES PATENTS—
#2,585,670; 2,609,503; 2,625,655; 2,644,091; 2,661,423, others pending.

FACT- These antennas positively receive ALL channels 2-83 from ALL directions without a rotor motor.

MONEY BACK GUARANTEED TO RECEIVE *All* CHANNELS 2-83 FROM *All* DIRECTIONS AND POSITIVELY OUTPERFORM *All* OTHER ANTENNAS WITH OR WITHOUT A ROTORMOTOR

FACT- These antennas have consistently OUT-GAINED and OUT-PERFORMED all others in actual public demonstrations.

FACT- These antennas will unquestionably OUT-PERFORM all others, on YOUR roof, with YOUR set, or YOUR money back.

FACT- SAVES YOU MONEY. Eliminates rotor motor, uses only ONE transmission line, uses only ONE antenna for both UHF & VHF—and only ONE simple, quick installation.

FACT- Perfect pictures have consistently been received as far as 3 times the guaranteed distances.

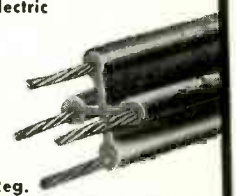
FACT- ONLY one antenna, ONLY one transmission line, ONLY one installation. You solve once and for all your PRESENT and FUTURE antenna problems.

9 POSITION ELECTRONIC ORIENTATION SWITCH

PRICE INCLUDES
Antenna arrays - necessary stacking bars - 9 position switch - switch-to-set coupler - necessary hook-up harness - 7½" stand-offs Individually boxed in mailable carton.

NEW **POLYMICALENE**
4 CONDUCTOR TRANSMISSION LINE

- Low Loss External Air Dielectric
- Matched Impedance
- Eliminates End Sealing
- Eliminates Condensation
- Up to 50% Less Loss Than Tubular When Wet
- Easily Spiraled
- No Breaking or Shorting
- Patents Pending - T. M. Reg.



ALL CHANNEL ANTENNA CORP.,

70-07 Queens Blvd., Woodside 77, N. Y. Hickory 6-2304

COLOR ON LONG ISLAND

The Long Island Television and Radio Technicians Guild is sponsoring a Color Forum, in which the fundamentals of color theory and servicing will be discussed. At the introductory session held at the American Legion Hall, Williston, L. I., attendance broke all records. Approximately 250 service technicians turned out to learn about color TV.

Murray Barlowe led the discussion, stressing the complexity of color TV circuitry and the necessity of additional knowledge and new shop equipment to handle color problems. He stated that the screwdriver technician — already given a near-fatal blow by television—is now entirely through, and that, with color, servicing becomes an industry which will require highly specialized skill, complete knowledge of the subject, and—considerably better compensation.

COUNCIL ELECTS HAAS

The Philadelphia Council of Radio-Television Associations has elected Albert M. Haas of the Television Contractors Association (TCA) as its 1954 chairman. Ray Cherrill, of the Northeast Television Service Dealers Association, was elected vice-president, and William Wile, Jr., of the Television Service Dealers Association, secretary. Dave Krantz was appointed chairman of the broadcast and public relations committee.

A TECHNICIAN'S LOT

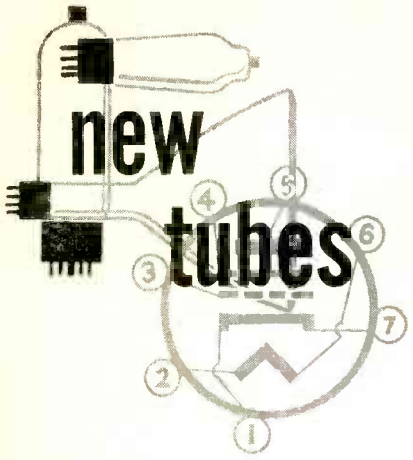
The inspirational little piece below is reprinted from *ARTSNY News*, by special permission of that organization. Its authorship is attributed to Seymour Weinberg of the Associated Radio-TV Service Technicians:

When a television set starts acting crazy,
When the picture rolls and horizontally runs,
When the video and sound are weak and hazy,
A technician's lot is not a happy one.
When a customer starts hollering for service
And you have some other jobs that must be done,
When his visits and his phone calls get you nervous,
A technician's lot is not a happy one.
When your wife complains you're never home to take her
When all your friends go out to have some fun,
When your customers call you a gyp and a faker,
A technician's lot is not a happy one.
What good is all your fussin' and your fumin';
Alone you'll never get a darn thing done.
You must make the public realize you're human
If you want to make your lot a happy one.
So why not get behind us at ARTSNY;
We're working hard for our place in the sun.
Now's the time for all good men to join the party—
Make the technician's lot a happy one!

NEW ORLEANS OFFICERS

The Radio, Television and Appliance Association of New Orleans elected Robert V. Schumert president; Stanley B. Reinherz, vice-president; Wesley P. Massey, secretary; and Leonard Estorge, treasurer of the organization for 1954.

A silver plaque was presented to the retiring president, Robert J. Magoni, "in recognition of outstanding service" to the association. The presentation was made by Morris Warnick, a past president of RTAA. END



G-E has announced development of its first receiving tube type intended primarily for use in color TV receivers.

The tube, type 6BJ7, is a miniature triple diode. Its primary use is as the d.c. restorer for the three signal channels of color receivers. The electrical characteristics of each section of the 6BJ7 are similar to those of each section of the 6AL5 twin triode.

Maximum ratings for the 6BJ7 are: peak inverse plate voltage, 330; peak plate current per plate, 10 ma; d.c. output current per plate, 1 ma; heater-cathode voltage (heater positive with respect to cathode), 100; (heater negative with respect to cathode), 330.

G-E has announced two new 21-inch picture tubes of the 90° deflection type. They are about 3 inches shorter than corresponding narrower-deflection types. The tubes, types 21ACP4 and 21-ACP4-A (aluminized), are of all-glass, rectangular construction.

Both tubes are 20 inches in over-all length. The 90° feature provides an increase up to 7% in screen area over tubes with narrower deflection angles. The tubes have an external conductive coating which acts as a filter capacitor when grounded.

Typical operating conditions for the 21ACP4 and the 21ACP4-A are: anode voltage, 16,000; grid 2 voltage, 300; grid 1 voltage, –28 to –72; ion trap intensity, approximately 40 gausses.

RCA has announced two new tube types: the 6BY6 and 6197.

The 6BY6 is a pentagrid amplifier of the 7-pin miniature type. It is intended for use as a gated amplifier in television receivers, where it may be used as a combined sync separator and sync clipper.

The 6BY6 has separate base-pin terminals for grids 1 and 3. Each of these grids can be used independently as a control electrode, and has a sharp-cutoff characteristic. The sharp cutoff permits good sync clipping and noise cancellation with relatively low input signals. Furthermore, grid 3 is processed to minimize secondary emission and the resultant possibility of blocking.

An important feature of the 6BY6 is its favorable current ratio of plate current to grids 2 and 4 current. With this ratio, the output signal can be

NEW DESIGN

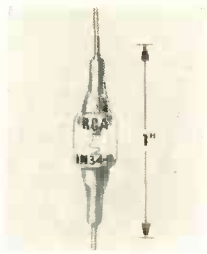
obtained with relatively low-power input to grids 2 and 4.

The 6197 is a 9-pin miniature sharp-cutoff pentode having very high transconductance. It is designed for frequency-divider and pulse-amplifier circuits in electronic computers and other on-off controls involving long periods of operation under cutoff conditions.

The stable cutoff characteristic of the 6197 permits a consistent cutoff bias to be maintained, and eliminates control-grid emission.

Among the features of the 6197 are radiating fins on grid 2 to increase its dissipation capabilities, a getter shield to minimize interelectrode leakage, and a pure tungsten heater to give long life under conditions of frequent on-off switching. Grid 3 and cathode have separate base-pin connections.

RCA also announces manufacture of germanium point-contact type sealed-in-glass crystal diodes, including: the 1N34-A, the well-known general-purpose diode for use in low-power rectification; the 1N38-A, a large-signal type with a peak inverse voltage rating of 100; the 1N54-A, a high-back-resistance type for use in clipping circuits, high-impedance high-voltage probes, d.c. restorer circuits, and high-impedance detector circuits; the 1N55-A, a large-signal type with a high peak inverse voltage rating of 150; the 1N56-A, a high-conduction type featuring an exceptionally low



dynamic impedance; the 1N58-A, similar to type 1N55-A but with a lower peak inverse voltage rating.

Sylvania has announced the 6AM8, a diode-pentode. The new tube is similar to a 6CB6 plus one-half of a 6AL5.

The pentode section of this 9-pin tube type has a transconductance of 5,800, and is intended for use as the last video i.f. amplifier in television receivers. The addition of the diode

allows the tube to be a combined i.f. amplifier and video detector, thus aiding in the reduction of tubes used in TV receivers.

A new mirror-back picture tube—the 21FP4C, has been announced by CBS-Hytron.

This tube, which may be used to replace the 21FP4, is aluminized, with low-voltage electrostatic focus. Using electromagnetic deflection, it has an all-glass, rectangular-bulb, cylindrical face-plate that gives greater contrast and a reflection-free viewing surface.

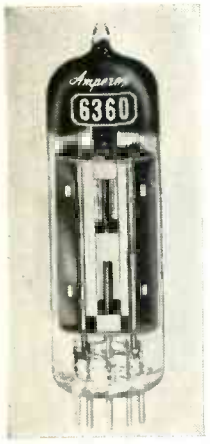
The aluminum-backed screen reinforces light output and provides brighter, sharper pictures, without additional demands on the other components of the set.

The 21FP4C has an electron gun designed for use with a single-field, external ion-trap magnet. Its outer conductive coating, when grounded, acts as a high-voltage filter capacitor.

The mirror-back (aluminized) screen reflects light output to the viewer that would otherwise be lost to the rear of the screen.

An addition to its line of twin-tetrode tubes has been announced by Amperex. The tube, type 6360, is a miniature twin-tetrode having an over-all length of $3\frac{1}{16}$ inches, and a diameter of $\frac{7}{8}$ inch.

The tube is particularly useful in low-drain, mobile transmitters and multiplier chains where its ability to increase the power level quickly and produce a balanced output make it ideal for driving higher-power and higher-frequency push-pull stages.



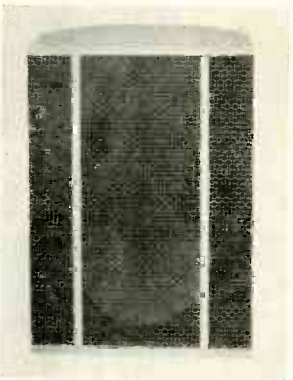
The 6360 is designed for use as a class C amplifier and oscillator, frequency multiplier, and modulator for frequencies up to 200 mc at maximum ratings. It can deliver 16 watts at 200 mc under ICAS conditions. As a frequency tripler from 67 mc to 200 mc, it can deliver 5 watts under ICAS conditions. END

"I'll take your things. We hang them in the kitchen now!"

NEW DEVICES

ENCLOSURE KITS

G & H Wood Products Co., 75 N. 11th St., Brooklyn 11, N. Y., has announced a kit series based upon the Klipsch corner horn enclosure design by Cabinart for 12 and 15 inch speakers.



THE K-12 and K-15 embody all the features found in the finished units. Large-enclosure performance is maintained by "backloading to increase the path length and to provide better reproduction of the lows. Unique cabinet design makes for easy accessibility to speaker and simplifies external installation. Dual port arrangement provides for the use of two speakers in varying combinations.

The units are available in unfinished birch, and can be finished in style and color desired. They are packaged complete, from hardware to precut baffle. Easy-to-follow assembly and finishing instructions also are included.

C-R TUBE CHECKER

Eico (Electronic Instrument Co., Inc.), 84 Withers St., Brooklyn 11, N. Y., has produced the new model 630 C-R tube checker in kit and wired form.

The model 630 indicates shorted or open elements in the electron gun, using a sensitive neon lamp. Bridge measurement of peak beam current (proportional to screen brightness) is made using a neon lamp as a balance indicator. Balancing control is calibrated directly in terms of tube condition. Test sockets and cables are provided for picture tubes with either duodecal or diheptal sockets to cover practically all modern tubes. An octal socket is provided so adapters can be plugged in for tubes with other bases. TV picture tubes can be tested right in the TV set or carton, using the test sockets connected to the tester by 2½-foot cables.

D.C. POWER SUPPLY

Electro Products Laboratories, 4501 Ravenswood Ave., Chicago 40, Ill., has announced a low-cost d.c. power supply unit that supplies up to 16 volts d.c.

Its output is continuously variable from 0–8 and 0–16 volts d.c.; maximum continuous current rating is 10 amperes for all voltages up to 12 with intermittent current rating of 20 amperes. Other features are: low ripple; choke input-type filter; conduction cooling and selenium rectifiers; on-off switch and 8- and 16-volt switch; fused input on front panel; heavy-duty transformer and choke.

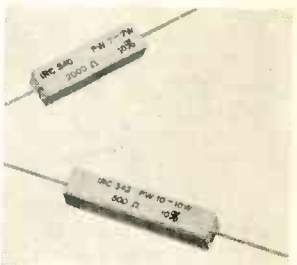
Ratings are: 110–120 volt, 50–60-cycle a.c. input, 250 watts with an 8-ampere 12-volt d.c. load.

Model D-612 is housed in an 18-gauge steel cabinet finished in blue hammerloid. It weighs 20 pounds and measures 12 x 7 x 8½ inches.

POWER RESISTORS

International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa., has introduced two new high-temperature resistors, types PW-7 and PW-10.

Wire elements are wound on glass fiber cores with axial leads 1½ inches long and .036 inch in diameter. Body dimensions of PW-7 are $12\frac{5}{64}$ x $\frac{3}{8}$ x $\frac{1}{32}$ inches; of PW-10, $1\frac{7}{8}$ x $\frac{3}{8}$ x $\frac{1}{32}$ inches. These element-lead assemblies are sealed into a ceramic case with a cement which provides a mechanical



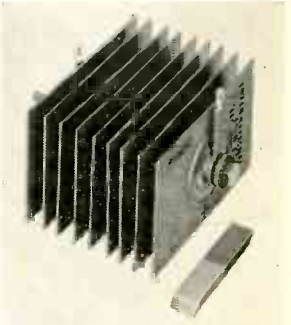
protective bond between the resistive element, the terminals, and the case. Type PW-7 is available from 0.5Ω to 5100 ohms; type PW-10 ranges from 1 to 8,200 ohms. Both are available in ± 5% and ± 10% tolerance.

Types PW-7 and PW-10 are recommended for circuits where a stable resistor is required with an actual wattage dissipation of 7 or 10 watts or less.

COLOR TV RECTIFIERS

International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif., has announced a series of selenium rectifier stacks for color TV sets. The rectifiers in this series are designed for capacitive loads of 600, 700, and 750 ma and are produced for maximum input voltage ratings of 130, 172, and 195 volts r.m.s.

A bellows type spring contactor affords a lower forward drop, lower temperature rise, and longer life. The 2 x 3-inch plate size allows wider



latitude in chassis layout. The photo shows a type RS609S rectifier stack, rated for 195 volts r.m.s. input and 600 ma output.

HIGH PASS FILTER

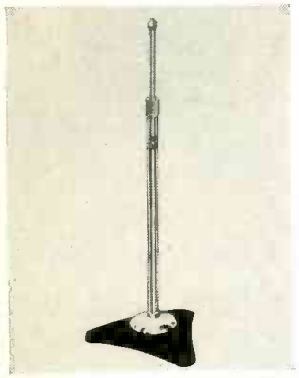
Service Instruments Co., 422 S. Dearborn St., Chicago, Ill., has designed a u.h.f. high-pass filter, the HP2, to pass ultra-high frequencies with less

than 1 db rejection and to reject all v.h.f. with an attenuation of from 45 to 50 db.

According to the company, the HP2 filter eliminates FM interference on u.h.f., airport interference on strips, and i.f. feed-through, and it prevents channel 5 or 6 from interfering on dual-conversion, all-channel tuners.

MIKE STAND

Atlas Sound Corp., 1451 39th St., Brooklyn 18, N. Y., has announced the model MS-25 microphone stand with an "air-cushioned" telescoping sec-



tion. The safety mechanism prevents the stand from crashing down and blasting sound into the amplifier.

The MS-25 has a height adjustment of from 37 to 66 inches and a base diameter of 17 inches. Tube finish is full chrome; base finish is chrome and gray shrivel. The tube terminates in a 5/8-inch-27 carefully machined thread. The stand weighs 24 pounds.

UHF TV GENERATOR

Industrial Television, Inc., 369 Lexington Ave., Clifton, N. J., has announced a u.h.f. TV generator. This device uses the signal from any v.h.f. station and translates it into a u.h.f. signal on any channel.

The LI-130R can be used as a source of u.h.f. signals for demonstrating receiving equipment on all channels. It is also useful as a laboratory test instrument.

WIRE-WOUND CONTROLS

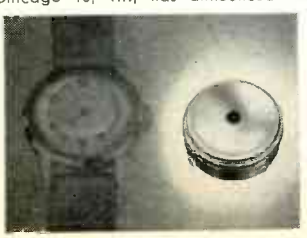
Clarostat Mfg. Co., Inc., Dover, N. H., has announced an improved version of its 1 1/8-inch diameter wire-wound potentiometer or rheostat, series 43c.

An improved wiper arm contact and end termination allows higher resolution, more intricate tapers, and tighter tolerances in over-all resistance and linearity. Terminals are fastened directly to winding, insuring low contact resistance. Collector and terminal are now in one piece, eliminating rivets as mechanical fasteners and current conductors. Stop is integral with base instead of in the cover, insuring a more positive stop, and leaving no holes in cover for dust, moisture, or oil to enter.

Series 43c controls are available in resistance from 1 ohm to 10,000 ohms, 2 watts rating. Taps and various tapers are available. Controls come with or without switch in single, dual, and triple assemblies.

MICROPHONES

Shure Brothers, Inc., 225 W. Huron St., Chicago 10, Ill., has announced the



MC series of magnetic microphones. These controlled-reluctance mikes are only 1 inch (25.4 mm) in diameter and are immune to varying conditions of heat and humidity.

Models MC10 and MC11 are similar, but MC11 has a mu-metal shield ring for reducing hum pickup. They were specifically designed for use with transistor circuits, but are applicable to other devices.

TEMPERATURE-COEFFICIENT SLIDE RULE

Sprague Products Co., 81 Marshall St., North Adams, Mass., has introduced a new capacitor temperature-coefficient slide-rule which speeds and simplifies ceramic capacitor installation problems.

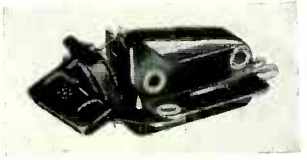
Values of stock N750 and NPO type ceramic capacitors which are to be connected in parallel to equal a capacitor of intermediate temperature coefficient of the required capacitance can easily be found with the C-753 slide-rule. The rule need only be set to the desired temperature coefficient and the value of the required N750 capacitor can then be read directly from the scales without consulting charts or tables. Values of the required NPO capacitor may be determined by subtraction.

The back of the rule is a key to ceramic capacitor color codes. Color bands and dots and their positions on each capacitor type are indicated for temperature coefficient, capacitance, tolerances, and voltage.

PHONO CARTRIDGE

Astatic Corp., Conneaut, Ohio, has introduced a new ceramic-element phonograph cartridge, the GCD. It is a turnover-needle cartridge, in which the cartridge remains stationary in the pickup arm, while the double-tipped needle rotates in switching back and forth to play both narrow- and wide-groove records.

Output is listed at 1 volt. Frequency range is 50-10,000 c.p.s., with 6 grams required as minimum needle pressure. No preamplifier or equalizer is required.



TUBE CADDY

Windsor Electronic Tube Co., 1515 Sheepshead Bay Rd., Brooklyn 35, N. Y. has announced the *Tube Caddy*, a portable carry-all for holding tubes, meters, tools, and other equipment for on-the-spot servicing.

NEW AMPLIFIER

Video Corporation of America, 229 W. 28th St., New York 1, N. Y., has announced the VC-6 amplifier, designed for use with radios, phonographs, or TV receivers. The unit supplies a push-pull power output of 6 watts and has a frequency response of 50–30,000 c.p.s. It has a bass or treble boost of 6 db from a single control.

The amplifier has a self-contained power supply rated at 110 volts, 60-cycle a.c. Impedance is 8 ohms. The unit is 1 3/8 x 3 1/8 x 11 inches long.

10-WATT AMPLIFIER

Brook Electronics, Inc., 34 DeHart Pl., Elizabeth, N. J., has announced the addition of a new 10-watt amplifier, model 22A, to their line of high-quality audio amplifiers.

SELENIUM RECTIFIERS

Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J., has introduced the *Universal* line of selenium rectifiers for replacement purposes. These units are of eyelet construction and come equipped with mounting hardware for simplified installation into the radio or television chassis.

Code numbers and ratings of the new selenium rectifiers making up the line are: 1236A, rated at 300 ma; 1238A, rated at 350 ma; 1241A, rated at 400 ma; and the 1237A, rated at 500 ma.

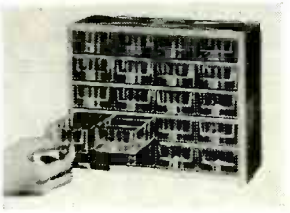
UHF ANTENNA

TV Products Co., 145 228th St., Springfield Gardens 13, N. Y., has introduced a single-bay u.h.f. corner antenna, model 706. This all-channel antenna was designed for use in fringe areas. The 706 has a gain of 14.8 db.

DRAWER CABINETS

General Industries Co., 5738 N. Elston Ave., Chicago 30, Ill., has announced a complete line of *See-Thru* drawer cabinets for small-parts filing and storage in factories, offices, school shops, home workshops, and garages.

Model J-20, pictured here, consists



of 20 clear plastic drawers, 5 7/8 x 2 3/4 x 1-7/16-inches in a welded all-steel cabinet.

Other units now include models ranging from 8 to 128 drawers, models with larger size or metal drawers, and portable models with carrying handles.

NEW AM-FM-TUNER

Fisher Radio Corp., 42-41 Van Dam St., Long Island City 1, N. Y., announces the new model 50-RT FM-AM tuner and audio control unit. It includes bass and treble controls with 15 db boost and cut at 50 and 10,000 cycles, a phono preamplifier with inputs for magnetic and high-impedance cartridges, adjustable equalization, for AES, LP, NARTB, and ortho recordings, separate AM and FM front ends, and a d.c. supply for all audio-tube heaters. Response is ±1 db from the FM and audio circuits and ±2 db from the AM circuit in the broad position.

The Armstrong-type FM system has separate inputs for 72- and 300-ohm antennas, a cascode r.f. amplifier, two i.f. stages, dual limiters, and variable a.f.c. with a cut-out switch. Sensitivity on the 72-ohm input is 1½ μv for 20 db quieting and 3 μv at the 300-ohm input.

The AM circuit has a tuned r.f. stage, and two variable-bandwidth i.f. stages. Sensitivity is less than 1 μv for 1 volt output. It has dual antenna inputs and a 10-kc filter.

Audio distortion is less than 0.04% for 1 volt and 0.8% for 10 volts output. There are two cathode-follower output circuits. One is ahead of the tone controls for output to a recorder.

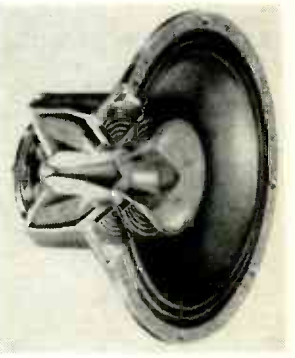
There are separate continuously variable bass and treble controls, a loudness control switched in and out from the panel, a 9-position channel and equalization selector, and volume and tuning controls, a total of six.

Tubes are: 2—6BQ7A, 1—6CB6, 1—6BE6, 3—6BA6, 2—6AU6, 1—6AL5, 1—12AU7, 1—12AX7, 1—6AV6, 1—5Y3, and 1—6U5. The over-all dimensions of the 50-RT are 14¾ inches wide, 8½ inches high, and 9¼ inches deep. Weight, 19 pounds.

AUDIO UNITS

Stromberg-Carlson Co., Rochester 3, N. Y., has added a new combined radio receiver and amplifier, and a 15-inch coaxial loudspeaker to its *custom 400* line.

The combined receiver-amplifier, the SR-405, unites in one chassis a high-fidelity tuner and 10-watt amplifier. It provides radio reception throughout both standard AM and FM broadcasting bands, plus faithful amplification of the entire sound spectrum, from 20 to 20,000 cycles.



The SR-405 gives a power output of 10 watts with less than 1% of total harmonic content. It has separate bass and treble controls of extreme sensitivity, and the volume control is tone-compensated. Input terminals and controls are provided for microphone, television, magnetic recorder, or crystal phono pickup.

The 15-inch coaxial loudspeaker, RF-475, has a 10½-pound permanent magnet of Alnico V metal.

SIGNAL GENERATOR

RCA Victor Division, RCA, Harrison, N.J., has announced the new WR-49A radio-frequency signal generator, useful as a TV and radio signal tracer as well as an alignment oscillator and marker designed for a wide range of AM or FM radio, and TV service operations and other applications which require a continuous wave or modulated r.f. sine-wave signal from 85 kc to 30 mc.

An important feature of the generator is the built-in blocking capacitors connected in series with the r.f. and a.f. cable connectors. The capacitors provide d.c. isolation of the attenuator circuits and prevent damage should the output cable be connected to a test circuit containing d.c. voltage. This feature eliminates the necessity of stringing d.c. blocking capacitors to the tip of the instrument probes each time the test operation involves direct current.

Other operating conveniences include: a separate range switch for the quick selection of one of the instrument's six tuning ranges; a fine-tuning control to facilitate precise setting of the output frequency, and a special dial and tuning assembly which makes possible rapid tuning and reading of the exact frequency setting.

CONICAL YAGI

RMS (Radio Merchandise Sales), 2016 Bronxdale Ave., New York 62, N. Y., has announced a new conical Yagi antenna for v.h.f. the *Mugwump*.

This antenna, model CY-1, is a single-bay unit said to offer the characteristic gain of a Yagi, together with the broad-band response of a conical. The antenna also comes in a 2-bay array, model CY-11.

V.H.F. COLLINEAR YAGI

Technical Appliance Corp., Sherburne, N. Y., has developed an all-channel v.h.f. collinear Yagi antenna, the *Trapper*.

This antenna, model 1880, has a forward director and two tuned driven elements with auto-match stubs, one tuned high-band reflector and one low-band reflector.

For fringe and ultra-fringe installations, two standard Trapper antennas are used with the associated stacking equipment supplied.

DEFLECTION COMPONENTS

RCA Victor Division, RCA, Harrison, N. J., has developed three 90-degree TV deflection components.

The RCA 220D1 is a de luxe, 90-degree, ferrite-core, deflecting yoke, similar to the RCA 219D1. Major differences include smaller size, lighter weight, molded-vinyl insulation, and a molded-bakelite terminal frame. The 220D1 provides good side-and-corner resolution and freedom from pincushion distortion substantially equal to that obtained with 70-degree systems.

The RCA 238T1 is a de luxe 18-kv, ferrite-core, horizontal output (flyback) transformer for use with the RCA 220D1 yoke. It will provide full scan of a 90-degree kinescope when driven by an RCA-6CD6-G operating at only 250 volts, and a cathode current of 115 ma.

The new RCA 239T1 is a low-cost equivalent to the 238T1 in performance and life expectancy. It is quite similar electrically and mechanically.

PORTABLE RECORDER

Magnemite Division, Amplifier Corp. of America, 398 Broadway, New York 13, N. Y., has announced a compact 8-pound weather-tight magnetic tape recorder, the *Flyweight Magnemite*, designed for rugged field use.

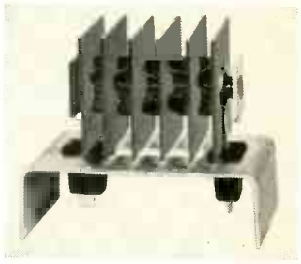
The unit employs a fly-ball governor-controlled triply shielded electric motor with built-in noise suppressor which assures constant speed and freedom from hash during the full life of the motor batteries. A built-in indicator shows when motor batteries should be replaced.

The recorder uses nonmicrophonic sub-miniature tubes and rewinds a full reel of tape in less than two minutes. It is powered by dry batteries. By powering the low-drain recording-playback amplifier independently of the motor, a supplementary set of inexpensive batteries will last 100 operating hours. Motor battery life is 4 hours.

Three different models are available, playing up to 4 hours on a standard 600-foot roll of ¼-inch tape on a 5-inch reel.

PLUG-IN SELENIUM RECTIFIER

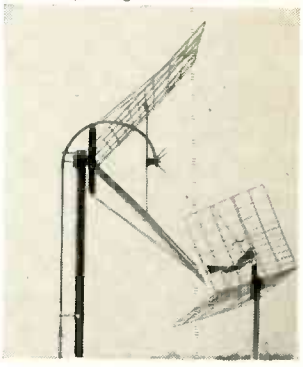
Sarkes-Tarzian, Inc., Rectifier Division, 415 North College Ave., Bloomington, Ind. announces that the *Centre-Kooled* line of selenium rectifiers is being converted to a plug-in type. The lugs are polarized (the positive lug has a 90° twist) for correct circuit connection. They are designed so the rectifier will not fall out or shake loose from the sockets designed for them. Separate sockets (type 9221-1, made by Cinch Manufacturing Co., of Chicago, Ill.) are used for each lug since spacing between them is determined by the rectifier size.



UHF ANTENNA

JFD Manufacturing Co., Inc., 6101 16th Ave., Brooklyn 4, N. Y., has added a corner reflector for fringe reception to its u.h.f. line. The model UHF15 *Golden Rig* features 4-way bracing for elimination of ghost-producing vibration.

This antenna has gold-colored anti-corrosion plating.



SWEEP GENERATOR

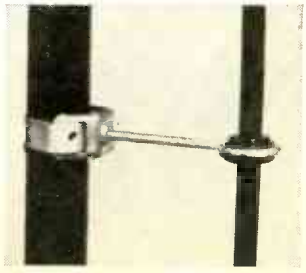
Hickok Electrical Instrument Co., 10531 Dupont Ave., Cleveland 8, Ohio, has announced a u.h.f. sweep alignment generator, model 697. The equipment has an all-electronic sweep that features no moving parts. Model 697 provides fundamental output on channels 14-83 with 0.5-volt r.f. output.

STANDOFF INSULATOR

The Insulin Corp. of America, 36-02 35th Ave., Long Island City, N. Y., has announced a new strap type standoff insulator that accommodates all standard television transmission lines.

A low-loss polyethylene grommet in the eye of the device securely holds flat twin-lead ribbon, tubular twin-lead, oval-tubular lead, or coaxial cable.

An adjustable steel strap permits the insulator to be used on any pipe from ¾ inch to 1½ inches in diameter. The assembly is tightened by a captive tension nut through which the threaded end of the insulator screw eye passes. All metal surfaces are heavily zinc-plated.



through their anode coils. At the same time, less current flows through the anode coils of B and C. These conditions are reversed during the next half audio cycle. Currents in the T2 primary are no longer cancelled out, and audio power is transferred to the loudspeaker.

The third winding on each core is for biasing the core magnetism. P is adjusted to bias the cores for linear response and high gain. C1 and C2 are used to bypass any carrier current that may remain. Although the fundamental carrier frequency is largely eliminated due to balancing and bypassing, some harmonics may be present. The network LCR is added to eliminate them.

A stage like the one shown here can amplify a.f. over a range of 200-2500 cycles. The carrier should be about 10,000 cycles.

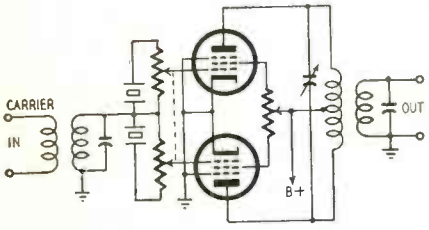
SELECTIVE CIRCUIT

Patent No. 2,653,194
Walter Lyons, Flushing, N. Y.
(assigned to Radio Corp. of America)

This patent has as its objective, a means of obtaining high selectivity without the use of multiple heterodyne circuits and filter arrangements.

Quartz crystals, having a very high Q, are sharply selective. In filter networks, crystals produce high loss so amplification is generally needed. This circuit combines sharp selectivity and high gain. It passes a very narrow band : 100 cycles at a carrier frequency of 50 kc.

The pentodes are in push-pull and each crystal feeds one of the tubes. One crystal is ground for a frequency slightly *above* the applied carrier frequency. The other resonates at a frequency slightly *below* the carrier. Due to the push-pull connection, the circuit can have no output if the grids are fed with identical (in phase) signals. If the applied signals are dissimilar (out of phase), output does exist.



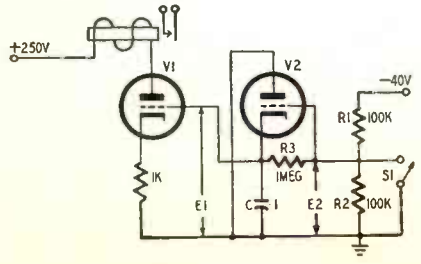
At frequencies far from the carrier, each crystal transmits an identical signal. For example, assume a 50-kc carrier. At 48 kc, the crystals may be assumed identical, for their resonance points are very close to 50 kc. Thus we get no output at 48 kc or any other frequency far from the carrier. Within the pass-band (that is, between the crystal frequencies), the story is different. Here, one crystal acts like an inductance because it is being operated above its resonant frequency. The other crystal acts like a capacitance since it is operating below its resonant frequency. Each tube receives a signal that differs in phase from that of the other. Thus, output exists only within the very narrow range of frequencies between the resonant frequencies of the crystals.

A ganged pair of resistors shunts the crystals. They control damping and bandwidth. The adjustable screen resistance permits balancing of the tubes for zero output when the grid signals are identical.

RELAY CONTROL CIRCUIT

Patent No. 2,622,195
John W. Smith, Cedar Rapids, Iowa. (assigned to Collins Radio Co., Cedar Rapids, Iowa)

Using an ordinary relay, this circuit provides a slow release. The relay is energized quickly ; the release time is long.



NEW PATENTS

If switch S1 is open, E_2 is −20 volts due to voltage divider R1, R2. Current flows through R3 into C. If the switch is left open for any length of time, C becomes charged. The grid bias of V2 drops to almost zero, but due to low plate voltage (20 volts) the tube passes little current. A large negative voltage E_1 blocks V1.

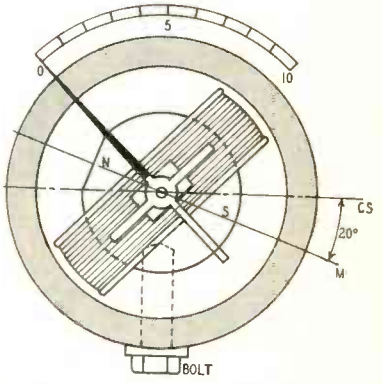
When S1 is closed, it grounds the grid of V2, making it 20 volts positive with respect to the cathode. V2 will then pass considerable current and discharges C. With E_1 down to nearly zero volts, V1 conducts and energizes its relay. All this takes place quickly.

If S1 is opened momentarily, V2 blocks at once because E_2 goes back to −20 volts. V1 continues to pass current because it takes time to charge C. With the values shown, 2 or 3 seconds are needed. The time constant C-R3 determines the interval. Thus, if S1 is opened for very short periods, the relay is not energized. It is actuated immediately, however, when S1 is closed.

MINIATURE METER

Patent No. 2,650,349
Francis X. Lamb, East Orange, N. J.
(Assigned to Weston Electrical Instrument Corp.)

This patent relates to small sized meter instruments, for example the 1-inch size. They use a permanent-magnet core within the coil winding, rather than the horseshoe magnet of large meters. As shown, the cylindrical core is flattened slightly at its north pole (N). The shaded region is a soft-iron yoke which provides the return path for magnetic flux. It also acts as shield for the coil. A bolt holds the core and yoke in place. As usual, a pointer moves with the coil.



The big problem with miniature meters has been scale linearity. This invention permits a nearly uniform scale without adding to the cost of the meter. The north pole of the core should be flattened until the diameter through N-S is 5% of the original diameter. Furthermore, N-S diameter (M) should make a 20° angle with the center-scale axis (CS).

TRANSISTOR TRIGGER

Patent No. 2,604,496
Lloyd P. Hunter, Pittsburgh, Pa.
(Assigned to Westinghouse Electric Corp.)

This circuit can be triggered by a positive pulse of about a volt. Triggering is extremely rapid, requiring only about 0.1 microsecond. Reset time is a few microseconds. The transistor may be N-type with a small P region surrounding the collector. See Fig. 1.

P1 and P2 adjust the emitter and collector voltages. The output characteristic of the point-contact transistor is shown in Fig. 2. The lowest portion AB shows positive resistance. At higher currents there is a kink in the curve indicated by

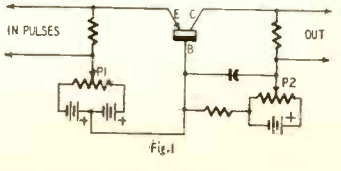


Fig. 1

CONTACT RESTORER

Electronic Chemical Corp., 813 Communipaw Ave., Jersey City 4, N. J., has introduced its *No Noise* volume control and contact restorer in a new spillproof, easy-to-use, 6-oz. spray can. The product is also available in 2- and 8-ounce bottles and quart cans.

SIGNAL EQUALIZER

Tele-Matic Industries, Inc., 1 Joralemon St., Brooklyn, N. Y., has introduced an automatic signal equalizer designed for use in locations where the signals from the low-frequency channels cause overloading and where the high-frequency channels are not strong enough to tolerate any attentuation.

The equalizer, model AT-25, provides maximum attenuation on the low-frequency channel and minimum attenuation on the high-frequency channel without upsetting the impedance of the TV receiver.

REPLACEMENT FLYBACKS

Chicago Standard Transformer Corp., Standard Division, Addison and Elston, Chicago 18, Ill., has added three replacement flybacks for Sylvania to its line. These flybacks, A-8227, A-8228, and A-8229, are usable in 90% of all Sylvania receivers made up to 1953.

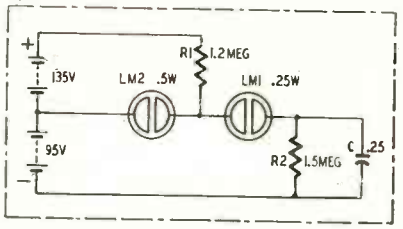
They are supplied as coil and core for easy installation on the original brackets which are a permanent part of the chassis. New filament leads are packed with each transformer. END

All specifications given on these pages are from manufacturers' data.

PERIODIC BLINKING

Patent No. 2,647,222
Robert T. Nieset, New Orleans, La.
(Assigned to Bierne Associates, Inc., New Orleans, La.)

This simple circuit controls flashing gaseous lamps. The inventor describes it in connection with toys. Two lamps are set to light alternately. Among other applications, the blinking lights may be placed at the wing tips of a toy plane or may illuminate the eyes of a teddy bear. The circuit is drawn with recommended component values.



When first connected, LM1 will break down because it is across the entire battery voltage. A voltage drop appears across R1 so LM2 cannot flash. As C charges (through LM1) it opposes the battery voltage. Finally, there is insufficient current through LM1 and it goes out. At this moment LM2 breaks down, even though its potential difference is only 40 volts.

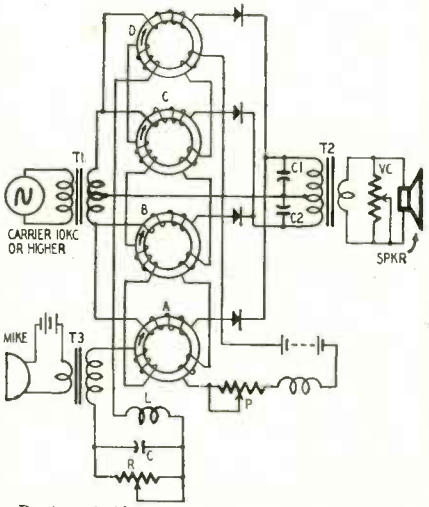
C discharges through R2 until there is sufficient voltage to break down LM1 again. The drop across R1 reduces the available voltage for LM2 and this lamp goes dark, completing the cycle.

MAGNETIC A.F. AMPLIFIER

Potent No. 2,657,281
Wolter C. Kluz, Yonkers, N. Y.
(Assigned to Word Leonord Electric Co.)

This amplifier operates at audio frequencies, and is capable of a power gain of about 10. It needs no attention and has nothing to wear out.

The four ring-type reactors A, B, C, D, have laminated, saturable cores. Each has three windings as shown, the top of each being an anode or exciting coil. Rectified a.c. from a carrier source flows through the anode coils and magnetizes the cores in the same direction. The carrier voltage should be at least four times greater than the peak audio voltage to be amplified. It may be about 250 volts.



During half of each carrier cycle, current flows through D and the T2 primary. At the same time current flows through C and the other half of the primary. Since these currents are opposite and equal, they cancel each other out. Likewise, during the next half of the carrier cycle, currents through A and B cancel out in the T2 primary.

On the left side of each core are modulating windings. They are fed from a mike through matching transformer T3. Coils A and D are polarized in one direction, B and C in the other. During one-half of each audio cycle, the flux in A and D is *strengthened* while the flux in B and C is *weakened*. Thus, cores A and D go deeper into saturation and more current can flow

BC. This portion has negative resistance. Thereafter, the resistance goes positive again (CD). The peak B varies with emitter bias. A more positive emitter reduces the peak, for example from B to H.

The collector load line is shown as L. It intersects the curve at 3 points: E, F, G. Since F lies on an unstable portion of the curve, there are only two permissible operating points. For this trigger application, E is chosen.

If a positive pulse arrives at the emitter, B

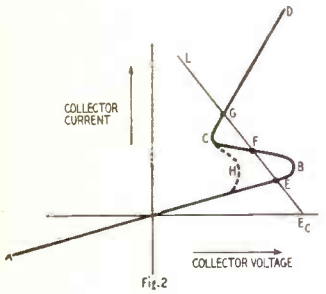


Fig. 2

is momentarily reduced to H. This leaves only one intersection (G) between load line and characteristic curve. The circuit is instantly tripped to this point, the collector current rising from about 1 ma to 10 ma. This output pulse lowers the collector voltage for an instant and the operating point returns to E.

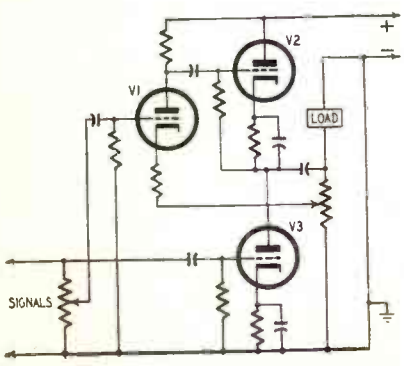
HIGH-FIDELITY AMPLIFIER

British Patent No. 688,273

A problem frequently encountered in electronic circuit design is the transfer of power from a relatively high impedance such as a vacuum tube, to a low impedance load. This problem is most pronounced in audio amplifier circuitry where the transfer of power can take place over an impedance ratio of 1,000 to 1, or more. The output transformer used for this transfer of power is a heavy and expensive component. Numerous attempts have been made to devise means for coupling a speaker load directly to an amplifier without the use of output transformers. This patent covers an audio amplifier that can be connected for direct coupling to a low-impedance load.

An output of more than 8 watts into 150 ohms is claimed for a single 6AS7-G tube. Fidelity is said to be at least as good as that of a Williamson amplifier. From the diagram, the circuit appears similar to—or identical with—the arrangement known here as the Sinclair, or single-ended push-pull, amplifier.

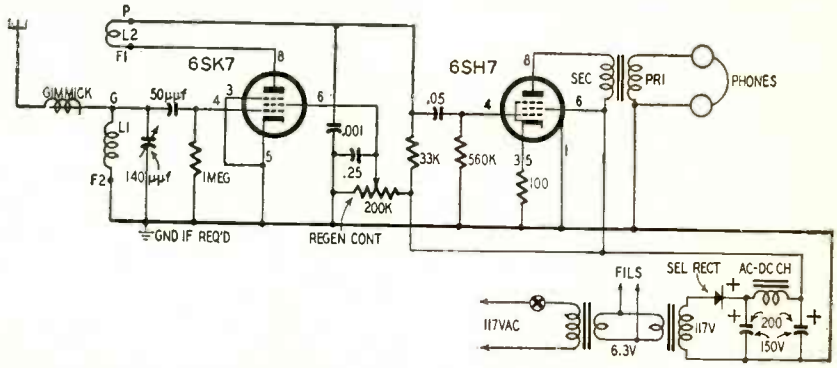
Output tubes V2 and V3 are in series across the B supply. They are in parallel with respect to the load. Therefore the output impedance is very low. The tube grids are fed out of phase. During one half-cycle of audio, current flows from ground through the load and into V2. During the next half-cycle, current flow is through V3, the load and ground.



V3 constitutes a large resistance in series with the cathode of V2. This would cause much degeneration and low gain. To cancel its effect, the cathode of V1 is fed by a portion of the output voltage. When correctly adjusted, this cathode voltage is equal to the feedback voltage at its grid. Besides eliminating degeneration, V1 is also a phase inverter for V2. END

SENSITIVE ALL-WAVE REGENERATIVE SET

After experimenting with a number of simple receiver circuits, I now have a set that is more stable and easier to tune and adjust than any set of its type that I have ever seen. Its sensitivity is good and I hear lots of dx on it with a 15-foot indoor antenna.



The set uses a 6SK7 detector with the regeneration control in the screen circuit. The relatively small grid resistor and the use of a remote-cutoff tube tend to eliminate squegging and pulling. A set of all-wave plug-in coils are used for short-wave reception. If the set is to be used for broadcast only, use a standard broadcast r.f. coil and tuning capacitor. It is a good idea to use a straight-line frequency capacitor such as the National SE or SEH series. A good high-ratio vernier tuning dial such as the National *Velvet Vernier* is essential for short-wave tuning and very helpful when using the set on the broadcast band.

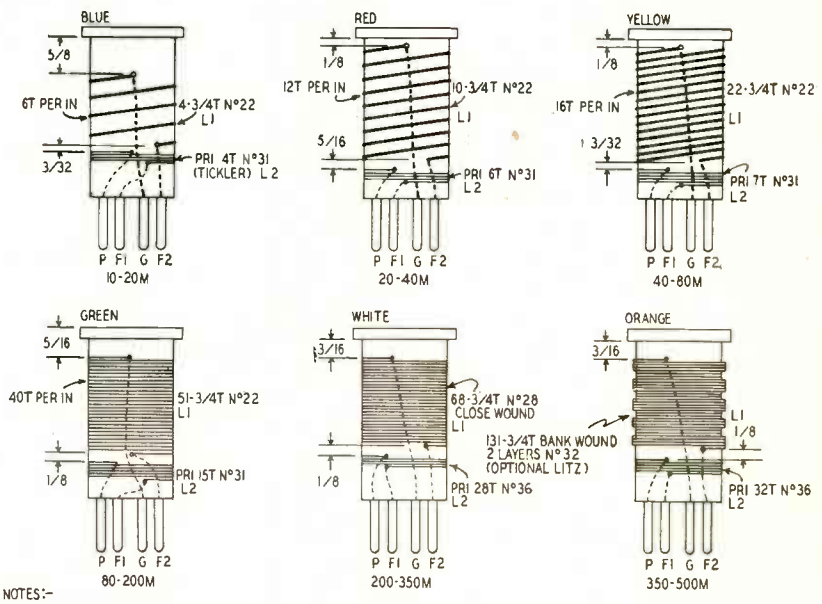
The a.f. amplifier is a 6SH7 with a standard interstage a.f. transformer connected in reverse and used as the output coupling unit. The transformer is not essential but it provides a better impedance match and higher gain, eliminates d.c. through the phones, and puts the phones at ground potential.

The power supply is a half-wave type using two filament transformers connected back-to-back. The dual 200-μf filter capacitor was on hand. Smaller values of capacitance may be used.

Many SWL's hesitate to use a regenerative receiver because they are afraid that it will reradiate and cause interference. With this set, reradiation could not be detected on a receiver in the next room when it was operated just beyond the point of oscillation (the normal operating point for c.w. reception). Radiation could be detected only when the regeneration control was advanced almost to the end of travel. However, this setting results in a marked reduction in volume so it is unlikely that the set will be operated in this manner. When operated properly, this set is no more of an offender than the average a.c.-d.c. superhet.

This set is not in the HRO class but it is perfect for those who want a lot of receiver for a little money.—*Charles Erwin Cohn*

(Winding details for coils for 10 to 500 meters is shown above. In all cases, the tickler (L2) should be wound below grid coil L1 and should have the smallest number of turns which permits the detector to oscillate over the entire band. If the detector suddenly clicks or plops into oscillation as the regeneration control is advanced, try using a larger or smaller grid resistor and cut down on the number of turns on L2. In any receiver, the smoothest control of regeneration is obtained



NOTES:-
ALL WIRE DSC; ALL PRIMARIES CLOSE WOUND; TUNE:140μμf CAPACITOR; DIMENSIONS IN INCHES; ALL FORMS 2-1/8" LONG, 1-1/4" DIA

when the grid leak resistance and the number of tickler turns are optimum for a given operating voltage. Even if you use commercial plug-in coils, you may still find it necessary to experiment with the circuit for best performance.—*Editor*)

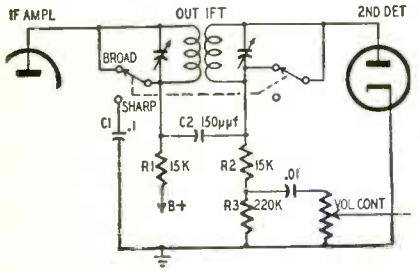
PARTS FOR ALL-WAVE REGENERATOR

Resistors: 1—1-megohm; 1—560,000, 1—33,000, 1—100 ohms, ½ watt; 1—200,000 ohms, 2-watt potentiometer.
Capacitors: (Paper) 1—0.25, 1—.05 μf, 400 volts. (Ceramic or mica) 1—.001 μf; 1—50 μμf. (air-spaced variable) 1—140-μμf, straight-line frequency. (Electrolytic) 1—200 μf, 150 volts, dual.
Inductors: 2—filament transformers, 6.3 volts, 1.5 amp; 1—Audio interstage transformer to match single plate to single grid; 1—a.c.-d.c. type filter choke; 1—set of all-wave plug-in coils (or six 4-prong plug-in coil forms and wire).
Miscellaneous: 1—selenium rectifier, 130 volts, 50 ma; chassis, dial, headphones, wire, hardware.

I.F. SELECTIVITY SWITCH

The i.f. circuits in many superhet receivers tune too sharply to provide high-quality output on local stations. Sideband cutting can be reduced by installing the selectivity switch described in *Radio Constructor* (England).

The diagram shows how the selectivity switch is added to a receiver with a single i.f. stage. In small a.c.-d.c. sets,



C1 and R1 would probably have to be added to the circuit. In larger sets these components may already be present as the decoupling network for the i.f. amplifier. C2 is the r.f. bypass capacitor for the detector load consisting of R2 and R3. Lift C2 off ground and connect it to the B plus side of the transformer primary as shown. Connect a d.p.d.t. switch so it shorts the transformer windings when in the BROAD position. In this position, R1 becomes the i.f. amplifier plate-load resistor and C2 the coupling capacitor. Throwing the switch to SHARP restores the selectivity provided by the tuned windings of the transformer. C2 now returns to ground through capacitor C1.

The volume will drop when the switch is thrown to BROAD. You can compensate for some reduction in gain by increasing the value of R1.

TV TEST PROBES

The need for special probes for TV servicing was discussed at length in the articles on TV signal tracing in the April, May, June, and October, 1953, issues of this magazine. Demodulator or detector probes are simply high-frequency rectifiers which convert TV carrier and i.f. signals into voltages which can be faithfully displayed on the screen of a scope. When pulses and video waveforms are to be studied, a special compensated probe must be used

to minimize high-frequency losses caused by capacitance of the cable and input capacitance of the scope. Voltage-divider probes are used when viewing high-amplitude waveforms.

The TV test probes shown in Figs. 1, 2, and 3 are described here through

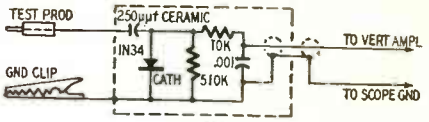


Fig. 1

courtesy of the Cornell-Dubilier Electric Corp. Fig. 1 is the diagram of a detector probe which may be used in servicing AM and TV receivers. The output of the 1N34 detector is filtered and applied to the input of the scope to show the modulation envelope.

Fig. 2 is a compensated probe for picking up video and complex pulse

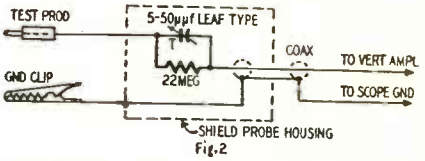


Fig. 2

waveforms and applying them to a wideband scope without distortion. The 22-megohm resistor and 5–50-μμf trimmer are in a shielded probe connected to the scope by low-capacitance coax such as RG-59/U. Keep the cable length below 3 feet to reduce shunt capacitance. Adjust the trimmer so its capacitance equals the sum of the cable and scope input capacitances.

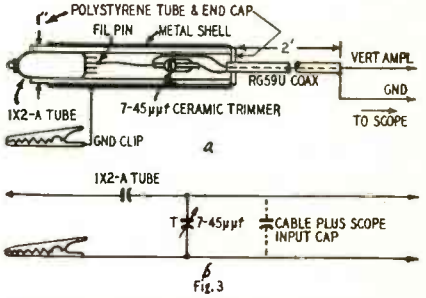


Fig. 3

The capacitive-divider probe in Fig. 3-a is used to observe pulses and waveforms too high to be applied to the scope's vertical amplifier. Fig. 3-b shows the schematic of the probe. The voltage applied to the input divides across the capacitors in inverse proportion to their capacitance. Thus, if C1 (the plate-to-filament capacitance of the 1X2-A) is 1 μf, and C2 and C3 total 100 μμf, the voltage ratio will be 100 to 1.

Cement the 1X2-A in one end of a 1-inch (outside diameter) polystyrene tube with its plate cap protruding to serve as a test prod. Slip a metal casing over the plastic tubing to serve as a shield. Insulate the casing to protect the operator against accidental shock. Drill a hole through the wall of the probe casing so the trimmer capacitor can be adjusted with a small screwdriver. Set the trimmer so the total output capacitance (the sum of the trimmer, cable, and scope input capacitances) equals 100 μμf. END

OUTPUT-METER ADAPTER

This simple hook-on type transformer makes it possible to connect an output meter quickly to the voice-coil circuit of a receiver. Furthermore, it isolates the meter and leads from any voltages on the receiver chassis. It can be used to detect a.c. and pulsating d.c. flowing in a lead without breaking it or contacting its terminals. The adapter operates as a current transformer. Its construction and layout is shown in Fig. 1-a.

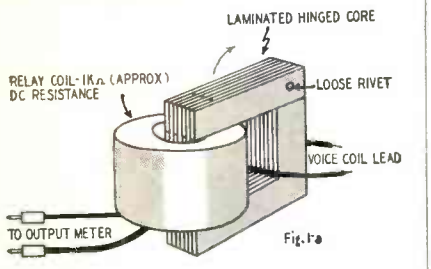


Fig. 1-a

The 1,000-ohm (d.c. resistance) coil came off an old relay. The core was fashioned from laminations removed from a small transformer or choke. To use the unit, connect the coil leads to the output meter and then hook the hinged core around an insulated voice-

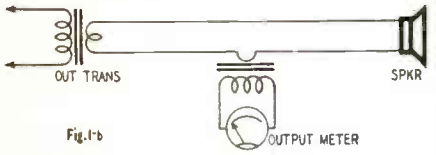
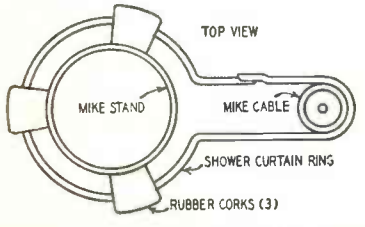


Fig. 1-b

coil lead and close it. Current flowing in the half-turn primary produces an indication on the output meter. The hookup is shown schematically in Fig. 1-b. If the voice coil lead is long enough, more than one turn can be used. Just divide the reading by the number of turns. The more turns used, the greater the sensitivity.—*G. L. Garvin*

ANCHOR FOR MIKE CABLE

Microphone cabes should be anchored near the base of the stand to prevent the hazard of a person tripping over the loop hanging from the mike, and also to give a neater appearance by having the cable lay along the floor right up to the base of the stand.



A suitable anchor must be easy to release when the mike is removed and must be firm enough that it won't scratch the stand. By slipping little rubber blocks, or corks, over a shower curtain ring as shown in the illustration, a very handy anchor can be quickly made. Let the clip lie against the base of the mike stand so the cable hugs the upright and the floor as closely as possible.—*Hugh Lineback*

TRY THIS ONE

HANDY CONSTRUCTION KINK

Model airplane dope is a handy item for the constructor to keep on hand. When constructing or converting a piece of rather complex apparatus, I put a small dab of bright-colored dope on each nut or bolt as soon as it is tightened and a drop of color on each soldered joint. This simplifies the task of checking all joints for a soldered connection. Ground lugs and other bolted connections which have loosened and cause trouble can be located quickly by looking for spots where the dope has flaked off. This method has been successfully used in radio factories for many years. It results in a great saving of time.—*Harold J. Weber*

DIAL-CORD DRESSING

For a good, nonslip dial-cord dressing, mix powdered rosin and amyl acetate to the desired consistency and apply liberally. Store in an airtight bottle.—*A. von Zook*

A TUBE AND PARTS SHIELD

Do you need a tube shield for that 870, 1625, 6BG6-G, or similar tube? If so, don't overlook the instant-coffee metal container with the twist-lock cover. It is ideal for shielding tubes with ST-16 and smaller bulbs.

To adapt it for shielding, first remove the bottom with a can opener—the kind which leaves a smooth, rolled edge. Locate the tube socket and its mounting holes on the cover of the can, then centerpunch and drill. The metal is very thin, so take care not to bend or tear it. Punch the socket hole, and if necessary enlarge it with a round file to clear the socket which is to be mounted on the chassis.

Next, fasten the cover to the top of the chassis, threaded side up, using the bolts which secure the socket flange to the underside of the chassis. The cover now becomes the base for the shield, and it is necessary only to insert the tube in the socket, slip the shield over the tube, and twist to lock in the base.

An unaltered container of this type may also be used to shield small plug-in or fixed coils, transformers, or other parts requiring shielding as well as ready access for removal or inspection. These cans are also useful to house high-pass filters for TVI elimination and simple low-pass filters for mobile or low-power ham transmitters.

The containers may be painted to match any color scheme for decorative purposes and rust prevention.—*George Rulffs, Jr., W2CJY*

WARPED SPEAKER CONES

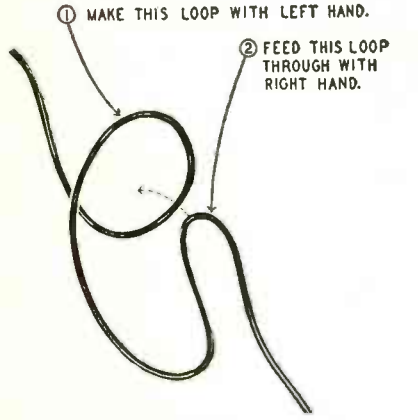
Frequently we get small table-model receivers that have warped speaker cones. Much of this trouble is caused by excessive heat radiated from a rectifier or power-amplifier tube mounted close by. After repairing the speaker, we prevent an early recurrence of the trouble by placing an asbestos shield between the offending tube and speaker. —*Robert E. Riddle*

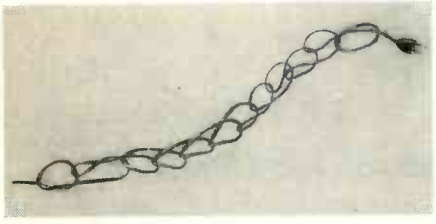
SHORTENING LINE CORDS

For quick setups of equipment where there is danger that excess line cord may cause a person to stumble—such as a temporary PA installation in a crowded place—here is a neat way to handle the extra wire. It may take a few tries before you can build up speed, but it is well worth the effort. In addition to preventing injuries, it also safeguards equipment which might be thrown to the floor in the course of an accident.

Make a series of loose hitches as illustrated in the photo. You'll find the motions just sort of come naturally, so don't try to figure out the loops in the picture.

The drawing shows how to start—then you just keep going, and stick the

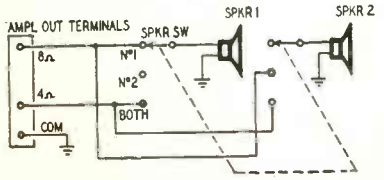




plug through the final loop to lock the chain. To get the line back to its original length you just draw the plug back through the last loop, and zip—the whole string of loops vanishes quick as a wink!—*Hugh Lineback*

SWITCHING DUAL SPEAKERS

On page 150 of the October, 1953, issue, Mr. Howlett describes a speaker-selector switch which maintains the correct match across the output trans-



former. The diagram here shows a simplified circuit which permits the use of a 2-pole, 3-position switch to be used instead of the 4-pole, 3-position type specified in the original item.

At the first two positions, the 8-ohm speakers are connected singly; at the third position, in parallel.—*Jack Palmer*

END

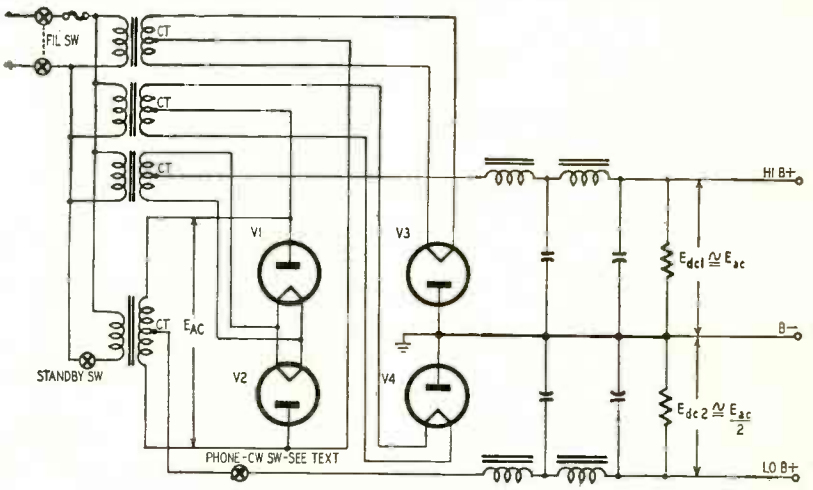
DUPLEX POWER SUPPLY FOR HAM TRANSMITTER

? I purchased a 3,000-volt center-tapped transformer rated at 800 ma. The dealer told me that I could use it to supply power to the final and modulator of a 1-kw phone transmitter. I would like to run the final at 2,500 to 3,000 volts but I cannot get more than 1,475 volts d.c. out. Please show me how I can get more than this out of the supply so that I can run the rated input to my final.—Wm. L., Florence, S. C.

A. The bridge-type supply shown in the diagram provides two independent output voltages. One is approximately equal to the full a.c. voltage across the secondary winding and the other is about one-half this value. For your purpose, V1, V2, V3, and V4 should be 872's. You can use 866's for a total current drain of 500 ma, or 816's or similar tubes if the drain does not exceed 250 ma. The phone-c.w. switch is included to open the low-voltage circuit and shut off the modulators when tuning up or working c.w.

This circuit can be used whenever it is desirable to obtain separate output voltages from a transformer whose full secondary voltage is equal to the highest voltage. For example, an 800-volt center-tapped transformer can be used in this circuit to supply 400 volts d.c. to a driver and 800 volts to a booster amplifier in a high power PA system. In this case, a single 83, 5U4-G, 5R4-GY or similar tube can be substituted for V1 and V2. Separate tubes of the same type with the plates strapped together can be used for V3 and V4.

In this circuit, the total current drawn by the supply should not exceed the maximum d.c. load current rating given by the rectifier manufacturer.

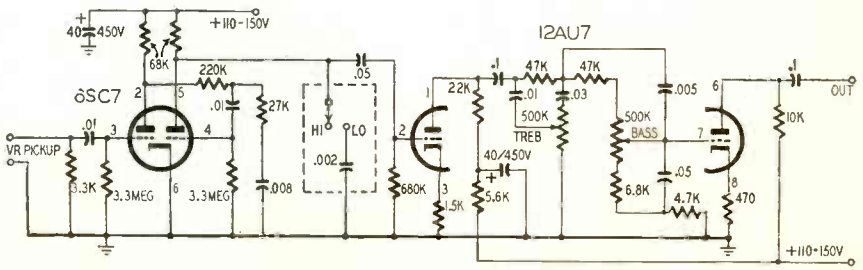


V-R PREAMP AND EQUALIZER FOR PHONO AMPLIFIER

? Please print a diagram of a preamplifier and tone control which will permit me to use a variable-reluctance pickup with the phono amplifier described in the December, 1952, issue.—S. F. R., Timmonsville, S. C.

A. The diagram shows a 2-tube preamplifier-equalizer which can be used between a V-R pickup and any conventional amplifier which does not have these circuits built in. If you do not require an elaborate tone control, you can omit the 12AU7 and its components and feed the 6SC7 output directly into the amplifier through the .05-μf blocking capacitor. Add the switch and .002-μf shown in the section enclosed by the dashed lines. If you use the 12AU7 equalizer circuit, omit the switch and the .002-μf capacitor.

All wiring should be short and direct. Heater leads should be twisted and dressed into the corners of the chassis well away from signal leads to minimize hum pickup.



MODIFYING TV ANTENNAS

? I have a 10-element channel 5 Yagi that I would like to cut down for operation on channel 6. Please give me the dimensions for a channel 6 Yagi.—J. T., Thief River Falls, Minn.

A. The dimensions of the elements and the spacing between them is determined by the desired bandwidth and the forward gain or back-to-front ratio. In commercial practice, the spacing and

the length of the elements may vary according to the manufacturers' standards for bandwidth, gain, and front-to-back ratio.

To cut your antenna for a higher frequency while retaining its present characteristics, measure the length and spacing of all elements and record these on paper. Now, multiply each dimension in inches by the lowest frequency of the channel for which the antenna was originally designed. The products of each set of figures gives a constant which is used in determining the length of the corresponding dimension in the new antenna.

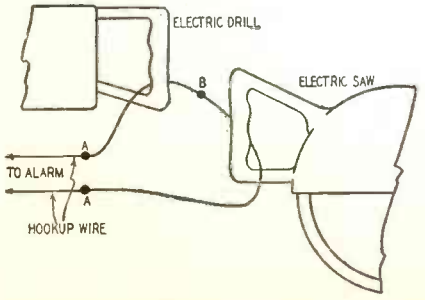
Take each of these constants and *divide* it by the lowest frequency of the new channel for which the antenna is to be cut. This gives the new dimension in inches. For example, suppose that you measure the channel 5 radiator and find it to be 73 inches long. The lowest frequency in channel 5 is 76 mc. The product of the radiator length and the channel frequency gives 5,548 as the constant for the new radiator, regardless of its frequency. Now, divide the constant (5,548) by the lowest frequency in channel 6 (82 mc). The resultant gives 67.6 inches as the length of a channel 6 radiator.

SHOPLIFTER ALARM

? *I have not been able to prevent shoplifters from removing electrical tools and appliances from the display counters in my store. At present, I am using a relay and alarm circuit which is completed through a loop of flexible hookup wire which passes through the handle or holes in the frames of the different appliances as shown in the diagram. This is far from foolproof. For example, if the wire is stripped at A-A and then twisted together, the tools can be removed without sounding the alarm simply by cutting the wire at B.*

Can you devise a protective setup which might work? I want to use a system in which the appliances are all plugged into receptacles as they would be when in use. I don't care to have control current flowing through the line cords because all switches would have to be on and the voltage would have to be very low to prevent the tools from operating under all conditions.—E. J. L., Chicago, Ill.

A. Many 3-way portable receivers have power change-over switches which resemble a standard power-line receptacle. Plugging the set's line cord into the receptacle on the chassis operates



a multipole double-throw switch which sets up the circuit for battery operation.

Most of these switches operate through pressure of the prongs on the line plug. There is no control voltage on the line cord or plug. You can install a number of these switches on a panel and wire the switch contacts to sound the alarm if any of the appliance plugs are removed from the receptacle.

CHECKING VIDEO AMPLIFIERS

? *I want to use my square-wave generator to check the response of the video amplifiers in TV sets. To what frequency should I tune the oscillator for this test?—V. R., Martins Creek, Pa.*

A. There are different opinions as to the relationship between the frequency of the square wave and the bandpass of the amplifier under test. Some engineers maintain that when an amplifier passes a square wave without distortion, it is flat from $f/10$ to $10f$, where f is the square-wave frequency. Others work between 3-db (cutoff) points. To check low-frequency response, they set the generator to 10 times the amplifier response at 3 db and watch for an undistorted wave on the scope. For the high-frequency check, they set the generator to a frequency whose 21st harmonic is the same as the amplifier response at the high-frequency cutoff point. In any case, it takes practice and familiarity with one's scope and generator to get the best results from a square-wave test.

A video amplifier is designed for a given bandwidth with predetermined input and output impedances and known values of stray-wiring and shunt capacitances. When any test instrument is connected directly across the input or output of a video amplifier, it will upset the normal operating conditions and cause misleading observations. Long test leads to the scope and generator will increase the stray capacitance of the circuit. The amplifier must work from and into the proper load impedances.

In TV broadcasting, special buffer amplifiers, probes, and other adapters are used with the scope and generator to prevent disturbing the inherent response characteristics of the circuit under test. You will not be able to rely on any square-wave response measurements that you make unless you can be sure that the frequency-determining constants of the circuit have not been altered by connections to the test instruments.

POWER SUPPLIES

? *I would appreciate having diagrams of two power supplies which operate from a 6-volt d.c. supply. The output of one supply should be high enough to give a bright flash from a NE-20 or NE-51 neon bulb. The other should deliver 25 volts d.c. at 15 amp.—W. M. W., San Francisco, Calif.*

A. If the neon lamp is the only drain on the first supply, it would be more

economical to use a pair of small 67½-volt portable radio batteries in series. The useful life of the batteries will be about equal to their normal shelf life in this application. On the other hand, you can use a conventional vibrator-type supply which delivers about 120 volts. In this instance, the drain of the vibrator alone may make this type of supply impractical.

For the 28-volt, 15-ampere supply, you will need a motor-generator set or dynamotor. The output power is 420 watts. Assuming that the dynamotor or motor-generator set is 65% efficient —a fair figure for small units—the input power will be 567 watts, or nearly 95 amperes at 6 volts. This drain is excessive for a standard vehicular storage battery. You will probably have to look around for another solution to this problem.

It may be that you are planning to install a piece of 28-volt surplus radio equipment in an automobile equipped with a 6-volt lighting and ignition system. If this is the case, your best bet is to convert the equipment to operate from a 6-volt supply. This would increase the over-all efficiency of the power-supply system and may make the equipment more practical to install and operate.

If the equipment is to be operated in a vehicle and you *must* have 28 volts d.c., then we recommend that you get a surplus 28-volt aircraft generator and hook it up to a small gasoline engine or drive it from the automobile motor as described in the article "75-Meter Mobile, California Style," in the January, 1952, issue of *QST*.

FOLDOVER IN WESTINGHOUSE

? A Westinghouse 605-T-13 receiver has developed a bad case of horizontal foldover. I made a complete examination of the horizontal circuits, checking the grid-coupling capacitor to the horizontal output tubes, the damper tube and its associated components, the horizontal output tubes, and the bypass capacitors in this circuit. I checked all voltages, but still to no avail. What else could I possibly check that might cause this condition? L. Y., Roanoke, Va.

A. In this model the foldover may be caused by a change in values of the two 220,000-ohm resistors and 330-μμf capacitor all in series and feeding pins 5 and 7 of the 6AL5 horizontal automatic frequency control tube from the horizontal output. Check for off-value parts and replace if incorrect by more than 5%.

Check all components in the 6AL5 phase detector circuit and try a new 6AL5. Finally, make the following changes as recommended by the manufacturer for foldover not caused by normally defective parts: Change the grid resistor of the 7A5 horizontal output tubes from 470,000 to 100,000 ohms. Also change the capacitor which shunts the resistor, from 470 to 270 μμf. This R-C combination is fairly critical, so at least 5% values should be used. END

TROUBLE IN G-E 803

After replacing the horizontal output transformer, the picture distorted when the brightness or contrast control was advanced. The trouble was finally traced to the lead which runs from terminal 4 on the transformer to damper-tube pins 2 and 5. This lead ran too close to the lead between transformer terminal 5 and the blue side of the width coil.

The trouble was eliminated by dressing the lead from terminal 4 along the top of the chassis.—*Geo. R. Anglado*

SELECTING A TV MAST

Before mounting a TV or FM antenna above a bright-colored sloping roof, make sure that the mast tubing you use is rustproofed inside and out. The fact that rust weakens the mast so it must be replaced in a few years may not be nearly as important to many home owners as the fact that the rust may cause unsightly, hard-to-remove stains on the roof. Most homeowners will appreciate your thoughtfulness and will be glad to pay the slight increase in the cost of using a more expensive type of mast.

If you are not sure that the tubing is rustproof on the inside, plug the top end with a large cork and then wrap the end with several layers of plastic electrician's tape to be sure that water will not get in.—*Henry O. Maxwell*

UNUSUAL HUM PROBLEM

An a.c.-d.c. type 3-tube portable record player was brought in with a bad case of hum. The usual checks of tubes and filters did not eliminate the trouble nor shed any light on its cause, so we settled down to examine the circuit layout.

We found that the volume control was mounted on the cabinet away from the chassis. The audio ground lead was used to carry a.c. from the switch on the control to the chassis. There was enough a.c. voltage drop in just the few inches of this ground lead to introduce an abnormal hum in the amplifier. The hum level was brought down to normal by running a separate lead from the switch to the chassis and clipping the original connection between the switch and the cold lead of the volume control. As a general rule, it is not a good idea to have the same wire carry both a.c. power and the signal. There is bound to be some hum pickup.—*Wayne Miller*

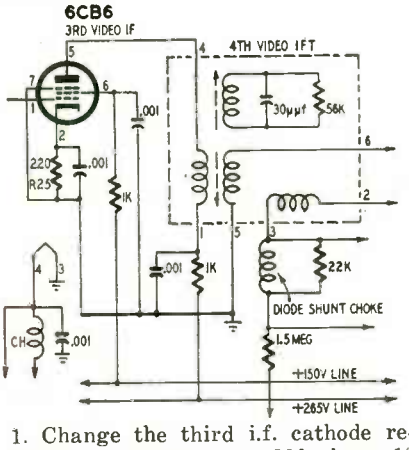
PACKARD BELL 2710 CHASSIS

The 0.25-amp fuse in this TV set would blow intermittently. A voltmeter connected to the cathode of the damper tube showed that the d.c. voltage dropped sharply just before the fuse blew. A complete check showed that the horizontal linearity transformer was intermittently shorting to ground. The trouble cleared up when the short was eliminated.—*Manuel E. Silva*

SENTINEL MODELS 454 TO 457

Tearing and rolling on strong signals may be caused by overloading of the third i.f. amplifier if it is not caused by the area control being in the wrong position (in the weak- or medium-signal positions in a strong-signal area). Overloading of the third i.f. amplifier occurs in early production runs of these models because its plate voltage is too low to permit it to handle strong signals.

This trouble can be eliminated by transferring the plate lead of the 6CB6 third i.f. amplifier from the 150-volt to the 265-volt line. Use the following procedure:



1. Change the third i.f. cathode resistor (R25) from 82 to 220 ohms, ½ watt.

2. Remove the connecting lead between the screen (pin 6) of the 6CB6 and terminal 1 of the fourth video i.f. transformer.

3. Connect a 1,000-ohm, ½-watt resistor between terminal 1 of the transformer and the 265-volt B plus line.

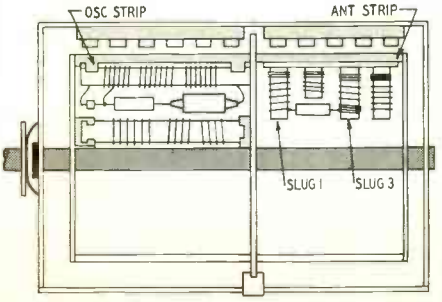
4. Add a .001-μf, 500-volt capacitor between chassis ground and terminal 1 on the i.f. transformer.

The diagram shows the revised circuit.—*Sentinel Service Department*

ADJUSTING U.H.F. STRIPS

Types Q and R u.h.f. strips for tuners in Sentinel TV receivers are prealigned at the factory for the specified channel. But, if you feel that further alignment is needed after checking the u.h.f. antenna and ascertaining that signal strength is adequate at the receiving location, a slight readjustment of the oscillator slug may be all that is necessary. Center the fine-tuning control for this operation. If this does not produce a sufficient improvement, try the following:

1. Turn the chassis on its side with the tuner at top left as shown in the drawing. Remove the tuner shield, rotate the channel selector to the de-



sired channel, and remove the four antenna strips that are removable with the tuner in this position.

2. Insert the screwdriver edge of a plastic aligning tool into the bottom of slug 1 and notice if its presence affects the picture. If picture strength increases, turn the slug clockwise about ⅛th turn or until the picture and sound improve to the best possible extent. Advance the slug a little further to compensate for removing the tool from the coil.

3. If the picture strength does not change when the plastic tool is inserted in slug 1, turn the slug counterclockwise ⅛th turn or until best picture and sound are received.

4. Turn slug 3 in the same amount and in the same direction as slug 1 was turned for the best picture.—*Sentinel Service Bulletin*

BARKHAUSEN OSCILLATIONS

Barkhausen oscillations (one or more black vertical lines on the left side of the screen) in the Stromberg-Carlson 421 and 521 series receivers may be cleared up by adjusting the horizontal drive control or by replacing the horizontal output tube.—*Stromberg-Carlson Current Flashes*

PHILCO 51-T1875

This receiver was brought in with an intermittent hum that could be stopped temporarily by jarring the cabinet. By carefully tapping various components, we localized the trouble in the aluminum can type electrolytic capacitor mounted above the chassis. The twist-type lugs were not tight enough to maintain a good electrical connection between the can and the chassis.

The situation cleared up when a capacitor mounting bracket was clamped over the electrolytic and bolted firmly to the chassis.—*Peter Bedrosian*

PHILCO 645

After several of these models had come in for various repairs and tube replacements, I noticed that all seemed to have a moderate amount of nonlinear distortion in the audio section. A check with an audio oscillator and scope failed to show up any nonlinearity. Since the distortion was most noticeable on strong signals, I decided that it was probably due to blocking or plate-current cut-off in one of the stages.

After checking the r.f., mixer, and i.f. stages, the trouble was traced to nonlinearity in the second detector. It was distorting on positive signal peaks.

I cleared the trouble by replacing the original 330,000-ohm diode load resistor with a 100,000-ohm unit. This resulted in perfect linearity. A potentiometer was used to determine the correct value.—*G. P. Oberto*

CROSLEY 56TG

Check the a.v.c. voltage if reception is weak. If it is abnormally high, remove the a.v.c. leads from pin 2 on the 35W4 socket and install a separate tie point. Excessive a.v.c. voltage is due to leakage to unconnected pins within the tube.—*Geo. R. Anglado* END

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40	450	.49
60-10-10-20	450-450-450-150	.89
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20-8-8-8	450-450-450-250	.59
80	500	.79
15-15-20	450-450-25	.59
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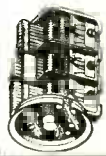

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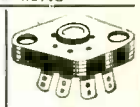

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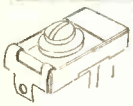

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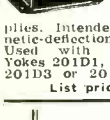

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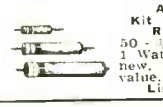

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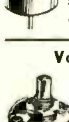

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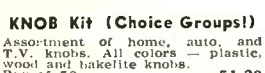

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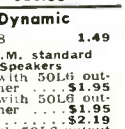

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5 x 7	2750	99c
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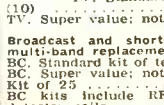

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0C3	.72	6BQ6GT	.79	12BA7	.60
0D3	.70	6BQ7	.90	12BD6	.45
0Z4M	.55	6BZ7	.90	12BE6	.39
1A5	.30	6C4	.37	12BF6	.39
1A7GT	.47	6C5	.39	12BH7	.63
1AX2	.62	6C6	.58	12BY7	.65
1B3GT	.68	6CB6	.44	12BZ7	.65
1B7	.30	6CD6	1.11	12C8M	.34
1C5	.43	6E5	.48	12SC7M	.63
1E7	.29	6F5GT	.39	12J5GT	.42
1G6	.24	6F6	.59	12K8	.59
1H4	.30	6G6	.52	12Q7	.59
1H5GT	.49	6H6GT	.41	12S8GT	.62
1L4	.46	6J5GT	.43	12SA7GT	.65
1L6	.59	6J6	.52	12SF5	.50
1LA4	.59	6J7	.43	12SJ7M	.67
1LC5	.59	6K6GT	.37	12SK7GT	.63
1LE3	.59	6K7	.44	12SK7M	.63
1LN5	.59	6K8GT	.37	12SL7GT	.47
1N5GT	.67	6L6	.64	12SN7GT	.52
1P5GT	.57	6L7M	.68	12SQ7GT	.56
1Q5GT	.58	6Q7	.45	12SR7M	.49
1R5	.49	6S4	.38	12V6GT	.46
1S4	.59	6S7M	.79	12X4	.38
1S5	.43	6S8GT	.53	14A5	.59
1T4	.49	6SA7GT	.43	14AF7	.59
1U4	.49	6SD7GT	.41	14H7	.59
1U5	.43	6SF5GT	.46	14J7	.30
1V	.53	6SG7GT	.41	14W7	.35
1X2A	.60	6SH7GT	.49	19BG6	.95
2A3	.30	6SJ7GT	.41	19C8	.70
2A4G	.24	6SK7GT	.41	19T9	.69
2W3	.38	6SL7GT	.48	19V8	.79
2X2	.59	6SN7GT	.52	24A	.39
3A4	.45	6SQ7GT	.37	25AV5GT	.83
3E5	.46	6SR7GT	.45	25BQ6GT	.79
3Q4	.48	6SS7GT	.42	25L6GT	.39
3Q5GT	.49	6T4	.99	25W4GT	.59
3S4	.49	6T8	.56	25Z5	.66
3V4	.51	6U4	.60	26	.45
5U4G	.50	6U5	.44	27	.39
5W4GT	.50	6U6	.59	35	.58
5Y3GT	.37	6U8	.61	35B5	.40
5Z3	.45	6V6GT	.39	35C5	.39
5Z4	.59	6W4GT	.44	35L6GT	.41
6AB4	.44	6W6GT	.44	35W4	.37
6AC7M	.86	6X4	.37	35Z3	.59
6AF4	.90	6X5GT	.37	35Z4	.47
6AG5	.48	6X8	.75	35Z5GT	.47
6AG7M	.99	6Y6G	.48	36	.39
6AH4	.57	7A4	.47	41	.42
6AH6	.73	7A5	.59	42	.42
6AJ5	.65	7A6	.69	43	.55
6AK5	.55	7A7	.69	45	.55
6AL5	.38	7AF7	.53	45Z3	.44
6AQ5	.39	7B4	.44	45Z5	.49
6AQ6	.37	7B6	.69	50B5	.43
6AR5	.37	7C4	.59	50C5	.39
6AS5	.50	7C5	.69	50L6GT	.41
6AT6	.37	7E5	.59	50Y7	.50
6AU4GT	.68	7E6	.30	53	.24
6AU5GT	.82	7E7	.59	55	.49
6AU6	.38	7H7	.59	57	.58
6AV5GT	.83	7L7	.59	58	.60
6AV6	.37	7X7	.70	70L7GT	.97
6AX4GT	.53	7Y4	.69	76	.44
6B4	.64	7Z4	.59	77	.57
6BA6	.39	12A8GT	.61	78	.47
6BA7	.57	12AL5	.37	80	.35
6BC5	.49	12AQ5	.52	83V	.68
6BD5	.59	12AT6	.37	85	.59
6BD6	.45	12AT7	.66	117L7	.99
6BE6	.39	12AU6	.38	117Z3	.37
6BF5	.41	12AU7	.54	807	.99
6BF6	.37	12AV6	.39	866A	1.39
6BG6G	1.25	12AV7	.63	1274	.30
6BH6	.46	12AX4	.56	2050	.89
6BJ6	.43	12AX7	.56	1000FM	.59
6BK7	.80			Hi-Po #567	1.39

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C. F. Stromeyer

Charles F. Stromeyer was promoted to executive vice-president of CBS-Hytron, Danvers, Mass. With the company since 1942, he was most recently vice-president in charge of manufacturing and engineering.

D. W. Gunn was appointed general sales manager of Electronic Products, Sylvania Electric Products, New York,

Left—D. W. Gunn
Above—H. P. Gilpin

N.Y. He was formerly assistant general sales manager of the Electronic Products Sales Division. In his new position, he succeeds **Harold P. Gilpin** who retired after 21 years of service with the company.

G. Richard Fryling and **W. Henry Fryling**, president and vice-president respectively, of Erie Resistor Corp., Erie, Pa., were presented with a testimonial

W. H. Fryling, center, and G. R. Fryling, right, receiving presentation.

of appreciation by employees at the company's recent 25th Anniversary Staff and Long Service Dinner.

Joseph H. Quick was elected president of the National Co., Malden, Mass. He has been a director and member of the Executive Committee of National and was formerly president of Harrington & Richardson Arms Co. He has also been associated with RCA, Philco and Sylvania.

J. H. Quick

A. Melvin Skellett and **Lawrence L. Hardin, Jr.** were named to the posts of vice-president in charge of manufacturing and engineering, and director of the Research Division, respectively, of National Union Radio Corp., Hatboro, Pa. Both are long-time employees of the

company. Skellett was also elected to the Board of Directors.

G. W. DeSousa, formerly manager of the General Electric Tube Department marketing administration, was named to succeed G. L. **Roark** as manager of equipment tube sales. Roark was recently upped to department marketing manager. **M. J. Strehle,** previously manager of intra-company sales for the department, succeeds DeSousa

G. W. DeSousa

Clifford Shearer

Clifford Shearer joined RMS (Radio Merchandise Sales), New York City, as advertising manager. He was formerly with a leading catalog publishing firm in the electronics field.

Gardiner G. Greene, has become president and principal stock holder of Browning Laboratories, Winchester, Mass. He is the founder of Workshop Associates and became director and vice-president of the Electronics Division of Gabriel Co. when Workshop merged with it. **Dr. Glenn H. Browning** former president of Browning Laboratories, becomes chairman of the Board.

Joe Chapman Lane, Jr. was promoted to manager of Advertising and Sales Promotion for the Westinghouse Electronic Tube Div., Elmira, N. Y. In his new position he will be responsible for trade magazine advertising and sales promotion.

J. C. Lane, Jr.

Obituaries

Sylvan A. Wolin, pioneer sales and advertising executive in the capacitor industry, died suddenly from a heart attack at his home in Englewood, N.J. He was 42.

Herman H. Smith, pioneer manufacturer of electronic hardware, died suddenly at his home in Brooklyn, N.Y., recently.

Ernest B. Loveman, a member of the executive staff of Philco Corp., Philadelphia, collapsed and died of a heart attack in the reception room of the company's main plant.

Personnel Notes

. . . **Joseph B. Elliott, W. Walter Watts, Dr. Elmer W. Engstrom** and **Charles M. Odorizzi,** RCA vice-presidents, were promoted to executive vice-presidents in charge of their respective operations in an organizational realignment by the Radio Corporation of America. Joseph

B. Elliott heads the Consumer Products Div.; W. Walter Watts, the Electronic Products Div.; Dr. Engstrom, the RCA Laboratories Div.; and Charles M. Odorizzi, a newly consolidated corporate staff serving all units and subsidiaries of RCA. Elliott, Watts and Odorizzi will make their headquarters in New York and Dr. Engstrom, in Princeton, N.J.

. . . **Joseph Schlig**, assistant to the sales manager of the Electronic Tube Division of Westinghouse Electric Corp., Elmira, N.Y., was selected as one of the 15 men whom the company is sending to the Harvard Graduate School of Business Administration to take a special 16-month management course.

. . . **Paul P. Wickman** was named merchandising manager of dealer products in the creation of a new communications link between the General Electric Tube Department's replacement sales organization and its distributors and dealers. Wickman was formerly Boston district sales manager for Tube Department replacement sales.

. . . **E. L. Lee, B. E. Barnes, M. L. Jones** and **W. E. Vande Kieft** were appointed regional electronic sales engineers for United Motors Service, Division of General Motors, Detroit. They will work with Delco electronic parts distributors in the Eastern, Southern, Central and Western regions, respectively.

. . . **Bob Middleton** joined the Sales-Engineering Div. of Simpson Electric Co., Chicago. He will conduct lectures for service technicians throughout the country. Middleton was formerly with RCA and Precision Apparatus.

. . . **Dean L. Nordquist** was promoted to assistant advertising manager of Electro-Voice, Inc., Buchanan, Mich. He joined the company in 1952.

. . . **Dick O. Klein**, vice president and general manager of Raytheon Distributors, Inc., was appointed director of marketing for the Television and Radio Division of Raytheon Manufacturing Co., Chicago, and at the same time named assistant vice-president of the parent company.

. . . **Jerome V. (Jerry) Deevy** rejoined National Union Radio Corp., Hatboro, Pa., as director of industrial relations. He had been with the company ten years prior to 1953, when he resigned to become an independent consultant.

. . . **Ralph R. Stubbe** was promoted to chief engineer of General Instrument Corp., Elizabeth, N.J.

. . . **Frank M. Folsom**, president of Radio Corp. of America, was presented with a gold clock and weather vane by Brig. Gen. David Sarnoff, RCA Board chairman, on behalf of the company's 65,000 employees, on Folsom's 10th anniversary with the company.

. . . **Gordon LeMay** joined Tele-Matic Industries, Brooklyn, N.Y., as assistant sales manager. He had been with Terminal Radio Corp., N.Y.C. END

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.

AUDIO HANDBOOK

Arrow's 1954 *Audio Handbook* is a well-illustrated 104-page catalog. The first 33 pages are devoted to "audio facts," featuring 4 pages on binaural sound reproduction, 14 pages on loudspeakers with construction details for cabinets, a 4-page excerpt from Weiler's *High-Fidelity Simplified* entitled "The How, What, Why, and Where of High Fidelity," and a 10-page reprint of Weil's "Phono Facts" (74 pointers for the person selecting phonograph equipment).

The remaining 71 pages illustrate and give specifications for amplifiers, tuners, speakers and speaker cabinets, and associated audio equipment.

Write to Arrow Electronics Inc., 82 Cortlandt St., New York 7, N. Y. for free copy.

ANTENNA BOOKLET

RMS has published a 32-page catalog illustrating and describing its line of TV antennas and accessories. The booklet is indexed by product groupings and includes a gain reference chart for v.h.f. antennas.

Free from RMS (Radio Merchandise Sales, Inc.), 2016 Bronxdale Ave., New York 62, N. Y.

GOVERNMENT PUBLICATIONS

A list of 17 government publications on electricity, electronics, radar, radio, and television has been issued by the Superintendent of Documents. Subjects covered range from basic reference works on electricity to advances in printed-circuit techniques, and prices run from 5¢ to $1.25. The highest-priced publications are two books on radar fundamentals, one of 474 pages and one of 394 pages.

Write the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for the list, "Electronics, Radar, Electricity, Radio and TV," which gives catalog numbers (necessary for ordering), along with prices and descriptions.

RECORDER-HEAD DATA

Sound Talk Bulletin No. 27 discusses the problems of tape-recorder head alignment and head wear. The 3-page bulletin covers azimuth alignment and tape skewing, importance of head contact, and the effects of head wear on magnetic tape recording and reproduction. In addition, it includes an 8-step check list for locating high-frequency response loss caused by head problems.

Available free upon request from Minnesota Mining and Manufacturing Co., 900 Fauquier St., St. Paul 6, Minn.

HIGH-FIDELITY

Lafayette's new 48-page high-fidelity catalog illustrates and describes hundreds of music system components ranging from tuners to binaural records.

Request catalog No. 454 from Lafayette Radio, 100 Sixth Ave., New York 13, N. Y.

TUBE DATA BOOKLET

Amperex's twin-tetrode tube, type 5894/AX-9903, is described in a new 26-page booklet. Included are detailed data, application notes, typical performance curves, special features, and a description of the construction of this tube.

Available without charge from Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.

WALL CATALOG

Sprague's C-452 wall catalog consists of five pages tabbed for the popular service types of electrolytic, ceramic, and molded-paper tubular capacitors, as well as printed networks. Listings include capacitance, voltage rating, dimensions, catalog number, and list price of each of the units.

Available free from Sprague Products Co., 81 Marshall St., North Adams, Mass.

UNITIZING EQUIPMENT

The 1954 edition of the Alden handbook, *Ideas—Techniques—Designs* describes new standard components for unitizing electronic equipment. It provides new data and planning sheets on plug-in packages and basic chassis for unitizing equipment and giving it rapid interchangeability. Also improvements and components for indicating and monitoring operation of electronic equipment with tiny tell-tales are described. New models of connectors and interconnecting systems that allow color-coding for easy circuit tracing have been added.

The booklet is available to manufacturers and designers writing on their letterhead to Department HB, Alden Products Co., Brockton, Mass.

OSCILLOGRAPH BULLETIN

General Electric has issued a 12-page bulletin on the features and operation of the general-purpose oscillograph PM-10, used in investigation work, design, and testing. The oscillograph permits simultaneous records to be made of voltage, current, time, speed, pressure, strain, and sound.

Write for Bulletin GEC-449B. Gratis from the General Electric Co., Apparatus Sales Div., Schenectady 5, N. Y.

TEST EQUIPMENT

Cal-Tronics has released a 12-page bulletin, *Electronic Test Equipment*, illustrating and describing a synchronizer test unit, electronic control amplifier test unit, computer systems test unit, and signal data converter test unit.

Copies may be had by writing Cal-Tronics Corp., 11305 Hindry Ave., Los Angeles 45, Calif.

END

HIGH-FIDELITY TECHNIQUES, by John H. Newitt. Published by the Technical Division, Rinehart Books Inc., 232 Madison Ave., New York, N. Y. 6½ x 9 inches, 494 pages. Price $7.50.

Written primarily for the "practicing engineer, home constructor, radio service technician, recording studio or sound system operators, and professional audio technician," this work can be read with profit by any music lover whose knowledge of electronics is enough to permit him to read a schematic.

The author devotes a short first chapter to defining the term "high fidelity," then follows with one on sound and hearing. The various components of a high-fidelity system—speakers, enclosures, crossover networks, and amplifiers—are then covered in chapters interspersed with a discussion of distortion and of high-fidelity circuits. High-fidelity radio receivers, records and record players, and magnetic recording each receive a chapter.

The longest chapter in the book is entitled "Custom Installation of High-Fidelity Equipment," and covers technical, subjective, business and mechanical angles. Several plans and photographs of custom installations are included.

Though aimed at the professional man, there is much fundamental information for the less technical reader, as well as for the electronic technician whose experience in audio has been limited. Though the book has a few weaknesses and unbalances (test records, for instance, are dismissed in two paragraphs while speaker enclosures receive 60 pages) there is more information in simpler and clearer language in this book than the reviewer has seen in any other on the subject. —*FS*

PRINCIPLES OF TRANSISTOR CIRCUITS, Richard F. Shea, Editor. Published by John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 6 x 9¼ inches, 535 pages. Price $11.00

This is the first of a long series of books which will compete for the attention of engineers specializing in electronic circuit and design work. It is an important book because it gathers much of the desired information on the characteristics and applications of transistors into one text for the first time. The hundreds of illustrative schematic diagrams cover the applications of transistors adequately. Before this the engineer has had to content himself with the information made available in technical journals.

All the authors are engineers at the General Electric Electronics Park Laboratories at Syracuse, N. Y.

Rather than to the service technician, this book is directed to the graduate student and the practicing engineer. Transistors came into the industry at a time when many practicing circuit-design and applications engineers had completed their formal training. Thus for the most part the individuals who will be most likely to profit from this

type of text are the younger men in the industry and those who have been keeping up with the phenomenal developments in this new field. But it would be a mistake for any of the older practicing engineers to bypass this book. It is hardly likely that any engineer can afford to be without some first-hand knowledge of transistors and their applications.

There are three main sections, treating low frequency, high frequency, and nonlinear applications. The low-frequency section considers such important topics as small and large signal applications, audio, d.c. and ultra-sonic amplifiers. Since transistors are limited in their frequency response this is the most important part of this text at the present time. However, since the frequency limitation is being moved forward almost daily, there is ample treatment of the basic principles of high-frequency operation and design considerations for high-frequency circuits with special consideration for video amplifiers.

The book is replete with circuit data on oscillators, i.f., r.f., and audio amplifiers, as well as flip-flops, multivibrators and pulse amplifiers. The chapter on feedback will be of especial interest to those engineers interested mainly in the audio applications of transistors.—*DA*

RADIO DATA CHARTS. By R. T. Beatty. Revised by J. McG. Sowerby. Published by Wireless World, London. Distributed by British Books Centre, 420 W. 45th St., New York 36, N. Y. 8¼ x 10½ inches, 91 pages. Price $2.00.

First appearing more than 20 years ago, this new fifth edition contains a series of 43 nomograms (or abacs as the British say) providing essential data required in receiver design. Each chart is accompanied by a page of illustrated text supplying pertinent radio theory. Use of the charts is demonstrated with clear examples.

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END

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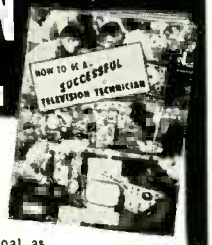

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PAGE 151

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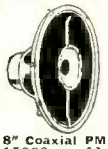

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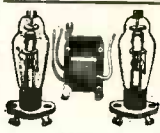

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MODEL AMP 5 Hi-Fi 5 watt AC Amplifier plus built in PreAmp GE V.R. pickup 60 to 18000 Cps/1DB/down 2 DB 40 cys. hum level-55 db. mike & phono volume, continuous bass treble controls 6SJ7, 6SC7, 6V6, 6x5 "TAB" HiFi special to your door PREPAID $21.39

AUDIO COMPONENTS

GE RPX041 Cart Gold Tone $5.25
GE RPX050 Triple Play Cart 4.98
Electrovoice Triple Play . . . 1.98
GE RPX-052 Triplay Diamond and Sapphire 17.75
"Tab" Headcutters Replacement Stylus
RPJ010 Dual .001" & .003" Sapphire $1.98
RPJ005 Single .001" Sapphire 1.35
RPJ001 Single .003" Sapphire 1.35
RPJ004 Single .001" Diamond 11.98
RPJ013 Dual Diamond & Sapphire . 12.98

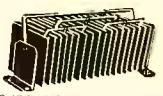
INFRARED SNOOPERSCOPE

SEE-IN-DARK TUBE
Image-Converter Tube Hi Sensitivity simplified design 2" dia. Willemite screen—data & tube, ea. . . . . $7.98; 2 for $13.98

SNOOPERSCOPE PWR SUPPLY

1800VDC/35MA, Using Doubler Crkt. Transformer, Rectifiers, Stockets, Resistors, Capacitors and Diagram $6.98

SELENIUM RECTIFIERS



We specialize in Rectifiers, Power supplies to specifications. Immediate delivery.

Current (Cont.)	18/14 Volts	36/28 Volts	54/40 Volts	130/100 Volts
1AMP	1.35	2.15	3.70	8.50
2AMP	2.20	3.60	6.00	10.50
4AMP	4.25	7.95	12.95	25.25
6AMP	4.75	9.00	13.50	33.00
10AMP	6.75	12.75	20.00	44.95
12AMP	8.50	16.25	20.50	49.00
20AMP	13.25	25.50	38.00	87.50
24AMP	16.25	32.50	45.00	95.00

Rectifier & Transformer

115V/60 cy inputs.
up to 14DVC at 12 amps . . . . . $ 19.98
up to 28VDC at 4 amps 14.98
up to 28VDC at 12 amps 29.98
up to 28VDC at 24 amps 63.98
up to 28VDC at 50 amps 127.00

Rectifier & Transformer & Variac

up to 14VDC at 12 amps . . . . . $ 30.98
up to 28VDC at 12 amps 45.50
up to 28VDC at 50 amps 167.00
C "TAB" fast delivery SPECIALS

HIGH CURRENT PWR SUPPLIES

Variable 0-28VDC, Completely Built, Ready to Go. Full Wave Selenium Rectifier, Transformer, Variac, Volt & Amp Meters, Switch, Terminals & Fuse. In Heavy Duty Steel Cabinet.

Continuous Rating	With Meters	Less Meters
0-28VDC at 4 Amp. . . .	$43.00	$39.95
0-28VDC at 12 Amp. . . .	89.00	74.95
0-28VDC at 24 Amp. . . .	129.50	114.95
0-28VDC at 50 Amp. . . .	239.50	224.95

RECTIFIER XFMRS

Primary 115V 60 Cyc
Secondary 0-9-12-18-24-36V
4 Amp . . . . . $ 8.75
12 Amp 16.75
24 Amp $35.75
18 Volt, 2 Amps . . . . . $ 1.98

RECTIFIER CHOKES

4 Amp .07 Hy .6 Ohm $7.95
12 Amp .01 Hy .1 Ohm 14.95
24 Amp .004 Hy .025 Ohm 29.95

FEDERAL "ITT" SELENIUM BATTERY CHARGER RECTIFIER

10-0-10V (CT) 100 Amp., fan cooled. Replace your old inefficient sulfide rectifier w/new selenium type. SPECIAL . . . $11.98

VARIABLE VOLTAGE TRANSFORMERS

POWERSTAT—GR—STACO

#10/132V/1.25A/LN	$7.98
#20/135V/3A/LN	11.25
#116/135V/7.5A/LN	20.70
#116U/135V/7.5A/LN	16.20
#216/270V/3A/LN,	23.40
#216U/270V/3A/LN	18.00
#1126/135V/15A/LN	41.98
#1226/270V/9A/LN	41.98
GR50A/0-135V/45A/LN	100.00
GR50B/0-270V/31A/LN	115.00
3000B/0-135V/30A/* Cased	55.00
3000BU/0-135V/30A/*	49.00
3020BU/0-270V/18A/* Uncased	49.00
3020B/0-270V/18A/* Cased	55.00
STACO/LRL5/Metered/140V/5A	41.50
STACO/Pal-7/Metered/135V/7.5A	40.50

Write for Qty Price & Catalog
(LN) Like New Complete Guarantee

TV & COAX CABLE

300 Ohm Twinex. Heavy duty 65 mil copper TV lead in. per ft. 2c; 100 feet **$1.39**
1000 foot reel $11.95
RG59U 73 ohm TV Coax Cable MFGRD to rigid UHF specs. per ft. 5c; 100 feet $4.50
SPECIAL 500 feet $22.00
RG8U Cable 52 Ohm Per Ft. . . . . 16c; 100 Ft. $14.98
HiVolts 15KV Wire Per Ft. 5c; 50 Ft. 1.25

ONE YEAR GTD PICTURE TUBES

7JP4	$17.95
10BP4	12.00
12" Glass	12.00
14" Rectangular	14.00
16" Glass	16.00
17" Rectangular	17.00
19" Round	19.00
20" Rectangular	20.00
21" Rectangular	21.00
24" Hytron	74.95
27" Hytron	89.95

Send your old tube prepaid only, and we will ship one year guaranteed Picture Tubes at above prices. No dud return required for 7", 24", 27" tubes. Prices based on $1.00 per inch. Metal or Electrostatic tubes add 10¢ per inch additional.

OIL CONDENSER SPECIAL

2MFD 600VDC

Aerovox Type P09 Steatite Insulators. Adjustable Mounting Clamp. Case 2" dia. x 2¾" high. BRAND NEW . . . 69c; 3 for $1.50

OIL CONDENSERS WAREHOUSE CLEARANCE SALE

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.5MFD	1500VDC	.95c 2 for $1.50
5MFD	600VDC	1.50; 3 for 4.00
10MFD	600VDC	1.98; 2 for 3.50
2x2MFD	600VDC/VIT "Q"	1.25; 2 for 2.00

BATHTUB SIDE TERMINALS

1MFD	600VDC	.39c; 3 for 1.00
4MFD	50VDC	.50c; 5 for 2.00
.1MFD	2000VDC	1.05; 5 for 4.50

MIKES & HEADSETS

Crystal Mike Cartridge $1.49 @ 4 for $5
Crystal Mike & Cable $2.98 @, 4 for $10
Navy Mike Carbon 2.98
P-20 Headset High Impedance 3.49
T30V Throat Mike Dble Button 200-5000 Cps #2B16301 . . . . . 98c
P-19 Headset Hi-Impedance $2.98
Sound Powered Headset, Chest Mike & Throat Mike Navy $15.98

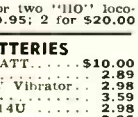
TUBES

***From This Special List We Ship $10.00 and Up Tube Orders At Our Expense (Postpaid) Within Continental Limits of U.S.A.**
90 Day Gtd. When ordering mention 3RE

0A2	.88	6AQ6	.81	6H6	.60	6X5	.54
0A3/VR75	1.04	6AQ7GT	1.29	6J4	6.66	6Y6G	.88
0B2	1.37	6AR6	2.98	6J5	.54	7A8	.68
0B3/VR90	.96	6AS5	.79	6J6	.58	7C7	.76
0C3/VR105	.92	6AS6	2.22	6J7	.72	7F7	.82
0D3/VR150	.92	6AS7G	3.48	6K6	.54	7F8	1.24
1B3/8016	.80	6AT6	.54	6K7	.58	7H7	.72
1L4	.48	6AU5GT	1.10	6K4A	3.50	7N7	.92
1L6	1.35	6AU6	.56	6K6GT	.54	7V7	1.06
1LD5	.98	6AVSGT	.98	6L6	1.48	7Y4	.68
1LN5	.78	6AV6	.49	6L6G	1.08	12A6	.48
1P5	.78	6AX4/6U4	.74	6L6GA	1.08	12AH7GT	1.45
1U4	.52	6B4G	1.18	6L6GAY	1.50	12AL5	.54
1U5	.54	6BA6	.54	6SA7GT	.66	12AT6	.54
1X2A	.98	6BA7	1.09	6SC7	.90	12AT7	.89
2A4G	1.18	6BC5	.63	6SF5	.78	12AU6	.72
2X2	.42	6BC7	1.23	6SF7	.73	12AV7	.69
2X2A	1.53	6BD6	.83	6SG7	.64	12AV6	.52
5R4GY	1.20	6BE6	.54	6SH7	.61	12AV7	.98
5R4GYW	1.75	6BF5	.98	6SJ7	.58	12AW6	1.18
5T4	1.45	6BG6G	1.58	6SK7GT	.56	12AX7	.98
5U4G	.55	6BH6	.63	6SL7GT	.64	12BA6	1.09
5Y3GT	.43	6BJ6	.69	6SN7GT	.68	12BA6	.59
6AC7	.80	6BK7	1.58	6SQ7GT	.62	12BA7	.94
6AG5	.71	6BL7GT	1.19	6SR7	.62	12BD6	.59
6AG7	1.14	6BN7	2.69	6SS7	.88	12BE6	.59
6AH6	1.89	6BQ6GT	1.20	6T8	.96	12BF6	.85
6AJ5	1.40	6BQ7	1.65	6U4	.74	12BH7	1.29
6AK5	.77	6C4	.52	6U8	.99	12C8	.62
6AK6	.92	6C5	.68	6V6	1.39	12H6	.64
6AL5	.48	6C8G	.59	6V6GT	.59	12J5	.52
6AL7GT	.98	6D4	2.70	6W4GT	.52	12K8	.68
6AN5	2.90	6F6GT	.79	6X4	.49	12Q7GT	.55
6AQ5	.52					12SA7GT	.68

12SC7	1.08	CK534AX	.99
12SF7GT	.84	CK536AX	.99
12SG7	.80	CK538DX	.98
12SH7	.63	CK539DX	2.19
12SJ7GT	.54	CK543DX	.99
12SK7	.66	CK544DX	.99
12SL7GT	.62	CK546DX	1.99
12SN7GT	.68	CK571AX	2.49
12SQ7GT	.54	CK1005	.68
19BG6	1.98	2050	1.48
19V8	1.98	CK5672	1.20
25BQ6GT	.98	CK5678	1.28
25L6GT	.58	5687	3.74
25Z5	.78	CK5702	2.90
25Z6GT	.58	CK5703	1.29
28D7	1.94	Xtal Diodes	
35B5	.52	1N21A	1.55
35L6	.58	1N21B	1.92
35Z5GT	.54	1N22	1.22
35Y4	.68	1N23	1.32
45Z3	.88	1N23A	1.98
50A5	.76	1N23B	2.22
50B5	.54	1N25	4.98
50C5	.54	1N26	8.75
50L6GT	.62	1N27	1.55
RK61/XFG1	2.65	1N34	.64
80	.58	1N34A	.90
81	1.38	1N35	1.65
83	1.12	1N38A	1.29
83V	1.22	1N41	8.95
84/6Z4	.62	1N42	16.95
117L/M7GT	1.98	1N45	1.45
117Z6GT	.96	1N46	.69
CK502AX	1.49	1N47	4.00
CK503AX	1.49	1N48	.55
CK505AX	1.79	1N51	.45
CK512AX	1.45	1N54	.78
CK531DX	1.89	1N60	.60
CK532DX	1.89	1N63/K63	2.49
CK533AX	1.29	1N69	.98

DC POWER SUPPLY



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 "110" locomotives. . . . . $10.95; 2 for $20.00

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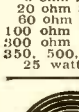
#25-2 GE PORTABLE BATT. $10.00
4V/16AH BATT Gould 2.89
2V/20AH Willard and 2V Vibrator . . 2.98
2V/20AH w/vib & acid* 3.59
6V/6AH Willd NT6/BH214U 2.98
6V/6AH Battery w/acid* 3.25
6V/40AH Battery 6.98
6V/40AH Battery w/acid* 9.25
* We ship acid in bottles. R exp only.

SOCKET ASSEMBLIES



½" Jewel Bayonet Socket Light Dimmer (Shutter) Regular 97¢ Less than (3) ea. 39c Lots of 5 **33¢ EA.**
Dialco 31101 Pilot Light 1" Jewel 115V. High Polish Finish. Reg. $1.03 "TAB" Price. 85c @ 10 for 55
Neon Panel Lite Dialco 95408 Clear With Neon. Reg. $1.09; Special 79c
Pilot Lamps 40-41-44-46-47 . .10 for 79¢

RHEOSTAT SALE

2 ohm 50W Model J . .2.25; 5 for 10.00
6 ohm 25W Model L . .1.49; 2 for 2.49
20 ohm 50W Model J . . .1.98; 2 for 3.50
60 ohm 50W w/Knob . . .2.25; 2 for 4.98
100 ohm 50W Model K . .1.98; 2 for 3.50
300 ohm 225W Model P . .2.98; 2 for 5.00
350, 500, 5000 ohm Slotted shaft, 25 watt . . . . . .79c; 3 for 2.00

TEST CORDS

8 FT 26 Strand Wire Alligator Clips, as Shown 3 PR . .$1.00
CD277 8 Ft/6 Conductor, With AN Connector, P/O BC312 . . . . . $1.25
15 FT Extension SJ Cord Heavy Duty, Rubber Insul. .$1.00
4 FT Flexible Instrument Test Leads Red & Black 2 Pair $1.25
10 FT Line Cord, Rubber Insul & Plug, Hvy Dty Hi-Quality . . . . . .2 for $1.00

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2.5V 2A @ 79c; 2 for $1.49; 10 for $6.49
2.5VCT/10A 12.5KVINS . .6.98; 3 for $18
5VCT/10A 5KVINS, $3.59; 2 for $6.50
7.5VCT/12A 15 KVINS 10.95; 2 for $17.50
24V/1.25A CSD . . . . . $1.98; 2 for $3.49
2X12V/2A or 24V/2A @ $3.89. 2 for 6.98
42.5V/2A Sel Rect Xfmr $2.95
64V/1 Amp HMSLD .. $3.49; 2 for $5.00

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All 115 V 60 Cyc Input TV, & CR pwr Xmfr up to 20" tubes, Hi VOLTS to 20 KV (w/quadrupler ckt.) ALL tubes, PL & FIL wndgs
300 VDC/275 Ma Full-Wave: 6.4V 10.3A, 5.4V/8A, 2.5V/3A Hypersil Core. Oil Fil . . $4.98; 2 for $8.50
1000VCT/45MA, 795VCT/80MA, 300VCT/55MA 3X5V/3A, 6.3VCT/1A, 6.3VCT/.3A CSD HVINS CAN BE USED 2X RATING HAYTHEON . . . . . $4.00; 2 for $7.00
900V/35MA 2X2.5V/2A, XCLENT 1800V DRIER TWO 2X2 FIL WNDGS . . . $2.25
850VCT 148MA, 5V/3A, 6.3V/5A, 6.3V 3A . . . . . $4.98; 2 for $9.00
778VCT/200MA, 5V/3A, 6.3VCT/5A $4.98
780VCT/250MA, 5V/6A, 12.6V/5.5A $7.95
770VCT/200MA, 5V/6A, 6.3V/5.5A $6.95
770V/2.5MA, 2.5V/3A, HVINS HMSLD includes FILTER PARTS 4/scope $2.95
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12Hy/80ma/H'sld/3KVins 2.25
10Hy/125ma/UTC/Csd/H'sld/1Kvins 1.98
50Hy/125ma, CSD, H'sld 2.89
20 Hy/300ma, or 15HY/400ma 12KVins 8.95
13.5Hy 1 amp 17 Kvins Raytheon . 39.95
6 Hy/175ma, 250 ohm . . .1.49; 2 for 2.49
10 Hy/85ma 550 ohm . . .95¢; 2 for 1.69
3 Hy/40ma UTC Hi "Q" 95¢; 2 for $1.39

CRYSTAL DIODES

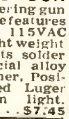
1N21 Lots of 100 40¢ ea
Smaller qty . . .85c; 10 for $5.00
Sylvania-Sylvania-Sylvania-W.E.
1N23B . . . . .$2.25; 5 for $10.00
1N46 . . . . .69c; 5 for $ 3.25
1N21A . . . . .$1.55; 5 for $ 7.00
1N21B . . . . .$2.89; 4 for $10.00
1N27 . . . . .$1.55; 5 for $ 7.00

OIL CONDENSER SPECIAL

10 MFD 600 VDC $1.75 ea
lots of 3
Case dimensions, not including insulators 4⅛H x 3¾W x 1¼"D
Smaller Quantities, special $1.98

TUBE SPECIALS

YOU PICK THEM **39¢ ea**
lots of 10
Cracked base or broken key electrically perfect
TESTED & 90 DAY GUARANTEED
ORDER NOW, WHILE THEY LAST
5U4G — 6SN7 — 25L6 — 25BQ6
5Y3GT — 6K6GT — 12SA7GT — 6H6
6V6GT — 6BQ6 — 6W4GT — 12SG7



"LENK" 180 WATT PERFECT BALANCE SOLDERING GUN

No other soldering gun offers all these features at any price. 115VAC 180 Watt, light weight 28 ozs., melts solder 3½ seeds., swivel 180° tip, special alloy korodless tip, Heavy duty transformer, Positive trigger—easy action, balanced Luger pistol feel grip. Focused beam light. Postpaid to Your Door $7.45

T2FD antenna resistor non-inductive 350 ohm/250 watt. $1.98

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Money Back Guarantee (Cost of Mdse. Only) $5 Min. Order F.O.B. N.Y.C. Add Shpg. Charges or 25% Dep. Tubes Gtd. via R-Exp. only. Prices subject to Change Without Notice. Phone Rector 2-6245. CABLE: "TABPARTS"

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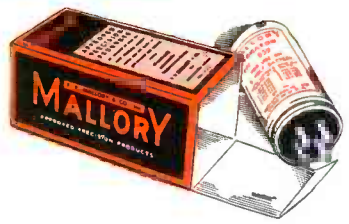

First On The Market . . . more than 20 years ago Mallory produced the first commercial Vibrators.

First As Original Equipment . . . today Mallory produces more Vibrators for set manufacturers than all other makes combined.

First With Servicemen . . . surveys show that Mallory Vibrators are preferred and used by 5 out of 6 servicemen.

Your Work Is Right The First Time when you use Mallory Vibrators. The patented, tuned mechanism assures completely dependable performance... always. Ask for Mallory Vibrators by name.

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Ask your Distributor about Mallory Deal 2448 which includes these 6 fast moving Vibrators.

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$50,000 "TELL & SELL" CONTEST

For Dealers and Servicemen* who use RCA Tubes

1954 DeSoto Automatic "Hard-Top"—170-H.P. Fire Dome V8 engine, Power-Flite Transmission, Power Steering . . . completely equipped, including radio and heater.

1954 Dodge DeLuxe ½-To Panel Truck—complete wit "Truck-o-matic transmission," radio, heater and accessories . . . *plus a full set of RCA Test Equipment*, aluminum ladder, and winner's business name and address on truck panel.

Here's all you do—

Get an entry blank from your RCA Tube Distributor Salesman. Complete the following sentence in 25 additional words or less:—

"I use and recommend RCA Tubes because"

It's as easy as that . . . and you may enter as often as you like, but each entry must be on an official entry blank.

Hints to help you win

See your RCA Distributor Salesman right away. He has a copy of the "clue book" waiting for you. This book contains full details on the whole exciting "Tell and Sell" Campaign, including contest rules.

You may win first prize . . . so don't waste a moment. Contest closes April 30, 1954.

*Your RCA Distributor Salesman will be glad to help you . . . because if you win, he wins a duplicate prize!

400 FABULOUS PRIZES

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* TV sets
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* Cameras
* Air Conditioners
* Test Equipment
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* Ranges

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HARRISON, N. J.