AUGUST 1954

RADIO-ELECTRONICS

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor

In this issue:

Horizontal Instability In TV Sets

•

Junction Transistor Checker

•

Printed Circuits in Hi-Fi FM Tuners

•

A Low-Cost Amplifier

•

Frequency Compensation For Your Scope

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New Solar Battery Produces Power from Light

(See page 4)

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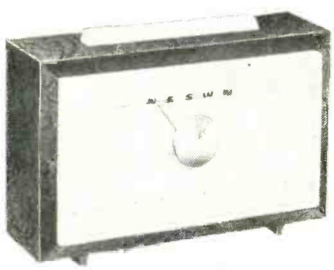

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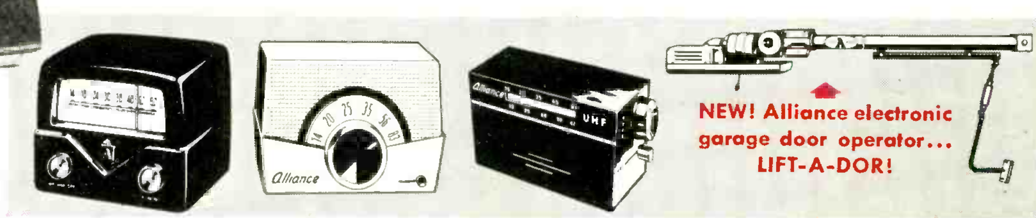

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ON THE COVER *(Story on page 76)*

Margaret Bagley, of the Bell Laboratories staff, operates the transmitter, which is modulated by a small phonograph. Power is furnished by an electric light bulb.

(Color original by Davis & Field)

CONTENTS — AUGUST 1954

Editorial (Page 29)

Rocky Road to Success .... by Hugo Gernsback 29

Test Instruments (Pages 30-41)

Junction Transistor Checker .... by Edwin Bohr 30
Improving the TV Alignment Generator .... by Frank DiElsi 33
Scope Frequency Compensation .... by Elliott A. McCready 35
High-Accuracy Ohmmeter .... by Norman H. Crowhurst 36
Miniature Audio-Frequency Test Oscillator .... by I. Queen 38
Distortion Totalizer .... by C. W. Palmer 39

Television (Pages 42-53)

Tracking Down Horizontal Instability, Part I .... by Cyrus Glickstein 42
New Television Stations 44
Color TV Circuits, Part III—Burst Amplifier, Color Oscillator and Control Circuits .... by Ken Kleidon and Phil Steinberg 45
Ghost Attenuator .... by H. E. Warriner 47
Television—it's a Cinch, (Twelfth conversation, first half: r.f. problems, visible noise, selectivity *versus* bandpass .... by E. Aisberg 48
TV Service Clinic .... Conducted by Matthew Mandl 51
Rejection Filter for TV Buzz .... by Irving Gottlieb 53

Audio-High Fidelity (Pages 54-74)

High-Quality Audio, Part XII—A popular "inverter", the cross-coupled amplifier .... by Richard H. Dorf 54
Servicing High-Fidelity Equipment, Part VI—Using oscilloscope patterns for analyzing and locating troubles .... by Joseph Marshall 56
High-Fidelity Loudspeakers, Part IV—The enclosure, cabinet or baffle can be a decisive factor .... by H. A. Hartley 60
High Fidelity for TV .... by Stanley Rowson 62
Low-Noise Transistor Preamplifier .... by Rufus P. Turner 64
Space Sound 69
Sound Destroys Sound 70
A Low-Cost Audio Amplifier .... by G. Franklin Montgomery 72

Electronics (Pages 76-78)

Solar Battery Powers Transmitter (Cover Feature) by D. M. Chapin and D. E. Thomas 76

Radio (Pages 80-88)

Printed Circuit I.F.'s for Hi-Fi FM Tuners .... by Robert Grodinsky 80
Regenerative Transistor Receiver .... by Dr. William G. Grace, Jr. 84
Transistor Dot Maker 86
Junction Transistors for High-Frequency Oscillator .... by I. Queen 87

New Design (Pages 92-95)

New Tubes and Transistors 92

Departments

The Radio Month 6
Correspondence 16
Technotes 89
Technicians' News 90
New Patents 96
New Devices 102
Question Box 106
Radio-Electronic Circuits 108
Try This One 110
Business 112
People 115
Electronic Literature 118
Book Reviews 120

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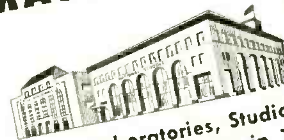

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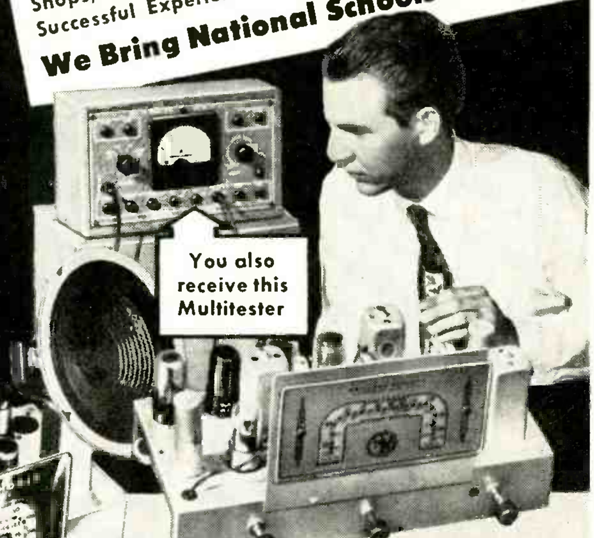

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THE RADIO MONTH

DR. KARL T. COMPTON, physicist and educator, died June 22 at the age of 66, following a heart attack some days earlier.

Dr. Compton was the founder and head of the Radiation Laboratory of the Massachusetts Institute of Technology. Later he became head of the Research and Development Board of the National Military Establishment, a position he held until medical reasons compelled him to abandon many of his activities in 1949. He remained chairman of M.I.T. till his death, however.

In addition to his research and organizational work in radar, communications, nuclear physics, guided missiles and other electronic applications, Dr. Compton was an advocate of broad education, and introduced a division of humanities at M.I.T. He received innumerable medals and awards, including the Congressional Medal of Merit for being "personally responsible for hastening the end of World War II", and 32 doctorates from institutions of learning in all parts of the world.

SELENIUM SHORTAGE has led to a salvage drive. Triggered by a letter from C. F. Honeywell, Administrator of the Business and Defense Services Administration of the Department of Commerce concerning the shortage of this highly strategic material since the Korean emergency, one large rectifier manufacturer has announced a system of purchasing burned out units.

The factory, according to the announcement, is already diverting factory-generated rejects for selenium reclamation. It is estimated that during the past 5 years 400,000 pounds of selenium have accumulated in out-of-warranty replaced rectifiers in the United States.

BASIC MEDIUM of communication in the United States is and will remain radio. This opinion was expressed by R. H. Hyde, acting chairman of the Federal Communications Commission in a speech at the recent NARTB convention.

Hyde said that on the basis of present grants and applications, there will be about 670 television stations in 325 communities. In contrast, 1,300 communities have their own local radio station.

The interest and attention devoted to television have obscured the continuing growth and development of aural broadcasting. In the past 10 months, 114 new AM station authorizations were issued, almost as many as new television grants.

FIVE NEW U. S. TV STATIONS have gone on the air since our last report. These are:

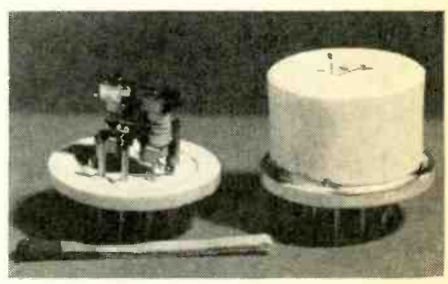
KFXJ-TV	Grand Junction, Colo.	5
WDBO-TV	Orlando, Fla.	6
KGLO-TV	Mason City, Ia.	3
WBOC-TV	Salisbury, Md.	16
KVDO-TV	Corpus Christi, Tex.	22

WECT-TV, Elmira, N. Y., channel 18, has gone off the air.

Two new stations have gone on the air in Canada: CHCH-TV, Hamilton, Ontario, channel 11; CBWT, Winnipeg, channel 4.

A NEW DEPARTURE in electron tube manufacture, the "stacked tube" was revealed recently to a joint Armed Forces-industry-press conference by Sylvania Electric Products Inc.

The base of the new tube is a ceramic disc, through which the usual contact pins are brought. There are two additional rigid pins on which the elements are mounted. Holes in the anode and in the frame holding the grid assembly, and slips attached to the cathode, slip over the pins. Ceramic washers between the elements space them correctly. The pins are then riveted down on the assembly and a ceramic cap sealed over the whole. The "stacked tube" will stand vibration, heat and shock that would destroy a standard glass tube of equivalent type.



CLINICAL THERMOMETER consisting of a tiny carboloy thermistor mounted at the end of a stainless steel probe gives accurate readings in 5 to 7 seconds. Besides being quicker, speeding up the taking of temperatures 40 times, the new thermometer's probe is unbreakable, making it safer than the old glass type.

The probe is connected by a flexible transmission cord to a mercury cell, with a meter that registers the temperature. The thermistor resists heat and translates this resistance in terms of degrees on the meter.

THE RADIO MONTH

MAGNETIC TAPE has replaced disc records in the nationwide franchise service of one of the largest "background music" concerns. The company, Muzak Corporation, developed its own playback unit for the purpose and states that it will make the service cheaper and improve the quality of the music. It will make background music service economically possible in smaller communities that could not have been served with the disc system, the company states.

The new tape plays a full eight hours, running four hours in one direction, stopping and reversing automatically, and playing the additional four in the other direction. Subsonic signals on the tape control the starting and stopping, preselect specialized music (such as Christmas carols) when desired, rewind, or shut off the machine and switch in a companion. Two machines can play indefinitely and automatically. The only attention necessary is one visit a day to change reels.

SOLAR GENERATOR using cadmium sulphide instead of silicon as its light-sensitive element has been announced by the Wright Air Development Center of the Air Research and Development Command. Cadmium sulphide is best known as a yellow powder used as a paint pigment. As a converter of solar energy, it appears in crystal form.

The crystal in the first model is the size of a sugar cube, but wafer-thin crystals would work efficiently. The electrode attached to the sides of the crystal are of dissimilar metals. The negative electrode is indium and the positive, silver. Small motors and an electric clock have been operated by the experimental generator.

Larger units could be constructed, and it is believed that a thin crystal slab with an area of 60 square feet, resting on or built into the roof of a house, could supply all its electrical requirements.

RADIO INTERFERENCE caused by high-voltage transmission lines in Sweden has been reduced successfully by transmitting radio programs over the power line itself. In the initial tests, a 250-watt transmitter operating at 182 kc was used.

The system consists of connecting a radio transmitter to the power line between one phase and ground via a capacitor conveniently located in the line system. The transmitter power is such that the signal level exceeds the interference level by an amount that makes the disturbance practically inaudible.

Radio noise interference had increased considerably when the 230-kv power system was extended to 400 kv. Attempts to reduce the difficulty by conventional methods—moving the antenna cable, shielding transverse lines, etc.—were unsuccessful. Radio reception is obtained in the usual manner by tuning the receiver to the wave length of the line radio. No special arrangements or equipment are required.

ULTRASONIC SOUNDS are produced by animals other than bats and porpoises. Dr. John W. Anderson of Cornell University has discovered that laboratory rats, guinea pigs and several other animals are also capable of producting inaudible sounds.

Dr. Anderson thinks the high-frequency sounds may serve for communication between individuals. Whether or not rodents use these for orientation as bats do is not known, but is not considered likely. END

Donald C. Reynolds (left) and Lt. Colonel Gerard M. Leies observe the solar generator as it turns small direct-current motor at 73 revolutions per minute.

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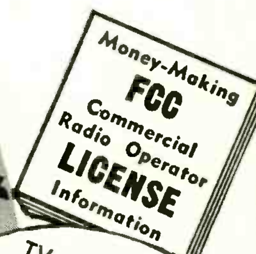

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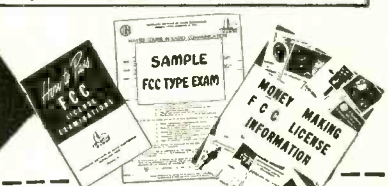

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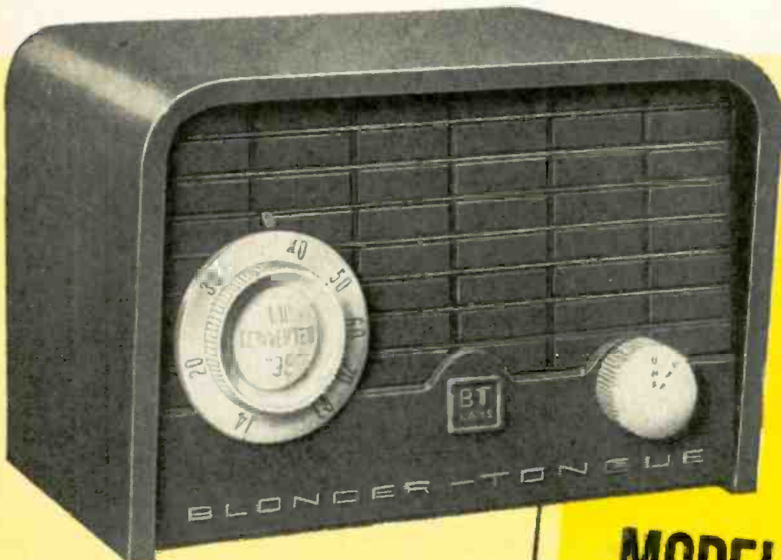

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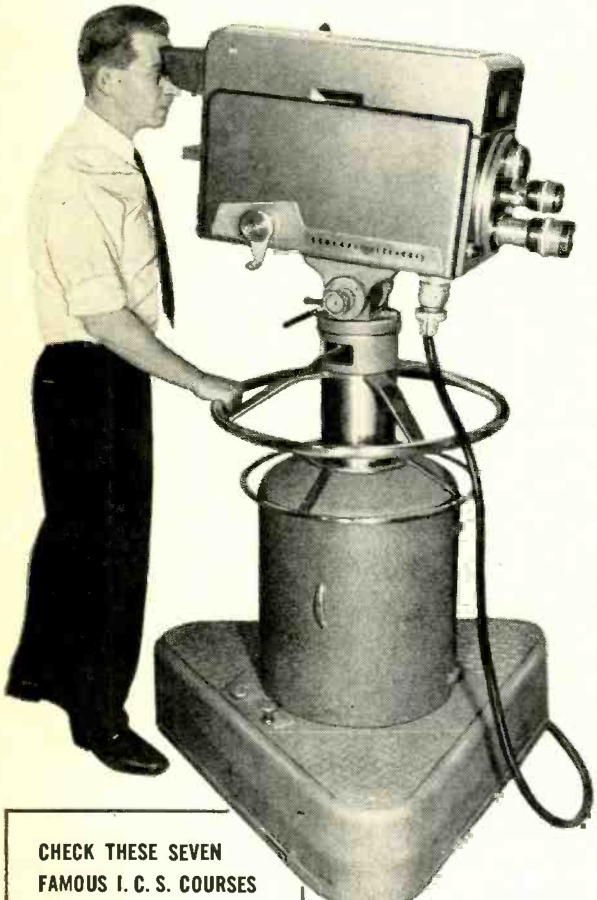

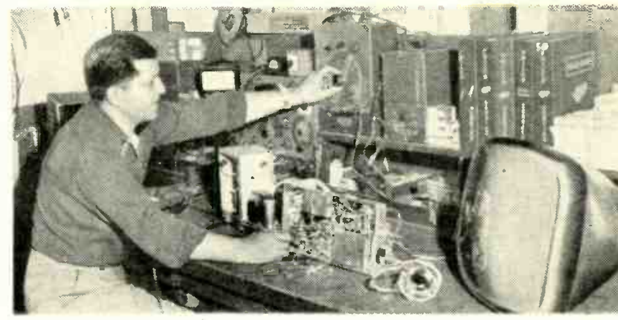

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ELECTRONIC COMPLEXITY

Dear Hugo:

I read with great interest and approval your editorial in the June issue of RADIO-ELECTRONICS. I think you have there offered a very practical solution to the ever-increasing complexity of television receiver and computer circuits, with their accompanying increasing liabilities to contact interruptions.

Unquestionably the idea of wrapping up the circuits in a relatively small number of compact packages would prove such a practical and economical solution that it would be widely accepted throughout the electronic industry.

I never fail to read your monthly editorials and inevitably find them interesting and suggestive.

LEE DE FOREST
Los Angeles, Calif.

ORCHIDS TO US

Dear Editor:

This is a note I've been intending to write each time I see a new issue of RADIO-ELECTRONICS. I am continually impressed by the wealth of valuable information presented in such down-to-earth form, so I just want to express my appreciation.

As a radio instructor I urge my students to recognize that they can't make a place for themselves in electronics just on the strength of class and laboratory training alone—that it takes individual initiative too, and I'm pleased to recommend RADIO-ELECTRONICS to help them keep on their toes in this fast-moving field.

I feel that much credit is due those who direct this publication.

HUGH LINEBACK
Oklahoma Agricultural and Mechanical College
Stillwater, Oklahoma

CORRECTION

Dear Editor:

I presume that Mr. Jesse Dines, as well as readers of his very elightening article, "Ceramic Capacitors," June 1954, have discovered an erroneous formula used to calculate the frequency change of a tuned circuit due to a change in capacitance. The correct formula, of course, is

$$f2 = \frac{f1 \times \sqrt{C1}}{\sqrt{C2}}$$

which is derived directly from the well known formula

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Therefore, the calculated frequency f2 should read 40.17 mc instead of 40.33 mc. In other words, the frequency drift is somewhat less serious than shown.

Perhaps Mr. Dines might also have mentioned that a capacitor with negative temperature coefficient is desirable in critical circuits where other components, such as coils, have positive coefficients.

HERBERT H. LENK
Cincinnati, Ohio

CORRESPONDENCE

DECOMPLEXITY

Dear Editor:

Thank you for your timely editorial "Decomplexity" in the June issue of RADIO-ELECTRONICS. Having been either radio engineer or service technician—or both—for the past 40 years, may I offer my two cents worth? You are *so* right!

And I do not refer to the horrendous combinations of radio-TV-record player combined in a box as big as a grand piano, but to the average television receiver chassis. Those big combinations are "for the birds," those birds with more dollars to spend than sense.

In the first place, no television receiver should be so large as to be not portable—not movable by the owner or service technician. Most housewives want things moved occasionally, and the TV is no exception. And they could put handles on TV sets, too, especially the 21-inch variety. *Did you ever try to pick up a 36-inch cube weighing 75 or 100 pounds?* The first one isn't so bad—but the third or fourth one gets to be awkward. And the average TV has to be serviced two or three times a year, and *has* to go to the service shop.

As you say, the TV set of today—not to mention tomorrow's color TV—has grown to be a monstrosity. Radio engineers(?) have spent years of study and experiment to "complexify" it, adding trick circuits—a.g.c., no-flutter, no flopover gadgets—more as talking and selling points than for their practical value. But the unfortunate customer doesn't understand, so he buys, thinking he is getting a "scooper-dooper" masterpiece.

Verily, *how complicated can they get?* When are we going to call a halt and go back to the simpler things? If we don't, a stalemate will soon result, where no one can service and keep in operation all the complex monstrosities of engineering genius. And set owners will not be able to afford either the receiver or the high cost of specialized service work required. This is not necessary.

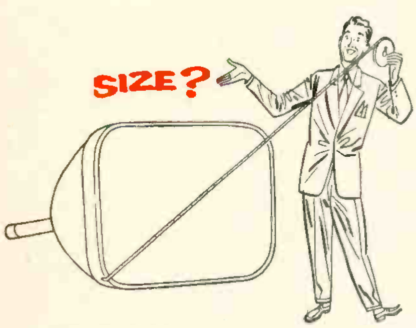
There are scores of different makes of television receivers, all different in their ways of arriving at the same objective. I have here between 25 and 30 different brands of TV receivers in all their various models. *All different!*

Talk about being a specialist! It reminds me of the wag who said that a specialist is a guy who learns more and more about less and less. If there were only one make of TV receiver we *might* become specialists, but we have to learn to solve all the riddles that the radio engineers have been able to concoct in their many years of endeavor to make things more complex.

Then—to top it off—they stick in cheap capacitors and other components where they think they won't cause trouble—in addition to mass-produced punchings for parts to reduce costs—and arrange them in such a layout that many of them are inaccessible.

(*Continued on page* 20)

Make old sets like new... have more satisfied customers!



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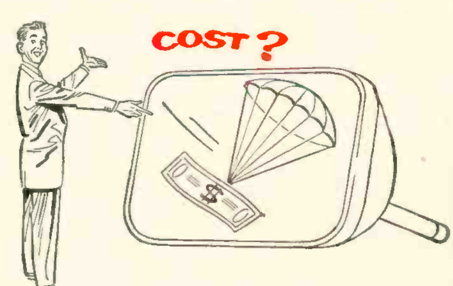
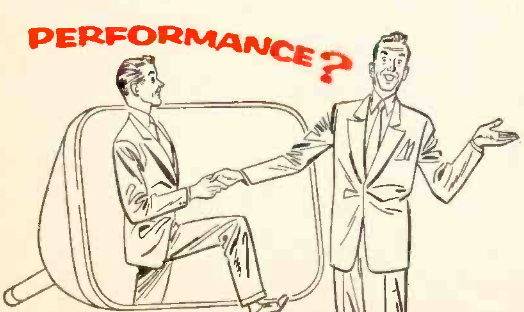
Sylvania Aluminized Picture Tubes are now available in most sizes for all popular TV sets. In other words, with Sylvania Aluminized Picture Tubes, you give your customers the best possible buy *and* the best possible service, including a full one-year warranty.



Remember, millions of set owners see and hear about Sylvania Picture Tubes on the nation-wide weekly television show "Beat The Clock." They know that they are famous for quality and dependability. For full details about aluminized tube replacement, write for Sylvania's "Aluminized Picture Tube Replacement Guide." Address: Dept. 4R-3808, Sylvania NOW!



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CORRESPONDENCE

The underside of many TV chassis consists of a space about two feet square and four inches deep, *completely filled* with hundreds of small parts, more hundreds of questionable soldered joints, and a maze of wires that discourages the repairman before he even attempts to trace a circuit.

On the other hand there are sets that amaze you at the comparative *lack* of parts and wires—and you wonder how the set can possibly perform so well with so few parts. These are the sets we service technicians fondly refer to as the "gutless wonders." They provide quite satisfactory service to most people in fair-signal areas, and—if they had a few more service adjustments—would go a long way toward the decomplexing of TV receivers.

These, the so-called gutless wonders, can even incorporate color facilities and still not have as many parts as a lot of the other makes have without them. And when those others incorporate color in addition to the mess already there, another chassis will be needed to contain the mess. The service technician may then throw up his hands in dismay—not to mention what else he may throw up.

The average TV set owner is now becoming aware that the table model is more desirable than the cumbersome console. First, because he may want to move it about occasionally, and second, because he knows that—at the present stage of (im)perfection at least—he will have to have it repaired at times. He also knows that *if he can take it to a repair shop,* it will be less expensive than to have a "specialist" call, take apart a complicated combination, and remove the chassis to his laboratory for a highly technical diagnosis, with the added expense of a return call and the reassembly of the set in the home.

Will this trend affect the manufacturer, or must the service technician boycott the makers of such complicated monstrosities and refuse to service their nightmares? It seems apparent that some manufacturers consider only the making and selling of their sets, with little regard to what happens after they have disposed of them. Let the suckers who buy them worry about that!

But it is the unhappy service technician who gets the rough time when he is expected to make the monstrosities work and perform in accordance with the claims put forth by the manufacturer and the dealers who peddle things they themselves know nothing about—and don't ever want to see again!

Even with the best of parts, careful connections and skillful workmanship, troubles can—and do—develop. Why increase the probability by the addition of many more—and such unnecessary—parts?

My hat is off to the gutless wonders—the less-complicated TV receivers. *Let's have more of them!*

OLE B. RITCHEY
Metz Radio and TV Clinic
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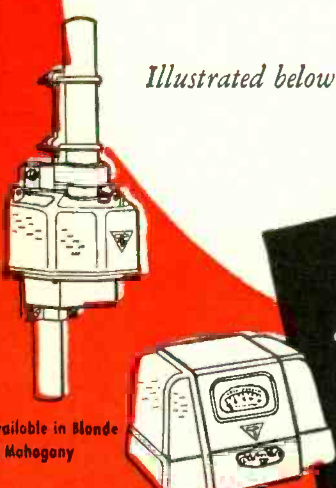

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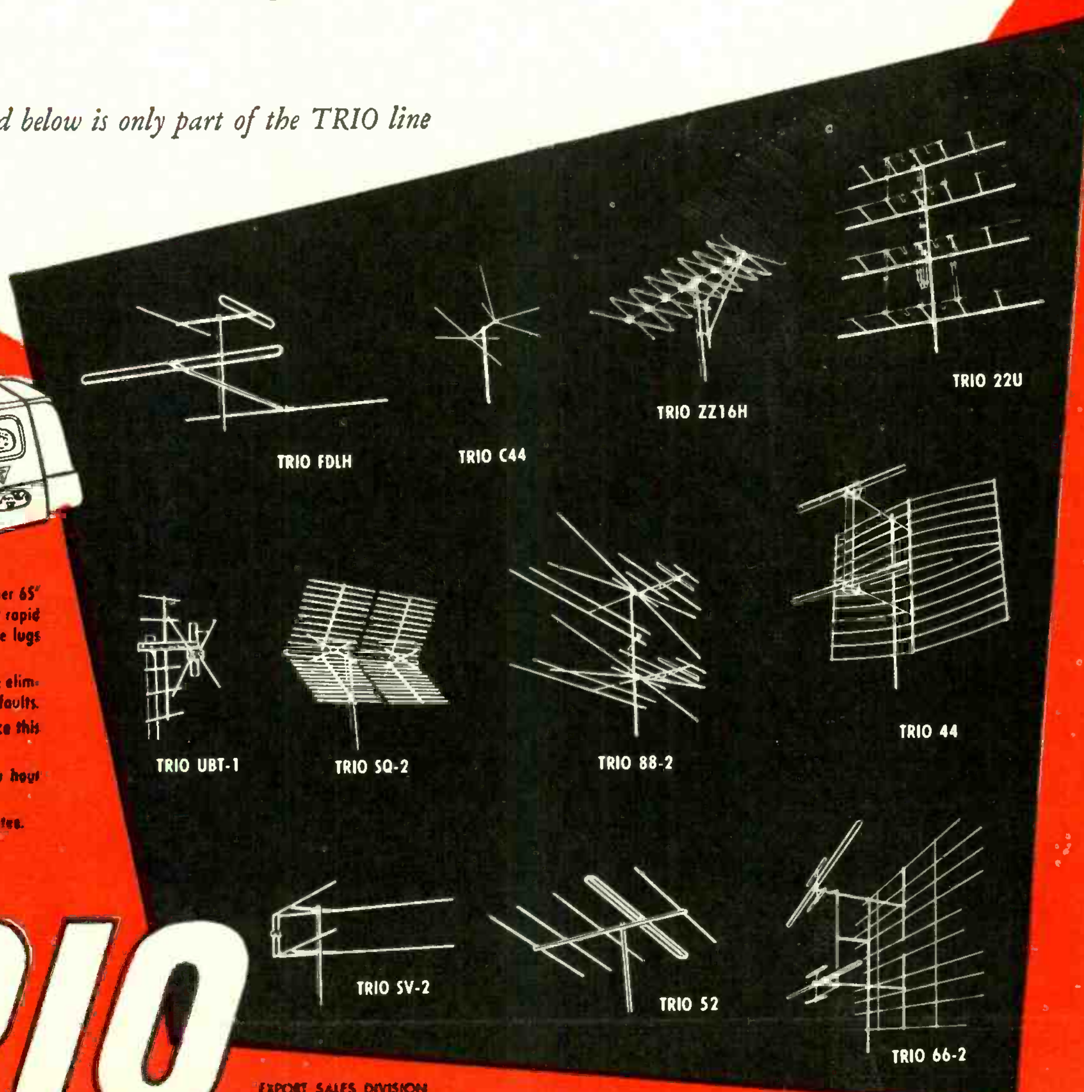

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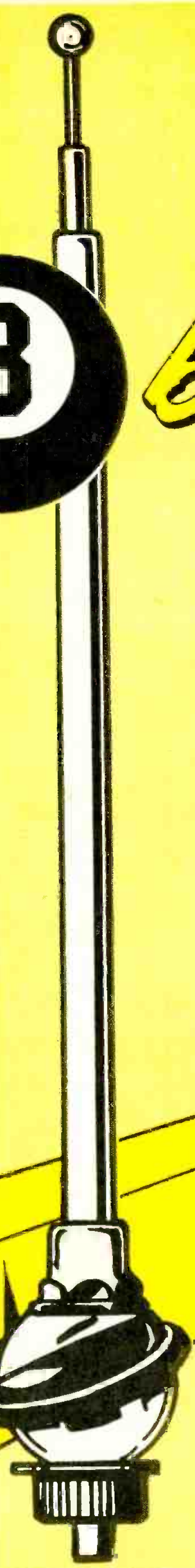

. . . and, when you get behind **this** 8-Ball you're backing a real winner! Ward's famous 8-Ball auto aerials are styled for beauty . . . engineered to assure best radio reception . . . designed for easy installation from the outside. Ward offers eye-catching wire display racks, envelope enclosures and hand-out pieces . . . all planned to help you win extra sales and extra profits.

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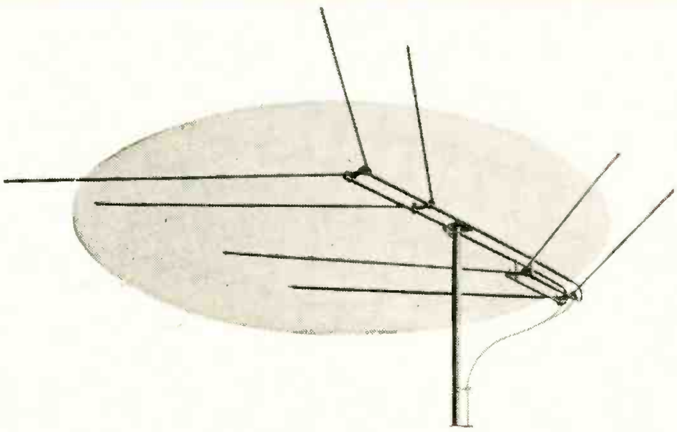
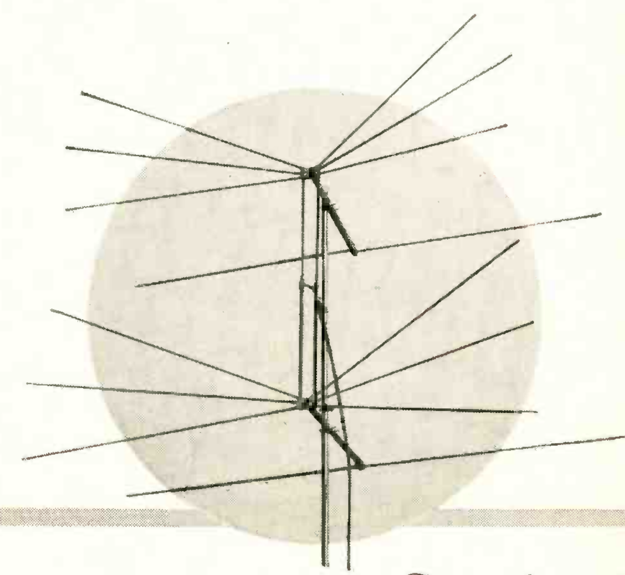
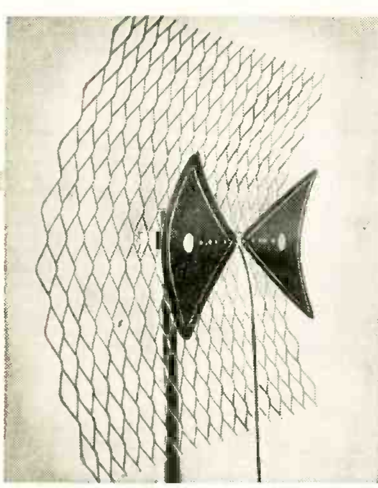


PHILCO ALL-CHANNEL UHF-VHF TROMBONE ANTENNA: The ideal antenna for areas having both UHF and VHF stations. The Philco Trombone can be stacked for VHF fringe area use. Completely pre-assembled at the factory . . . all-aluminum construction with dowelled elements: Part No. 45-1880.



PHILCO TWO-BAY SUPER CONICAL ALL-CHANNEL ANTENNA: Strong signal pickup on VHF channels 2 through 13, UHF channels 14 through 83 .. ideal reception in fringe areas . . . all-aluminum: Part No. 45-3096-2. Fringe area single bay design: Part No. 45-3096.



PHILCO PARAFLECTOR ALL-CHANNEL UHF ANTENNA: Pre-assembled, all-aluminum . . . 8 db to 10 db gain . . . outstanding fringe area performance . . . immediate mounting on existing masts: Part No. 45-3071. Bow Tie, Part No. 45-3069 and Bow Tie with reflector, Part No. 45-3070 provide top quality pictures in many UHF areas.

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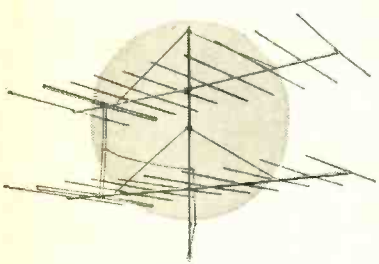
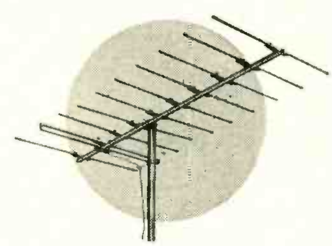
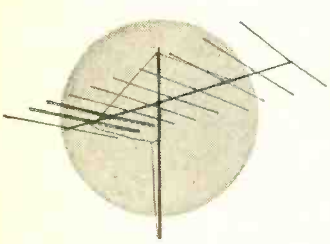


PHILCO TWO-BAY VHF LOW BAND YAGI ANTENNA: 10 elements . . . all-aluminum . . . factory pre-assembled. Top performance on channels 2 through 6 . . . 13 db to 15 db gain on various channels. Single bay Part No. 45-3112-2 through 6. Stacked version uses stack-harness Part No. 45-3267.

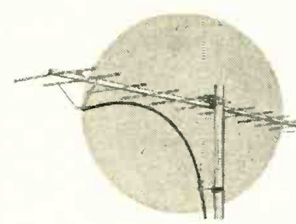
PHILCO HIGH BAND VHF YAGI ANTENNA: Pre-assembled, all-aluminum, 10 elements . . . high gain in fringe areas on channels 7, 8, 9, 10, 11, 12, or 13 . . . 10 db to 12 db gain on various channels . . . eliminates co-channel station interference: Part No. 45-3112-7 through 13.



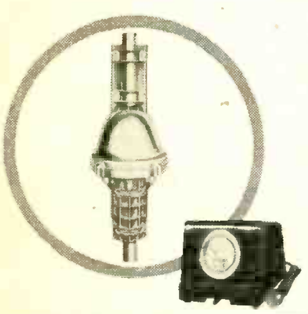


PHILCO BROAD BAND VHF YAGI ANTENNAS: All-aluminum, factory assembled for quick installation . . . high gain plus adequate band width. Three broad band models cover channels 2 to 6 . . . 4, 5, 6 . . . or 7 through 13: Basic Part No. 45-3112.

PHILCO GOLDEN YAGI UHF ANTENNA: Designed for 300 ohm operation . . . all steel construction . . . 11 db to 12 db gain on various channels . . . "Cronak" coated components resist salt air . . . humidity . . . six models cover entire UHF spectrum: Basic Part No. 45-1996.

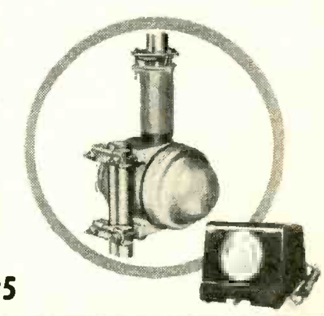


← PHILCO HEAVY DUTY ANTENNA ROTORS: →



PHILCO MODEL P-4: Supports antenna installations weighing up to 150 pounds . . . completely weather sealed . . . factory lubricated for life . . . uses 4-wire rotor cable . . . modern direction meter control cabinet: Part No. 45-1974.

PHILCO MODEL P-11: Easily handles two-bay arrays . . . mounts on masts up to 1⅝" in diameter . . . accurate direction control . . . heavy duty motor . . . streamlined design . . . uses 4-wire rotor cable . . . modern direction meter control cabinet: Part No. 45-1994.



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RADIO-ELECTRONICS
Hugo Gernsback, Editor

ROCKY ROAD TO SUCCESS

. . . Employment of specialized technicians is a complex undertaking . . .

THE two editorials "Wanted: Technicians" (February 1954 and "Specialization" April 1954) were responsible for a great deal more mail than any other two editorials this magazine has ever printed. From the vast volume of this correspondence, we have picked a few letters and are printing excerpts from them here merely to show the great variety in responses on the subject.

The letters themselves provide perhaps some of the best answers—better ones than we could have supplied ourselves. Evidently many readers did not see eye to eye with us on a number of points, which is not surprising because of the complexity of the subject itself. Then, too, readers of necessity have their own viewpoints and their own experiences. All this makes for great diversity in opinion.

One point, however, struck us forcefully when reading the many letters, and that is that few of the correspondents paid much attention to the *presentation* of their problems to would-be employers.

Unfortunately, today when large companies must sift personnel applications, employment managers are unconsciously influenced by many things. Automatically, the reviewer picks out the clearest, the best-written, and the neatest applications, often giving them preference. Employers are only human. When going through hundreds of letters, they have little patience to wade through poor, ill-written presentations. Many technicians, engineers, and others—and we know this from our own experience—spend little time with their applications.

One would think that when a $5,000 or $10,000 job was at stake, the applicant would secure the best talent to prepare the finest presentation that money could buy. This is rarely the case. Many applications are hand-written on a poor grade of paper, and even if they were typewritten, they are not too clear. Inevitably, such letters get little attention. *In these days of competition, it is necessary for the applicant to fight and battle* all the way through. Even if he calls in person, he still should have a well prepared application for record purposes.

Here is a true anecdote, very much to the point, which shows what we mean:

A clever mechanic in vain made the rounds of all factories in town. Undismayed, he had his wife type all his qualifications on heavy parchment sheets. These were bound into a thick cover book. He wrapped it carefully, then packed it in a 3 foot barrel and sent it to the biggest plant employer in town. The mechanic is now the assistant to the president.

Even after a job is landed, this is only a beginning. How well can you adapt yourself to your fellow workers? If you want to go ahead fast, the job is only a stepping-stone. *You must do much more than merely hold down a job;* you must impress your employers day in and day out by acts, suggestions, and otherwise that you look for much more than just holding down a position. Unfortunately, often the most excellent technicians don't do this. They do only what they are supposed to do—not one iota more. Then at the end of the year, they wonder why they do not go ahead. Being a good or even exceptional technician or engineer means nothing at all *if* this fact is not communicated to the management. No one can do this except the technician himself.

Now, let us turn to our correspondence. For lack of space the entire letter could not always be printed, but the substance in each case will be found intact.

Editor, RADIO-ELECTRONICS

(1) "Your article, 'Specialization,' in the April issue of RADIO-ELECTRONICS is well worth reading a second time. I believe it may influence my decision to this important question: 'Shall I return to the campus to pursue a Master of Science degree in Electrical Engineering?' Can you advise me in making this decision?

"Upon receiving a Bachelor of Science degree in Electrical Engineering in 1952, I was commissioned in the United States Navy. Since then, I have graduated from the Navy Electronics Material School at Treasure Island, California, and served as Electronics Repair Officer on one of the escort carriers. I expect to continue to work with electronics until January 1955, my date of release from active duty.

"Since my senior year at the University of New Mexico, I have had a number of job offers from leading engineering concerns. The salaries have varied—all attractive. I have been advised to return to the campus by some of their spokesmen and to start to work immediately by others. Presently, I am undecided, but I feel that I should commence specialization by working for a Master's, regardless of the field I finally choose."

Roland L. Cooper
Alameda, California

Answer: *We certainly would recommend working for a Master's degree. In electronics, you can never have too good an education.*

Editor, RADIO-ELECTRONICS

(2) "Thanks for your words in the April issue of RADIO-ELECTRONICS. I am one of the mediocrities—but striving.

"I was riding high (I thought) as a supervisor of test operations of the production-line output of electronic devices at Hughes Aircraft, Culver City, California. Then, for family health reasons, we came to Tucson, Arizona. I was transferred to a job here at Hughes as Maintenance electrician. For nearly a year I fought the 'lowly' position. Suddenly I discovered that I didn't know much about all the devices which are my responsibility. Strange electronic control devices all about me and I was crying about the lack of opportunity to pursue my chosen profession.

"When I was discharged from the military service in 1945, I was handed a booklet which supposedly described my abilities as Chief Radio Technician, U.S.N.R. If today, after intervening years of study and experience, I really had all those qualifications, I believe I would be much closer to being an advanced specialist.

"Sir, it seems I am expending a good deal of energy. However, there is so much to know that many times I wonder if it is properly channeled (the energy). I have met no man in the field who can but rate your editorial as a challenge of the highest order."

D. B. Hatchett
Tucson, Arizona

Answer: *Your letter is self-explanatory. In our opinion, more study is needed, plus a little push on your part to move ahead to the position to which you are entitled.*

Editor, RADIO-ELECTRONICS

(3) "Being neither *summa cum laude* nor genius, my efforts shall perhaps go unread and, without doubt, unpublished.

"To begin with, perhaps it is an idiosyncrasy of the genii to ridicule those who are not similarly endowed, but, as Ben Franklin would have it, the stature of a man's character is judged by the company he keeps or competes with. By publishing the letter of an overzealous young man, you have accomplished nothing other than to point out the fact that youth is usually ignorant of: success is rarely attained through prescribed dosage of the so-called authorities, but is something that comes through years of experience and effort. As the most prolific inventor of our time has said, genius is more perspiration than inspiration.

Your conception of a specialist is somewhat incompatible with the term as it is generally understood, and is surely a misnomer of the person described. I seriously doubt that anyone can attain 'a thorough understanding of all phases of electronics.' It is possible to spend a lifetime studying and designing power supplies alone and leave many a stone unturned.

Wayne Dowd
West Covina, California

Answer: *Correct. Hardly a man alive can master* all *the intricacies of every phase in electronics. But many men, in specialization, can learn a great deal about certain specialized jobs in certain electronics industries, in our opinion.*

(*Continued on page* 122)

JUNCTION TRANSISTOR CHECKER

Varying transistor characteristics make this an especially useful instrument

By EDWIN BOHR

EVERY transistor owner needs some quick, convenient way of checking its performance characteristics occasionally. This simple, inexpensive instrument will do the job. For about $6 worth of parts and a few hours of labor, anyone can build it.

Because individual transistors vary tremendously in their initial characteristics, a transistor checker is far more important to transistor circuitry than tube testers are to vacuum-tube circuits.

A type number is given to a transistor when it falls within certain maximum and minimum values called a production spread. This spread, for practical reasons, is large. Production techniques for maintaining rigid, uniform characteristics have not been developed. Often, the better transistors—with high current gain—are selected from a production run and given one type number while the lower gain units are given another. High-gain transistors are thus picked and marked for sale at a higher price.

Data sheets for lower-price transistors usually give only an *average* value of current gain without specifying any minimum. This is a "pig in a poke" situation where the buyer cannot be very sure about the quality of what he is getting.

Of two similar transistors purchased "off the shelf" one may operate well into the megacycle region; yet, the other may be good to only a few kilocycles. The purchaser of transistors must recognize these facts and realize that they exist even in brand new units that have never been connected to a circuit. The experimentor will find it highly advisable to measure the gain of his transistors even before they are put into service. By doing this he can then reasonably judge the capabilities of the transistor and thus use it in circuits where it will perform most efficiently.

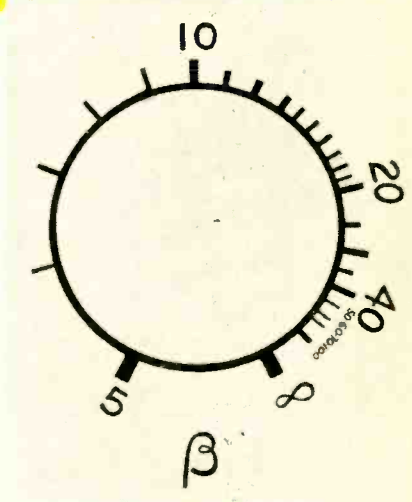
Adding to these initial unit-to-unit variations are the changes caused by the transistor's electrical and physical environment, such as excess humidity, careless overheating, and exceeded ratings. Wrong socket insertion, the surge of a charging capacitor, and excess supply voltage are just a few of the things that can cause harmful changes or permanent transistor damage.

It is a good idea to keep a record of a transistor especially when it is used in different circuits. An occasional gain check can reveal any transistor damage and isolate the cause.

Current gain

Current gain is the most useful single transistor measurement. This gain varies with the transistor's type of operation. For grounded-base operation, the current gain is termed *alpha* and is always less than 1 but approaches 1 for the junction transistor. Alpha is the ratio of collector current change to emitter current change for a fixed collector voltage. This is sometimes referred to as the short-circuit gain since it does not take impedance change into account. Manufacturers usually express the gain of their transistors in terms of alpha.

However there is another term that expresses current gain for grounded-emitter operation. This grounded-emitter gain is called *beta* and bears a simple mathematical relation to alpha.



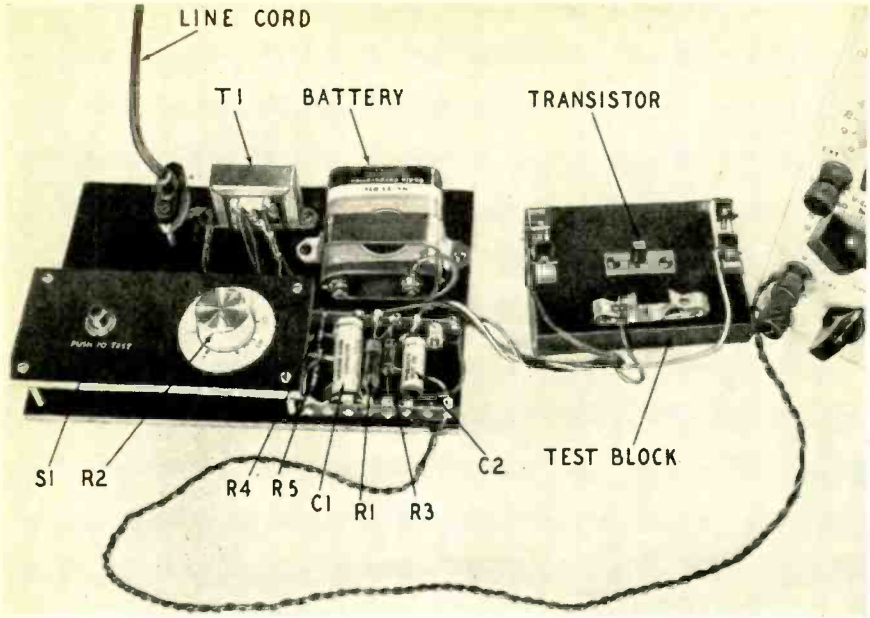
The calibrated balance-control dial.

If you know one you can easily find the other.

While alpha is always a decimal fraction less than 1, beta is expressed in small numbers greater than 1. With the beta measurement it is possible to glance at the gain and quickly know just how much better one transistor is than another. Alpha is not always so obvious. For example, how much better is a transistor with an alpha of 0.98 than a transistor with a 0.94 alpha?

The meaning and relationship between alpha and beta can be seen by observing the electron flow in the grounded-emitter and grounded-base circuits. These two circuits are shown in Fig. 1.

Suppose, as in Fig. 1-a, a signal change of 1 ma is applied to the emitter and this produces a 0.95 ma change in collector current. Alpha then must have a value of 0.95 because it is the change of collector current divided by the change of emitter current. Since the current flowing into a point must equal



Checker uses separate transistor mounting board. Battery is 4.5-volt unit—3 flashlight cells may be used.

the current flowing out, the base current change is 0.05 ma.

If the same transistor is connected as a grounded emitter, a 0.05-ma signal applied to the base will create a 0.95-ma collector change. The gain in this case is the change in collector current divided by the change in base current. This is the beta gain, and it has a numerical value of 19 for this transistor (Fig. 1-b). It is this gain that the checker measures.

The arrows in Fig. 1 indicate electron flow to the connections of a p-n-p junction transistor. Delta (Δ) means "a small change of," and the numerical relation of alpha to beta is: $B = \frac{A}{1-A}$

Circuit

The junction transistor checker is a "null balance" instrument that measures the current gain by comparing the transistor input and output signals (Fig. 2). The circuit is simple and its accuracy is limited mainly by the care with which the balance dial is calibrated and the accuracy of R1.

A 60-cycle signal is applied to the transistor base through R1, R4, R5, and C1. The emitter is grounded to point A, the neutral point for the checker. Capacitor C1 prevents the d.c. bias on the base of the transistor from flowing into the measuring circuits. The input signal is provided by a small stepdown transformer T1.

The signal to the base is called "constant current" because the high values of R4 and R5 almost completely determine the signal current flowing between the base and emitter terminals. The base-to-emitter resistance can vary from zero to several hundred ohms without appreciably affecting the transistor signal current.

Signal current flowing in the emitter-base loop generates a small voltage across R1 directly proportional to the signal current. Thus the current is indicated by the voltage generated across R1.

Parts list for transistor checker

Resistors: 3—100,000 ohms, ½ watt; 1—5,000 ohms, 1% (precision); 1—1,000 ohms, potentiometer (linear). **Miscellaneous:** 1—.02-µf, 1—.05-µf, 600 volts, capacitors; 1—stepdown transformer, 25,000 ohms c-t to 3-4 ohms; (Stancor A-3857); 1—push-button switch, normally open, s.p.s.t.; 1—4.5 volt battery; 1—power cord; 1 transistor socket; 1—chassis; terminals, terminal strips.

Since quantities are compared in a balance circuit, the absolute value of the signal current is not too important—the voltage from T1 may vary without affecting the accuracy—but the accuracy of the comparison standard R1 is important. Resistor R1 must be a 1% precision unit.

A d.c. bias current, larger than the signal current, must be supplied to the base for class-A operation. The 4.5-volt collector battery supplies this current through R3.

The changing base input signal produces a larger collector-current output. This current flows through balance control R2, generating an output voltage proportional to the current. The voltage across R2 is opposite in phase to the voltage across R1. If they are equal in amplitude, they will cancel and no signal difference will exist between points B and C.

To measure transistor gain some null detector must be connected to the checker — an oscilloscope or audio amplifier will do—and R2 is adjusted until the 60-cycle output is zero or minimum. In this position the ratios of R1 and R2 are in the same proportion as the transistor input and output signals. The gain then can be read from the calibrated balance control.

Construction

Almost any reasonable layout is suitable for the checker. The original unit used breadboard type construction on sheet bakelite (see photo). However, this is not necessarily the best scheme of things. Bakelite is sometimes expensive and difficult to obtain.

The parts will fit under any 5 x 7 inch, or larger, chassis base. The terminals and balance-control dial could be

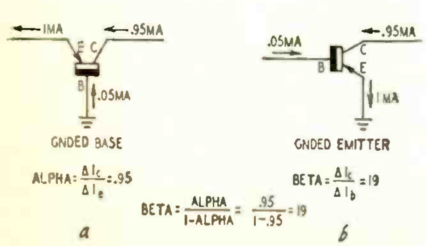


Fig. 1—Basic operation of the grounded base and grounded emitter circuits.

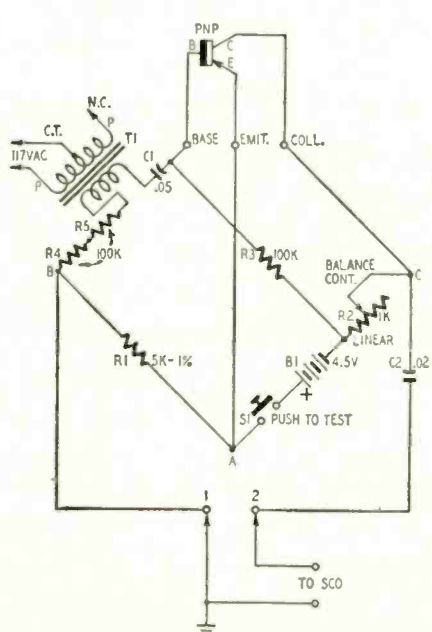


Fig. 2—The junction transistor checker—a "null balance" instrument.

mounted on top. This probably would be a good-looking and simple way to assemble the parts. To keep the cost of the transistor checker down, existing components were used as much as possible. This was not too difficult to do as most of the components consist of standard parts.

Several transistor test sockets mounted on bakelite were already available, so these were used "outboard" and connected to the checker by three short lengths of hookup wire. Otherwise, it might probably be more convenient to mount the socket on the checker.

Since the socket is used frequently, it is advisable to use the hearing-aid 5-pin socket. This type is considerably more rugged than some of the currently available sockets. The two unused pins can be pushed out and the holes plugged.

Step-down transformer T1 is an output transformer with half of the primary connected across the 117-volt a.c. line and with the voice-coil winding providing the test voltage. The transformer used matches 25,000 ohms plate-to-plate center-tapped, to a 3-4 ohm voice coil. Any brand of transformer with similar specifications should be satisfactory.

Filament transformers can be used for T1 by changing the total value of R4 and R5. The sum of R4 and R5 should be 100,000 ohms for each volt of the filament transformer. Thus, a 2.5-volt transformer would require 250,000 ohms.

Two components, R1 and R2, must be chosen with care. Either a deposited-carbon or metal-film resistor is satisfactory. These resistors are nominally rated at 1%, but the stock resistors I checked all fell within ½%.

Ordinary replacement carbon controls should not be used for R2. However, molded composition potentiometers such as the Ohmite type "AB" are O.K. These controls cost more than twice as much as radio replacement units; but their superior characteristics make the additional cost worth while. Several mail-order houses stock this type control.

Most wire-wound controls can be used. Even the dollar-or-less wire-wound controls are stable enough to be dial-calibrated for R2. The wire-wound laboratory potentiometers found on the surplus market are excellent for the checker.

Low checker impedances keep stray 60-cycle pickup problems to a minimum. The leads to the oscilloscope can be unshielded; and no shielding of any of the checker components is necessary. The ground terminal post from the oscilloscope is connected to terminal 1 and the input wire of the scope goes to terminal 2.

If the checker is built in a metal box or chassis, the chassis should be grounded to point A.

A television-type power connector is used to connect the 110-volt input. These TV connectors and cords make a very neat and inexpensive power-disconnect for experimental and commercial electronic equipment.

The collector battery can be any 4.5-volt battery. Three flashlight cells in series are also satisfactory.

Calibration

Beta markings on the balance dial correspond to specific resistance settings of R2. These values are given in the table. The maximum resistance of 1,000 ohms is equal to a beta reading of 5 since this resistance is ⅕ of R1. Minimum resistance of course indicates infinite gain.

One way to calibrate the dial is to connect an ohmmeter and rotate R2 to each of the resistance values in the table. At each of these points mark the beta value on a dial made from some firm material that can be conveniently marked on.

If the control is sufficiently linear, the dial shown in the photo may be used. Most experimenters will find this dial sufficiently accurate for their particular purpose.

Use of checker

Connect the oscilloscope, the transistor socket, and the 117-volt a.c. plug. Set the oscilloscope's vertical gain to maximum.

The horizontal deflection may be turned off. This gives straight-line vertical deflection, in which case the balance knob is rotated for minimum deflection when the transistor is checked.

Alternately, the horizontal deflection may be turned on and the scope may be synchronized with the line frequency. This procedure permits observation of the signal waveform in the transistor circuits. If the scope does not have a 60-cycle position on the sync switch, set the sync selector to "external" and run a jumper from the 60-cycle "test" terminal to the external sync terminal. Synchronizing the scope with the line, rather than the internal signal, makes the horizontal sync very stable and independent of both the phase and amplitude of the vertical deflection.

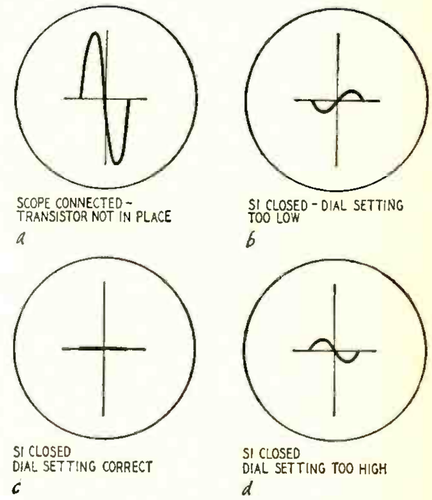


Fig. 3—Oscilloscope test patterns.

While S1 is open, the oscilloscope input floats and there is large 60-cycle pickup from strays (Fig. 3-a). With the transistor in place and S1 still open, the stray pickup will be clipped since the transistor functions as a simple rectifier.

When S1 is pushed, the scope display indicates how close to balance the checker is. The patterns either side of and at balance are shown in Figs. 3-b, 3-c, and 3-d.

Because the signal from the checker is in the order of millivolts, the deflections with S1 closed will be small but large enough for use with even the lowest gain scopes. Do not expect large deflections.

If an oscilloscope is not available, the output from the checker can be fed into the microphone or variable-reluctance phono input of an audio amplifier. Rotate R2 until a minimum hum level is heard. Do not use an amplifier that does not have a transformer power supply.

To check n-p-n transistors, simply reverse the connections to the 4.5-volt battery. This is the only necessary change.

A total of 13 new transistors have been tested on the checker. The average beta should be 9 according to the data sheet. One transistor had a gain of 14, while three units measured gains dangerously close to 5. The remainder of the transistors had betas of about 7 or 8. Of course it is not implied that this was a representative group of transistors; but it does point up the earlier statement about variations that must be expected. END

BETA AND BALANCE CONTROL RELATIONSHIP

Beta Value	R2 Setting (ohms)
5	1,000
6	833
7	714
8	622
9	555
10	500
11	455
12	417
13	385
14	357
15	333
16	313
17	294
18	287
19	263
20	250
25	200
30	167
35	143
40	125
50	100
60	83.3
70	71.4
100	50.0
Infinity	00.0

improving the TV ALIGNMENT GENERATOR

Adding audio modulation to a variable marker oscillator

By FRANK DiELSI

A LOW-FREQUENCY oscillator to modulate a variable marker oscillator and act as an independent source of audio will greatly improve the usefulness and effectiveness of television alignment generator.

Although the circuits in this article refer to the Heathkit TS-2 sweep generator (Fig. 1), they can easily be added to almost any other generator to increase the accuracy and versatility of the instrument.

After installing the crystal marker generator on the front panel of the Heathkit TS-2 as described by Bruce Morrissette in the January, 1953, issue of RADIO-ELECTRONICS (Fig. 2), I found that crystal markers could be put to much better use in conjunction with a variable marker oscillator by providing for modulation by an internal audio tone or an external signal. The instrument used originally had an absorption-type marker. This type marker is limited to fundamental frequencies only, cannot be zero-beat with the crystal markers, is not very distinct on some portions of the response curve, and it cannot serve as an independent signal source for aligning individually tuned circuits or traps.

By using the same coils and tuning capacitors in the instrument, a circuit similar to the Heathkit SG-7 signal generator was added without seriously affecting the original calibration (Fig. 3). The only coil changes necessary were to change the coupling links to 3 and 4 turns on the high- and low-frequency coils respectively. The two trimmers C1 and C2 on the tuning capacitors were turned out to compensate for the capacitance added by the 6C4 oscillator tube, V2.

To carry the additional load of V1 and V2, it was necessary to change the power supply. This led to the use of voltage regulators to improve the stability of the oscillators. By putting current-limiting resistor R1 in the negative leg of the power supply and mounting the filter capacitor on an insulating wafer, the voltage drop across R1 became a convenient source of a.g.c. substitution bias. This bias, although not entirely independent of large line-voltage variations, is independent of the load changes on the power supply and is satisfactory for a.g.c. substitution. The bias voltage on the stages being aligned has a con-

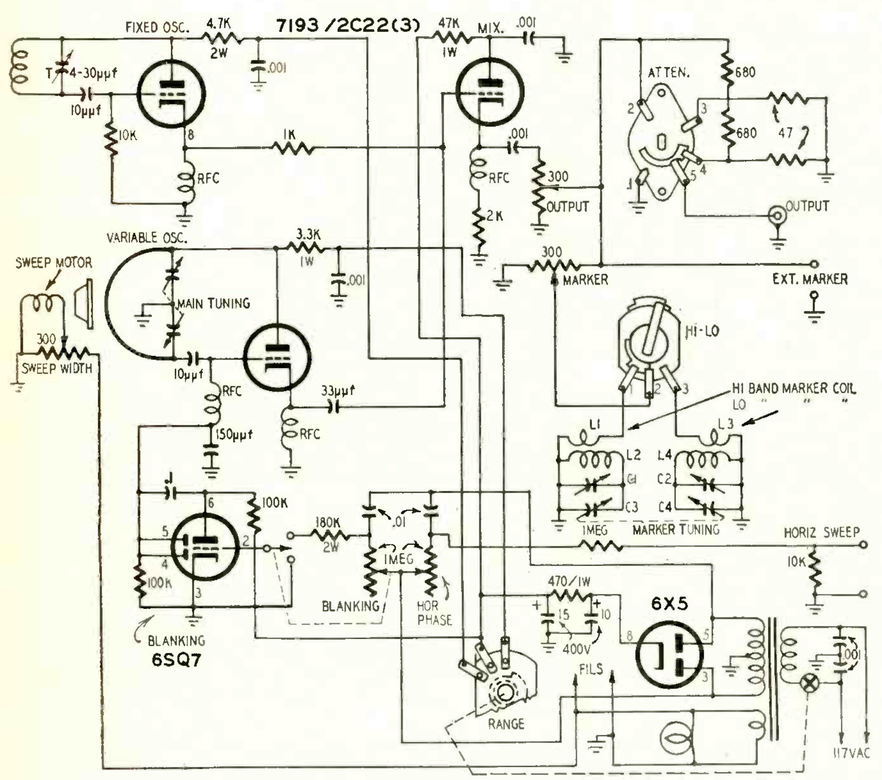


Fig. 1—Schematic of Heathkit TS-2 sweep generator before improvement.

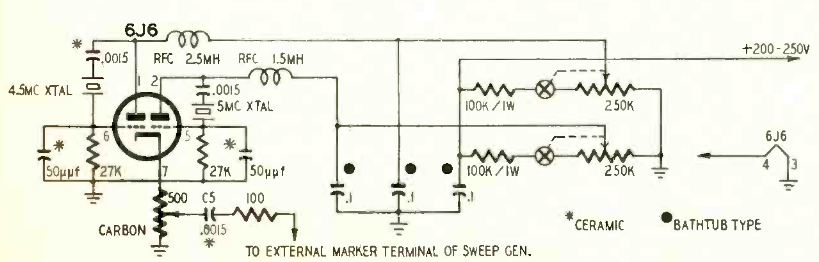
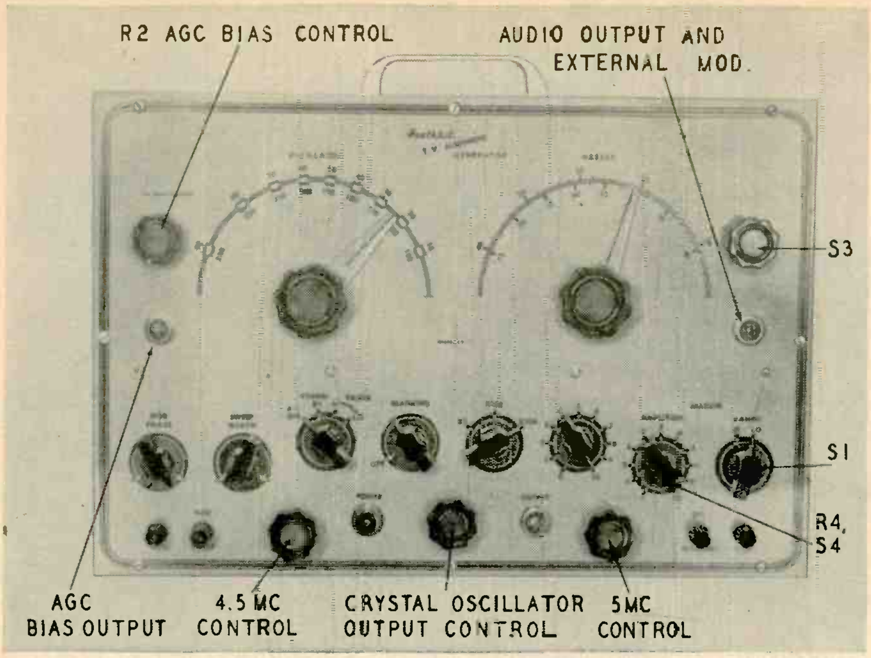
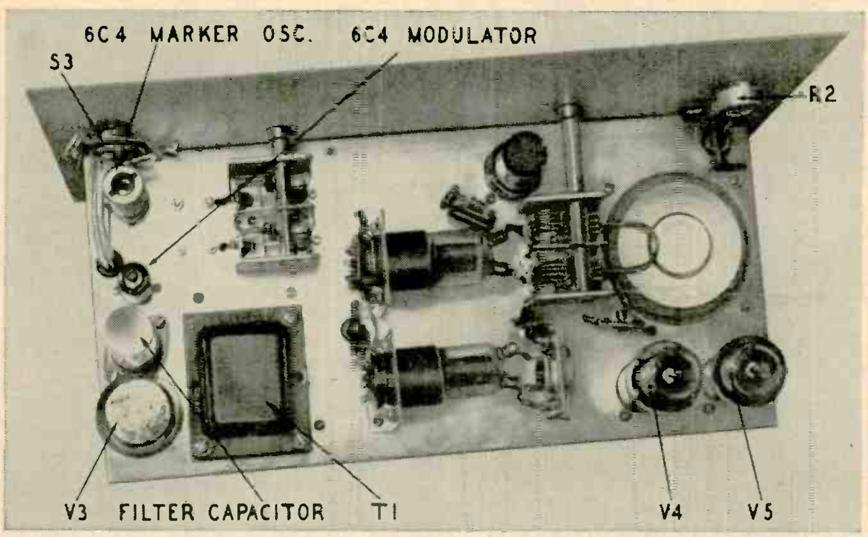
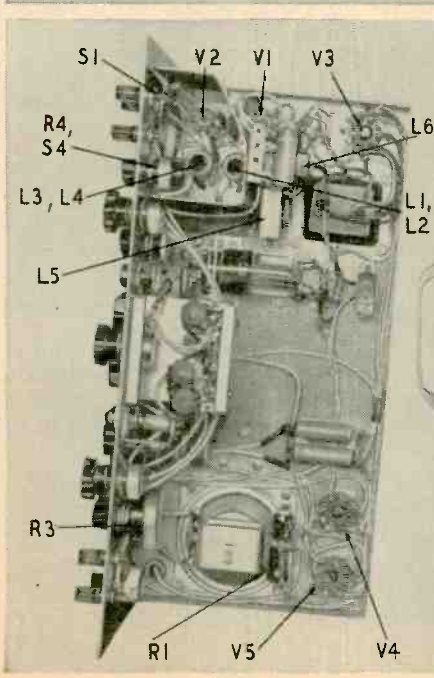


Fig. 2—Schematic of calibrator. Two crystals are used—4.5 mc and 5 mc.







siderable effect on the response curve, and the manufacturer's recommended value should always be used. Having a range of 0 to 45 volts, this negative voltage may be used also as a cutoff bias for the control grid of a receiver's horizontal output tube to eliminate the pulse radiation from the high-voltage supply that sometimes causes a series of spikes to appear on the response curve and its base line.

The power line cord was shielded and a separately shielded line filter was added to reduce the r.f. leakage from the instrument.

Construction

The layout of the additional components is evident from the photographs. The bias output control and connector are mounted on the left side of the panel, and the audio modulation switch and connector are on the right. The marker oscillator is separately shielded. It is very important that all the new parts be mounted securely with lock washers to prevent loosening caused by vibration from the sweep motor. Bypass capacitors C5 and C6 should be grounded at a common point with the tuned circuits and should go directly to the tube socket of V2. The wiring between V2, band switch S1, and coils L1, L2, L3, and L4 should be as short as possible.

Using the generator

When aligning a TV receiver with a sweep generator and markers, it is a disadvantage to use a wide-band oscilloscope because the marker hetrodyne frequencies will be visible for several megacycles on each side of zero-beat, distorting the alignment curve and making it very difficult to spot the zero-beat point. Since the alignment curve is basically a 60-cycle square wave, the oscilloscope response can be limited to a few thousand cycles without noticeably affecting the shape of the curve, yet keeping the marker more confined about its zero-beat position, thus making it distinct and much more easily recognized. The high-frequency response of the oscilloscope can be temporarily reduced by shunting a capacitor of approximately .006 μf across the oscilloscope vertical input terminals.

With some combinations of sweep generators and oscilloscopes, the two sweep curves cannot be properly superimposed, especially when using a narrow sweep for sound i.f. alignment. This difficulty can be corrected by installing a d.p.d.t. switch, S2, to reverse either the leads going to the sweep motor or the ones feeding the phasing network for the horizontal deflection of the oscilloscope.

The 360-cycle oscillator can be used to modulate the variable marker oscil-

Top—The modified Heathkit generator. Center and bottom left—The top—and underchassis views of the generator. Bottom right—The r.f. line filter.

SCOPE FREQUENCY COMPENSATION

By ELLIOTT A. McCREADY

MOST lower-priced oscilloscopes, including many of the scope kits on the market today, have vertical amplifiers with adequate frequency response— only if the gain control is set to maximum position. This drawback limits the usefulness of the oscilloscope.

There are several methods of compensating for this limitation. A separate step-type attenuator can be used in conjunction with the scope, or a lower-resistance vertical gain control can be substituted. The second method reduces the vertical gain excessively and the first means another piece of equipment on the already too-small workbench.

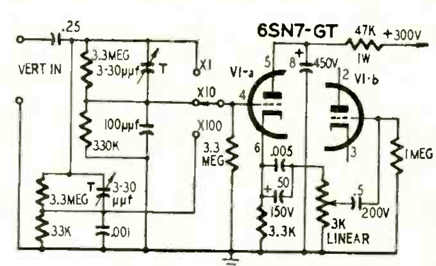
A self-contained vertical frequency-compensated gain control seems to be the answer to the problem, but such an answer is not as simple as it seems. A step type attenuator, if substituted for the regular gain control, would require at least 8 to 10 positions to give even minimum coverage of the numerous input voltages applied to the instrument. Even so, this would not provide continuously variable control of the input, and would require at least 8 to 10 resistors and 16 to 20 fixed and variable ceramic capacitors. The size and cost would be prohibitive.

There is, happily, a fairly simple answer to this problem: the fact that most scopes use a triode as the vertical input amplifier. Mine uses a 6J5. If the octal socket of the 6J5 were rewired it would be possible to use half of a 6SN7 as the vertical input amplifier. The other half could then be used as a cathode follower with a three-step compensated attenuator at the input and a continuously variable gain control at the output of this stage.

The circuit I used is not unique and is a composite of various other such circuits which have appeared in various radio and other magazines.

The three-step attenuator in the input circuit maintains a high input impedance—approximately 40 $\mu\mu$f and 2 megohms. The frequency response of the unit, with any setting of the attenuator or gain control, is as good as the final stage of vertical amplification in the original circuit.

Locating the controls on the scope panel may present a problem. The 3,000-ohm gain control can be substituted for the original gain control. Locating the attenuator switch was, for me, a problem that required some thought and considerable maneuvering. It must be close to the vertical input circuit to reduce stray pickup.



V1-b replaces original amplifier and is wired same as the original circuit.

Parts for frequency compensation

Resistors: 1—3,300, 1—33,000, 1—330,000 ohms, 1—1 megohm; 3—3.3 megohms, ½ watt; 1—47,000 ohms, 1 watt; 1—3,000 ohms, linear taper, carbon potentiometer (replaces original gain control); **Capacitors:** 1—100 µµf, 1—.001 µf, 1—.005 µf, ceramic; 1—.25 µf, 600 volts; 1—0.5 µf, 200 volts; 2—3-30 µµf, trimmer; 1—8 µf, 450 volts, 1—50 µf, 150 volts, electrolytic. **Miscellaneous:** 1—6SN7-GT tube; 1—3-position, single-pole switch.

Calibrating the attenuator requires a square-wave generator. Set the generator to approximately 1,000 cycles and the attenuator to the "× 100" position. Adjust the appropriate trimmer for a flat-topped trace on the screen of the scope. Repeat this procedure with the attenuator switch in the "× 10" position.

This modification will certainly be worth while to the owner of any low-priced scope and can be built with a minimum of parts and reworking. END

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lator or as an independent source of audio. When the modulation switch is set at INTERNAL, the 360-cycle sine wave is available at the panel connector and is also modulating the marker oscillator. When the switch is in the EXTERNAL position, the second 6C4 is used as an amplifier to modulate the marker with any audio signal fed to the same panel connector. An external variable-frequency audio oscillator may be used to modulate the marker oscillator, producing horizontal or vertical bars on the receiver picture tube for linearity adjustments. If a square wave is used instead of a sine wave, the edges of the bars will be sharper. For checking vertical linearity, 360 cycles, a multiple of 60 cycles was chosen as a modulating frequency so that a stationary pattern of six horizontal bars would appear on the screen. END

Parts for TV generator improvement

Resistors: 1—1,000, 1—10,000, 1—56,000, 1—100,000, 1—270,000, ½ watt; 1—5,600, 1—200,000, 1 watt; 1—2,000, adjustable (set at 1,700), 25 watts. **Potentiometers:** 1—500, linear (with switch), 1—200,000, linear; 1—150, linear, 2 watts. **Capacitors:** 1—51 µµf, NPO, 1—.001 µf, 2—.0015 µf, 1—.01 µf, ceramic; 2—.05 µf, 2—0.1 µf, 1—0.25 µf, 200 volts; 1—10 µf, 1—15 µf, 450 volts, electrolytic. **Miscellaneous:** 1—5V4-G, 1—0C3, 1—0D3, 2—6C4, tubes; 1—power transformer, 600 volts ct at 70 ma, 5 volts at 2 amp, 6.3 volts at 3 amp (Thordarson T 22R02); 1—filter choke, 8 h at 80 ma; 1—choke, 6 h at 40 ma (UTC R14); 2—radio-frequency chokes, 7 µh at 1 amp; (Ohmite Z-50); 3—d.p.d.t. switch (Centralab 1462); 1—s.p.s.t. switch; 1—s.p.s.t. switch (on marker-amplitude control).

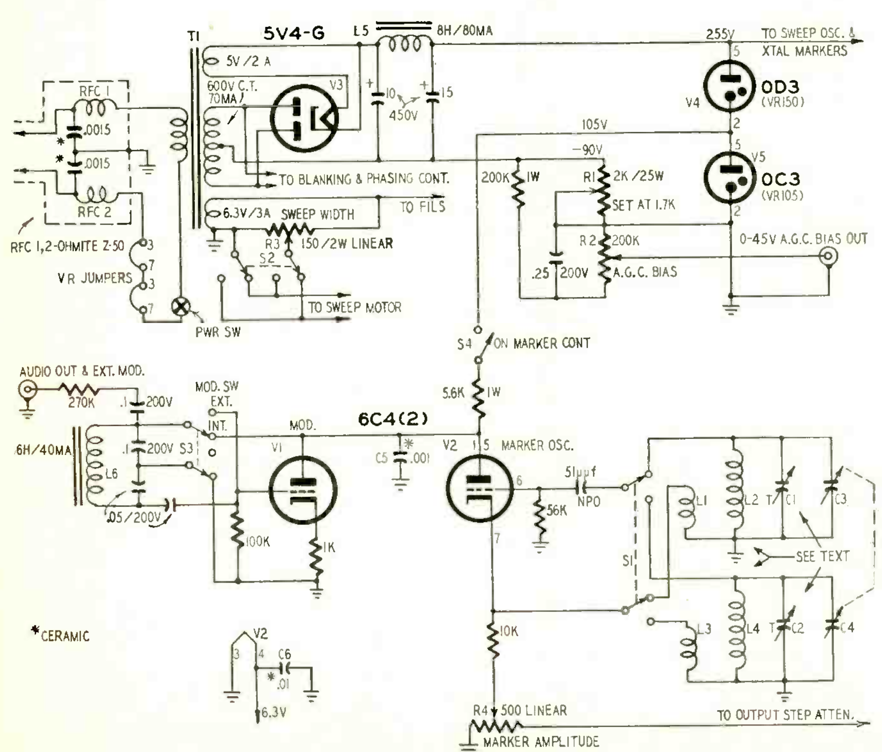
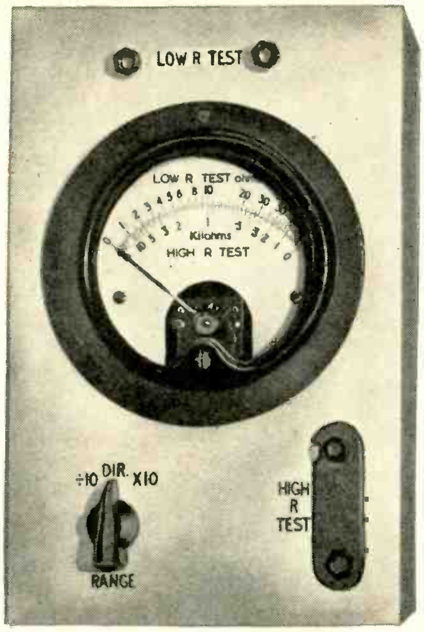


Fig. 3—Schematic diagram for improving the television alignment generator.

HIGH-ACCURACY OHMMETER



Front of the ohmmeter. Zero control is screwdriver adjusted through hole in case

A practical test instrument capable of measuring extremely-low resistance values—simple to construct

By NORMAN H. CROWHURST

THE simple direct-reading ohmmeter circuit, which is really an extension of the earlier and cruder continuity tester, is extremely useful for making resistance checks where high-order accuracy obtainable by using bridge methods is not required. It has an advantage over the bridge because it does not need manipulation of calibrated components to obtain a balance before the answer can be calculated; the required value appears as a direct reading on the ohmmeter scale.

It is surprising, however, to find that many ohmmeter circuits use arrangements where the accuracy is unnecessarily dependent upon a specific supply voltage, whether this comes from a battery or the power line. Whichever source of voltage is used, it is desirable that the accuracy of the instrument be almost independent of supply-voltage variations within a workable range.

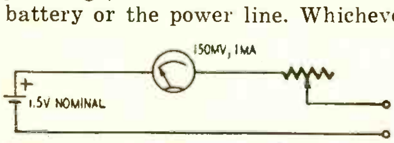


Fig. 1—A simple ohmmeter circuit.

As an example suppose the ohmmeter, built around a milliammeter with full-scale deflection of 1 ma, is to use a dry-cell unit nominally rated at 1.5 volts. When brand-new these cells give a voltage of practically 1.6, and they can probably be used until the voltage falls to 1.2 before they become seriously unreliable. A circuit for such a meter is shown in Fig. 1. This is a simple series circuit where equal current flows through each component.

To consider the accuracy of any ohmmeter calibration, the easiest method is to consider what value of resistance will give exactly half-scale reading. In this example, when the battery voltage is 1.6, the total resistance of the circuit to give full-scale deflection of 1 ma, with the terminals short-circuited for zero adjustment, will be 1,600 ohms. Having set the zero point, an external resistance equal to this will reduce the reading to half scale. So, for maximum battery voltage, the half-scale reading should be 1,600 ohms. When the battery drops to 1.2 volts, the total series resistance for full-scale current deflection, with terminals short-circuited, will drop to 1,200 ohms, so the half-scale reading should then be 1,200 ohms.

The question comes, what reading should be put on the scale at this point? Probably 1,500 ohms, because this is based on a battery voltage at the nominal value of 1.5. But the range of zero adjustment necessary to use the battery over its workable range of voltages means that the value indicated as 1,500 ohms may be anything between 1,200 and 1,600, according to the conditions of the battery.

Fig. 2 shows a circuit that reduces this possible error. We start by deciding that the center scale reading is going to be 1,000 ohms. This means that the total resistance in the circuit, with the terminals short-circuited, must also be as near as possible to 1,000 ohms.

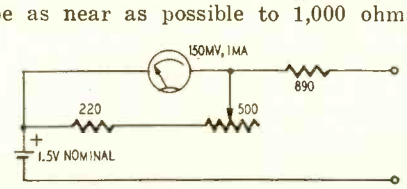


Fig. 2—Zero adjustment method that considerably reduces the dependence of accuracy on the battery voltage.

At the maximum battery voltage, this will allow a current of 1.6 ma, while at the lowest battery voltage the current with the terminals short-circuited will be only 1.2 ma. So the meter shunt must be arranged to pass from 0.2 to 0.6 ma at full-scale deflection for zero adjustment range.

Assuming the meter has a full-scale voltage drop of 150 millivolts (resistance of 150 ohms), then the shunt resistor, to pass 0.6 ma, corresponding to maximum battery voltage, should be 250 ohms; while to pass 0.2 ma, it must be 750 ohms. Using the nearest practical values, a fixed 220-ohm resistor in series with a 500-ohm potentiometer provides the necessary range of coverage.

Now to work out the value of the series resistor: First we need to know the resistance of the meter with its shunt. The actual meter resistance, in this example, is 150 ohms. At maximum battery voltage, when the meter shunt is 250 ohms, the parallel combination of 150 with 250 ohms is about 94 ohms. For the lowest battery voltage condition, the parallel combination, of 150 ohms with 750 ohms, rises to 125 ohms. To ease the figuring, say the variation is from 95 to 125 ohms. Then the average value of the meter with its shunt is 110 ohms. This would be subtracted from the total circuit resistance of 1,000 ohms, which leaves 890 ohms for the series resistor.

In practice, then, the total circuit resistance varies from 985 ohms at maximum battery voltage zero setting to 1,015 ohms when set for minimum battery voltage. So the center-scale reading will always be within 1.5% of its calibrated value.

Accuracy can be increased still further by making the fixed series resistor a greater proportion of the total circuit resistance, using a higher nominal battery voltage so full-scale deflection is still possible. Suppose, for example, three 4.5 volt batteries are connected in series to give 13.5 volts nominal; these batteries willl have extremely long life with a maximum current drain of only a little over 1 ma for full-scale deflection. A terminal voltage variation from, say 11 to 14 could be allowed. The supply voltage is approximately 10 times the previous figure, so the total series resistance in circuit, to determine the nominal center-scale reading, could be 10,000 instead of

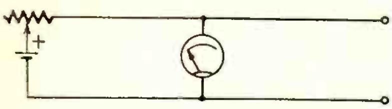


Fig. 3—A shunt ohmmeter circuit.

1,000 ohms. Subtracting the mean value for the instrument with its zero adjuster shunt of 110 ohms, this means the series resistor should be 9,890 ohms, and the variation of total circuit resistance is now only .15% from its average value of 10,000 ohms. Using the high battery voltage, the inaccuracy due to battery voltage variation is thus much less than the probable inaccuracy

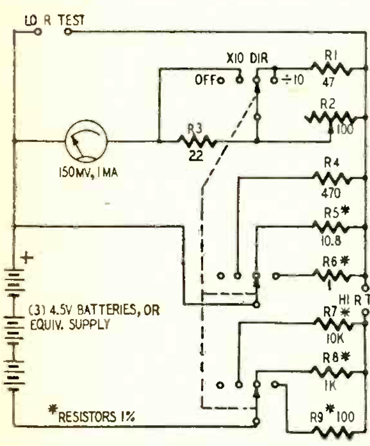
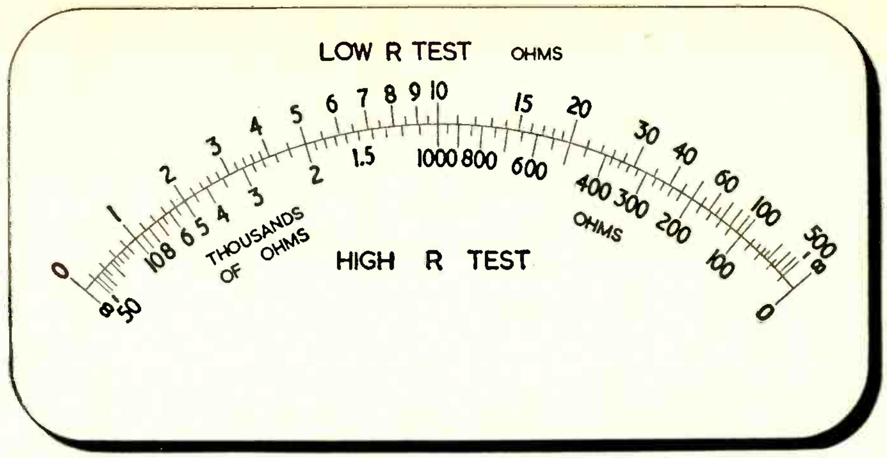


Fig. 4—A high-accuracy ohmmeter requiring a minimum of calibration.

in the original calibration of the milliammeter.

Both these circuits are for what is usually described as the "series" ohmmeter circuit, because the resistance to be measured is connected in series with the meter and its supply voltage. It is obvious from the values in the above discussion that it is suitable for measuring relatively high resistances, but could not easily be used to measure such resistances as loudspeaker voice coils, which would give a reading indistinguishable from a short-circuit.

For this purpose a better instrument is the shunt-reading ohmmeter, shown in Fig. 3. In this circuit the instrument is adjusted to full-scale deflection with the terminals open-circuit. When a resistance is connected to the terminals it provides a shunt for the meter, and



Fig, 5—Scales for Fig. 4. Low scale is for shunt operation; high is for series.

gives half-scale reading when the external resistance is *approximately* equal to the internal meter resistance.

Note the word "approximately." Some books omit it in describing this instrument. Assuming that the battery voltage comes from the original single cell of nominal voltage 1.5, and the instrument is still the 150-mv, 1 ma full-scale job, then at the nominal battery voltage, with no resistance connected, there will be 150 millivolts across the meter and a 1.35-volt drop across the series resistor. When the meter is shunted with a resistor to bring it down to half scale, there will be only a 75-millivolt drop across it, so the drop across the series resistor must rise to 1,425 volts, which means the current must have risen from 1 ma to nearly 1.1 ma. If the shunting resistor, connected to the terminals, is equal to the meter resistance, this current will be equally divided between them, so the reading will be about 0.55, instead of 0.5 as would be the case according to the statement usually given. To produce half-scale reading a resistor of slightly lower value must be used.

In practice it can be shown that half-scale reading is produced when the external resistance connected is equal to the combined parallel resistance of the meter with any internal shunts, and also with its series feed resistor, as viewed from the terminals of the instrument (regarding the battery resistance as zero).

Now we have the basic requirements for producing an instrument whose accuracy is not to be too dependent on the battery voltage.

The adjustment for full scale, which is zero ohms for the series type or infinity for the shunt type, must adjust the balance of current in the circuit associated directly with the meter movement, without appreciably altering the internal resistance as seen from the instrument terminals.

It has already been shown that using a higher battery voltage improves the possibility for the series instrument. This is true also in the case of the shunt instrument, because the series resistor, although variable, is then always much higher than the meter's own resistance.

Whatever circuit is used, its range is somewhat limited compared with the wide range of resistance values encountered in practice. To extend the useful range of an instrument it would be good to have a multirange ohmmeter with an accuracy similar to that achieved by multirange testers for voltage and current. Fig. 4 shows a circuit the author has designed, which has the following useful features:

1. Circuit simplicity—a minimum of special resistors that have to be adjusted to fit the scale.

2. A minimum number of contacts in the switching arrangement.

The latter is particularly important for the lower range readings, because contact resistance can often ruin a reading. In this instrument the number of switch contact decks is reduced by using a strap across the high-resistance test terminals for the ranges using the shunt ohmmeter principle.

A single variable resistor is used for zero adjustment. Some may feel that it would be an advantage to have independent zero adjustment for each range, so that changing the range does not make it necessary to readjust for zero. Circuits devised to do this usually have the disadvantage that each adjustment interferes slightly with the others, unless extra switching is employed to disconnect from the circuit the variable resistors not in use. This would increase the number of switch contacts necessary.

In this circuit a variation from that of Fig. 2 is used for the zero adjustment, to enable the same variable resistor to serve all ranges, and to avoid the use of low-value variables, which can cause poor reliability.

With the 3-pole switch in the "× 10" position, the instrument has a center-scale reading of 10,000 ohms, using the HIGH R TEST terminals. To obtain this the series resistor R7 should be just under 10,000 ohms. A resistor of 10,000 ohms 1% should serve here, trimmed, if desired, by setting the instrument to give center-scale reading with a standard resistor of 10,000 ohms. The instrument shunt has a fixed value of

470 ohms (R4), while the zero adjuster is a series resistor (R2) of 100 ohms maximum, that varies the voltage drop across the meter branch at full-scale deflection and so varies the current bypassed by the 470-ohm shunt.

The other two switch positions—the direct reading and the "÷ 10" position —give the instrument center-scale readings of 1,000 ohms and 100 ohms respectively. The standard resistors for these ranges are also about 1,000 ohms and 100 ohms (R8 and R9). One per cent resistors can be used here, being trimmed to the correct value by obtaining a center-scale reading with a resistance standard of 1,000 ohms and 100 ohms respectively. For these ranges, the meter shunts are R5 and R6, which also serve as resistance standards for the two lowest ranges, using the shunt-ohmmeter principle. For series-ohmmeter operation, the zero adjustment provides—at full-scale deflection—a path for the current exceeding the 1 ma that goes through the meter. On the "÷ 10" position the total current at full-scale deflection is about 135 ma, so, to conserve battery life, the instrument should never be left in this position for longer than is necessary to take a reading.

The meter that forms the basis of the instrument shown has a resistance of 150 ohms. This was chosen to allow the circuit to be applied to use an old type of meter with some useful life still left in it. Modern meters of 1-ma rating have a lower resistance, or alternatively, for the same resistance a more sensitive meter can be obtained. The limiting factor for the high range is the volt drop necessary to give full scale deflection through 10,000 ohms. With a more sensitive meter—for example a 500-microampere job—the same circuit can be used with only half the battery volts (say 6 volts' worth) and much longer battery life. To use the same circuit with a 1-ma meter of lower resistance value, the simplest method is to build out the meter resistance to suit the values given, so the effective resistance of the meter with a series resistor comes to 150 ohms. This avoids the necessity of recalculating all the circuit values. If a 200-microampere meter should be handy, the circuit could be revised slightly to make it work on only 3 volts' worth of battery. The revision would consist of increasing the resistance values of the zero adjuster and associated switch connections somewhere between two and five times. R4 would also need increasing. The aim in selecting these values is to minimize the readjustment necessary when the range is changed.

For the shunt-connected ranges, giving center-scale readings of 10 ohms and 1 ohm, the positions marked DIR and "÷ 10" are used, with the HIGH R TEST terminals strapped together to give full-scale reading. The resistance to be measured is then connected to the LOW R TEST terminals.

To obtain the correct values for the "standards" R5 and R6 on these ranges: R5 is calculated so that with the average full-scale setting of R2, the combined resistance made up of R5, R8, and the meter branch all in parallel is 10 ohms. This procedure is simpler for R6, because the other branches, R9 and the meter branch, are both much higher in value than 1 ohm—the required combined value in this case, for absolute accuracy. If the low-value resistors R5 and R6 are not available, they can be made up of resistance wire.

As with the series arrangement, the lowest range should be used only long enough to check for full-scale deflection and then to measure the required resistance. Carelessness about this precaution will quickly flatten a set of batteries.

This can be overcome, for bench work, by using a rectified supply from the power line. A step-down transformer to give an output voltage of 15 to 20, using a metal rectifier to give the right d.c. output, will provide an energizing supply for this ohmmeter. The method of zero adjustment will still render it practically independent of supply-voltage variations. Values of R1, R2, and R3 may need adjusting to suit the exact voltage used; also the values of R7, R8, and R9 may need modifying slightly, due to the effective internal resistance of the supply. This can be calculated by measuring the reduction in d.c. output voltage from the supply when the maximum full-scale current on the lowest range is drawn from it. Dividing this current value into the drop in output voltage it produces will give an effective internal resistance. For example, if the current is 140 ma, and the voltage drops from 16 to 13.2, a difference of 2.8, the internal resistance is 2,800 divided by 140, or 20 ohms. This resistance should be subtracted from the values given for R7, R8, and R9, particularly the last, to keep the center-scale reading correct.

Using the convenient center-scale reading of multiples of 10, the instrument willl have a scale of the type shown in Fig. 5, the scale marked HIGH R TEST being used for the readings using series-ohmmeter connections on the upper three ranges and the scale marked LOW R TEST for readings on the shunt-ohmmeter circuit used for the two lower ranges, when the HIGH R TEST terminals are strapped together.

The strap for the HIGH R TEST terminals can be made from a metal strip, with two holes drilled to fit the terminal spacing. One of these holes is then slotted out sideways, so the strap can be held by the other hole to one terminal, being clamped on the remaining terminal, or released, according to whether the LOW R TEST or HIGH R TEST is being used.

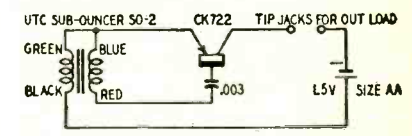
With television, high-fidelity audio, and other electronic equipment demanding closer-tolerance resistors, this high-accuracy ohmmeter is a valuable test instrument. END

MINIATURE AUDIO-FREQUENCY TEST OSCILLATOR

By I. QUEEN

THIS tiny oscillator is self-contained (except for load) and is mounted inside a plastic box only 2¼ x 1¾ x ⅞ inches. The heart of the circuit is a Raytheon transistor, type CK722. It is powered by one AA dry cell. Output is strong enough to provide a good headphone signal.

Audio feedback is maintained by a "Sub-Ouncer" 3:1 ratio audio transformer. Any other transformer may be used but will require considerably more space. If the "Sub-Ouncer" is used, follow the terminal connections specified. If another type is used, connect the low-impedance winding in the base circuit, the high-impedance winding in the collector circuit. If no oscillations are heard, try reversing connections to one of the windings.



The frequency is determined by the particular transformer used and the capacitor in series with the base. With the circuit and constants shown in the figure the frequency is 1,500 cycles. To change the tone use a different value of capacitor. The frequency will vary (upwards) to some extent when the oscillator is used near a strong incandescent lamp. For example, the frequency will rise to about 2 kc if a 40-watt lamp is brought a few inches from the oscillator. A fluorescent lamp does not cause a perceptible change. Sunlight, even indirect, makes a considerable difference in the frequency. Evidently the transistor is slightly photosensitive.

The oscillator was constructed to see how compact a *reliable* instrument could be. It is more than a mere toy. It may be used to test a.f. amplifiers or for long-distance CW communication by wire. It may be used as a source of known frequency (if shielded from light). It is easily carried about in a pocket to permit indulging in code practice during lunch hours or recess, or other spare periods.

The efficiency of the CK722 transistor is astounding. In this circuit it consumes 5 microwatts. This is about .005 of 1% as much power as required by a sensitive high-frequency buzzer, or a low-power tube oscillator.

This oscillator contains an unusual degree of miniaturization. With an extremely small cell for power, the CK722 transistor, and the UTC subouncer SO-2 transformer (10,000-ohm primary, 90,000-ohm secondary), the unit can be easily handled. END

Distortion TOTALIZER

By C. W. PALMER

An excellent instrument for a rapid check of audio-amplifier distortion

DISTORTION measurement is a very important part of audio servicing. An amplifier can hardly be said to have been serviced thoroughly without some measurement of distortion. The distortion totalizer is a relatively simple device for measuring total harmonic distortion. It is basically a twin-T null network that suppresses the fundamental frequency, leaving only the harmonics, which can then be compared to the amplitude of the fundamental to give the percentage of harmonics.

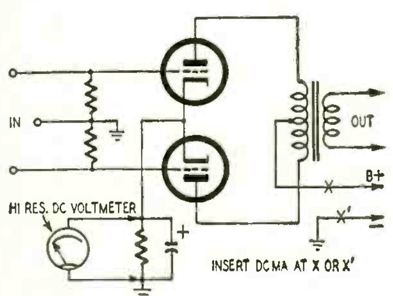


Fig. 1—Diagram shows method for checking class-A amplifier distortion.

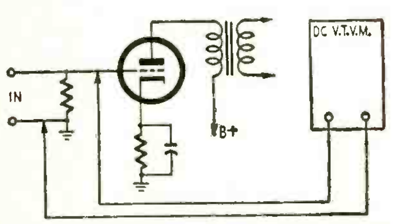


Fig. 2—Distortion check with v.t.v.m.

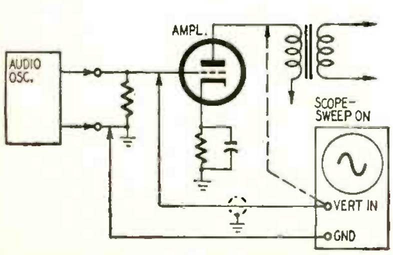


Fig. 3—Setup for indicating distortion.

In its simplest form, distortion is the disfiguring of a signal as it passes through a circuit. When distortion is present, the tone from the amplifier is combined with one or more higher tones called harmonics, which were not in the original signal. This change causes the amplified tone to sound harsh or unnatural.

The service technician will be most concerned with the second, third, and fourth harmonics, as these are much stronger and more troublesome than the higher-order harmonics. The second harmonic can be considerably reduced by using a push-pull output stage in the amplifier. Incidentally, this is one of the principal reasons why push-pull is so popular in the power stages of modern amplifiers.

Measuring distortion

Harmonics can be measured separately and the percentage of each figured against the voltage of the fundamental. The percentages can then be combined to give a total harmonic percentage. A second method is to measure all the harmonics together, giving a total harmonic figure. But this does not tell the relative strength of the individual harmonics.

Each harmonic can be measured and compared separately in the following manner:

$$\% \text{ distortion (of harmonic)} = \frac{E2}{E1} \times 100$$

where E1 is the voltage of the fundamental, and E2 is the voltage of the individual harmonic.

Each separate harmonic percentage must be figured in the same manner, but they cannot be simply added together to get the total harmonic distortion. To do this, we must square each percentage, add the squares, and then find the square root of this total. The following formula is used:

$$\text{Distortion (total)} = \sqrt{D_2^2 + D_3^2 + D_4^2, \text{etc.}}$$

where D_2, D_3, D_4, etc., are the respective harmonic percentages which may be measured—usually at least to the fifth harmonic.

To measure each harmonic voltage individually, a wave analyzer is needed. This is a laboratory instrument which can be tuned like a radio receiver to each harmonic and indicates the voltage of each.

More simple and certainly less expensive is a method of checking total distortion. This will be described in greater detail along with details for making the special apparatus needed.

Qualitative tests

The simplest test that can be made for distortion is to listen to the output of an amplifier, but this is probably the least reliable. The distortion must be considerable before even a trained ear can distinguish it (the ear will respond to distortions of something over 5%). In addition to this there are all the mental and physiological conditions that mask the true result, making the ear an extremely unreliable measuring instrument.

Electrical tests that are indicative of distortion can be made in some cases. In class-A amplifiers the plate current remains steady when a signal is applied or removed, if there is no distortion. A milliammeter inserted in the B+ or B– lead to the amplifier will serve as an indicator. A high-resistance voltmeter connected across the cathode resistor of

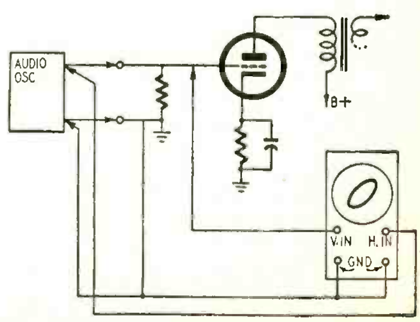
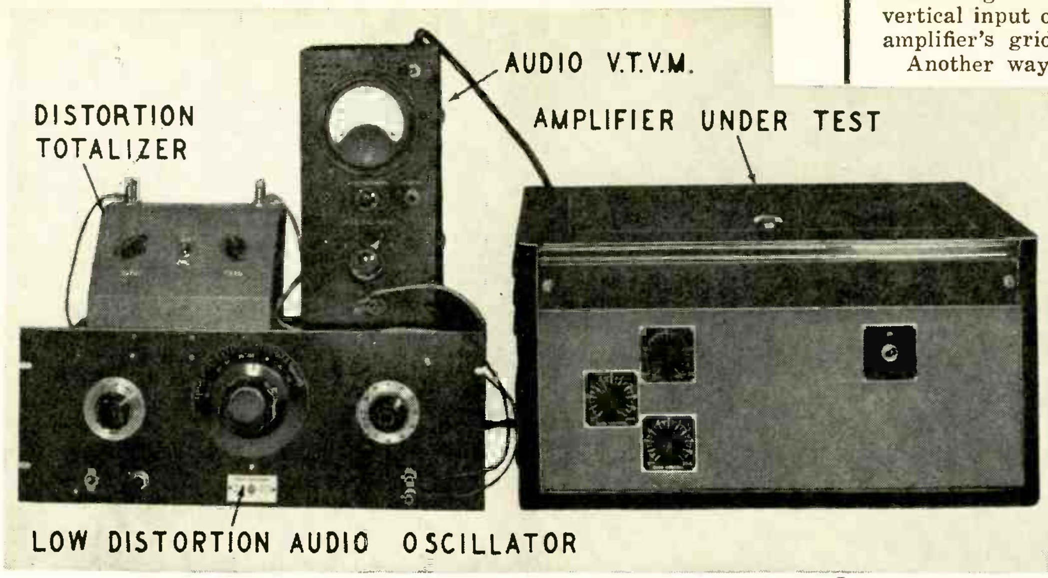
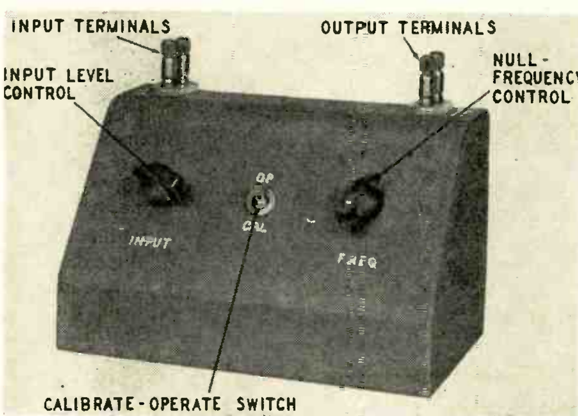


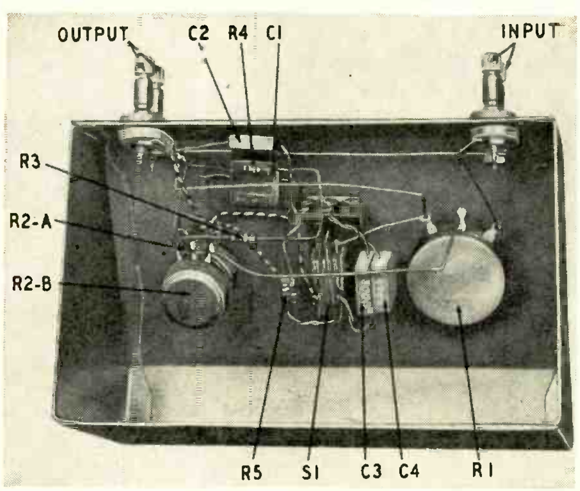
Fig. 4—Fig. 3 setup using audio sync.



Test setup for distortion measurement.



Controls indicate simplicity of operation.



Internal view of distortion totalizer.

the amplifier stage being checked also will indicate a change in plate current (the voltmeter should not show a change in indicated voltage when a signal is applied or removed). See Fig. 1.

This method cannot be used on class B or class C (transmitter) amplifiers because grid current flows part of the time, and plate current varies with signal.

Another method that can be used on all class-A1 and AB1 amplifiers is to connect a vacuum-tube d.c. voltmeter from grid to ground. A negative voltage will be indicated equal to the negative grid bias voltage. This should not fluctuate, and any variation is indicative of distortion. See Fig. 2.

The oscilloscope with an audio oscillator having good waveform, can be used to indicate distortion by connecting the oscillator to the amplifier input and connecting a shielded lead from the vertical input of the oscilloscope to the amplifier's grid or plate. See Fig. 3.

Another way to use the oscilloscope is to connect it as above but do not turn on the horizontal sweep. Instead, connect a shielded lead from the horizontal terminals of the scope to the audio oscillator output as shown in Fig. 4. Now the image on the screen will look somewhat like the various patterns in Fig. 5. With no phase shift, a straight diagonal line would be seen on the scope screen (Fig. 5-a); however, most amplifiers introduce some phase shift so that a more common image is the diagonal ellipse in Fig. 5-b. Distortion is indicated when the ellipse becomes irregular or broken in shape as shown in Fig. 5-c and 5-d. This method is described in the article beginning on page 58 of this issue.

Quantitative tests

The qualitative tests have their use in engineering, but for the service technician who wants a quick over-all look, the quantitative test is preferable.

In this type of test, a comparison is made between the signal at the output of the amplifier (or any stage)—with the oscillator fundamental present, and then with it suppressed.

The theory of operation depends on a dual-input parallel-T null network that was developed by C. F. White and K. A. Morgan of the Naval Research Laboratory and presented at the 8th National Electronics Conference in

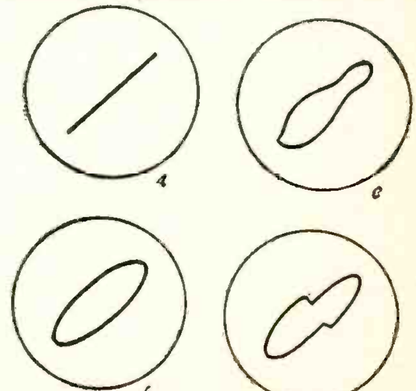


Fig. 5—Patterns indicate distortion.

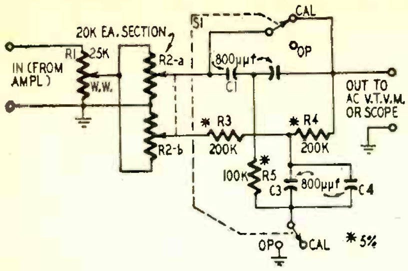


Fig. 6—Distortion totalizer circuit.

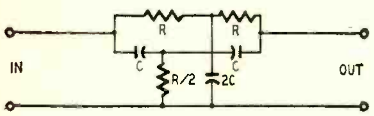


Fig. 7—The parallel-T null network.

Chicago in the fall of 1952.

Fig. 6 shows the circuit of the network and the photos show several views of the test setup and the network alone.

The characteristics of the network have been so chosen that the null frequency can be adjusted between 100 and 10,000 cycles. The network is tuned to match the frequency of the audio oscillator by watching the oscilloscope or a v.t.v.m. for minimum output.

By switching S1 to the CAL position, the network is made ineffective and a reading (E1) of the output of the audio oscillator through the amplifier under test is taken at a given frequency—say 200 cycles. R1 will be useful to get a suitable indication on the output meter. (Once set, R1 should not be moved until a test has been completed.) Switch S1 is then switched to OP and the dual potentiometer R2 is turned until minimum output is indicated (E2). This will remove the fundamental, leaving all the harmonics and the ratio:

$\frac{E2}{E1} \times 100 = \%$ of distortion at the test frequency.

This procedure is then repeated at several selected frequencies through the audio band to get a complete picture of the total distortion percentage.

Distortion totalizer theory

The secret of this simple total distortion device lies in the variable-frequency version of the well-known parallel-T null network. The basic circuit of this network is shown in Fig. 7. It consists of two T networks identical in impedance but opposite in phase, so that at some critical frequency the outputs are equal and opposite, thus canceling each other. White and Morgan, in their paper, tell how, by dividing the input and adjusting the selective signal voltage to the two T's, the critical null frequency can be varied. This is done in our version of the dual-input parallel T network, by two identical potentiometers having a common shaft. The characteristics of this network are shown in the graph (Fig. 8) at the mid-frequency and at the extremes. The attenuation of the critical frequency is better than 60 db greater than the insertion loss of the attenuator. This is adequate for our distortion meter.

Construction

The entire unit is housed in a small sloping-front cabinet on which the potentiometers and switch are located. The input and output terminals are mounted on the top of the cabinet.

Parts for distortion totalizer

Resistors: 1—100,000, 2—200,000, carbon, 5%, 1 watt; 1—25,000, wire-wound, potentiometer, 4 watts (Mallory M25MP or equivalent); 1—20,000 each section, dual potentiometer (Allen-Bradley JU2031 or equivalent).
Capacitors: 4—800 μμf, silver mica.
Miscellaneous: 1—sloping-front cabinet 4½ x 4¼ x 4¼ inches (ICA 3905 or equivalent); 1—d.p.d.t. toggle switch; 2—insulators; 4—binding posts; 2—knobs with pointers.

In wiring the device, care should be taken to keep wires short and direct. It is important to have a *good* ground connection to the cabinet.

Shielded leads should be used to connect the amplifier output to the distortion totalizer and from this unit to the oscilloscope or v.t.v.m. used for the output indicator.

The input potentiometer is a wire-wound unit capable of dissipating several watts of power. This is necessary in checking power-amplifier stages of radio and TV receivers and the harmonic distortion of PA amplifiers.

Mica capacitors and high-quality resistors should be used to produce a high-Q network so that the null will be sharp. Otherwise, some of the harmonic distortion may be suppressed along with the fundamental. END

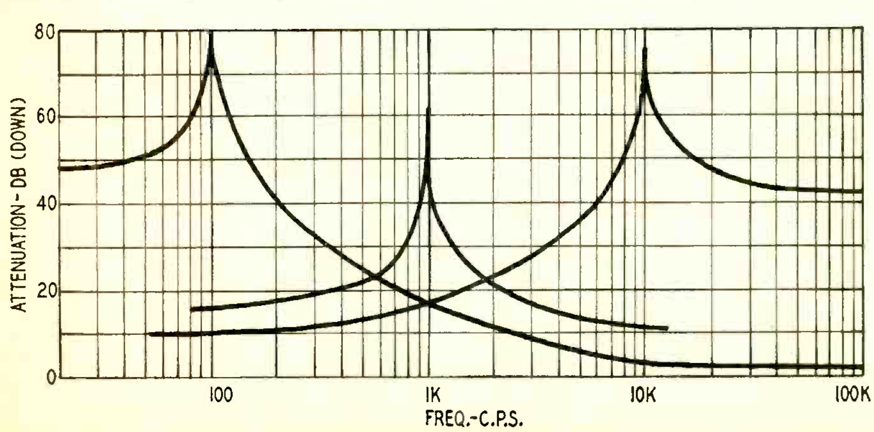
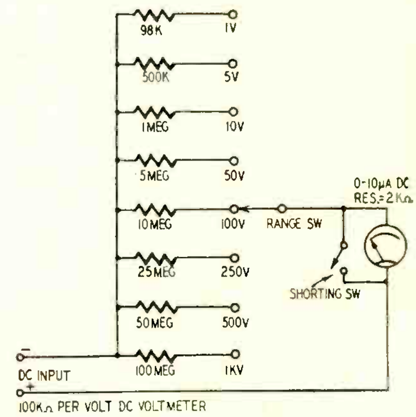


Fig. 8—Characteristics of T network.

SUPERSENSITIVE METER

NOT so long ago, the 20,000 ohms-per-volt meter was used for most shop work, with a v.t.v.m. for high-impedance measurements. Today multimeters with sensitivity ratings of 100,000 ohms per volt are standard equipment in many shops. They do not need external power, like the v.t.v.m., and are usually more compact and easier to carry. They have no tubes to age and affect calibration, and need no warmup period. The input resistance is equal to that of a 10-megohm v.t.v.m. on the 100-volt range and exceeds it on higher ranges.



A 100,000-ohms-per-volt d.c. voltmeter can be made around a 10 μa d.c. meter, one multiplier resistor for each range, and a selector switch. The diagram shows an instrument described in a recent edition of the *Aerovox Research Worker*.

To find the correct multiplier resistance for each range, multiply the ohms-per-volt sensitivity by the full-scale voltage for the range. If the multiplier resistance is less than 100 times the internal resistance of the meter, subtract the meter resistance from the calculated value of the multiplier for greater accuracy.

In constructing this or a similar meter, observe these precautions:

1. Insulate the terminals from the panel with high-grade polystyrene or ceramic material.
2. Use a high-grade ceramic-wafer range selector switch and do not touch the ceramic more than absolutely necessary. After wiring, clean the ceramic with carbon tet or lacquer solvent.
3. If the meter is to be used on a metal panel, be sure to so specify when ordering it.
4. Use special instrument type resistors for values above 50 megohms. Do not touch the bodies of the resistors. After soldering, clean them with a solvent recommended by the resistor manufacturer.
5. Make the case as near airtight as possible to keep out dirt and moisture.
6. Keep the shorting switch closed when the meter is not in use, to protect the delicate movement from shocks. END

TRACKING DOWN HORIZONTAL INSTABILITY

Part I—The problems of analysis and location

By CYRUS GLICKSTEIN

HORIZONTAL instability in TV may appear in several ways:

1. Bending or pulling
2. Touchy horizontal hold
3. Tearing
4. Horizontal jitter
5. Intermittent loss of horizontal sync.

The fault usually arises from a defect in the video strip, sync section, horizontal a.f.c. circuit, or horizontal sweep section (Fig. 1). Instability may arise also from interference signals, generated either internally or externally. A horizontally stable picture requires four basic ingredients: good horizontal sync pulses (sufficient amplitude and correct shape); correct waveform in the horizontal sweep circuit with respect to amplitude, shape, and approximate frequency; normal action in the horizontal a.f.c. circuit to lock in the horizontal oscillator at the correct frequency; absence of internal or external interference to upset synchronization.

To provide good horizontal sync pulses both the video strip and the sync section must be operating normally. For correct waveform the horizontal sweep section and the horizontal a.f.c. circuit must be functioning correctly.

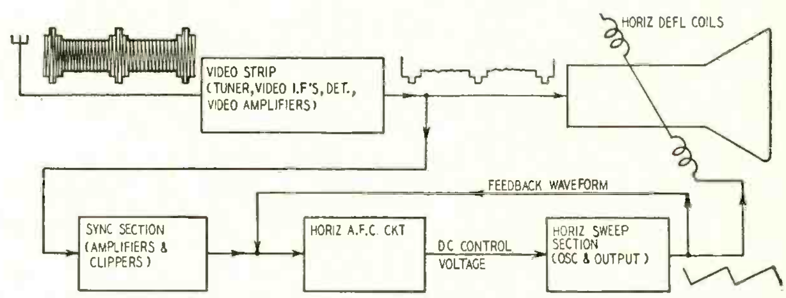


Fig. 1—Block diagram shows partial layout of a typical TV receiver.

Localizing the trouble

It may be helpful to list the most common causes and symptoms of trouble in each section. Very often these symptoms provide clues which help localize the trouble quickly. It should be kept in mind that older sets occasionally may develop multiple troubles.

1. Video Strip. Consists of the tuner, the video i.f. section, video detector, video amplifier, and the C-R tube. Composite video signals, consisting of both video information and sync pulses, pass through the video strip. As a result, video-strip troubles may cause not only horizontal instability but also additional picture defects.

Overloading. Too strong a signal at the antenna terminals or a failure in the a.g.c. system can cause overloading. This shows up as excessive contrast.

Misalignment of the r.f. or i.f. sections. Shows up as a weak, smeared, or blurry picture. This condition usually produces weak sync pulses.

Hum pickup. Sixty-cycle hum pickup may result from leakage from the heater to other elements in any tube in the video strip. This produces a 60-cycle hum modulation of the picture (Fig. 2). Other types of hum pickup are 60-cycle or 120-cycle ripple in the B+ line to the video strip and 15,750-cycle pickup in the a.g.c. system, due to poor filtering of the a.g.c. output voltage. These also hum-modulate the picture with a characteristic pattern.

Nonlinear operation. A defective component such as a leaky coupling capacitor may cause nonlinear operation in a given stage, resulting in horizontal instability and a degraded picture.

External interference. Heavy noise pulses, ignition, diathermy, and other types of external interference which may affect horizontal synchronization usually show a characteristic noise pattern on the screen.

Internal interference. Internally generated interference — such as pickup from the sweep circuits—may feed into the video strip, the sync section, or the horizontal a.f.c. circuit. Horizontal sweep pickup in the video section may cause one or more vertical lines in the picture or raster as well as horizontal instability. Horizontal sweep pickup in the sync or a.f.c. circuit results only in unstable sync.

2. Sync section. Sync circuit defects usually affect sync horizontally and vertically. Very often, the defect is more pronounced in a vertical direction, because of the stabilizing effect of the horizontal a.f.c. circuit. However, 60-cycle leakage between heater and cathode in one of the sync tubes may not greatly affect vertical operation but may still show up as a horizontal fault—horizontal bend. Hum originating in this section (or in the a.f.c. or horizontal sweep section) produces bend but does not hum-modulate the video information (Fig. 3). That is, there is no black stripe across the picture or raster. Generally, horizontal trouble originating in the sync circuit can be spotted by a check of the vertical hold control. If, in addition to horizontal instability, the vertical hold control is touchy and has less than the normal hold-in range, while video information is normal, a defect in the sync section is indicated.

3. Horizontal a.f.c. section. Horizontal a.f.c. circuit troubles usually affect horizontal synchronization only and have no effect on the vertical sweep. These troubles include 60- and 120-cycle pickup, vertical sweep coupling into the horizontal a.f.c. circuit, misalignment, and faulty operation due to component breakdown.

Hum pickup (60- or 120-cycle) in the a.f.c. circuit can cause a bend in the picture (Fig. 3). This will also show up on a blank channel as a bend along the side of the raster, if the raster is moved by the horizontal centering con-

Fig. 2—Sixty-cycle hum modulation.

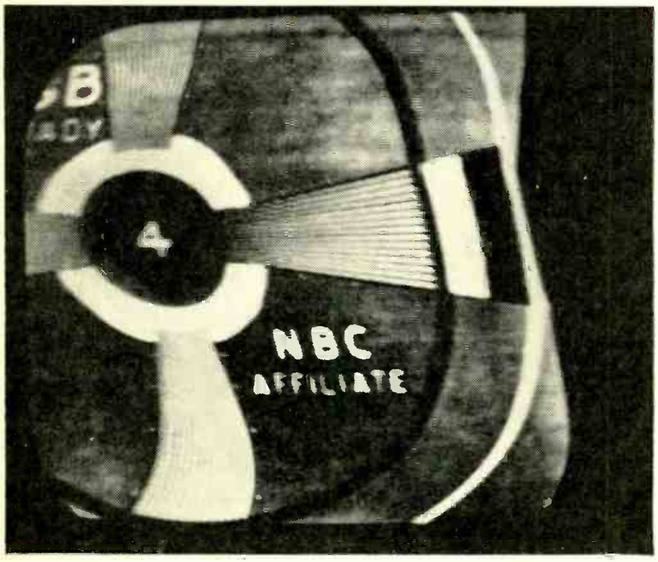


Fig. 3—Horizontal bend due to cathode-heater short in sync amplifier.

trol or other centering adjustment so the side is visible. Since this can be caused also by hum pickup in the horizontal sweep circuit, one method of localization is to remove the a.f.c. tube and note the effect on the side of the raster.

Misalignment of the a.f.c. circuit can cause any of the symptoms of horizontal instability. In certain cases, it is difficult to determine whether the trouble is originating in the a.f.c. circuit or in the horizontal sweep section.

4. Horizontal sweep circuit. Faults in the horizontal sweep circuit which cause horizontal instability often cause other troubles at the same time—such as vertical lines on the picture or raster, horizontal foldover, or a dim raster. Most of these faults are seen on the raster (blank channels) as well as on the picture (active channels).

Some types of horizontal instability, such as touchy horizontal hold or an intermittent loss of horizontal sync, originating in the horizontal sweep section are noticeable only when there is a picture on the screen. Instability originating in this section may arise from incorrect settings of the horizontal frequency controls (hold, lock, etc.), component breakdown, changed values, or incorrect values in the horizontal oscillator or output stages.

Trouble-shooting procedure

Although horizontal instability may originate in several sections of the receiver, the cause is usually not too difficult to track down if a systematic trouble-shooting procedure is followed.

As usual, the first problem is to find the defective section. This is usually solved as follows: Check the picture on each active channel and the raster on a blank channel. Then vary the pertinent controls to determine their effect on the picture. Check the effect of changing lead dress at critical points. If necessary, check waveforms.

Suppose, for example, a broad black horizontal stripe (60-cycle hum) is seen on the picture. Checking the raster on a blank channel will help localize the source of the hum. A 60-cycle signal by itself cannot pass through the r.f. and i.f. stages, since these stages are not designed to pass such low frequencies. The hum can pass through these stages only by modulating the incoming signal. On the other hand, a 60-cycle hum signal can be amplified directly in the video amplifier stages. Therefore, if the hum is noted on every *active* channel, *but not on a blank channel*, it must arise from a fault in the tuner or video i.f. section. If the hum is also visible on the screen when a blank channel is tuned in, it must originate in the video detector or video amplifier stages.

In the same way, if a vertical line is seen on active channels only, it indicates a possible defect in the a.g.c. filter system. If the vertical line is seen on blank channels also, this indicates a fault in the horizontal sweep circuit, horizontal sweep pickup in the video amplifier stages, or input to the C-R tube.

Another step in localizing the defective section is to check the action of the pertinent controls. The most important are: horizontal hold, vertical hold, contrast, brightness, fine tuning, and horizontal lock. Additional controls which should be checked in receivers having them are the a.g.c. and the noise compensator (or equivalent) controls.

Each type of horizontal a.f.c. circuit has a certain hold-in range, varying from about one-quarter to full rotation of the horizontal hold control. Although this may vary somewhat in different models, the range is fairly uniform for each type of a.f.c. circuit. In checking horizontal instability, the horizontal hold should be varied to determine how much of the normal hold-in range is obtainable. Then the vertical hold should be checked. If the hold-in range of both the horizontal and vertical hold controls is abnormally low and the picture information is too light, too dark, or otherwise abnormal, the trouble is most likely in the video strip or in the incoming signal. If the hold-in range of both controls is abnormal while picture information is normal, the trouble is most likely in the sync section. If the vertical hold-in range is normal and the picture information is normal, while the horizontal hold has much less than the normal range, the trouble is most likely in the horizontal a.f.c. or horizontal sweep circuit.

In this last case, operating the horizontal hold control may localize the trouble further. If the horizontal hold control is very touchy throughout its range, but each readjustment temporarily returns the picture to a synchronized condition, while the vertical hold is normal, the trouble is very likely in the a.f.c. circuit. If the horizontal hold barely reaches a synchronized position at the end of its range, the a.f.c. circuit may need realignment, or else there has been a change in component value in the horizontal oscillator circuit.

To check whether a.f.c. realignment is necessary, leave the horizontal hold in the center of rotation. Turn the rear panel (or top-of-chassis) horizontal lock control a little in either direction. If some improvement is noticed, complete the regular alignment procedure for that type of a.f.c. system. If no improvement is noted, return the control to its original setting and continue trouble-shooting.

Rotating the contrast control indicates whether the picture contrast has the normal range of variation and whether the video strip is functioning correctly. When there is a smeared picture or one with poor definition which cannot be cleared by rotating the fine-tuning control, then r.f. or i.f. misalignment or a breakdown in the video strip is indicated.

Rotating the a.g.c. control may eliminate an overcontrasted condition due to overload. In some receivers, misadjustment of the noise cancellation or equivalent control can cause a dark picture with poor sync action. In checking these two controls, turn them a little to either side of the original setting to determine if the condition improves and if the control is operating normally. If there is no improvement, return the control to the original setting and check further.

If control checking is completed and results are inconclusive, check whether poor lead dress is causing the trouble. Horizontal jitter or tearing can be caused by interaction between leads. Dress leads as far away from each other as possible without bringing them close to other circuits which may introduce interference. Take special care with: cathode (grid) lead of picture tube and deflection yoke cable, antenna lead-in to the tuner, and damper tube leads.

When the defective section or sections are localized, the next step is changing tubes. If the trouble is not due to a bad tube, the fault can be localized to a particular stage by signal tracing with an oscilloscope.

Using the oscilloscope is especially useful when all other checks prove inconclusive and it is not clear just where the trouble is originating. Signal tracing with an oscilloscope can usually localize the trouble not only to the section but to the particular stage that is defective. Once the trouble has been localized it can then be pinpointed by standard voltage and resistance measurements. With a little practice this procedure will prove highly profitable.

Check the waveform at each stage to determine at what point the output becomes defective, starting at the video detector and going on to the video amplifier, sync section, horizontal a.f.c., and horizontal oscillator stages. At the stage where the waveform becomes defective, check further with voltage and resistance measurements. This shows up the fault in most cases. When these measurements do not indicate the trouble, it is usually caused by an open capacitor or one that has changed value, so try substituting capacitors. In some cases, a coil or transformer with a few turns shorted or with a broken ferrite core may show normal voltage and resistance readings but may not function properly. In such cases, it may be necessary to substitute parts to determine the trouble. (TO BE CONTINUED)

NEW TELEVISION STATIONS

(List of stations which started operation since our last January list was printed)

Alaska		
KTVA	Anchorage	11
Arkansas		
KARK-TV	Little Rock	4
KATV	Pine Bluff	7
California		
KBID-TV	Fresno	53
KQED	San Francisco	9
KSAN-TV	San Francisco	32
KTVU	Stockton	36
Colorado		
KFXJ-TV	Grand Junction	5
KOA-TV	Denver	4
Florida		
WDBO-TV	Orlando	6
WINK-TV	Fort Myers	11
WITV	Fort Lauderdale	17
WJDM	Panama City	7
WJHP-TV	Jacksonville	36
Georgia		
WALB-TV	Albany	10
WRDW-TV	Augusta	12
WTOC-TV	Savannah	11
Hawaii		
KULA-TV	Honolulu	4
Idaho		
KID-TV	Idaho Falls	3
Illinois		
WBLN	Bloomington	15
WDAN-TV	Danville	24
WSIL-TV	Harrisburg	22
Indiana		
WSJV	Elkhart	52
Iowa		
KGLO-TV	Mason City	3
WHO-TV	Des Moines	13
Louisiana		
KSLA	Shreveport	12
Maine		
WCSH-TV	Portland	6
WGAN-TV	Portland	13
WLAM-TV	Lewiston	17
Maryland		
WBOC-TV	Salisbury	16
Massachusetts		
WMGT	Adams-Pittsfield	74
Michigan		
WKAR-TV	East Lansing	60
WNEM-TV	Bay City-Saginaw	5
WWTV	Cadillac	13
Minnesota		
KDAL-TV	Duluth-Superior	3
WDSM-TV	Duluth-Superior	6
Mississippi		
WCOC-TV	Meridian	30
WLBT	Jackson	3
WSLI-TV	Jackson	12
Missouri		
KOMU-TV	Columbia	8
Montana		
KFBB-TV	Great Falls	5
Nevada		
KHOL-TV	Kearney	13
New Hampshire		
WMUR-TV	Manchester	9
New Jersey		
WRTV	Asbury Park	58
New York		
WKNY-TV	Kingston	66
WTRI	Schenectady	35
North Carolina		
WAYS-TV	Charlotte	36
WMFD-TV	Wilmington	6
WNCT	Greenville	9
North Dakota		
KFYR-TV	Birmarck	5
Ohio		
WSTV-TV	Steubenville	9
Oklahoma		
KCEB	Tulsa	13
KTEN	Ada	10
KWTV	Oklahoma City	9
Oregon		
KVAL-TV	Eugene	13
Pennsylvania		
WARM-TV	Scranton	16
WQED	Pittsburgh	12
WSEE	Erie	35
Puerto Rico		
WAPA-TV	San Juan	4
WKAQ-TV	San Juan	2
Rhode Island		
WNET	Providence	16
South Carolina		
WAIM-TV	Anderson	40
WFBC-TV	Greenville	4
Tennessee		
WDEF-TV	Chattanooga	12
Texas		
KBMT	Beaumont	31
KMID-TV	Midland	2
KRGV-TV	Weslaco	5
KVDO-TV	Corpus Christi	22
Virginia		
WBTM-TV	Danville	24
West Virginia		
WJPB-TV	Fairmont	35
Wisconsin		
WEAU-TV	Eau Claire	13
WHA-TV	Madison	21
WNAM-TV	Neenah	42
Wyoming		
KFBC-TV	Cheyenne	5

The following stations, which appear in the list on page 80 of the January, 1954, issue, have since gone off the air:

KRTV	Little Rock, Ark.	17
KDZA-TV	Pueblo, Colo.	3
WKLO-TV	Louisville, Ky.	21
KFAZ	Monroe, La.	43
WBKZ-TV	Battle Creek, Mich.	64
WTAC-TV	Flint, Mich.	16
KACY	Festus-St. Louis, Mo.	14
KCTV	Kansas City, Mo.	25
KFOR-TV	Lincoln, Nebr.	10
WFPG-TV	Atlanta City, N.J.	46
WBES-TV	Buffalo, N.Y.	59
WECT-TV	Elmira, N.Y.	18
WIFE	Dayton, O.	22
KETX	Tyler, Tex.	19
WACH	Newport News, Va.	33
WOSH-TV	Oshkosh, Wisc.	48

The following stations have changed channels: WRGB, Schenectady, N.Y., from channel 4 to 6; WOOD-TV, Grand Rapids, Mich., from channel 7 to 8. KEYL, San Antonio, Texas, channel 5, has changed its call letters to KGBS-TV. KGBS-TV, Harlingen, Texas, channel 4, has changed its call letters to KGBT-TV.

COLOR TV CIRCUITS

By KEN KLEIDON AND PHIL STEINBERG*

Part III—Burst amplifier, color oscillator, and control circuits

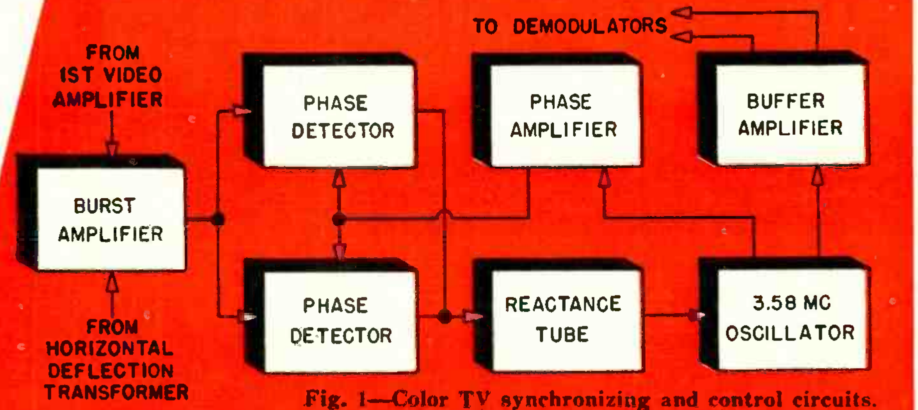


Fig. 1—Color TV synchronizing and control circuits.

THE circuits discussed in the two previous articles were common to any color receiver regardless of the type of picture tube used. The color sync channel, consisting of the burst amplifier, phase detector, reactance tube, oscillator, phase amplifier, and buffer amplifier (see Fig. 1), is basically the same whether the three-gun dot type (RCA or CBS) or the single-gun strip type (Lawrence) picture tube is employed.

As mentioned in the last article (Part II) the composite color video signal from the video detector is coupled to the first video amplifier, and then separated and fed to four different circuits. The signal we are interested in now is the one coupled to the burst amplifier. The other three signals were discussed in the previous article.

The composite color video signal contains the color burst on the horizontal blanking pedestal following the horizontal sync pulse as shown in Fig. 2. The color burst is nothing more than a synchronizing signal provided to control the phase and frequency of the color oscillator. It can be considered as additional sync information similar to the horizontal sync pulse, but its frequency and phase is accurately controlled at the transmitter. This color-burst signal is approximately 9 cycles of a continuous sine wave whose frequency is 3.579545 mc (approximately 3.58 mc). The 3.58-mc tuned transformer in the plate circuit of the first video amplifier serves as a pick-off coil for the color-burst signal which is applied to the burst amplifier and—by acting also as a 3.58 mc trap with respect to the monochrome or luminance take-off from either plate or cathode of the first video amplifier—keeps the color burst and subcarrier (color information) out of the luminance channel.

The color-burst signal is shown (see Fig. 2) in the composite color video signal and at the output of the 3.58 mc transformer. Actually some chrominance or color information will also appear at the output of the 3.58-mc tuned transformer, as the color subcarrier is at the same frequency as the color-burst signal. To prevent this, the burst amplifier is *gated*—allowed to conduct only during the horizontal blanking period—by a pulse from a winding on the horizontal deflection transformer. Since the color-burst signal occurs during the horizontal blanking period (Fig. 2) and the burst amplifier is gated, only the color-burst signal will be amplified by the burst amplifier. This action is very similar to that of a gated a.g.c. circuit, where a pulse from the horizontal deflection transformer allows the a.g.c. tube to conduct only for the period corresponding to the horizontal sync pulse. The operation here is the same, only the pulse is delayed slightly by a resistance-capacitance network in the cathode circuit so the pulse will occur at the time of the burst. Applying a negative pulse to the cathode has the same effect as a positive pulse applied to the plate of an a.g.c. tube. Between pulses the tube is held at cutoff by a positive bias voltage applied to the cathode by a resistor network connected to B plus.

Referring to Fig. 1 again, the color-burst signal from the burst amplifier is applied to the phase detectors which feed a reactance tube which in turn controls the color oscillator. One output from the color oscillator feeds the I and Q demodulators through a buffer stage while the other output is fed back to the phase detectors through the phase amplifier. The operation and function of the phase detectors, oscillator, and phase amplifier are similar to that of the horizontal oscillator and control circuit in many monochrome and color receivers. Two sync pulses of opposite polarity and equal magnitude are usually derived from the incoming horizontal sync, and are fed to the phase detectors (a.f.c. diodes) which compare these pulses to a signal fed back from the horizontal oscillator. The discriminator action of the phase detectors produces a d.c. bias voltage when the oscillator is slightly off frequency and applies this d.c. bias voltage to the oscillator for frequency correction.

The phase detector input transformer in the plate circuit of the burst amplifier (Fig. 3) is tuned to the burst frequency (3.58 mc) and provides the two sync signals at 3.58 mc of equal magnitude and 180 degrees out of phase (opposite polarity) to the phase detectors by the split secondary winding. The signal from the oscillator coupled through the phase amplifier is compared to the incoming color-burst signals and is used as a reference so that any phase difference results in a d.c. bias voltage applied to the reactance tube. The polarity of the d.c. bias voltage depends on whether the oscillator signal is leading or lagging the reference burst signal and the magnitude is dependent on the degree of lead or lag.

The d.c. bias voltage is applied to the reactance tube which controls the frequency of the oscillator. The reactance tube, for simplicity, can be considered a variable capacitor in parallel with the crystal of the oscillator. The resulting or effective capacitance presented by the reactance tube varies according to the polarity and magnitude of the d.c. bias voltage from the phase detectors.

The crystal-controlled oscillator is connected as a cathode follower for the

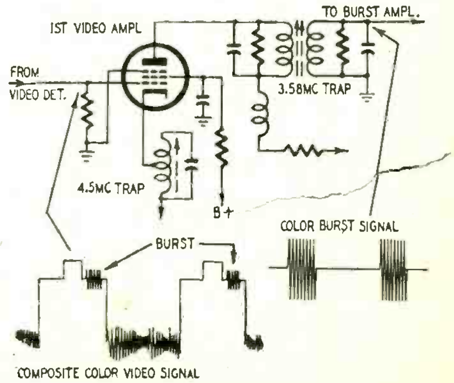


Fig. 2—The burst amplifier signals.

*Raytheon Manufacturing Company, Television and Radio Division.

circuit shown and generates a 3.58-mc signal which is applied to a demodulator. The function of the color oscillator is identical to that of a local oscillator in a radio receiver. The demodulator can be considered similar to the first detector or converter in a radio receiver. The r.f. signal in a radio receiver is coupled to the converter stage along with the signal from the local oscillator. The difference frequency (local oscillator frequency minus r.f. signal frequency) is coupled to the i.f. amplifier. The chrominance signal or color information (similar to the r.f. signal) from the bandpass amplifier is coupled to the demodulator (similar to the converter stage) along with the signal from the color oscillator (similar to the local oscillator). The resulting signal (similar to the difference frequency) from the output of the demodulator is coupled to an amplifier.

From the above it can be seen that

A typical color sync crystal.

the only function of the color oscillator is to generate two signals at the same frequency (3.58-mc) and 90 degrees out of phase with each other, to be applied to the demodulators. Due to the composition of the chrominance signal, two demodulators are required, necessitating two signals—90 degrees out of phase with each other—from the color oscillator. This is accomplished in the buffer amplifier by transformer T4.

As mentioned previously, the color oscillator is crystal controlled. The color television standards are precise, so the frequency and phase tolerance of the color oscillator are extremely critical. To meet these critical tolerances a crystal oscillator is used, as it has a very high Q so that once it is locked in phase and frequency it is very stable and difficult to disturb. A crystal oscillator may be something new to the average television service technician unless he is an amateur or has had experience with transmitters. The photograph shows a typical crystal used in a color oscillator. It is 5/16 by 11/16 by ¾ inch in size and the operating frequency 3,579.545 kc. (3.58 mc.) is usually stamped on its top side. It is equivalent to a tuned circuit with a very low energy loss due to the low resistance value of R and so presents a very high Q.

Reviewing the over-all operation of the color oscillator and control circuits, assume that the oscillator is slightly off frequency. Since one of the outputs from the oscillator is coupled back to the phase detectors through the phase amplifier (an amplifier tuned to 3.58 mc) a phase difference will result between the burst and oscillator signals. This phase difference will cause a change in the d.c. bias voltage applied to the reactance tube, which will change the effective capacitance across the oscillator to change frequency and phase to correspond to that of the burst signal. This elaborate control network for the color oscillator is necessary as a frequency tolerance of not more than 11 cycles deviation is allowable. False color information will result with even the slightest change in the frequency of the color oscillator.

The other output from the oscillator is coupled to a buffer amplifier. In the plate circuit a quadrature transformer (T4 in Fig. 3) is used to obtain two signals 90 degrees out of phase (one signal lagging the other by quarter of a sine-wave cycle) for application to the demodulators. The demodulators, to be covered in our next article, beat the chrominance signal with the two signals from the oscillator to obtain the three color signals (red, green, and blue) after matrixing.

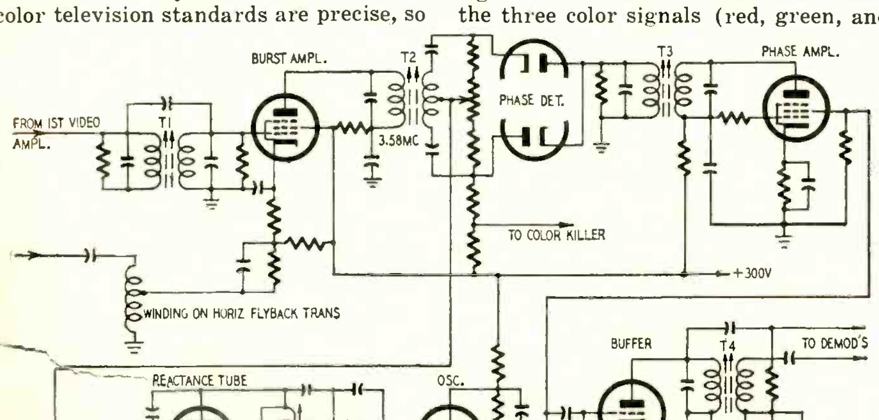


Fig. 3—These are the circuits that synchronize the color in the picture.

The only function of the oscillator and control circuits is to provide two signals to the demodulators, and the burst signal's only function is to synchronize the color oscillator with the station to assure proper color registration. Any defects in this section of a color receiver will cause one of two conditions: Either no color information will appear on the picture tube or the color information will not be synchronized with the black-and-white information. The face of the picture tube may then portray a stationary monochrome or black-and-white picture with color bars running diagonally. This is similar to the out-of-horizontal-sync condition often encountered in monochrome servicing. It will occur when the color oscillator is slightly off frequency, and the number of color bars running diagonally will vary according to the number of cycles the oscillator differs in frequency from the burst signal. The greater the difference in frequency, the greater the number of color bars. Coil L2 in Fig. 3 will have the greatest effect on the operating frequency of the color oscillator and this adjustment will be provided as a control at the rear of the receiver. If a condition of out-of-color-sync (color bars running diagonally) occurs, adjusting L2 will usually correct the condition.

In some instances the color oscillator may be so far out of sync that the number of color bars will be very high and they will not be distinguishable. Such a condition would generally be caused by a circuit defect. Whenever a condition of out-of-color-sync occurs you can be sure that the defect is in the color oscillator or control circuits. Of course any control that could cause this condition, such as tuning or coil L2, should be adjusted to correct the condition and then all the tubes in the suspected circuit should be substituted for.

If when tuned to a color telecast and only a black-and-white picture appears, the color oscillator and control circuits may be at fault. However, other circuits—such as the color killer and the burst amplifier, if defective—will cause the same condition.

Trouble-shooting in this section of a color receiver, once its function and operation are understood, should not be difficult. However, due to the critical phase and frequency tolerances, caution is necessary when component replacements are required. A number of resistors, capacitors, and coils have close tolerances, and exact part replacements should be obtained if at all possible. The general-purpose scopes of most service shops will be inadequate for checking this section because of the limited frequency response of the vertical amplifier. A scope with a vertical amplifier frequency response of at least 3.6 mc. will be needed to observe the color burst and oscillator signals. (TO BE CONTINUED)

GHOST ATTENUATOR

By H. E. WARRINER

AFTER opening the TV door for maximum input from a good roof antenna installation, many of us have found that the excellent signal strength has included a bounty of dead cats. This is true particularly in city installations considered primary telecast zones—the dead cats being persistent ghosts from nearby tall buildings, chimneys, or gas tanks. This problem, encountered so close to the transmitters, calls for a compromise one way or another. You either live with double vision or seek out new antenna locations and set up separate narrow-beam antennas with matching stubs.

But what else can be done about persistent ghosts after you have done the best possible job of orienting your roof antenna in a strong multipath area? Before you compromise on one or two clear channels and discount the rest, here's how to put the principles of mismatch to work in a positive way: Attenuate the ghost!

For fringe-area reception the antenna lead-in should be perfectly matched to the TV set. Mismatch of the line will choke off reception as standing waves form on the line. Equalizing devices such as variable matching stubs will correct line mismatch for maximum fringe area reception.

In local strong-signal areas line mismatch creates standing waves that are amplified into visible ghosts by the great strength of the transmitted signal. The antenna may also produce ghosts from the crossfire of multipath reflections. The city dweller living close to transmitters receives too much signal power.

The handling of excess signal strength is recognized by many TV manufacturers who install *local* and *distance* switches in their equipment, or provide attenuation-pad instructions to accommodate their sensitive tuners. Too much signal input creates harmonics and too much contrast or loss of definition. So there is a definite need for control of the signal before it enters the TV set.

Since there are situations where multipath effect is almost unavoidable, lead-in mismatch and too much signal strength can further aggravate the problem. However, these factors can be harnessed to work just as well for good reception as against it. The 4-way antenna attenuator (Fig. 1) will give you a wide variable control of your TV antenna and lead-in. If you must accept a ghost-present compromise at the antenna you may still be able to fade the ghost before it reaches your screen.

Ghosts in a primary service area are subject to antenna and lead-in attenuation because there are two or more signals in the system, the original being the stronger. If the roof antenna is properly oriented toward the transmitters, any ghost-producing secondary signals will be entering the antenna pattern from the sides or rear. Their strength is therefore less than that of the primary signals. Because of this it is possible, by skillful attenuation and a degree of controlled mismatch, to minimize or completely eliminate such unwanted secondary signals. This can be done without sacrifice of a good picture from the original signal since it is over-abundant. There is a margin of decrease which is actually good, for the set is relieved of overload. This effect can be seen on clear channels where some attenuation improves picture quality.

Construction

The attenuator consists of four carbon potentiometers (taper unknown, probably linear) wired in a conventional attenuation network, mounted on a 4 x 4-inch lucite blank (Fig. 2). One 2-inch angle bracket holds the attenuator on the back of the set close to one side within easy reach for adjustment while you watch the picture screen. Lucite was selected for its low-loss characteristic at v.h.f., even though the attenuator was designed to insert losses into the line. The fact remains that there may be channels on which you will need maximum gain.

Experiments with and without line-matching stubs at the set terminals show that the line can be balanced to the set by proper adjustment of the attenuator so no additional line balancers are required. The device has also been used with excellent results from simple dipole, indoor antennas, giving improved reception in every case.

In the schematic, Fig. 3, two 5,000-ohm carbon potentiometers, A and B, are the main attenuators through which both legs of the line pass. Crossover 1,000-ohm balancing potentiometers C and D are equipped with regular line switches for cutting in and out of the circuit as needed. Some ghost conditions clear up best with either C or D in the circuit, or both. In my case, channel 2, New York City, which is perfectly clear without any attenuation, yields a better picture with some attenuation on A and B and a shade of crossover balance from D. Channel 4 requires the full system, while channel 7 needs only attenuation on B. The resistance values are high for purpose of strong ghost medicine on the low channels of the v.h.f. band.

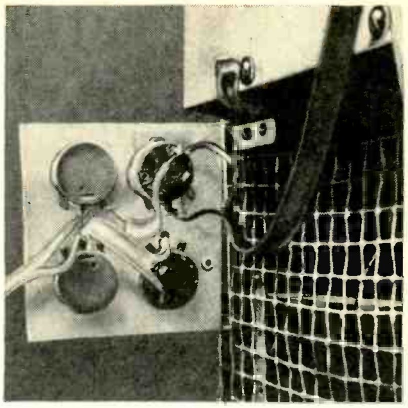


Fig. 1—4-way antenna attenuator.

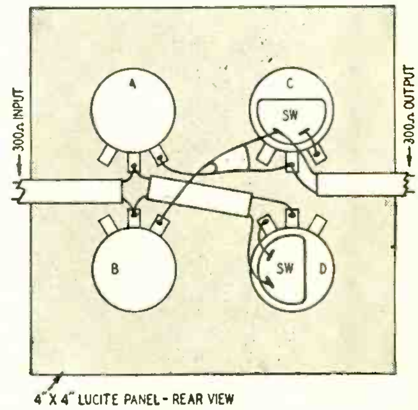


Fig. 2—Diagram shows the physical layout of the carbon potentiometers.

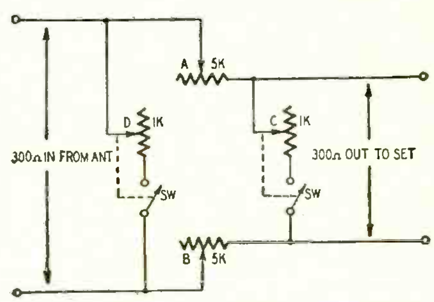
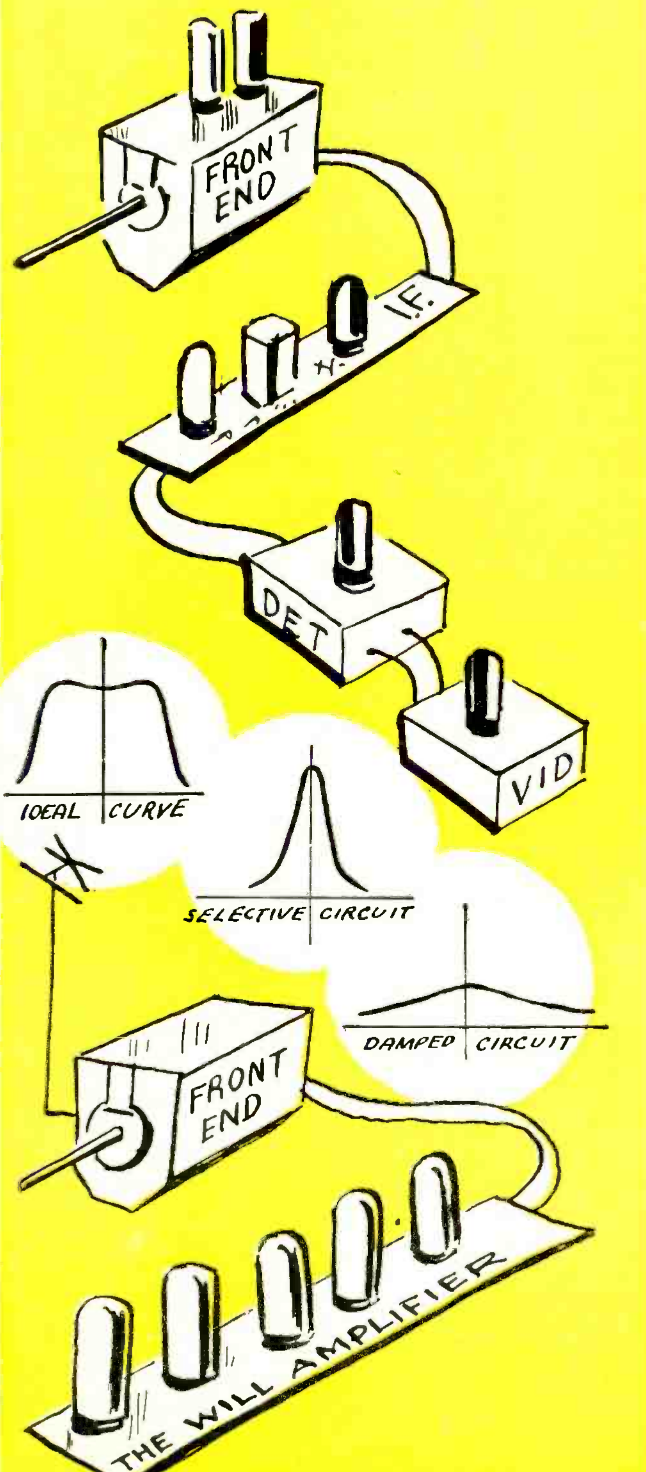


Fig. 3—Schematic of TV attenuator.

Operation

The method of operation is simple and the only rule to follow is to watch your screen closely for the desired results—clear pictures. If your set has LOCAL and DISTANCE switching, turn to DISTANCE when using this attenuator; it will perform best at full input. With C and D cut out of the circuit, turn A and B away from zero until ghosts are eliminated or minimized. These controls work against each other as you are inserting degrees of mismatch into the lines. Then cut in C and D for line balance, checking all adjustments against each other for desirable shading. You will find that proper adjustment will reach a point of minimizing or routing the unwanted ghost. END

TELEVISION . . . it's a cinch



By E. AISBERG

Twelfth conversation, first half: r.f. problems, visible noise, selectivity versus bandpass

WILL—Now that we've taken your "Empire State Tower" view of how a television receiver is made up, how about getting right down to circuits this time?

KEN—O.K.! Suppose today we follow the video signal from the antenna to the picture tube. We can forget the power supply, sync, and other auxiliary circuits for the time being.

WILL—In other words, we'll go through the r.f. amplifier, frequency changer, picture i.f., detector, and video-amplifier circuits. I didn't realize that TV was so much like radio—the only difference seems to be that instead of audio, we have video signals. All the rest is just the same!

KEN—You've been wrong plenty of times before, Will, but not often quite as dead wrong as you are now! How many times have I tried to tell you that even the best broadcast radio transmission has a bandwidth of less than 20 kilocycles, while a single television video channel is 4 *megacycles* wide? That one thing makes each and every circuit different!

WILL—Different, but not difficult. For instance, you wouldn't have to make your circuits as selective as in radio. You get out of one difficulty right there!

KEN—You mean you get into one! Just as in AM radio, you have to worry about trying to satisfy the opposite demands of selectivity and fidelity, so in television you are faced with the struggle between getting a broad enough band and getting enough gain.

WILL—You seem to have a few contradictions today yourself! Isn't it just the circuits that aren't selective that pass a wide band? When I remember how much trouble we used to have making our circuits selective enough, I don't think there can be much difficulty in cutting down the selectivity. All you have to do is use what in radio we called low-quality circuits.

KEN—This time you're right. Unfortunately, you can't get very much gain with "low-quality circuits." And you have to apply up to 50 video volts to the picture tube's control element, even though the signal on the antenna may be measured in microvolts. You need a voltage gain of several hundred thousand to do that!

WILL—So that's why a TV receiver has so many stages of different kinds of amplification?

KEN—That's the main reason. We'll go into some of the other reasons later.

Why the r.f. stage?

WILL—I've noticed that you can have a couple of r.f. stages, a number of i.f., and two or three video amplifier stages.

KEN—You don't see many sets like that! But sets with one r.f., three i.f., and one or two video stages are becoming the common type. And notice, Will, that when you have your i.f.'s tuned up above 40 mc, you are already in the v.h.f. range. So you can be studying v.h.f. while you learn how the i.f.'s operate.

WILL—But if that's so, why bother dividing up the amplification between r.f. and i.f. stages? Why not use just one 5-stage i.f. amplifier?

KEN—First of all, your amplifier is likely to oscillate if you cascade too many stages, even though the gain of each stage is pretty low. With two amplifiers working at different frequencies, you're going to have less regenerative feedback. But the r.f. amplifier has a far more important advantage. You can use it to cut down the amount of noise as compared with signal.

WILL—But why worry about *noise* in a picture receiver?

KEN—The word "noise" came from AM radio, but we give it a little different meaning in television. It means all those current irregularities that result in the confused rushing noise you hear in an AM radio with no signal and the gain turned up. It's caused by several things: the current flowing through resistors, oscillating circuit irregularities, and unevenness in the cathode emission of the many tubes in the set.

WILL—But even then, noise in inaudible in a video channel!

KEN—Yeah, but it's not invisible! These irregularities of current—amplified through all the stages of a TV receiver—modulate the electron beam just as a video signal from a transmitter would. So the noise comes out on the screen as snow or a grainy image. I'm sure you've seen both, though maybe you didn't know you were looking at noise!

WILL—So r.f. amplification makes the pictures less snowy?

KEN—Exactly! In more technical terms, r.f. amplification improves the signal-noise ratio. And it has still another advantage. Even though TV r.f. stages are not particularly selective, they are a great help in cutting down interference from stations on neighboring channels.

WILL—But I thought the FCC didn't allot adjacent channels in the same area.

KEN—It's supposed to work out that way, but there are places where there is adjacent-channel interference. And you have image frequencies to think about.

WILL—Oh, yes! If I remember right, they are frequencies that are the same distance away from your oscillator as are the frequencies you want to receive?

KEN—Queerly put, but I think you have the idea. But to make sure, suppose you have a channel 6 video signal at 83.25 mc. With the oscillator at 129 mc, you have an i.f. of 45.75. A signal at 174.75 mc will give you the same i.f. with the same 129 mc oscillator. The video carrier of channel 7 is at 175.25 mc, only a half megacycle away—well within the fine-tuning range of the usual receiver. Suppose you lived in a region where channel 7 was a strong station and channel 6 a weak one . . .?

WILL—. . . maybe I could get two programs at once, without buying the expensive special receiver I read about not long ago!

KEN—Except that you couldn't unscramble them with polarized glasses! But seriously, I think you've learned enough to know how useful r.f. amplification can be in a TV receiver.

WILL—So let's start with the r.f. stage. How about a diagram?

KEN—Here it is. You'll recognize an old friend—the tuned-plate circuit—in this schematic.

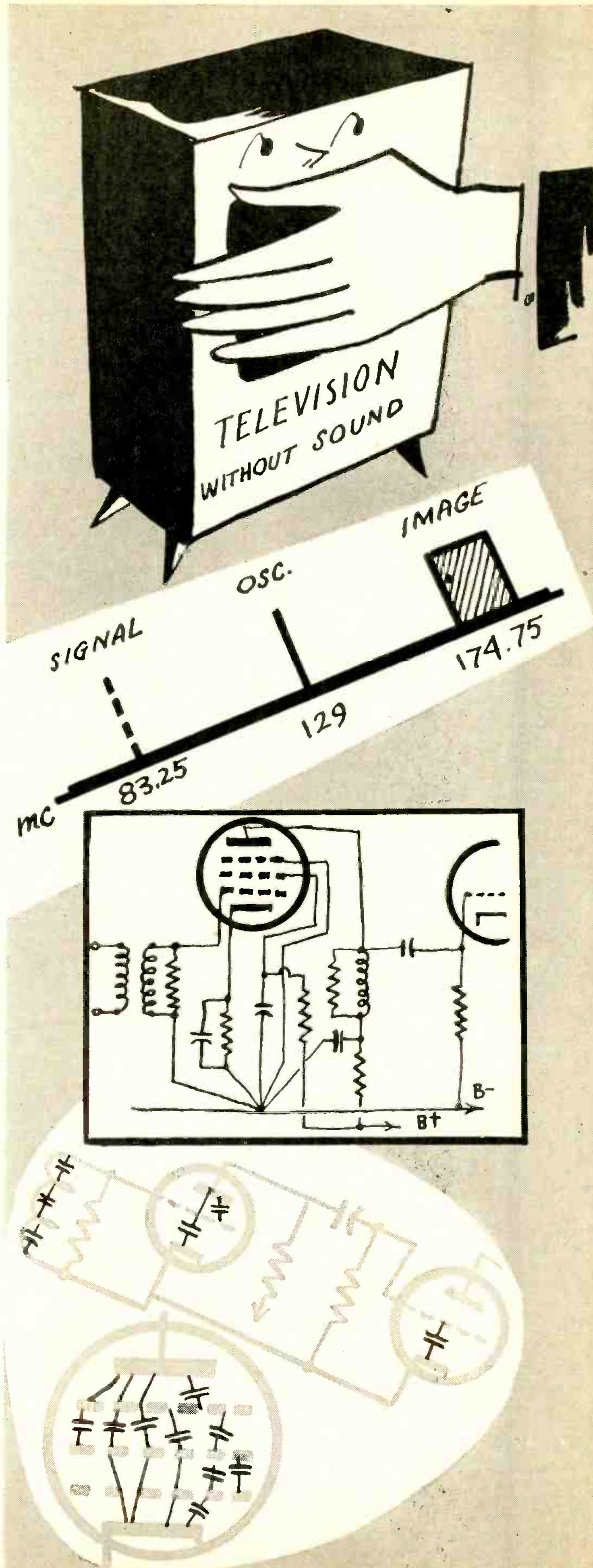
WILL—Are you kidding? Don't tell me that coil and resistor in the plate circuit are a tuned circuit!

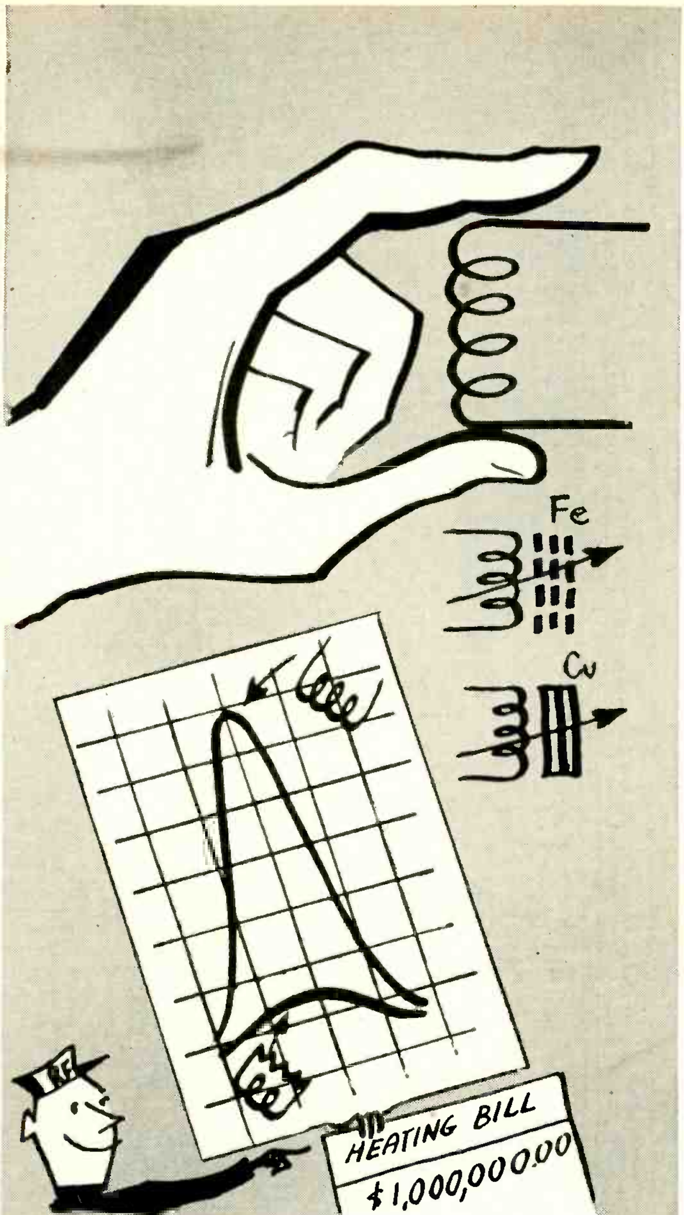
KEN—Haven't we talked about invisible components before? If not, we'd better start now—they keep getting more important as the frequency goes up! The capacitor you can't see across the coil is really there! It's made up of all the capacitances shunted across the winding—its own distributed capacitance, stray wiring capacitances, and the interelectrode capacitances (between the plate and the other electrodes of the first tube and the grid and other electrodes of the second tube).

WILL—But why not use a variable capacitor, like a real self-respecting tuned circuit . . .?

KEN—Because—to get any gain at all—we need as much inductance and as little capacitance as possible in our circuit. We even have to space the coil turns and keep leads as short as possible, to cut down distributed and wiring capacitances.

WILL—I suppose the first grid coil is also a tuned circuit?





KEN—Yes. And you'll note that it's also inductively coupled to the antenna coil.

WILL—But I don't see any variable capacitors or cores if these are *tuned* circuits, how do you tune them?

KEN—By changing the coil inductance. Most of these coils are made of a few turns of fairly stiff wire, so you can tune them by squeezing the turns together or pulling them apart a little. But they use permeability-tuned coils occasionally at these frequencies, with cores of powdered iron or of copper.

WILL—I understand the magnetic core all right. But how can a nonmagnetic core change the inductance of a coil?

KEN—The r.f. fields set up eddy currents in the conducting core. And these currents set up fields that oppose and weaken the field of the coil. The effect is to reduce its apparent inductance. You'll notice that conductive cores have an opposite effect to that of magnetic ones, which increase the inductance.

WILL—Then I see a practical difficulty. How are you going to adjust the cores? If you move them in and out of the coil by turning a screw, isn't the metal in the screw going to get into the argument?

KEN—Quite correct. And that's the reason you'll often find the screws on this kind of coil made out of insulating material.

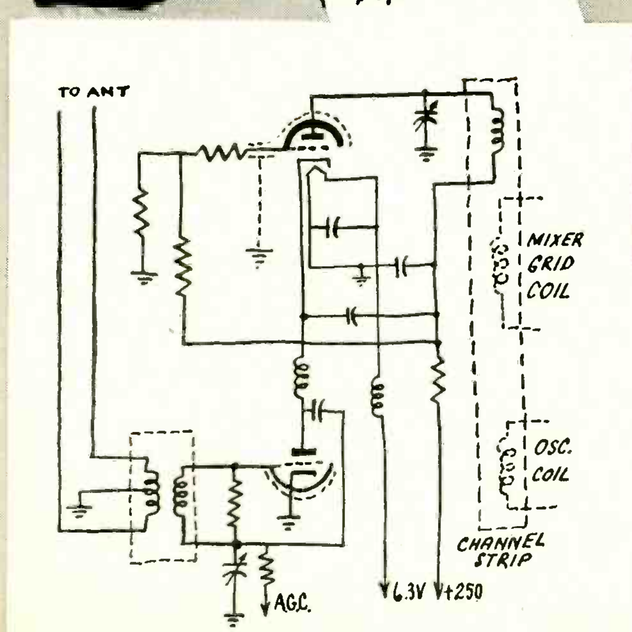
WILL—You see, I think of everything! But let's get back to our diagram. I see you have resistors shunted across your grid and plate coils. I hope they're high-resistance units! Otherwise they're going to absorb a lot of that high-frequency energy you've been trying to save.

KEN—I've bad news for you, Will! Their resistance is pretty low—may go down to 5,000 ohms or so. But you're quite right about their absorbing a lot of the energy in the circuits. That results in what the technicians call "damping." And it's just such damping or flattening of the selectivity curve that lets the circuit pass the necessary wide-frequency band.

WILL—That's not my idea of a smart operation. Just to pass all the video modulation frequencies, you feed the tiny parcels of energy you get from the antenna into these damped circuits. There you dissipate them in heat, instead of amplifying them to help the signal. Isn't that the most expensive form of heating in the world?

KEN—You're absolutely right, but we can't get away from it! Now you understand why stage gain is low. But, to make up for it, you can use very high-gain tubes. Some pentodes with extremely high gain have been developed specially for TV r.f. amplifiers. But, unfortunately, the more elements you get in a tube, the more noise it produces. So some manufacturers prefer to stick to the triode, with its lower gain and better signal-noise ratio. Now practically all TV front ends have an r.f. amplifier that uses the famous *cascode* circuit, which consists of two triodes so hooked up that they give the gain of a pentode with the much lower noise level of two triodes.

(TO BE CONTINUED)



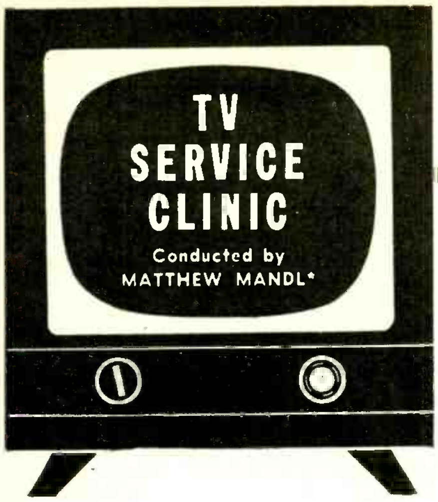


Fig. 1—Misadjusted focus assembly.

Fig. 2—Video amplifier overpeaking.

MENTION mathematics to some service technicians and you get either a cold stare or an effort on their part to change the subject—but quick! Perhaps my mention of math in this opening paragraph has the same effect on you and you're thinking: "If he's going to discuss *that* this month, I might as well skip reading the Clinic this time."

I hope you keep reading, however, because simple math can help you with many servicing problems. I'd like to illustrate:

Example 1. Sometimes you suspect that the second-anode current of a picture tube is excessive. It's easy enough to measure the current—but what amount is excessive? The general rule given by tube manufacturers is that the second-anode voltage multiplied by the average anode current should not exceed 6 watts. Thus, suppose you measure 12,000 volts on a 16GP4 tube—what is the current limit? Since current flow is equal to power divided by voltage, we divide 6 by 12,000 and get 0.0005 ampere, or 0.5 milliampere. Thus, ½ milliampere of current is our limit for the 16GP4 with 12,000 volts at the second anode.

Example 2. There are 20 horizontal dark bars on the screen of a picture tube during reception. What is the frequency of the interfering signal? Since the screen is darkened 20 times during the *vertical* scan which occurs in 1/60 of a second, the frequency of the interfering signal is 60 times 20, or 1,200 cycles. (One or two bars may not be visible because of retrace, but the calculation will give a fairly good idea of the approximate frequency of the interfering signal.)

For vertical bar interference, multiply the number of visible bars by 15,750 to calculate for the frequency of the interfering signal *which is reaching the picture tube.*

If the interfering signal is arriving at the antenna and is not generated within the set itself, the above calculation indicates the *difference* frequency which results when the interfering signal mixes with the local oscillator signal in the tuner.

Example 3. Your customer wants a 12-inch speaker mounted in his console television. The set now has a 6-inch speaker, but you don't know its impedance. The schematic indicates that a single 6V6 audio output tube is used. The tube manual recommends an 8,500-ohm load resistance. You disconnect the voice coil from the output transformer, and remove the 6V6 tube. You now put 1 volt a.c. on the secondary of the audio output transformer and read the primary voltage. (Assume the primary voltage now reads 46 volts a.c.) This indicates the turns ratio of the transformer, 46 to 1. Now square 46: $46 \times 46 = 2,116$. Divide the recommended load resistance by 2,116: 8,500 divided by 2,116 equals 4 (approximately). You then get a new speaker having a 4-ohm voice coil.

The foregoing samples require simple mathematics. If you become more proficient as well as familiar with the many formulas which can be used, you will find it saves considerable time.

NOTE: I regret to inform the readers of the Service Clinic that the press of other work forces me to withdraw from editing this column. The Clinic will continue, however, so keep sending in any queries you have on television servicing. I'll still be associated with this magazine as television consultant and as a contributor of articles from time to time.

*Author: Mandl's Television Servicing

Inverted picture

After replacing the vertical output transformer in a Philco model 2272 receiver the picture was upside-down. I'm sure I wired the secondary to the yoke properly, but I had to reverse the leads to get the picture right-side up. Is there some condition which I've missed with respect to the picture inverting? What other conditions cause an upside-down picture? J. V., Bethpage, L. I.

The color code of the secondary may have been incorrectly indicated. Since the picture is now all right, it is obvious that reversed leads caused the trouble. The only other condition which gives an inverted picture is extreme foldover. During the latter condition the picture overlaps and the secondary image will be inverted.

Bottom margin

I have been attempting to correct a black margin at the bottom of the picture tube in a Stromberg-Carlson model 317. I suspect the circuit associated with the 6BL7-GT tube is creating this condition. Is there some circuit change which I could make to correct this condition? O. J. B., Olean, N. Y.

When this condition appears, circuits should not be changed, but rather the faulty tube or component causing this trouble should be located. A black margin at the bottom may be caused by improper picture positioning. For this reason the focus assembly should be adjusted to center the picture properly, and the height control should be adjusted to fill out the mask. A misadjusted focus assembly can cause considerable picture shift, as shown in Fig. 1. If height is inadequate, the vertical output tube should be replaced. If this does not help, a check should be made of the resistors and capacitors as well as other components in the vertical oscillator and output amplifier.

The vertical linearity control may have to be readjusted when the height is changed, since these controls often affect each other.

27NP4 substitution

I would like to change the 27NP4 picture tube in a Muntz chassis 17B8 to some other 27-inch picture tube. What tube will produce the most brilliancy and contrast and be mechanically interchangeable with the 27NP4? E. C. P., Park Forest, Ill.

You could use the 27RP4 tube which has an aluminized face. This will give you better brilliancy and contrast, and this tube is interchangeable with the 27NP4. With the 27RP4, however, you may get a brilliancy decrease if the high-voltage system of the receiver is not operating at peak efficiency. Usually the 27RP4 is operated at approximately 1,000 volts more on the second anode than the 27NP4 for the brilliancy necessary for daylight viewing. The 27RP4 is 1/16 inch longer than the original tube. You could also use a 27LP4, except that this tube is 1 23/64 inches longer than the 27NP4. The 27LP4 requires approximately 2,000 volts more than the 27NP4.

Color conversion

One of our local television stations is broadcasting some programs in color. I am interested in receiving these in color, and have been wondering whether or not it would be practical to convert a present black-and-white set to color. If it is practical, I would appreciate advice on what problems are involved. W. E. M., Charlotte, N. C.

It is not practical to convert a present black-and-white receiver to color, since the cost would be almost that of a new color receiver. For color reception it is essential that the video i.f. stages and the turner have a bandpass of 4.2 megacycles to receive full color information. Many existing black-and-white receivers have an i.f. bandpass of only approximately 3.5 to 3.8 mc. and would thus be unable to properly handle the color information. In addition, it is necessary to have color demodulator circuits, a subcarrier oscillator, bandpass amplifiers, matrix systems, and a much higher second-anode voltage. These factors, plus numerous other circuit modifications, make the project impractical at the present state of the art.

Sync troubles

I have just completed wiring a 630 type television kit. The picture quality is excellent but I receive a picture where both the vertical and horizontal blanking bars meet at the center of the screen. By decreasing the vertical oscillator grid leak the picture moved up into its correct position vertically. By decreasing the 27,000-ohm horizontal oscillator grid leak, the other blanking bar disappeared to the right. I can hold the picture in the center of the screen now, but the horizontal and vertical hold controls no longer lock in at the center of their range and they are critical. The horizontal and vertical controls are at the extreme end of the range and the core of the synchrolock discriminator secondary is screwed all the way in to keep the blanking bar at the right of the screen. Could you tell me how to correct these defects? P. C., Toronto, Ontario.

Off-value parts in the vertical and horizontal oscillators would necessitate setting the controls at the extreme end of the range for proper synchronization. This can be corrected by checking all parts values against the schematic and replacing any which are off by more than 5%. If this does not help, the lack of center-range control may be caused by improper lead dress. Wires should be kept short and spaced from other component parts or adjacent wiring. If this does not help, the series resistors in the hold-control circuits can be changed to permit center setting. When the vertical circuit is out of synchronization it should roll and not lock in with the blanking bar across the center. When the latter occurs, it usually indicates a higher than normal hum level. When a 60-cycle hum enters the vertical circuits, the hum signal can cause a lock-in, and, depending on the phase of the 60-cycle signal with respect to the sync, the blanking bar may be visible across the screen.

Incorrect voltages in the horizontal oscillator also will cause unstable synchronization. Most technicians are not aware that the synchro-lock horizontal a.f.c. system used in the 630 receiver requires a step-by-step adjustment for good lock-in as well as pull-in. This involves adjustment of the phasing control and the frequency control, as well as the hold control. If this information was not furnished with the kit, you can find it in the original RCA 630 service notes.

Overpeaking

In several receivers I have serviced lately I noticed a picture which either has a very slight ghost effect along the right-hand side of the objects or a slight highlight along such edges. The fine-tuning will, in some instances, partially eliminate some of this trouble, but usually not completely. I understand the cause for the ghost reception, but would like your explanation regarding the cause for the faint highlights or repeat lines following objects in the picture. C. C. M., Scardsdale, N. Y.

Such repeat lines may be caused by overpeaking in the video amplifiers (see Fig. 2) or by a misoriented antenna. For this reason, check the antenna orientation, and if this does not help, you will have to check the tubes and parts in the video-amplifier stages. Incorrect values in the peaking coils, or shorted turns in the latter will affect fine detail. When the peaking coils do not have the right value they may over-accentuate the high-frequency response, which will result in trailing edges at fine-detail picture information. Voltage checks also should be made, since abnormal voltages can aggravate the high peaking condition. The most simple testing procedures consist of checking tubes. If these do not help, voltages and part values should be tested, using accurate equipment.

Weak volume

I am servicing an RCA model 7T103B chassis KCS47F. The complaint is low sound output, although the picture is O.K. This is a split-carrier type, taking the sound i.f. from the 3rd video i.f. stage through a sound take-off coil. The sound is not distorted and it is not extremely weak, except that the volume control must be turned up all the way for normal listening. All of the tubes in the sound i.f. stage and audio have been replaced and the i.f. coil feeding the limiter has been taken apart and examined and found to be O.K. I can short out the limiter screen resistor and raise the sound output almost 3 times, but the fine-tuning control must be readjusted to get the increased sound, and then the picture detail suffers. All capacitors and resistors check, so I am at a loss to understand the low audio output, unless it could be caused by a defective sound take-off coil or discriminator coil. When adjusting the discriminator to zero at 21 mc it seems that the dip from positive to negative is not as sharp as it should be, as I must keep turning the adjusting screw several turns before it starts in the other direction. Any help you can offer me in correcting the above trouble will be very much appreciated.

Since the picture is all right, the weak sound undoubtedly is caused by troubles after the sound take-off. You mentioned having checked all the tubes as well as replacing the i.f. coil feeding the limiter. Since you have also checked capacitors and resistors, the trouble is probably caused by incorrect sound i.f. alignment. For this reason you should check the sound i.f. and discriminator alignment, using accurate equipment and referring to the step-by-step procedures given in the service notes for this receiver.

If you have adjusted the controls without accurate generators, you may have thrown them off to a point where the cumulative effects are contributing to a decline in output. If proper alignment fails to give good results, and if you are sure that tubes and components are all right, you may have to replace the sound take-off coil as well as the discriminator inductance. Before doing this, however, check the output transformer to make sure no shorted turns or other defects exist. When difficulty is encountered in adjusting the discriminator circuit, it is usually caused by an unbalance. END

REJECTION FILTER FOR TV BUZZ

Sync buzz, 60-cycle hum, and other audio interference can be eliminated with a notch type filter like the parallel-T

By **IRVING GOTTLIEB**

MANY intercarrier TV receivers produce an annoying 60-cycle buzz or hum despite correct adjustment and compliance with the manufacturer's operating instructions. This is caused because the audio amplifier responds to the 60-cycle field repetition rate. Ideal design would eliminate this undesired signal ahead of the audio channel. This is hard to do in practice. However, it can be trapped out of the audio amplifier by substituting for the conventional R-C coupling elements a special parallel-T filter network. The technique is also suitable for audio amplifiers in other applications which are plagued with 60-cycle interference from the power lines.

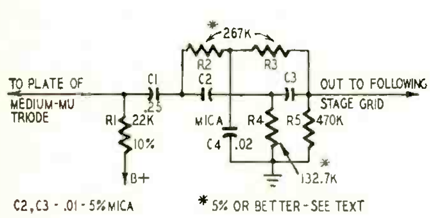


Fig. 1—The parallel-T filter network.

The 60-cycle interstage coupling filter is shown in Fig. 1. Many combinations of resistance and capacitance attenuate 60 cycles. Only a few of these are satisfactory for use with vacuum tubes. The values shown were found to provide the best compromise between insertion loss, good audio frequency response, and effective 60-cycle rejection. The parallel-T coupling network reduces the gain to about 85% of that obtained with the conventional R-C coupling network it replaces. This figure was obtained experimentally by measurements at 1,000 cycles. In other words, the insertion loss is about 1.5 db. In TV receivers, this can generally be tolerated, and is a worthwhile exchange for annoying 60-cycle buzz.

Fig. 2 shows the frequency response of a test audio amplifier incorporating the parallel-T coupling network. The degree of network balance affects the response. Good balance increases the attenuation of 60 cycles and improves the over-all audio frequency response as well. The high-frequency response is very good—better, in fact, than that from the conventional R-C coupling circuit. The combined effects of grid input capacitance and stray wiring capacitance do not degrade the response at high frequencies as rapidly as the ordinary R-C coupling network.

For good balance the parallel-T components (C2, C3, C4, R2, R3, and R4) should all have tolerances of 5% or better. Values specified in Fig. 1 give best results when working from the plate circuit of a medium-μ triode. Other types increase the insertion losses. R2 and R3 are each made by connecting 240,000- and 27,000-ohm 5% resistors in series. R4 is made by putting 2,700- and 130,000-ohm 5% units in series. R1 and R5 need not be precise values. Optimum performance in any given circuit is obtained by substituting variable components for C4 and R4 and adjusting these for exact circuit balance. A 250,000-ohm potentiometer may be used for R4. Replace C4 with a .015-μf capacitor. Connect .001 μf capacitors in parallel with C4 to bring the effective capacitance up to the vicinity of the nominal .02 μf. For each change in one arm, the other should be readjusted. This tuning procedure is easy with the test circuit of Fig. 3. Although the performance of the bridge is greatly improved by precise adjustment of all its elements, tuning the shunt arms alone will produce a 60-cycle voltage rejection ratio of somewhere between 80 and 150 to 1. This is more than enough to trap out 60-cycle interference and yield good audio frequency response in television receiver and amplifier applications in general. If an extremely sharp rejection characteristic is required, vernier adjustments of the series elements will be needed. The actual calculated value of R2 and R3 is 265,770 ohms; that of R4 is 132,885 ohms. These values were derived in terms of the 0.01-μf and the 0.02-μf capacitors used in the other bridge arms. The equation for balance or resonance is $C4 \times R2 = 4 \times C2 \times R4$ when using the configuration in Fig. 1 where $R2 = R3 = 2R4$ and $C2 = C3 = \frac{1}{2}C4$. The resonant frequency in cycles equals $0.159/C4 \times R4$, where C is in microfarads and R is in megohms.

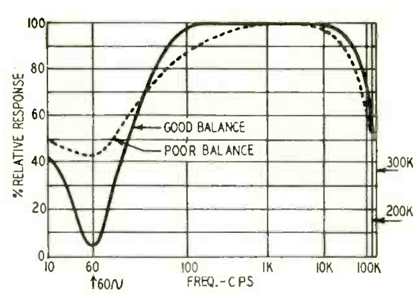


Fig. 2—Sharpness rejection notch varies with values of the components.

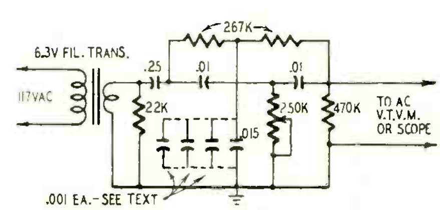


Fig. 3—Setup for tuning the network.

Parallel-T filters such as this have numerous other applications in audio, electronic control, and communications. A filter tuned to 10 kc may be inserted in the audio-amplifier circuits of a high-fidelity tuner or receiver to attenuate adjacent-channel heterodynes and whistles. Tunable filters may be used in communications receivers to eliminate heterodynes and interference.

Tuned amplifiers for communications and electronic control often use a parallel-T network in a feedback loop. The feedback voltage is lowest and the amplifier gain is maximum at the resonant frequency. All other signals are attenuated in proportion to the feedback voltage at that frequency.

The parallel-T is the ideal frequency-selective network for miniaturization of circuits in audio oscillators, tuned amplifiers, and filters in electronic control applications such as radio control of model boats and airplanes. END

HIGH - QUALITY AUDIO

Part XII—A popular "inverter," the cross-coupled amplifier

By RICHARD H. DORF*

THE final type of phase splitter we shall discuss here is more complex than the previous ones. It is known as the *cross-coupled* circuit and was designed to overcome the one characteristic disadvantage of all the more common types.

Almost every common phase splitter is unbalanced at the high and low frequencies because of two factors: First, the inverted signal goes through two vacuum-tube amplifiers, while the uninverted signal presented to the other output-tube grid goes through only one. Thus the inverted signal is twice subjected to the effects of tube output capacitance and Miller effect, with the result that its treble output is lower than that of the uninverted signal. Second, the inverted signal goes through d.c. blocking capacitors twice, so that its low-frequency output is somewhat poorer. And of course at both ends of the spectrum the phase of the two signals is not exactly opposite because of the unequal phase-shifting effects of the unequal capacitive reactances.

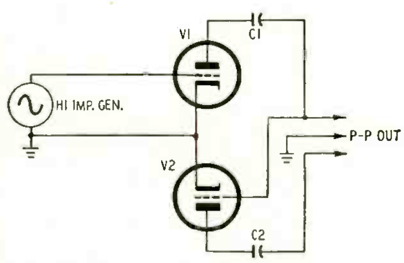


Fig. 1—Conventional phase splitter.

It is true that in a well-designed conventional circuit this characteristic unbalance can be reduced to a very low degree by a good choice of component values, and most amplifier designers do not go to the trouble and expense of using the cross-coupled circuit. However, some amplifiers do contain it, and it does maintain balance over a larger spectrum, with resulting possibility of more negative feedback and less danger of instability.

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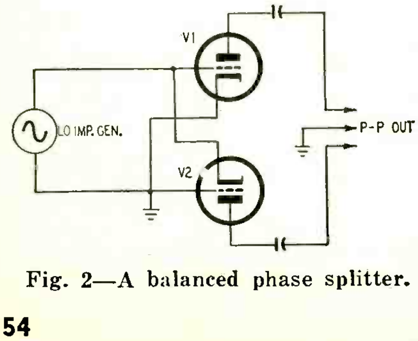


Fig. 2—A balanced phase splitter.

The cross-coupled circuit really does only one thing. It makes sure that both the inverted and uninverted signals are subjected to the same (or very nearly the same) reactive effects.

Figs. 1 and 2 make this clear. Fig. 1 is a simplified a.c. diagram of a conventional phase splitter. A generator (phonograph preamplifier, or a voltage-amplifier stage) feeds the grid of V1. The output of V1 goes through C1 to the upper output lead. So far so good. Some of the signal from the upper output lead (voltage divider not shown) is fed to the grid of V2, and the V2 output goes through C2 to the lower output lead. Notice that the upper output signal has gone through one tube and one capacitor; the lower signal has gone through two of each. Obviously, there is no balance.

The split-load inversion circuit has the same defect because, as we explained last month, the plate output is at a high impedance, allowing tube output capacitance to have its effect, while the cathode output capacitance is swamped by a low output impedance.

Fig. 2 shows the ideal balanced splitter (again as a simplified a.c. diagram). The identical signal is applied to both tubes, but in phase opposition. Each signal goes through only one tube. and if the tubes are identical the outputs must be balanced. There is, of course, one additional requirement. The lower tube V2 is operating as a grounded-grid amplifier with cathode input, so its input impedance is low. The source of signal, shown as a generator, must therefore also be of low impedance. And the low generator impedance swamps out the input capacitances which exist across the grid circuit of V1.

If we tried to replace the generator symbol of Fig. 2 with a practical source such as a preamplifier output and, without using transformers, tried to fill in the details and make Fig. 2 practical, we would have quite a problem in completing the d.c. circuits for plate current and bias. For that reason it is necessary to use two additional triodes as shown in the complete circuit of Fig. 3. (Actually two duo-triode tubes are used.)

Cross-coupled amplifier

The 6SL7-GT V3-V4 performs in the same way as V1 and V2 in Fig. 2. The 6SN7-GT V1 and V2 of Fig. 3 simply provides the low-impedance source and facilitates the d.c. connections. V1 and V2 do no phase inverting in themselves.

The sequence of events is not hard to understand. The single-ended input signal is placed between V1 grid and ground, across R1. V1 is a cathode follower and its output appears between its cathode and ground—that is, across R2 and the upper part of R3.

A cathode-follower output signal would normally be applied to the grid of the following tube. However, remembering what we said in connection with Fig. 2, the signal is fed to the cathode rather than the grid of V3.

Let us assume for a moment that R4 does not exist and that the V3 and V1 cathodes are connected together. We know that a signal fed into a tube must be effectively placed between grid and cathode (remembering that it is usually "grid-and-ground" simply because the cathode is usually grounded). But the grid of V3 is not connected to any signal point where, as far as we can see, this condition is fulfilled.

The answer to this is simple. The V1 and V2 circuits are symmetrical for

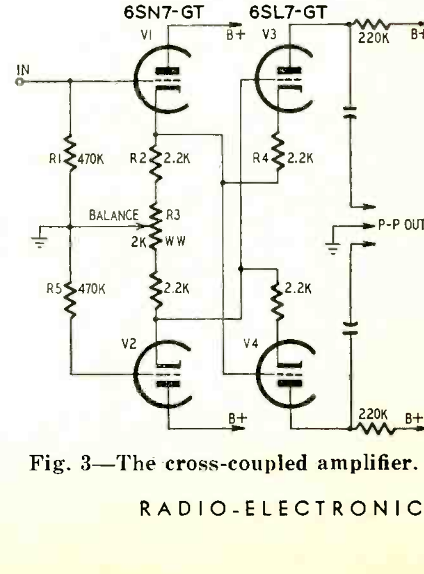


Fig. 3—The cross-coupled amplifier.

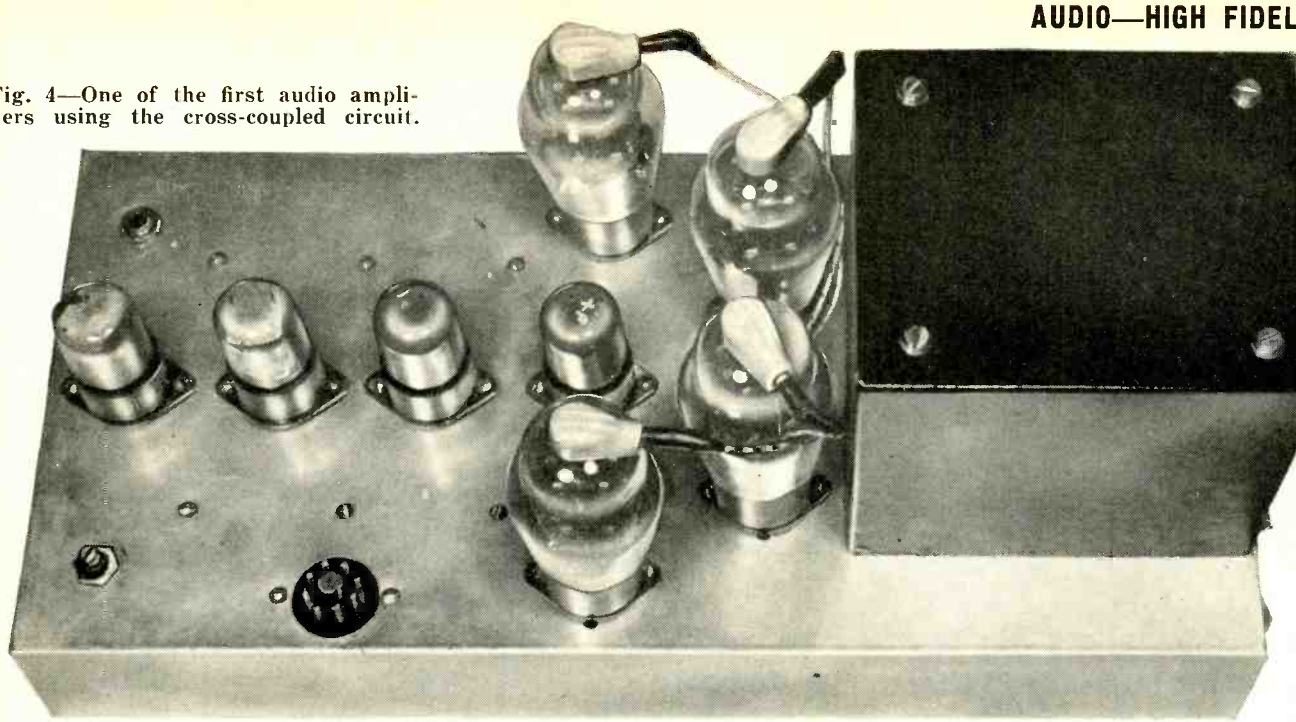


Fig. 4—One of the first audio amplifiers using the cross-coupled circuit.

d.c., and, because of the cathode resistors, both cathodes are positive with respect to ground. For a.c. the cathode of V2 corresponds to ground; so that connecting the V3 grid to that point is the same as connecting it to ground, as far as the signal is concerned. With the V3 cathode at the same potential as V1 cathode and the V3 grid at ground, the a.c. signal excites V3 and an audio signal is produced at its plate.

The d.c. potentials at the cathode and grid of V3 (with R4 shorted) are identical, so that V3 is operating with zero bias. To get the correct bias we insert R4. Current passes through R4, making the V3 cathode more positive than the V1 cathode and the V3 grid—and there is the bias. (But even though a d.c. voltage drop across R4 creates bias, there is no audio voltage drop across R4 which would reduce the transfer of signal from V1 to V3. This is simply because we apply only a potential to a tube input to excite it and the tube input draws no current).

Now let us see how V4 operates. The V4 grid is connected to the V1 cathode, while the V4 cathode is connected to the V2 cathode. This is exactly the opposite to the V3 connections. The V2 cathode serves merely as a point of equal potential and handles no signal.

It should be obvious now that the V3-V4 circuit of Fig. 3 is a practical design of Fig. 2, and obvious why *cross-coupled* is a good term to apply. The low-impedance generator required in Fig. 2 is the cathode-follower V1 of Fig. 3. V2 does no work of the kind usually expected of a tube; it simply provides a necessary d.c. level. The balance potentiometer R3 compensates for any variation in tubes or components and allows the d.c. level at the V2 cathode to be set so that it is exactly the same as that at the V1 cathode.

However, there are three very useful ways in which V2 can be put to more profitable use. Notice that the entire circuit from beginning to end is perfectly symmetrical. Obviously the input can be applied to either V1 or V2 with equivalent results except that the phase at the push-pull output will change. The circuit thus can be used as a push-pull amplifier for balanced signals. A typical use might be as a transformerless bridge to monitor a balanced broadcast or telephone line.

Two separate single-ended signals also may be applied to the two grids, in which case the circuit is a combination electronic mixer and phase splitter. For this use R1 and R5 might be made potentiometers, with the grids connected to the arms.

The third use, which is desirable wherever the circuit is used, is as a self-balancer so that no instruments need be used to set R3 properly. If a single-ended signal will change phase at the output when changed over from one grid to the other, then the same single-ended signal applied to both grids in parallel will produce cancellation and zero output—if the circuit is properly balanced. Therefore, to set the balance control, any single-ended signal is applied between ground and both grids temporarily connected together (perhaps by a push-button). Then R3 is varied until no output is heard, and balance is perfect.

The circuit as shown in Fig. 3, once the balance adjustment is set, can be unbalanced only by a difference in the output capacitances of V3 and V4. This is only a fraction of a $\mu\mu$f and unbalance is negligible up to almost 1 mc. The voltage gain of the circuit is 25, and the output can be run up to 50 volts or more (meaning input maximum of 2 volts or so) without significant distortion. Negative feedback from the output transformer can be fed to the V1 cathode. It need not be fed symmetrically to the V2 cathode as well, because a signal fed only to the V1 cathode will give balanced results for the same reason that the V1 signal itself does. The feedback could be connected to V2 instead, of course, with the same results.

Fig. 4 shows one of the first amplifiers made available to high-quality audio enthusiasts using the cross-coupled circuit. It was designed by Ulric J. Childs. The first two tubes at left are for the cross-coupled circuit. The next is a gainless feedback stage, and the fourth is a direct-coupled driver for the push-pull-parallel 807 power stage.

Power output stages

The power output stage of an amplifier might well be characterized as the most important because it is the hardest stage to design and operate correctly. The output stage, unlike those preceding it, is concerned with power, a good deal of power which must drive a loudspeaker required to push a considerable amount of air—a substance not as light as some might think. Designing a good power stage is a little like training an elephant to dance the more delicate selections from Tchaikovsky's *Swan Lake* ballet. Just as in mechanical engineering bodies are harder to move accurately and quickly when they are larger and heavier and require more pushing power, so power output stages are harder to control accurately than voltage amplifiers which merely deal with voltages and do little if any actual work.

The reasons for the difficulties and the methods used to clear them up are more intricate than in mechanical engineering and brute force is of little value. Next month we shall embark on our discussion of the power amplifier.

(TO BE CONTINUED)

servicing HIGH-FIDELITY equipment

Part VI—Using oscilloscope patterns for analyzing and locating troubles

By JOSEPH MARSHALL

THE testing routine using the IM analyzer with or without a scope as detailed in my last article, is by far the most effective when the IM is below 10 or 12%. But when the IM distortion is higher, amplitude distortion usually exceeds 3%, and in that case using an audio generator and a scope to give a phase-shift pattern is faster and yields more information. This method has been described many times, but seldom from the point of view of the service technician—that is, with the purpose of pointing out how it may be used most effectively to diagnose trouble.

The layout for this type of testing is shown in Fig. 1. The amplifier is loaded by the internal load of a wattmeter, or, if no wattmeter is available,

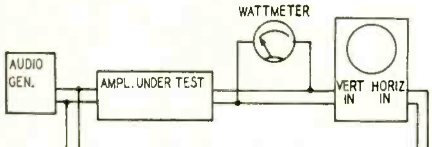


Fig. 1—Audio amplifier test setup.

by an appropriate load resistance. The wattmeter is most helpful as an indicator of the output level at which distortion begins.

The IM analyzer should be handy for making IM runs, since it is still the best measure of real high-fidelity performance. All that is necessary to make an IM run is to substitute the signal from the IM analyzer for that coming from the audio generator, and to shift amplifier output from scope to the analyzer portion of the IM meter. The shop specializing in hi-fi servicing might very well construct a junction and switch box (Fig. 2). Thus the instruments could be connected to the junction box more or less permanently. All that would be necessary to make a test would be to run three wires from the amplifier under test—a common ground, a hot input and a hot output. The double-throw switch would automatically change the setup from scope to IM analysis.

The test procedure is simple, once it has been tried a few times. We will assume your scope has a square on the ruled grid, of the type shown in various diagrams of Fig. 3. If it does not, you can ink one on or make a new one of thin plastic to slip over the present one. Such a marking is of very great assistance in interpreting the patterns and diagnosing causes of changes in it.

Phase-shift patterns

Set the audio generator for around 1,000 cycles. Adjust the generator output, the amplifier gain, the scope gain and positioning until you obtain a straight line running diagonally from corner to corner of the square, as in *a* of Fig. 3. If you do not get a straight line, but rather some sort of oval or ellipse, shift the generator frequency until you find a point at which a line is formed. It will take some experimentating to learn how the various controls are manipulated to obtain this diagonal line. It will help if you remember that increasing the vertical amplitude or gain of the scope or the volume control of the amplifier will tilt the line upward, while increasing horizontal gain will tilt it downward. Concentrate at first on obtaining a line of any length, which tilts the necessary 45°. When you have this, position it in the center of the square. Now an increase or decrease of generator output will either stretch the line or contract it so that it goes from corner to corner of the square without changing the tilt.

The straight line, running from corner to corner of the square, indicates that the voltage applied to the horizontal plates of the scope is exactly equal to that applied to the vertical plates; and that there is no (or 180°) phase shift between generator output and amplifier output. Any change in the output of the generator, the gain of the amplifier, and any shift in phase, will be indicated by a change in the pattern. Changes in output or gain will change the *size* of the pattern; changes in phase will change the form or shape and possibly the size too. What's more you can tell at a glance whether the change is due to a change in generator, amplifier, or both.

For example, let us suppose the amplifier is flat but the generator is not. If generator output increases or decreases, the pattern will enlarge or contract in *both* directions. If generator output increases, the straight line will expand beyond the square; if lowered, it will contract inside the square. If instead of a line, there is an ellipse or circle, these too will either expand beyond the square or contract within it. Ordinarily a change in generator output will not produce a change in the form of the pattern, but the inclination or angle of the line or pattern may change. These changes are detailed in *a* of Fig. 3.

If the generator output is constant, but amplifier gain varies, the pattern may shift in form because of phase shift, and will enlarge or contract in the *vertical* direction. *As long as the generator output is constant, the extremes of the pattern will continue to* *touch the sides of the square;* but, if amplifier gain varies, they will no longer touch the top and bottom. These effects are shown in *b*. You may have both a shift in size and a shift in form. If amplifier gain is constant, but there is a phase shift within it, the size of the pattern will be the same, but the line will turn into an ellipse or vice versa. On the other hand, you may have both a change in phase and a change in gain; in that case the form will change and the pattern will enlarge or contract vertically. The important thing here is to keep in mind that whatever the change in the pattern, if it continues to contact the two *sides* the change is due entirely to a shift in amplifier characteristics.

There may be a combination of effects—the generator output may change and the amplifier gain may simultaneously increase or decrease. The change in the trace will depend on the net effect and can be analyzed by examining the relation of the trace to the sides of the square. Thus if the generator output decreases but amplifier gain increases to a greater extent, the pattern will no longer touch the sides of the square, and will pass through the top and bottom; conversely, if generator gain increases, but amplifier gain falls off to a lesser extent, the pattern will pass through the sides of the square but will no longer touch top and bottom.

In other words, the pattern reflects the changes in both the generator and the amplifier under test and you can tell at a glance whether the change is due to generator or amplifier or both. There is no necessity for monitoring the output of the generator or the amplifier; the scope simultaneously monitors both of them. Drawings at *c* in Fig. 3 show effects of changes in generator output and amplifier gain.

Distortion indications

All the forms of distortion which occur in amplifiers are indicated on the phase-angle patterns. For instance, clipping due to underbiasing or overdriving will be indicated by a very sharp bend of the line toward the *outside* of the square and an extension of the line parallel to the top or bottom as the overdriving becomes more severe. If you will recall what I have already said about the behavior of this setup, you can understand this readily. Clipping means that the amplifier is saturated—its gain stops and a further input of signal produces no further increase in output. So the signal delivered to the vertical plates of the scope does not increase. On the other hand (assuming that we control gain and produce the distortion by increasing generator output) the input to the vertical plates continues to increase. So the line pattern stops growing upward, but continues to grow sideward. Because the relation between the two forces has changed, the angle of the line at its end changes, therefore the sudden bend in the line pattern.

At any rate, clipping due to either overdriving or underbias produces a very severe and sharp bend as indicated in *a* of Fig. 4. If the clipping occurs only on the positive or the negative peak, the bend will show on one end of the line only. If it occurs on both positive and negative peaks, you have a similar bend on both ends. A single bend may result from overdriving a single-ended amplifier such as a preamp; or it might be the result of overdriving one side of an unbalanced push-pull stage. Symmetrical bending occurs only in push-pull stages; if the two bends appear at about the same signal input level, the stage is well balanced; but if one bend appears long before the other, the stage is unbalanced.

If the pattern is ellipsoid or circular, the top of the trace will be squared to a straight line and a crimp will appear in the rounded portion close to one end and on the outside of the pattern. In symmetrical clipping, the effect occurs on both ends.

How do you tell whether the distortion is due to overdriving or underbiasing? Very easily. In a well-designed amplifier, such as any commercial high-fidelity amplifier, overdriving occurs only near maximum output. So watch the wattmeter as you force the bend to appear by increasing generator output. If the bend starts reasonably close to maximum rated output, it is caused by overdriving; but if it occurs considerably below maximum rated output, it is due to an underbias condition caused by some shifting of the operating characteristics of one or more stages. Be careful to take line voltage into account; when the line voltage is unusually low, the bend will appear considerably below rated output even in a perfect amplifier; while if the line voltage is much higher, it will appear around rated output in a bad amplifier. Often, excess distortion is due to nothing more serious than low line voltage.

The effect due to overbiasing or operation on the bend of a tube's curve, is indicated in *b* for the various shapes. The bend due to clipping is a very sharp one; the bend due to curvature is much more gentle, really a curve rather than a bend.

When the pattern is an ellipse or circle, curvature merely flattens the ends, whereas clipping turns them into straight lines. The crimp in the outside edge is more gentle and more kidney-shaped. When in doubt, however, you can always turn the scope to the internal sweep position, synchronize, and look at the sine wave. Clipping squares the top severely—in extreme cases makes a square wave out of the sine wave—while curvature merely spreads the peak, producing a wider bend.

The bend due to curvature may also be symmetrical or single-ended. Here too, the single-ended one can be due to

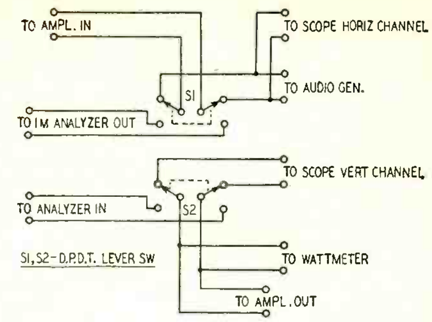


Fig. 2—A junction and switch box.

a single-ended stage or to an unbalanced push-pull stage, and the unbalance can be determined by the difference in the appearance of the two bends.

It is possible to have clipping on one end and curvature on the other end. This would appear when the operating point of a stage is very close to the middle of its operating curve. The positive peaks would be clipped when the grid turns positive; and the negative peaks would be curved when the tube gets close to cutoff. Although, theoretically, this should occur often,

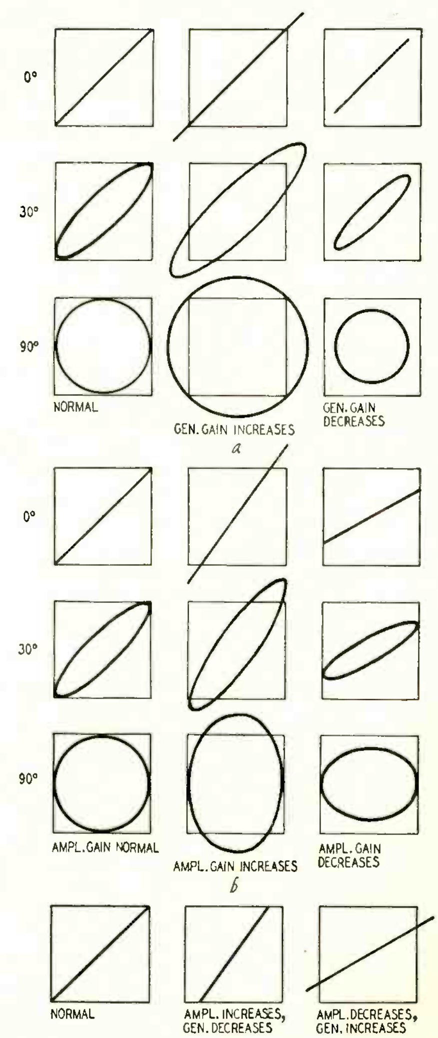


Fig. 3—Gain and phase angle patterns.

in practice it seldom does, since few operating curves are that symmetrical. This form can also occur in a not very well balanced push-pull stage, especially one with a balancing control. In this case one half can be overbiased and the other half underbiased.

In high-fidelity amplifiers in which most or all stages operate class A and not beyond AB1, clipping is likely to occur earlier than curvature. This is because in a class A stage the quiescent operating point is usually nearer the zero bias than the cutoff point. So if a curvature bend occurs before a clipping bend, an abnormal overbias condition is indicated.

In-phase distortion

The common forms of distortion are out-of-phase with the original signal; but there are some forms of distortion which are in-phase. These are indicated by a bend toward the inside of the square as shown in *c*. The shape of the bend is similar to that of curvature, but the direction is opposite; the figure will usually expand vertically a little, but this is not usually very noticeable. The single-ended type of in-phase distortion is sometimes found in amplifiers, like the Williamson, which use the split-load or cathodyne inverter. This happens if the output tube or amplifier driven by the cathode is overdriven hard enough to draw grid current. When this happens the cathode of the inverter is partially shorted. The result is that the plate-side gain increases to more than 1. This is easily spotted because shifting to the sine-wave pattern will show that the sine wave has a peak on it, instead of being flattened or squared.

Symmetrical in-phase distortion occurs normally only under class B operation and therefore is unlikely to be found in a high-fidelity amplifier. If it does show up, it indicates that the output-stage characteristics have shifted so severely as to throw the stage into or near class B operation. This could happen if the bias supply has gone haywire and has increased the bias voltage severely.

Figures in *d* indicate the changes in the pattern caused by transformer core saturation or magnetization. It will occur with almost any amplifier at half-power output or more below 40 cycles. If it happens far below maximum rated output it could be due to unbalance in the output tubes since this would cause the uncanceled d.c. in the primary to increase and thus produce earlier saturation and magnetization. The straight-line pattern is the least likely in this case because in most amplifiers there will be some phase shift below 50 cycles and the pattern will be an ellipse or circle. It is easily distinguished from all others by the extreme squaring off of two sides of the pattern. When the effect is really bad, you may get two parallel straight lines joined by curves or loops.

In *e* we have the effect of parasitics or ringing. Very aptly the pattern acquires *riders* very similar to those which are produced on an i.f. alignment curve by the marker generator.

Many of these distortions can be found in any amplifier—even one in perfect operating condition. The difference is that in a good amplifier they appear only at or beyond the useful maximum output; whereas in an ailing one they occur very much earlier. A good way to familiarize yourself with the method is to put together a training amplifier with variable resistors or potentiometers in the cathodes and plate circuits; and to observe the traces as various operating conditions are varied.

One caution: Always be careful not to overdrive the scope amplifiers. For this reason I keep the size of the initial or reference square on a scope with a 7-inch face to 2 inches on each side, and I change attenuator setting when the pattern exceeds 4 inches on a side. For smaller scopes, a smaller initial square is called for. If you're not careful about this, the curvature you'll observe may be the result of the scope amplifiers, not the amplifier under test.

Analyzing the amplifier

Now then, let us run through a step-by-step analysis of an ailing amplifier with this method:

1. Set the generator at around 1,000 cycles and establish the reference line from corner to corner of the square.

2. Make a quick sweep of the whole audio spectrum at a low input and output level. Do this with the tone controls in their flat position. Observe the behavior of the trace. In today's good hi-fi amplifiers the phase shift from 1,000 cycles downward and upward will be small—usually the pattern will not pass beyond a narrow ellipse up to 10,000 and down to 50 cycles. Beyond those points the ellipse may expand into a circle, which indicates a phase shift of 90°.

You might think that since an amplifier is said to be flat within this range, the line ought to remain straight and not open into an ellipse. However, keep in mind that the input capacitor of any amplifier is outside the feedback loop, and although one time-constant does not produce a great phase shift it does produce some. Furthermore, you can have a constant and gradual phase shift from one end of the range to the other without a significant change in gain or flatness. If the phase shift does not go beyond a circle at the two extremes, the situation is all right. But if it goes beyond a circle and approaches a straight line inclined in the other direction, which would be a phase shift of 180 degrees, there is serious danger of instability, motorboating, ringing, and a poor transient response.

3. You can check for such instability by increasing generator output at 20 cycles and 20,000 cycles. Be sure to change the attenuators on the scope. The presence of high-frequency ringing will be seen by riders on the patterns; low-frequency motorboating will produce a violent distortion of the trace. If neither of these things happen up to maximum output you can assume the amplifier is stable at all frequencies. If there is evidence of instability, make a note of it and deal with the problem later as I detailed in the previous chapter on IM analysis.

4. Determine how bad the distortion is. Return the generator to around 1,000 cycles and, remembering to change the attenuator settings, increase the generator output and amplifier gain, if necessary, until you obtain evidence of some kind of distortion. Determine by watching the wattmeter, or by interpreting the output voltage as read on a voltmeter, at what point in the dynamic range the distortion occurs. If it occurs only at or near maximum output, the amplifier is in pretty good shape; and balancing and a change of tubes ought to bring it around to good condition. But if it occurs at a lower output level, something is seriously wrong.

5. Analyze the type of distortion from the illustrations and descriptions I have given. If necessary to make sure of the type, shift the horizontal channel of the scope to internal sweep and examine the sine wave. Note whether the distortion is overdrive or curvature type, single-ended or symmetrical.

For instance, suppose you get a sharp, overdrive type bend at half-rated output. This would indicate a single-ended stage being overdriven because it is underbiased. To check, increase the generator output to see if you can produce another bend in the other end. If you do not get it up to or near maximum output, you're pretty safe in deciding it is in fact a single-ended stage that's causing trouble.

But suppose that by driving the amplifier a little harder you get another similar bend on the other end. You know now it cannot be single-ended because a single-ended stage won't clip both positive and negative peaks. So the indications are that it is an underbiased and unbalanced push-pull stage. You can judge the amount of unbalance by noting how much additional input voltage is necessary to produce the second bend.

What if driving harder produces a curvature bend on the other end? A little reflection will show you that two things could account for this: First, it could happen with a single-ended stage—the overdrive-type bend being produced when the positive peak is clipped, and the curvature-type bend being produced when the negative peak reaches the knee of the curve. You can judge how far the quiescent point is from the center of the operating curve by noting how much difference in input voltage is necessary to produce the second bend. Actually this condition is not likely to occur unless the plate voltage supplied to the single-ended stage has for some reason been seriously reduced. In a well-designed amplifier, overdrive of a single-ended stage should occur only at maximum rated output, and the curvature bend would then be unlikely to show up until way past maximum rated output. So, here you have a pointed indication of a faulty filter capacitor, bad rectifier, shorted decoupling resistor or plate load, etc.

The appearance of a trace with an overdrive bend on one end and a curvature bend in the other could occur in a push-pull stage which has a balancing potentiometer across both cathodes. A misadjustment of such a potentiometer would underbias one side, overbias the other, and produce the asymmetrical double-ended bend. A push-pull stage in which the two tubes have separate bias resistors also could produce this effect if one tube draws much more current either because the bias resistor is too low, because the tube itself is abnormal, or because the plate load has changed or has been partially shorted. Since it is almost impossible that a single amplifier would have all three types of amplified stages, a look at the circuit diagram should make it possible to put the finger on the most likely possibility.

If the output stage has a balancing potentiometer, you can check that possibility by adjusting it. If the distortion is really produced in that stage, changing the balancing adjustment will change the pattern, removing one or both bends, or transposing them. Even if the potentiometer doesn't affect the bends, you can adjust balance, which will be indicated by making the line straight again; by putting similar bends on both ends; or by a point at which the line or pattern is narrowest and least deformed. The last situation is almost conclusive proof that a single-ended stage is involved. In this case a point will be found in varying the balance control at which the pattern will open and close. The bend will remain, but as you move the potentiometer slightly on each side, the pattern will tend to open. The proper setting is at the point where the pattern is most completely closed. If you observe the wattmeter you will see that this point also produces maximum output with a given input signal, another indication of good balance.

6. Now that you have some idea of the trouble and its seriousness, and location, you can open up the amplifier and examine the stage which is the most likely offender. If your scope permits push-pull input, so much the better. If not, you will have to look first at one side and then at the other; and you'll want to do this in any case when the push-pull stage is the offending one, since the trouble usually is in one side only.

7. When you have definitely isolated the stage, you can proceed with ohmmeter and v.t.v.m. to determine the exact trouble. The scope will give you an immediate indication of improvement or worsening as you make adjustments or changes.

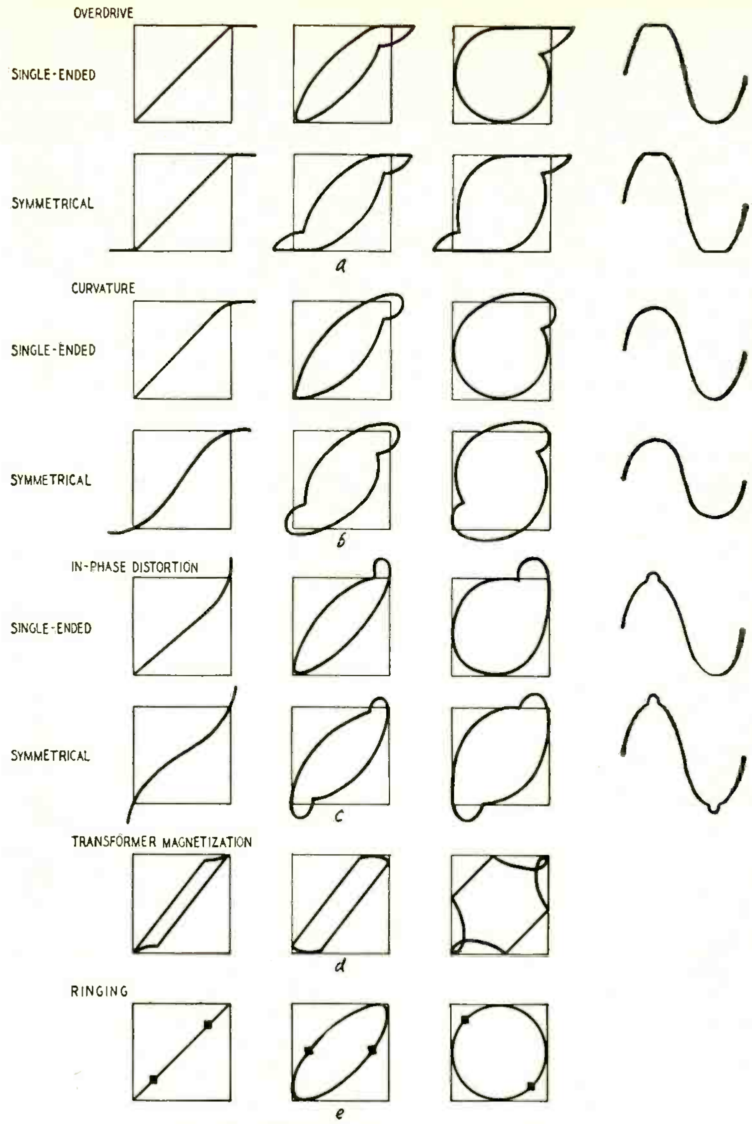


Fig. 4—Various distortion patterns.

8. Having reduced the distortion in the offending stage so that it no longer occurs or only at or beyond maximum rated output, it would be wise to take an IM reading to see if there are any other, smaller troubles. If not, balance the amplifier, with the scope trace if you like. If you do balance with the trace, take IM readings both at maximum output and a low output. Sometimes balancing at maximum output like this will unbalance the stage at lower levels. In that case, rebalance, using a voltmeter, plate to plate, for an indicator.

9. Make another frequency run at low levels; and then one at or just below maximum output. In the first instance watch to see that the response is flat and the phase shift small; in the latter, see if the distortion remains fairly constant as the frequency is varied.

10. If the amplifier has tone controls you can set them for the flattest response. Set the generator at 50-60 cycles and boost or attenuate with the bass control to produce the straightest line or narrowest oval; do the same with the treble at 10,000 cycles. Mark these positions for the benefit of the customer; or, if you like, loosen the set-screws on the knob and reset them so the pointers are at the flat position.

11. If your audio generator permits a square-wave output, it won't take over a couple of minutes to check the response to square waves at 20, 60, 1,000, 10,000, and 20,000 cycles. This will give you a good idea of the amplifier curve below and above audibility. If the waveform is fairly good at 60 and 10,000 cycles—with not over a 50% slope at 50 cycles and neither too much ringing nor too much rounding-off at 10,000 cycles, the job is flat enough for hi-fi use.

This would complete the job of testing and checking. Although it seems complicated, familiarity will bring speed with it. No other method is so rapid. A good man can test, diagnose, repair, and adjust an amplifier in less than an hour. (TO BE CONTINUED)

HIGH-FIDELITY LOUDSPEAKERS

Part IV—The enclosure, cabinet, or baffle can be a decisive factor

By H. A. HARTLEY*

EVERY loudspeaker making any pretensions to providing high-fidelity reproduction must be mounted in a way that agrees with its design. Horn-loaded speakers obviously must be loaded with a horn, but direct radiators can be mounted in various types of housings. Not all are equally good, nor can any particular design be chosen as the best mounting for any given speaker. The housing must be designed for the unit which will work in it. The only exception to this rule is the original and simplest mounting—the flat baffle—and it is now generally recognized that this is not the best design, with the sole exception of a hole in the wall. That is very nearly perfect, if the back of the wall is not obstructed.

The baffle

The effective size of any baffle is the shortest path from the edge of the cone in front of the baffle board to the edge of the cone behind the board. Under certain circumstances the speaker can be deliberately mounted off center to reduce interference patterns in the sound waves, but this is a type of experiment that can be done only by trial and error, the mathematical analysis being hopelessly involved. The larger the baffle the better the bass response. Fig. 1 gives the bass loss at various frequencies for different sizes of baffles. Intermediate sizes can be interpolated.

The baffle must be made of thick material. Wood, well braced and backed with sound-absorbent material for deadening purposes, is as convenient as anything. The thickness must be increased with increased size, for the vibration from the speaker can set the baffle in motion at its own natural frequency—it acts like the skin of a drum. The front edge of the speaker cone should be in the same plane as the front of the baffle, for even the short tunnel of the baffle opening can impair results. If the baffle is placed across the corner of a room, the sides should not touch the walls; otherwise air-column resonance will be set up in the triangular space behind the baffle. By the same token, a speaker mounted in a hole in the wall should play into another room, not into a cupboard.

The baffle need not be flat. It can be "bent"—even to the point where it becomes a box with open back. The effective size is still the shortest distance from the front to the back of the cone, and the diagram for bass cutoff given for flat baffles (Fig. 1) still applies. However, with a box baffle, complications creep in. If the speaker has no bass resonance—and very few have none—the flat baffle performance will be as shown in the diagram; if it is mounted in a box, two additional resonances will be generated. One is the resonance of the enclosed air; the other is the resonance of the box itself, which is more pronounced than with a flat baffle. The deeper the box the more pronounced is the air-column resonance.

Lining the box with absorbent material will help to deaden box resonance, but it seems to be very difficult to convince some people that this does nothing to kill the air-column resonance. This latter is resonance of the air itself, and it can be overcome only by introducing specially designed absorbent screens or by eliminating the air. Such is clearly impossible, but an equivalent effect can be got by packing the whole of the interior space with lightly compressed sound-absorbent material. A recently published book on high-fidelity reproduction states that "such . . . resonance can be eliminated simply by closing the rear opening of the box, thus completely enclosing the loudspeaker." Such a statement cannot be justified. If there is air inside the box, open or closed, it will resonate at its own natural frequency when set in motion by the movement of the speaker cone.

A unique method that I developed uses what are, in effect, acoustical filters. Fig. 2 shows a section of the

*H. A. Hartley Co., Inc.

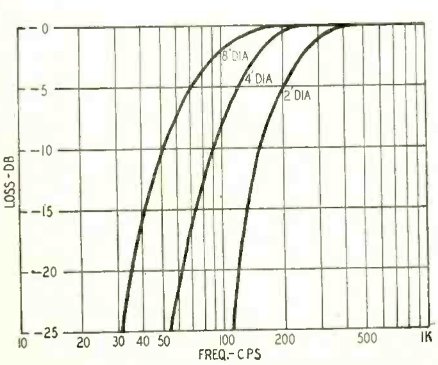


Fig. 1—Bass loss with finite baffles.

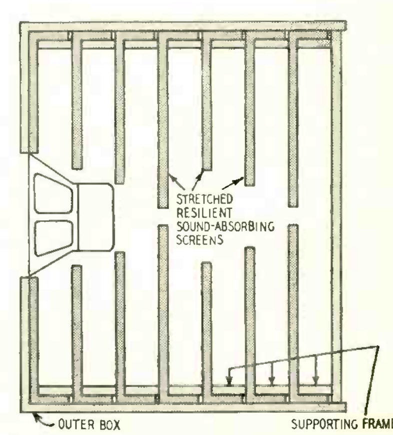
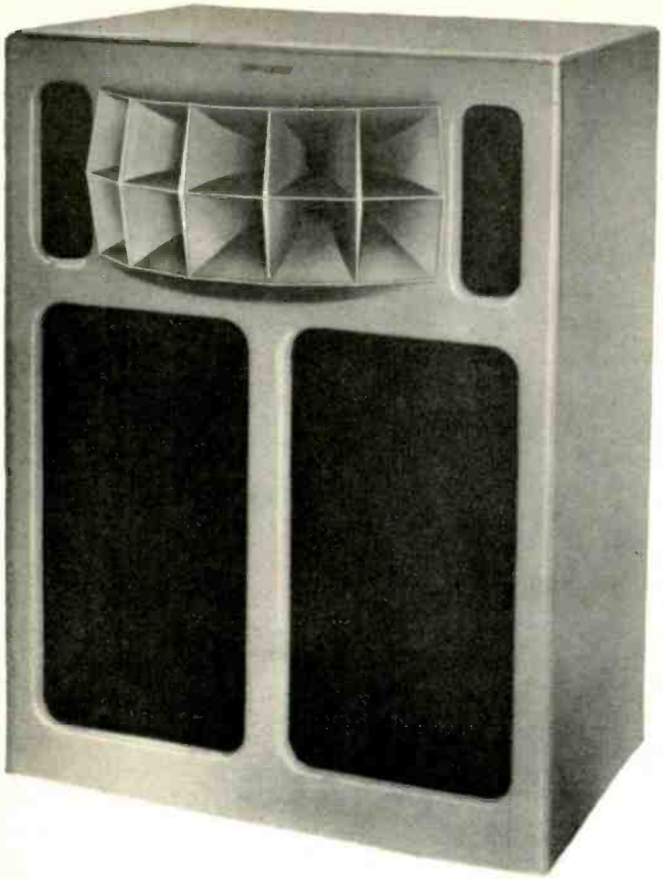
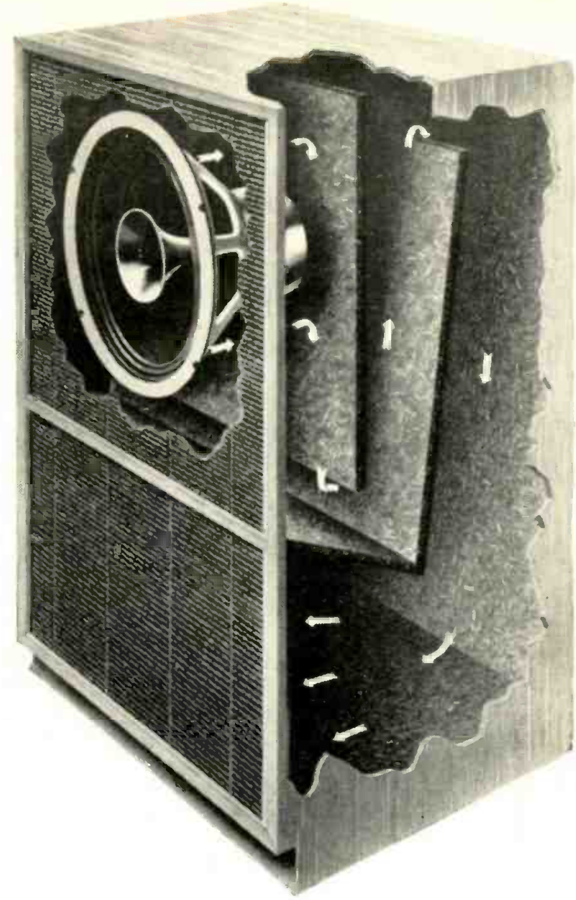


Fig. 2—The author's nonresonant box baffle makes use of acoustic filters.



Stephens enclosure with tweeter horn.



Stromberg-Carlson speaker enclosure using an acoustic labyrinth. Arrows show air path from rear of the cone.

speaker box in which there are two series of sound-absorbing screens. The screens are made up of absorbent material stretched across wooden frames, the material being carried around the frames so that it is nipped between the frames and the cabinet. This dodge not only keeps the screens in place but damps out vibration in the sides of the box. The distance between screens should be about 2 inches, and the back of the box is not closed. The scheme can be used in any square or rectangular container; the effective baffle area is about half as great again as an ordinary unfilled box, and there is neither air-column resonance nor cabinet resonance.

Electrical filters are made up of inductors, capacitors, and resistors. The components of acoustic filters are masses, springs, and friction. In this design, the air between the screens forms the masses, the stretched screens themselves are the springs, and the absorbency of the screens represents the friction. The holes in the screens, tapering in size, control the slope of the filter; Fig. 2 shows a two-stage filter. The action is somewhat as follows: The enclosed air is broken up into small sections, each of which has a rather high resonant frequency. The energy of the moving air in each section is absorbed by the screen immediately behind it. The first section gets the greatest impact from the moving air, so the first screen has a rather large hole to allow most of the moving air to escape into the second section; the smaller hole in the second screen allows the same *proportion* of air to escape into the third section, and so on, to the end of that stage in the filter. The process can be repeated several times if the cabinet is so deep as to form a real tunnel.

Absorption of the lowest frequencies can be made complete, but experience has indicated that a total volume of about 4 cubic feet is all that is necessary for a 10-inch speaker. The box should not be placed closer than 4 inches from a wall.

Completely closed boxes, so-called infinite baffles, have quite different properties. As already explained, the enclosed air will resonate at its own frequency and this produces a peak in the impedance curve of the speaker. Standing waves inside the box cannot be absorbed by soft lining, because their wavelength is much greater than the thickness of the lining. A perfectly smooth surface reflects a sound wave perfectly, a soft absorbent surface will absorb a wave up to the limit of its absorption movement. Properly designed anechoic test rooms have a lining some feet deep, usually arranged in wedges to break up the standing waves. The thin lining of a closed box can only help to deaden the box structure itself.

If the box is so dimensioned that the enclosed air resonates at some frequency which makes good a lack of response in the speaker, then the air-column resonance can be turned to good purpose; apart from this the presence of it is nothing more or less than a nuisance. In particular the air-column resonance must not coincide with the bass resonant frequency of the speaker, otherwise distortion and boom at this frequency will be very bad. The simple rule is that the box size should increase as the speaker resonance falls. Some suitable figures are given:

Speaker bass resonance in c.p.s.	80	70	60	50	40
Box size in cubic feet	1.5	2	3	5	10

Cabinets

Phase-inverter or bass-reflex housings are deservedly popular because they minimize one of the most common defects in speakers—the bass resonance due to tight suspension. On the other hand, if the selected speaker has no bass resonance, a phase-inverter cabinet will spoil its performance. This type of housing can be used as a carefully designed cabinet for a given speaker, when it is called a matched phase-inverter, or it can be used in an unmatched condition, when it is not designed to fit the speaker but is adjusted to make a pleasant noise. These applications must be considered separately.

A matched phase inverter improves the bass, decreases the bass-resonance impedance, increases power-handling capacity above the bass-resonant frequency, and reduces the movement of the cone at bass resonance. The construction must be substantial and free from resonances in the component parts of which it is made. As with a horn the ideal construction would be precast concrete, but this is inconvenient for household use. The port opening should have the same area as the speaker diaphragm, and the tunnel behind the port may be as short as the thickness of the front of the cabinet or as long as 1/12 wavelength of the bass-resonant frequency; the length of the tunnel affects the design of the cabinet. If the cabinet is too small it will behave as a completely closed box. Regardless of how it is designed it will have two defects inherent in the idea: introduction of two resonant peaks, above and below the bass-resonant frequency, and phase shift at resonant frequency.

There will be loss of treble through reflections and absorption; a single wide-range speaker used in such a cabinet therefore will not be as good as on a flat baffle. However, if the phase-inverter is used to house a bass unit, this is an advantage, and the interior may well be lined with soft material to provide a further treble loss; this will, in some small degree, help to reduce phase distortion at crossover frequency. Design of the complete housing is simple, using the following equation:

$$V = \pi r^2 \left(\frac{1.84 \times 10^8}{(2\pi f)^2} \times \frac{1}{1.7r + l} + 1 \right)$$

where V = volume in cubic inches; r = radius of cone in inches, l = length of tunnel in inches, f = vent resonant frequency (which can be taken as the speaker bass-resonant frequency). The vent area is obviously equal to πr^2.

If internal bracing is used to strengthen the cabinet, allowance must be made for the volume of this in computing the total volume, and it must be remembered that the figure for volume is the volume of enclosed air, *not* the external size of the cabinet.

The unmatched phase inverter is, as indicated, an experimental device, in which the resonances of the cabinet are used to fill out defects in the speaker response or to introduce some synthetic bass to give body to the reproduction. Some reasonable size of cabinet is selected, the tunnel is predetermined, and adjustable vents are used to get the desired effect. Once the cabinet has been built, the vent is the only way of altering the speaker characteristics.

From the outside, an acoustic labyrinth looks like a phase inverter in that there is a speaker at the top and a hole at the bottom; generally, however, the speaker will be displaced from the center and the bottom opening will be larger than a bass-reflex port. The acoustic labyrinth behaves like an organ pipe. It is of little importance how the pipe of the labyrinth is shaped, provided the form is as simple as possible. Whether the enclosure is called a labyrinth, an air column, or something else, it is virtually putting the speaker at the end of a wooden pipe of constant cross-section. For minimum distortion the construction should be as simple as possible, and as rigid as possible, and the length of the pipe should be one-quarter of the wavelength of the bass-resonant frequency of the speaker. The unique property of the acoustic labyrinth is that it lowers the bass-resonant frequency of the speaker; all other cabinets dependent on acoustic jugglery raise it to a greater or lesser extent.

Folded horn enclosures *must* be properly designed to be effective; if they are not, electroacoustic efficiency will be impaired, phase distortion will be excessive, and harmonic distortion will be generated in the throat, and the sound chamber will undo all the good that might result from good design. Constructional diagrams of the better-known folded horns have appeared many times and there is no need to repeat them here; the mathematical design is beyond the scope of the present series. For those who wish to design their own horns the following basic formulas apply:

Exponential horns. $A = A_t e^{mx}$ where A = area of cross-section (in any convenient unit of area) at any point x feet along the axis; A_t = area of throat (in the same units); e (epsilon) = 2.71828; m = flaring constant (which determines the total bulk of the folded horn).

Hyperbolic exponential horns. $A = A_t (\cosh mx + S \sinh mx)^2$ where the symbols are the same as in the previous formula and S is the shape parameter, which may be anything from zero to infinity. A usual value is between 0.5 and 0.7.

(TO BE CONTINUED)

High Fidelity for TV

GOOD sound reproduction is as important in some respects as a sharp, linear picture for real enjoyment of television, especially musical programs. Yet this is one of the weakest points in most television receiver designs. Audio circuits provide a bare minimum of performance; speakers are small and poorly placed; tone controls usually are absent. This is especially regrettable since the general quality of the sound signal received is fully worthy of a good wide-range audio system.

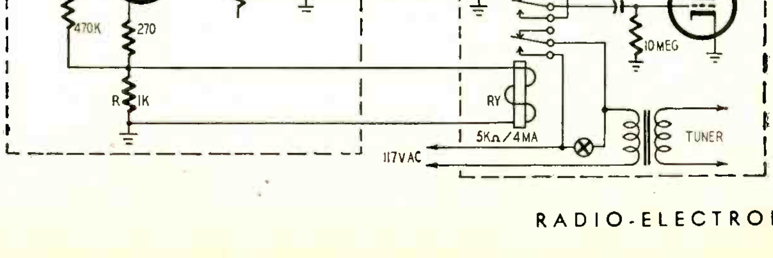
The diagram shows a way to improve this situation. The assembly uses an AM-FM tuner chassis with built-in high-fidelity audio, operated by remote control from the TV chassis. Any high-quality radio receiver (or audio amplifier) can be used as the tuner.

The controls are simple and foolproof. The tuner can be turned on with its own switch (without turning on the TV) and AM, FM, or phono can be selected with the regular tuner selector switch.

When the TV switch is turned on, the plate current of the otherwise unused TV audio output tube actuates the double-pole double-throw relay. One section of the relay turns on the 117-volt power for the tuner and the other section switches in the TV audio signal. This relay section is so placed that when the TV set is *on*, sound is obtained regardless of the setting of the tuner selector switch. The tuner tone control, between the first and second audio stages, functions for TV, FM, AM, or phono.

The value of R can be chosen to give proper operating current for whatever relay may be desired or available. Placing the relay in the cathode circuit of the output tube keeps all connecting cables between the two chassis at low potential. (Special precautions may be needed to prevent hum pickup from the a.c. lines wired to one set of contacts on the relay. We suggest using a relay with wide separation between the individual switching sections. Use shielding braid on the a.c. leads between the line switch on the tuner and the relay contacts.—Editor)

In the event that either the TV set or the tuner uses a transformerless power supply, a common ground should be avoided. The shield of the grid wire can be brought to a.c. ground potential by grounding it through a .05-μf 600-volt capacitor.—*Stanley I. Rowson*



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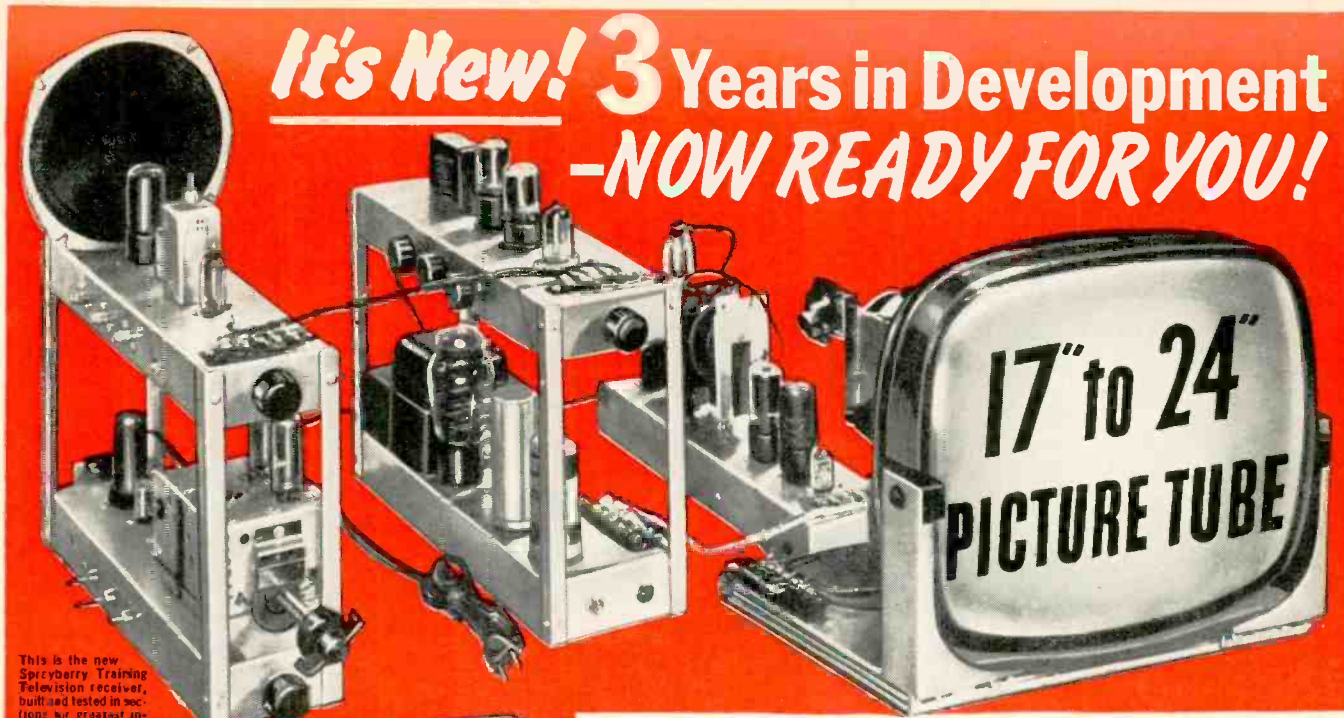

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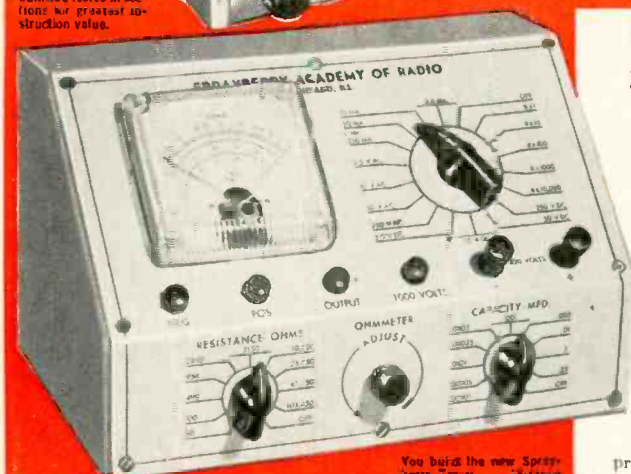

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low-noise transistor preamplifier

The new CK727 insures both quiet operation and high voltage gain

By RUFUS P. TURNER*

ALTHOUGH the junction transistor in the common-emitter circuit always has offered attractive possibilities as a high-gain, single-stage, nonmicrophonic, single-battery, voltage preamplifier, there has been some objection to its use because of the inherent high noise level of the transistor. When operated ahead of a main amplifier having high voltage gain, this noise voltage has appeared as an annoying hiss in the final output.

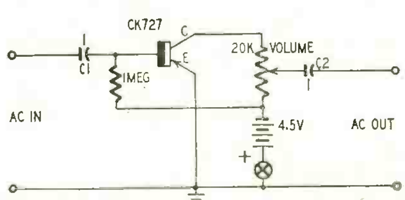


Fig. 1—Common-emitter preamplifier.

The new Raytheon CK727 p-n-p transistor has a lower noise factor (18 db maximum in the common-emitter circuit with 1.5 volts collector potential) than previous high-alpha units. In other respects, the room-temperature characteristics of this new transistor are similar to those of the CK721 in the 1.5-volt common-emitter circuit, except for a collector resistance in the CK727 of 1 megohm, base resistance of 800 ohms, and cutoff current of 5 μa.

*Author, *Transistors, Theory and Practice.*

Fig. 1 shows a common-emitter preamplifier circuit which I found optimum for my particular requirements. This resistance-capacitance-coupled arrangement is designed to operate into a high impedance, such as an a.c. vacuum-tube voltmeter or the grid circuit of an amplifier, which will allow full use of the preamplifier voltage gain.

For the transistor tested, voltage gain at 1,000 cycles is 93. The maximum 1,000-cycle input-signal voltage before rounding of the positive peaks of the output signal is 10 millivolts. Output voltage is 0.93 volt across 1 megohm connected to the amplifier output terminals. The measured input impedance at 1,000 cycles is 7,500 ohms (output impedance of the signal generator used was 600 ohms, resistive). The noise voltage, measured with a vacuum-tube a.c. millivoltmeter at the amplifier output terminals, was 3 millivolts with the input terminals short-circuited. This is 49.8 db below maximum signal-voltage output.

Fig. 2 shows the frequency response of the single-stage amplifier when worked into a 1-megohm load resistor connected to the output terminals. Response is constant from 500 to 5,000 cycles, and is 1.66 db down at 50 cycles and 3.75 db down at 50 kc. It is 1.29 db d'wn at 20 kc. This curve was plotted with a constant 10-mv input signal and with the amplifier gain control set at maximum output.

A single 4.5-volt battery powers the amplifier. Since the current drain is only 100 microamperes d.c., this can be a miniature battery, for example three 1.5-volt penlight cells connected in series. The battery switch can be operated by the volume-control potentiometer. I used small metallized-paper 1-μf coupling capacitors for C1 and C2. For compact installations, however, these components may be miniature tantalum electrolytic capacitors. If the latter are used, the positive terminal of C1 must be connected to the top a.c.-input terminal, and the positive terminal of C2 to the top a.c. output terminal.

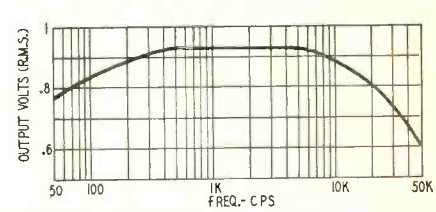
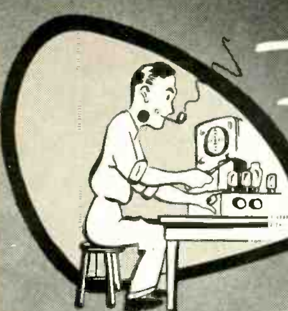


Fig. 2—Amplifier frequency response.

It is a comparatively simple matter to build this preamplifier into a test probe, microphone case, stethoscope pickup, or similar accessory requiring high voltage gain with few components, freedom from the power line, and a simple circuit. Its low power drain (around 500 microwatts d.c.) makes it economical to operate for long periods and prevents the mortal sin of forgetting to turn it off. END



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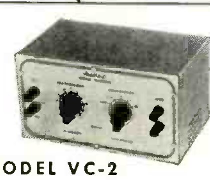
New features unheard of in a kit oscilloscope have been added to the already popular Heathkit series. All top quality components are used including a brand new RCA 5UP1 CRT. Ten other first line tubes complete the lineup. Voltage regulation provides a rock steady pattern regardless of normal line voltage variations. A built-in blanking amplifier eliminates the retrace line entirely. Other important advantages are a phasing control, Z axis input, direct connections to the deflection plates, 1 volt peak-to-peak calibration voltage and a calibrated grid screen.

Wiring is simplified by the use of the harness technique which also results in a neat professional appearance. Extremely wide vertical bandwidth allows accurate reproduction of even a 500 KC square wave. Excellent focusing characteristics are made possible by the use of the new RCA 5UP1 CRT and a spot shape control. One of the most versatile of test instruments, the Heathkit 0-9 Oscilloscope will be invaluable in the radio and TV service shop, as a work project in schools and for all types of circuit investigation work in the laboratory. Its new features make Model O-9 comparable in every way to many commercially built oscilloscopes selling for as much as $400. Don't pass up this opportunity to add a really fine instrument to your service or experimental lab.

Heathkit VOLTAGE CALIBRATOR KIT

The use of a Voltage Calibrator will greatly increase oscilloscope usefulness. Provides a convenient method of making peak to peak voltage measurements by establishing a relationship between the unknown wave shape and the Voltage Calibrator. Voltage ranges .01–100 volts peak to peak. The Voltage Calibrator features direct reading scales and a regulated power supply system.



MODEL VC-2
$11.50
Shipping Wt. 4 lbs.

Heathkit ELECTRONIC SWITCH KIT

The Heathkit Electronic Switch Kit will further extend scope usefulness by permitting simultaneous observation of two individually controlled traces. Continuously variable switching rates 10 cps to 2,000 cps in three ranges. Will also serve as a square wave generator over the range of switching frequencies.

MODEL S-2
$23.50
Shipping Wt. 11 lbs.

Heathkit VACUUM TUBE VOLTMETER KIT

The beautiful new 1953 Heathkit Model V-6 VTVM, the world's most popular kit instrument, now offers many outstanding new features in addition to retaining all of the refinements developed and proven through the production of over 70,000 VTVM kits. The Heathkit VTVM now features extended voltage ranges with 50% greater coverage on the DC range. New 1½ volt low scale provides well over 2⅓ inches of scale length per volt permitting faster measurements with greater accuracy. AC and DC ranges are 0–1.5–5–15–50–150–500–1500 volts (1,000 volts maximum on AC). Ohmmeter ranges are X1, X10, X100, X1,000, X10K, X100K X1 meg. Measures .1 ohm to 1,000 megohms. Other features are db scale, center scale zero adjust and polarity reversal switch. High 11 megohm input resistance virtually eliminates circuit loading.

The low anti-inflation price of this tremendously popular kit includes all tubes, necessary constructional material, test leads and the construction manual.

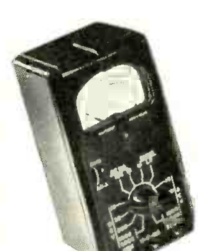
MODEL V-6
$24.50
Shipping Wt. 6 lbs.

Heathkit AC VACUUM TUBE VOLTMETER KIT

MODEL AV-2
$29.50
Shipping Wt. 5 lbs.

A new amplifier type AC VTVM that makes possible those sentitive measurements so essential in laboratory or audio work. Ten voltage ranges covering from .01 RMS full scale to 300 volts RMS full scale. Input impedance 1 megohm with frequency response 20–50,000 cycles. Ten DB ranges from —52 to +52 DB. Four diodes in meter bridge circuit for maximum linearity.

Heathkit HANDITESTER KIT



MODEL M-1
$14.50
Shipping Wt. 3 lbs.

The ever popular Handitester is now supplied with a Simpson 400 microampere meter movement. Provides AC and DC voltage ranges 0–10–30–300–1,000–5,000 volts. Ohmmeter ranges 0–3,000 and 0–300,000 ohms. DC current measurements 0–10 and 0–100 milliamperes. A completely self contained portable instrument.

HEATH COMPANY • Benton Harbor 20, Mich.

HEATHKITS for the ENGINEER

Heathkit VISUAL AURAL SIGNAL TRACER KIT

Designed especially for service applications in AM-SW-FM-TV repair work. RF and audio two channel input. More than adequate sensitivity—new noise locator circuit—calibrated wattmeter—substitution speaker—visual signal indication. Can be used with scope and VTVM, checks phono cartridges, phono mechanisms, microphones, tuners, etc. Let the Heathkit Visual Aural Signal Tracer help you.

MODEL T-3 $23.50

Shipping Wt. 10 lbs.

Heathkit RESISTANCE SUBSTITUTION BOX KIT

MODEL RS-1

Ship. Wt. 2 lbs. $5.50

Choice of 36 switch selected resistance values 15 ohms to 10 megohms. All standard RTMA 1 watt 10% resistors. Buy several for those lab and service applications.

NEW *Heathkit* 20,000 OHMS PER VOLT MULTIMETER KIT

Here is the solution to all service problems requiring a portable measuring device of high accuracy. 20,000 ohms/volt sensitivity on DC and 5000 ohms/volt on AC. Full scale voltage ranges of 1.5, 5, 50, 150, 500, 1500 and 5000. DC current ranges of 150 microamperes; 15, 150 and 500 milliamperes; and 15 amperes. Resistances are measured from .2 ohms to 20 megohms in 3 ranges and decibels from —10 to +65 db.

Model MM-1 uses standard commercially available batteries and is not affected by strong RF fields as encountered in and near transmitting equipment. 1% precision resistors on a very easily wired ring type range switch and a highly accurate Simpson 50 microampere meter fully qualifies the Heathkit Multimeter for close tolerance laboratory and service work. The meter movement is placed in a recessed position for maximum non-glare readability. The kit includes the attractive black bakelite cabinet, 2 color meter scales, test leads, batteries and all other necessary components. Overall cabinet size is 5½" wide x 4" deep x 7½" high.

MODEL MM-1

$26.50

Ship. Wt. 6 lbs.

Heathkit CONDENSER CHECKER KIT

An instrument designed solely for its particular job. Not a "sideline" or a multiple function instrument. Measures value and quality of unknown condensers and resistors. Capacity range .00001 mfd to 1,000 mfd. Resistance range 100 ohms to 5 megohms. Sensitive electron beam indicator—five polarizing test voltages—safety spring return leakage test switch. An amazingly accurate instrument at this low price.

MODEL C-3

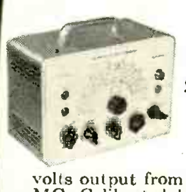
$19.50 Shipping Wt. 8 lbs.

Heathkit SIGNAL GENERATOR KIT

MODEL SG-8

$19.50

Ship. Wt. 8 lbs.



The standard service instrument for alignment work. .1 volts output from 160 KC to 110 MC. Calibrated harmonics up to 220 MC. Internal (400 CPS) and external modulation. Pre-calibrated coils for all 5 bands. Good stability and accuracy. All test leads included.

Heathkit GRID DIP METER KIT

One hand operation. 5 pre-wound coils cover 2—250 MC. Controlled sensitivity. Usable as an oscillator or an absorption wave meter. Extra low frequency coils available.

MODEL GD-1B

$19.50

Ship. Wt. 4 lbs.

Heathkit TUBE CHECKER KIT

Checks overall tube quality, filament continuity, and individual elements for shorts and opens. Features chart illumination, harness type wiring, and large 3-color meter scale.

Portable Model TC-2P at $34.50. Wt. 14 lbs. No. 91-8 Cabinet only at $7.50. Wt. 7 lbs. No. 355 TV Picture Tube Adapter at $4.50. Wt. 1 lb.

MODEL TC-2

$29.50

Shipping Wt. 12 lbs.

Heathkit LABORATORY GENERATOR KIT

MODEL LG-1

Ship. Wt. 16 lbs. $39.50

A professional laboratory instrument designed for extreme accuracy in frequency and output level. Colpitts oscillator operates in 5 ranges from 150 KC to 30 MC. Panel meter calibrated in output voltage and percent of modulation. Output in excess of .1 volts. Features complete shielding of oscillator, buffer and attenuator sections; regulated power supply and 50 ohm output cable. Comparable instruments priced many times higher than the cost of this new kit.

Heathkit LABORATORY REGULATED POWER SUPPLY KIT

A regulated variable 160-450 volt DC output power supply for the lab or service shop. Accurate voltage and current measurements with large Simpson meter. AC supply 6.3 volts at 4 amperes—standby switch eliminates warmup time. Low hum content—5 tube circuit. AC and DC output voltages isolated from panel for maximum operational flexibility.

MODEL PS-2

$33.50

Ship. Wt. 20 lbs.

Heathkit AUDIO WATTMETER KIT

Measure output power levels directly with the Heathkit Audio Wattmeter. Flat response to frequencies from 10 CPS to 250 KC. Full scale ranges of 5 MW, 50 MW, 500 MW, 5 W and 50 W. Db calibration from —10 to +48. Uses non-inductive built-in load resistors providing impedances of 4, 8, 16 and 600 ohms. Meter bridge uses 4 germanium diodes.

MODEL AW-1

Ship. Wt. 6 lbs. $29.50

HEATH COMPANY • Benton Harbor 20, Mich.

SERVICEMAN · AMATEUR · STUDENT

Heathkit
IMPEDANCE BRIDGE KIT

Modern design with built-in 1 KC generator for AC measurements. A choice of the Wheatstone, Maxwell, Hay or capacitance comparison bridges for measuring resistance, capacitance, inductance, dissipation factor and storage factor. ½% resistors and precision mica condensers provide maximum accuracy. Completely AC operated.

MODEL IB-2
$59.50
Ship. Wt. 15 lbs.

Heathkit
COMMUNICATIONS RECEIVER KIT

Full coverage from 550 KC to 35 MC on 4 bands, with good sensitivity and selectivity. Features electrical bandspread, BFO, headphone jack, slide rule dial with ham band identification, RF gain control, noise limiter and phone-standby-CW switch. Top quality, high gain components used throughout. Pre-wound coils in a shielded turret assembly and a transformer operated power supply assure trouble-free performance.

Cabinet available separately. No. 91-10. Shipping wt. 5 lbs. Price $4.50.

MODEL AR-2
$25.50
Ship. Wt. 12 lbs.
(Less Cabinet)

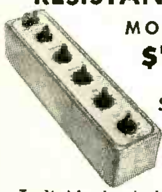
Heathkit
AUDIO OSCILLATOR KIT

MODEL AO-1
$24.50
Ship. Wt. 11 lbs.

Features sine or square wave coverage from 20–20,000 cycles in 3 ranges. Variable 10 volt output level at 600 ohms impedance. Thermistor controlled linearity—precision multiplier resistors—distortion less than .6%. An outstanding instrument value at this amazing low price.

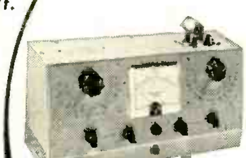
Heathkit
DECADE RESISTANCE KIT

MODEL DR-1
$19.50
Ship. Wt. 4 lbs.



Individual switch selection of twenty 1% precision resistors in 1 ohm steps from 1 to 99,999 ohms. Sturdy ceramic wafer switches featuring silver plated contacts and smooth, positive detent action.

Heathkit
Q METER KIT



A typical Heathkit invasion of the laboratory instrument field. Here is the first successful low priced Q meter ever offered in kit form. Oscillator supplies RF in the range of 150 KC to 18 mc. Reads Q directly on calibrated meter scales. Measures Q of condensers, RF resistance and distributed capacity of coils. Calibrate capacitor with range of 40 mmf to 450 mmf with vernier ±3 mmf. All measurements made at the operating frequency.

MODEL QM-1
$44.50 Ship. Wt. 14 lbs.

Heathkit AMATEUR
TRANSMITTER KIT

Power input up to 35 watts on 80, 40, 20, 15, 11 and 10 meters. Can be crystal or VFO excited. Complete with modulator input socket and VFO power output provisions. Other desirable features are good shielding, AC line filter, key click filter, standby switch and a 52 ohm coaxial output. Model AT-1 is AC operated and is suitable as an exciter for a higher powered rig. Complete with full instructions for construction and use.

MODEL AT-1
$29.50
Ship. Wt. 16 lbs.

Heathkit
TELEVISION SWEEP GENERATOR KIT

MODEL TS-3
$44.50
Ship. Wt. 18 lbs.

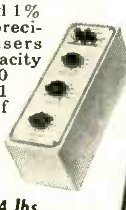
Simplify your TV alignment jobs with the new Heathkit TS-3. Full coverage on fundamentals from 4 MC to 220 MC at an output of well over 100,000 microvolts . . . Automatic blanking and wide range phasing. A triple marker system ranges from 19 MC to 180 MC using a Colpitts oscillator plus the 4.5 MC crystal controlled oscillator for check points (crystal furnished). Provisions are also made for using an external marker.

Featured is the new sweep system, using an *INCREDUCTOR controllable inductor. Sweep width is variable from 0 to 12 MC at the lower RF frequencies and increases to 0–50 MC at the highest . . . Other advantages are power supply regulation, constant RF output level, independent marker and RF output control circuits, low impedance output and properly terminated output cables. The construction manual is complete in all detail and with a reasonable amount of care, Model TS-3 will serve faithfully for many years to come.

**Trademark, C.G.S. Laboratories, Stamford, Connecticut*

Heathkit
DECADE CONDENSER KIT

Switch selected 1% silver mica precision condensers providing capacity range of 100 mmf. to 0.111 mfd. in steps of 100 mmf.



MODEL DC-1
$16.50
Shipping Wt. 4 lbs.

Heathkit
AUDIO GENERATOR KIT

A new extended range 18 cycles—1 megacycle audio instrument at a remarkably low price. Five continuously variable output ranges—600 ohm output impedance—low distortion figure, less than .4% from 100 cps through audible range.

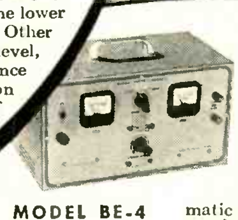
MODEL AG-8
$29.50
Ship. Wt. 11 lbs.

Heathkit
BAR GENERATOR KIT

Small, compact and easy to use, Model BG-1 supplies horizontal or vertical bars for TV linearity adjustments. Output cable clips directly to the TV receiver antenna terminals.

MODEL BG-1
Ship. Wt. 6 lbs. **$14.50**

Heathkit
BATTERY ELIMINATOR KIT



6 or 12 volt operation with current and voltage constantly monitored. Double protection with a fused transformer and automatic overload relay. Well filtered output and all heavy duty components. Designed for auto radio repair and as a storage battery charger.

MODEL BE-4
Ship. Wt. 18 lbs. **$31.50**

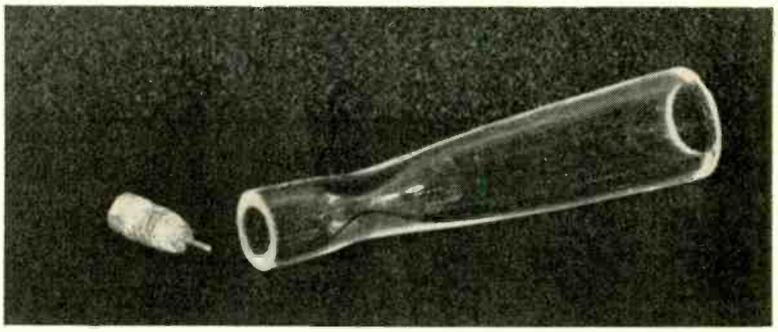
WRITE FOR *Free*
CATALOG

New 40 page 1954 Catalog lists all kits, specifications, schematics and latest price information.

HEATH COMPANY · Benton Harbor 20, Mich.

SPACE SOUND

New discovery may pave the way for the inertialess loudspeaker



The fundamental Ionophone unit, demonstrated in the U. S. recently.

A RECENT report from France states that audible sounds have been produced in the empty space between two loudspeakers, both of which were operating at an *ultrasonic* frequency. This accomplishment was reported by Siegfried Klein, inventor of the Ionophone, in a paper published in the January 1954 issue of the *Annales des Telecommunications.* This sound is produced only when the two speakers face each other an integral number of half waves apart. It is strongest in the vicinity of the nodes and loops of the standing-wave pattern between the speakers.

Musicians are familiar with beats between two sound waves of nearly the same frequency, and radiomen know that the superheterodyne receiver works because of similar beats between two r.f. waves. As in the radio circuit, the sound beats occur at a rate equal to the frequency difference between the two waves. (These beats have been noted only at very low frequencies; presumably when the beat rises far enough in frequency to be heard as a musical sound it is masked by the two louder notes that produce it.)

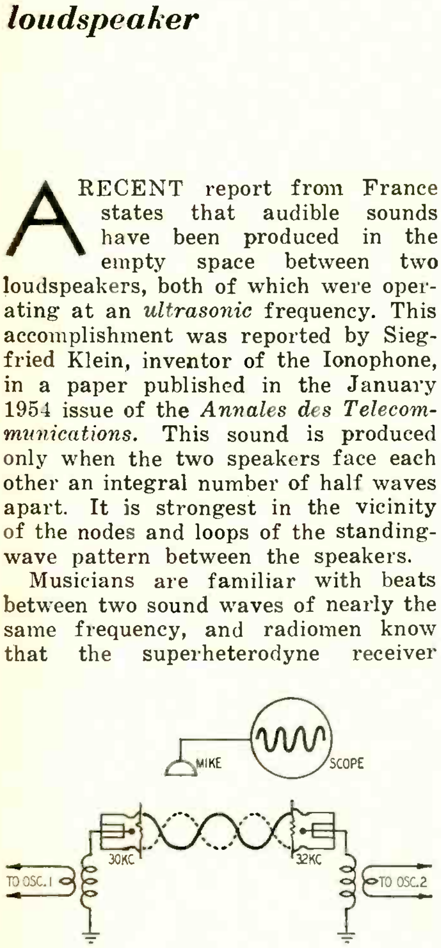


Fig. 1—Microphone and scope are used to explore area where sound is produced.

If two *ultrasonic* waves beat together at an audible rate, only the beat frequency can be audible. Two Ionophones, operating 2,000 cycles apart, were used to produce the sound-in-space effects.

The Ionophone (RADIO-ELECTRONICS, November and December, 1951) is a true molecular speaker, and works better as the frequency is increased. As illustrated in the photo, it is a small quartz glass exponential horn, approximately 2 inches long. Its larger end is butted smoothly to the small end of a larger horn, which continues the exponential curve to make the unit look like an ordinary tweeter. (This description is of a unit commercially manufactured by the British firm of Plessy as the tweeter of a woofer-tweeter combination.)

The smaller end of the Ionophone is just large enough to admit a fine platinum wire. Radio-frequency energy (at about 27 mc) applied to this wire causes it to ionize the air around it, producing a pink glow in the "throat" of the horn. When the r.f. current is modulated by speech or music, the varying ionization sets up pressures in the air as would a moving diaphragm. These variations in pressure are heard as sound.

As a generator of ultrasonics, the Ionophone approaches the ideal, though probably its results in the sound-from-space experiment might be reproduced with a magnetostriction transducer or possibly even with one of the new capacitor tweeters, which also become more efficient as they leave the audio range.

How the sound is produced

Two Ionophones are mounted 4 to 6 inches apart, pointing directly at each other. In the first experiments, one was excited at 30,000 cycles (30 kc) and the other at 32 kc. The distance between the speakers is varied slightly to bring them to an integral number of half wavelengths apart. (The adjustment is approximate, may be calculated at 30 or 32 kc or some point between them, and is best made by experiment.) At the correct point, a 2,000-cycle beat note is heard coming from the space between the two loudspeakers.

To prove that the sound is not subjective, a microphone and oscilloscope may be used, as in Fig. 1, to pick up the sound. If one of the signals is modulated, as shown in Fig. 2, the 2,000-cycle output note is modulated correspondingly.

In the experiments, reproduction fell short of perfection. One of the bugs was intrusion of the beat-note "carrier." Further work is being undertaken, in which the speaker frequencies will be above 50 kc and far enough apart in frequency that the beat note will itself be ultrasonic. Then only the modulation will be audible.

At present, work is in the purely experimental stages—much at the point the Ionophone was when first reported in late 1951. Enough has been learned, however, to foreshadow the possible development of an entirely new type of loudspeaker, without moving parts—because of the Ionophone—without cone, horn or enclosure—due to ultrasonics—and possibly with a new method of reproducing bass notes by frequency-modulating one of the waves so that the wavelength (and therefore the amplitude of the standing-wave pattern and the sound produced by that pattern) is varied accordingly. END

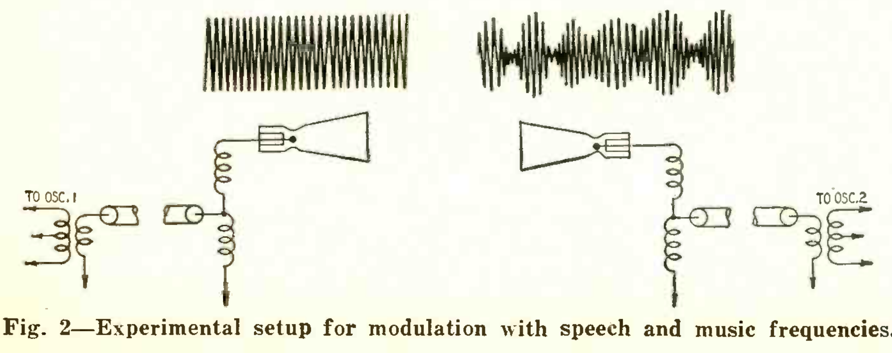


Fig. 2—Experimental setup for modulation with speech and music frequencies.

SOUND DESTROYS SOUND

A noise-reducing system which amplifies the sound and uses it to oppose and cancel the original noise

THE April, 1952, issue of RADIO-ELECTRONICS carried an article about a strange apparatus which was supposed to neutralize noise by picking it up with a microphone, amplifying it, and reproducing it at the original loudness, but 180 degrees out of phase. The original sound and that produced by the speaker would then annihilate each other. That article was not meant to be taken seriously—it was in fact our annual April Fool story. But many people *did* take it seriously, and many requests for more information were received. Apparently there is a big need for just such a noise neutralizer.

Prospective users were not the only ones interested in noise neutralization. Such minds as Dr. Harry F. Olson of RCA, possibly the country's foremost acoustical authority, were also working on it. The reason is that the standard method of absorbing sound in some porous material becomes progressively less efficient as the frequency is lowered. For example, in the well-padded interior of an airplane high-frequency noises are practically absent, and conversation sounds as it would in a sound-conditioned room. But the low-frequency roar of the engine comes through with near-maddening intensity. Looking for a way to reduce low-frequency noise, RCA scientists turned to resonators and out-of-phase sound waves for a solution.

Cancellation of out-of-phase sound waves is not a new idea. For many years high-school students have experimented with the setup of Fig. 1. The two large-mouthed bottles are so "tuned" by glass slides placed across their mouths as to resonate loudly with the tuning fork. Correct tuning and positioning of the jars then results in a great reduction of sound as the waves from the bottles cancel each other.

Why not, then, use simple resonators as sound absorbers? They do work, but they have serious disadvantages. At the low frequencies where they are needed, they would be very bulky. And they are rather sharply tuned. A battery of 20 such resonators with a total content of 40 cubic feet would be needed to cover the range from 30 to 200 cycles, according to Dr. Olson.

The electronic sound absorber can be made to act like a whole group of individual resonators, absorbing sound over a wide band in the lower frequencies. It consists of a microphone, amplifier, and speaker, arranged as in Fig. 2. The phasing of the signal is so controlled that the output of the speaker acts to reduce the sound pressure around the area of the microphone.

The equipment has to meet some rather particular specifications. The speaker, for example, is only 3 inches in diameter (to keep the enclosure size down) yet has a natural resonance of 30 cycles (to work most effectively at low frequencies). The soundproof enclosure is dictated by the fact that no sound can be permitted to come from the back of the speaker. The microphone is a special electronic type chosen for low-frequency response and phase characteristics. (RCA Radiotron 5734, described in this magazine July, 1948, page 36).

The microphone is oriented in the

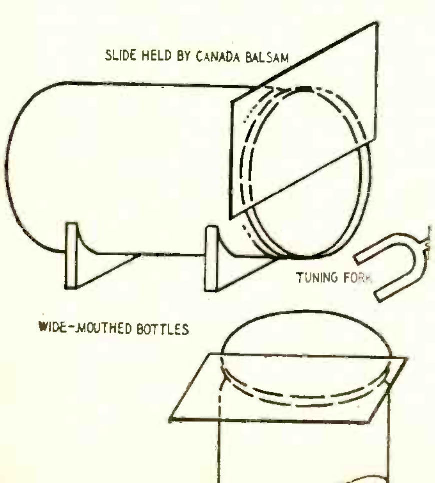
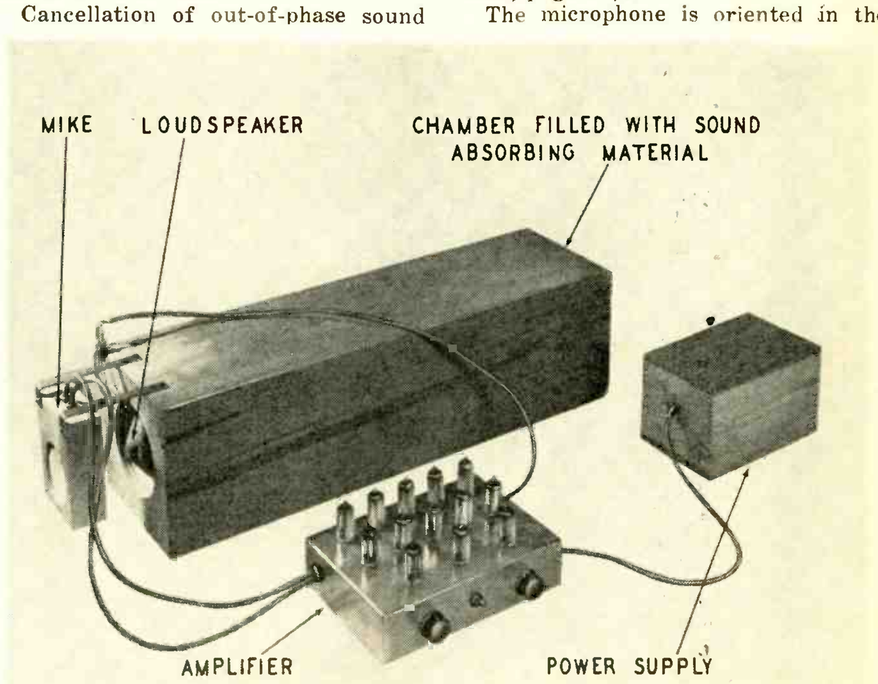


Fig. 1—Setup for sound cancellation.



The absorber includes three units: microphone, speaker-enclosure and amplifier.

direction of the sound to be suppressed, and shielded from sound from its own speaker. The complete enclosure—less than half a cubic foot in bulk—can then be used to reduce noise over a small or larger area.

For spot noise reduction, the equipment is placed in the center of the spot

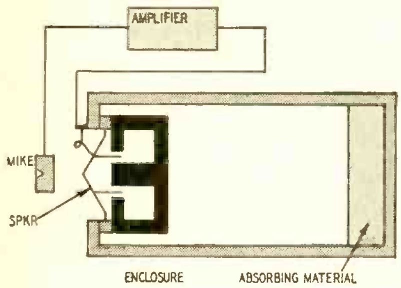


Fig. 2—The electronic sound absorber.

of desired low noise level. It is suggested, for example, that it could be placed in or on the back of an airplane seat, reducing the sound level 10 to 20 decibels. A sound absorber might also be mounted near the head of the operator of a noisy machine, putting the

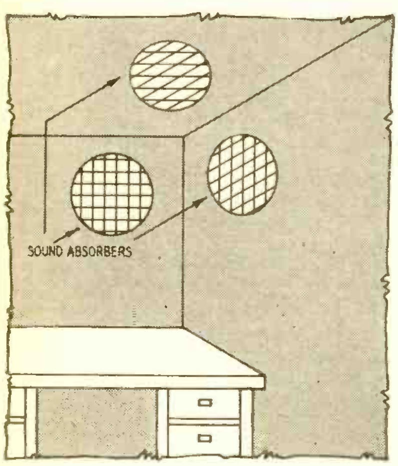


Fig. 3—Reducing sound in room corner.

operator's ears in a region of lower noise. Since many machine operations are such that the operator's head normally remains in the same small area most of the time, the noise he hears could be reduced tremendously in many cases.

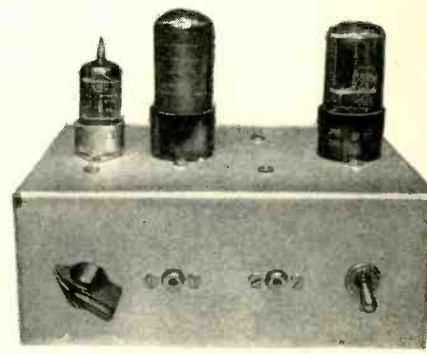
To reduce the noise level over a wider area, a bank of absorbers may be used, much in the manner of ordinary sound-absorbing material. Fig. 3 shows three mounted around the corner of a room or office.

Another application of the large-area absorber is to mount a bank of units near the point the noise is produced. Thus noise neutralizers could be used to reduce sound intensity around large internal-combustion engine exhausts, air conditioner ducts and similar sources of loud low-frequency noise. END

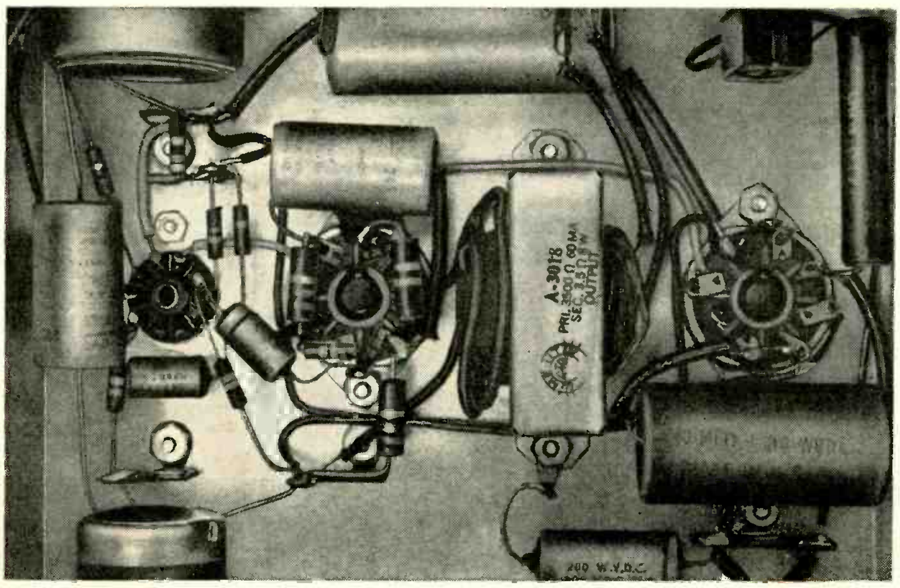
A LOW-COST AUDIO AMPLIFIER

Splendid performance despite transformerless power supply and low-priced output transformer

By G. FRANKLIN MONTGOMERY



Front view of the 3-tube amplifier.



Note the clean uncluttered under-chassis view of the compact a.c. unit.

THIS amplifier has several features that most audio enthusiasts will assume they cannot possibly put up with. The power output stage is single-ended, the output transformer is inexpensive, the power supply is transformerless, and the maximum power output is only about 2 watts. My claim for it is simply that it performs reasonably well in an average living room with a direct-radiator loudspeaker. Owners of more efficient horn-loaded speakers should be able to get along with considerably less.

It may be a waste of money and equipment in many cases to provide an amplifier capable of many watts output when there never will be need for more than a watt or so. The unit in the photographs and Fig. 1 represents the results of an effort to assemble inexpensive components in an amplifier that meets the need. The cost of all components, including tubes, chassis, and hardware, is less than twenty dollars at current net prices.

The circuit in Fig. 1 shows a 50L6-GT power amplifier driven by a 12AX7 whose two sections are connected in cascade. Voltage feedback from the 50L6 plate to the cathode circuit of its driver reduces distortion and lowers the amplifier output impedance. Feedback of this sort, as compared with feedback from the output transformer secondary, is singularly trouble-free and requires no additional compensating networks within the amplifier to avoid oscillation at extremes of the frequency range.

Plate voltage for the amplifier is supplied by a 50Y6-GT half-wave voltage-doubler. Hum produced by plate-supply ripple is balanced out by substituting the hum-balancing potentiometer R1 for the usual decoupling resistor. R1 can be adjusted so no supply ripple appears in the output. Adjust R1 and polarize the a.c. power connection for minimum hum when installing the amplifier.

In some cases, it will be found that hum is inaudible when there is no input connection to the amplifier but increases greatly when the input is connected to a tuner or phonograph amplifier. Such developed hum may be reduced by increasing the capacitance of C1.

The measured performance of the amplifier is shown in Figs. 2 and 3. All measurements were made with the amplifier working into a 4.7-ohm load. Fig. 2 is the relative power output

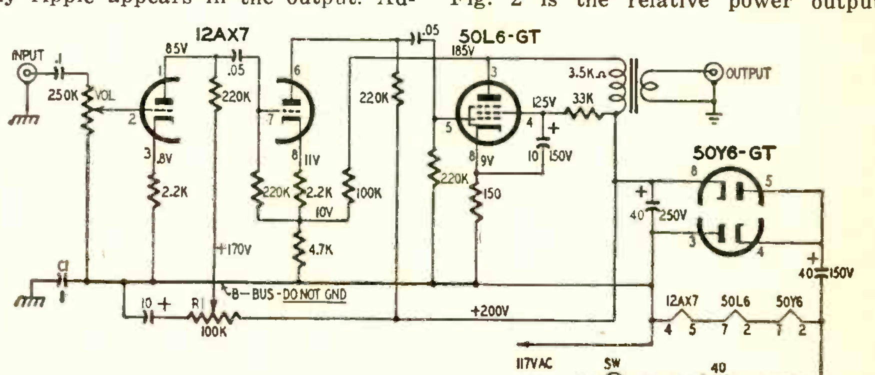


Fig. 1—The schematic. Note well that the negative B bus must be isolated from chassis by C1 as shown. Any direct connection between minus B and ground or chassis is dangerous. This would be true for any transformerless power supply.

versus frequency for a small, constant-input voltage, showing that the low-level power output is constant to within 3 db from 25 to 15,000 c.p.s. The square-

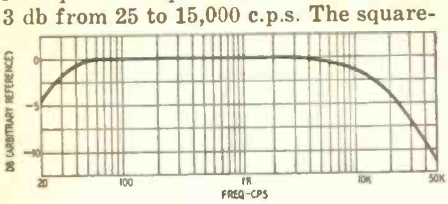


Fig. 2—Output *versus* frequency curve.

wave response of the amplifier is smooth and well-damped, displaying no ringing or overshoot. There is also no tendency toward transient oscillation when the amplifier is overdriven. Fig. 3 is the power output in decibels above 1 watt for 1% total harmonic distortion.

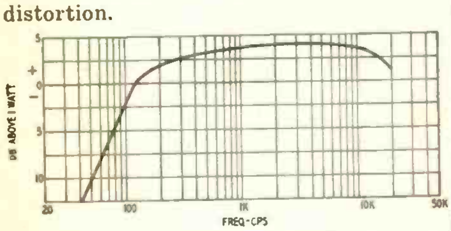


Fig. 3—Amplifier output in db above 1 watt for 1% total harmonic distortion.

Curve A in Fig. 4 shows the total harmonic distortion in percent for 1 watt power output. At this power level, the harmonic distortion is less than 2% for all audio frequencies above 70 c.p.s. Curve B is the harmonic distortion for 2 watts output. Fig. 5 is a

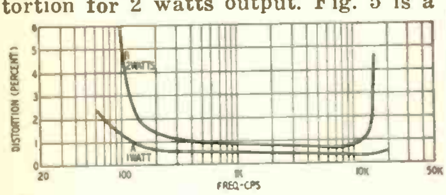


Fig. 4—Curves of total harmonic distortion for 1 and 2 watts power output.

plot of amplifier output impedance *versus* frequency. At low frequencies, where loudspeaker damping is important, the output impedance is slightly greater than 1 ohm. At 1,000

Fig. 5—Output impedance is below 2 ohms for frequencies below 7,000 cycles.

Materials for low-cost amplifier

Resistors: 1—40 ohms, 10 watts, 1—150, 1—33,000, 1—100,000 ohms, 1 watt; 2—2,200, 1—4,700, 4—220,000 ohms, ½ watt; 1—100,000, 1—250,000 ohms, potentiometer with audio taper.

Capacitors: (Paper) 1—0.1, 1—1.0 μf, 200 volts or more; 2—.05 μf, 400 volts. (Electrolytic) 2—10, 1—40 μf, 150 volts; 1—40 μf, 250 volts.

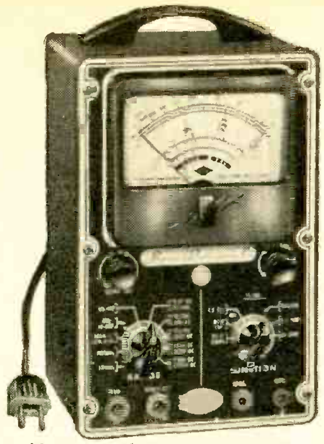
Miscellaneous: 1—Audio-output transformer, 3,500-ohm primary, 3.5-ohm secondary, 8 watts (Merit A-3018 or equivalent); 1—s.p.s.t. switch; 2—octal sockets, 1—9-pin miniature socket with shield; chassis, hookup wire, line cord, hardware.

c.p.s. and full gain, the amplifier delivers 2 watts to a 4.7-ohm load with an r.m.s. input of 120 millivolts. END

Superior's new Model 670-A

SUPER METER

A COMBINATION VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS



Measures 6¼" x 9½" x 4½"

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.

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.

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

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SUPERIOR'S NEW MODEL TV-40

C.R.T. TUBE TESTER

★ **A complete picture tube tester for little more than the price of a "make-shift" adapter!!**

The Model TV-40 is absolutely complete! Self-contained, including built-in power supply. It tests picture tubes in the only practical way to efficiently test such tubes: that is by the use of a separate instrument which is designed exclusively to test the ever increasing number of picture tubes!

EASY TO USE:

Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube base *(Ion Trap Need Not Be on Tube)*. Throw switch up for quality test . . . read direct on Good-Bad scale. Throw switch down for all leakage tests.

★ **Tests *all* magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton!!**

SPECIFICATIONS:

- Tests ALL magnetically deflected picture tubes from 7 inch to 30 inch types.
- Tests for quality by the well established emission method. All readings on "Good-Bad" scale.
- Tests for inter-element shorts and leakages up to 5 megohms.
- Test for open elements.

Model TV-40 C.R.T. Tube Tester comes absolutely complete—nothing else to buy. Housed in round cornered, molded bakelite case. Only..........

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71% MORE SCALE AREA!!

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Features

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THE MODEL 770-A COMES COMPLETE WITH SELF-CONTAINED BATTERIES, TEST LEADS AND ALL OPERATING INSTRUCTIONS.

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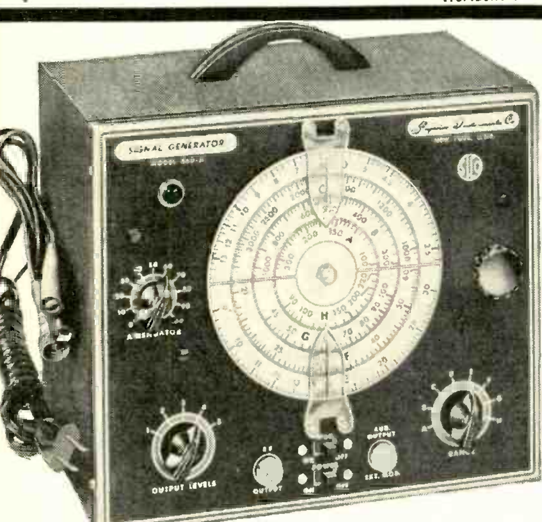

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COVER FEATURE

Solar Battery Powers Transmitter

By D. M. CHAPIN* and D. E. THOMAS

This sun-powered battery and a tiny FM unit make a complete pocket-size self-powered radiophone

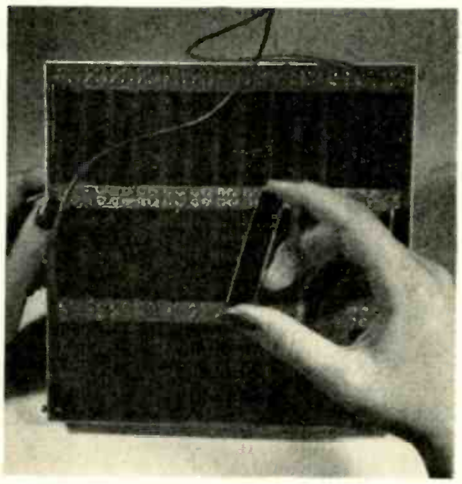


Fig. 1—A 39-cell solar battery.

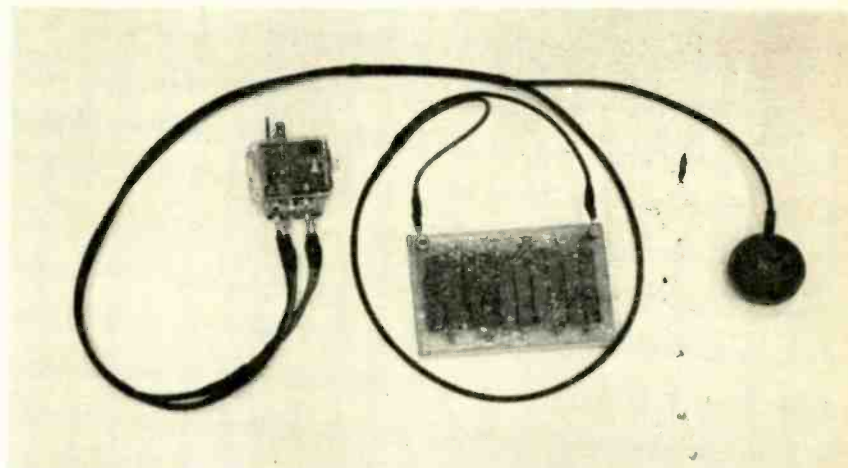


Fig. 3—A mobile station—the solar battery microphone and FM transmitter.

THE Bell solar battery and the FM transistor transmitter shown on the front cover together constitute a solar powered radio transmitting station which uses the sun's energy to transmit speech or music. The solar battery, recently invented at Bell Telephone Laboratories, converts the sun's radiation directly into usable amounts of electrical power; no other power source is needed by the transmitter. This article will explain how this is done.

Everyone knows that the sun delivers large amounts of energy as heat. It is not so generally recognized that all this heat comes as radiation. Even that part which we can't see and are accustomed to calling heat rays differs from the light or visible portion only in "color" or wavelength. To obtain electrical power by first converting this radiation into heat, as in a sun-powered thermocouple or steam engine, is very inefficient, especially in low power units. The solar battery uses radiation directly without conversion to heat.

*Co-inventor, with G. L. Pearson and C. S. Fuller, of the Bell solar battery.

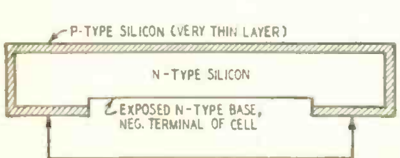


Fig. 2—Cross-section of silicon cell.

Before looking further into the actual operation of a solar battery, perhaps we should first consider the nature of the battery itself. One form is shown in the photograph, Fig. 1. It is made up of strips of silicon approximately 1/25 inch thick, ½ inch wide, and about 2 inches long. Each strip is a photovoltaic cell. The whole top surface is sensitive to visible light and infra-red radiation. Mounted together to present a large surface to the sun, they convert useful amounts of radiation to electrical power.

As might be expected, the size and shape of a solar cell are determined largely by the properties of silicon and the manner of use. When the action of light on silicon is understood, the main features of construction become understandable.

Two types of silicon are used. When very small quantities of certain impurities are added to pure silicon, the product is called "n," or "negative" type. Certain other impurities produce "p," or "positive" type. When the two types appear side by side in the same piece of silicon, the dividing face is called a p-n junction or barrier and special properties exist here. For our purpose, the important property is the response to light. Light striking the silicon near this barrier liberates positive and negative carriers which cause the p-type region to charge up positive and the n-type region to charge up negative.

This remarkable property of light and a p-n junction means that current can be drawn from such a cell just as from any voltaic cell. It is required only that we direct enough light to the barrier to be useful and then make good contacts to the p and n regions to obtain the generated current for our use.

The first problem is to get useful amounts of light to the barrier. As might be suspected, light penetrates silicon only a very short distance. It is necessary to spread out the p-n junction over a wide area and have it practically on the surface where the light can get to it. The diffusion process does this. Diffusion at high temperature is used to introduce an impurity of the proper type into a piece of silicon previously prepared with an impurity of a different type. The new impurity resides in a layer only about one ten-thousandth of an inch thick and covering the entire strip to produce a large sensitive surface capable of receiving the sun's radiation and converting it directly into electrical power. Adequate connections must then be made to get out the available current.

The cell's construction

The diagrammatic illustration of a solar cell in Fig. 2 shows how this is done. Contacts are made to the diffused surface layer at the edges of the back or under surface. This leaves the top surface free and unobstructed to catch radiation. The current flows to the edges through the surface layer which has high resistance owing to its thinness. To keep this resistance down to a tolerable level, the strips are made only about half an inch wide. As also shown in the diagram, the surface layer is removed down the middle of the back face to expose the base material. A lead to this base material completes the cell. For the cells shown in the photographs, the outside leads are plus and the center lead is negative.

A silicon cell in full sunlight will produce about half a volt on open circuit. Into a load adjusted to take maximum power, the voltage is about one-third volt for a wide range of light intensity. The amount of current available depends on the light intensity and the active area per cell. On short-circuit and in full sunlight, a cell will deliver about one-eighth ampere for each square inch of active surface, or about one-tenth ampere at one-third volt. Groups of cells can be connected in series or parallel depending on whether more voltage or more current is needed. For the FM radio transmitter described here, ten cells were connected in series. Twelve cells would appear to be better except that this transmitter draws so little current that each cell is able to operate at more than the one-third volt indicated for maximum power.

Several mounting techniques have been used. An array of cells held in a metal shell with a transparent cover is shown in Fig. 1. In this case the cells are connected with pressure contacts on the back side. The battery shown on the front cover was cast in solid plastic. This gives a very rugged mounting favored for its durability and apparent resistance to weathering and vibration. In a portable outdoor piece of equipment like a solar transmitter, these are important considerations.

It is not necessary to have full sunlight to get usable amounts of power. Considerable radiation comes from the sky even when the sun is hidden from view—as many a sunburned bather will testify. On open circuit or into a high-impedance load, a good voltage appears with much less than full light intensity. For this reason and because the radio transmitter is a high-impedance load, the solar battery and transmitter combination has operated satisfactorily on quite cloudy days.

The transmitter

A closer-up photograph of the solar-powered FM transmitter on the cover appears—in its portable form—in Fig. 3, at the head of this article. This transmitter takes advantage of the small amount of power required by the transistor, also a Bell Laboratories invention. The transmitter uses a single M1832 point-contact transistor which functions simultaneously as a 106-megacycle r.f. oscillator and frequency modulator, plus an A1858 junction transistor as an audio amplifier. The complete transmitter circuit is packaged in a plastic container about two-thirds the size of a package of cigarettes.

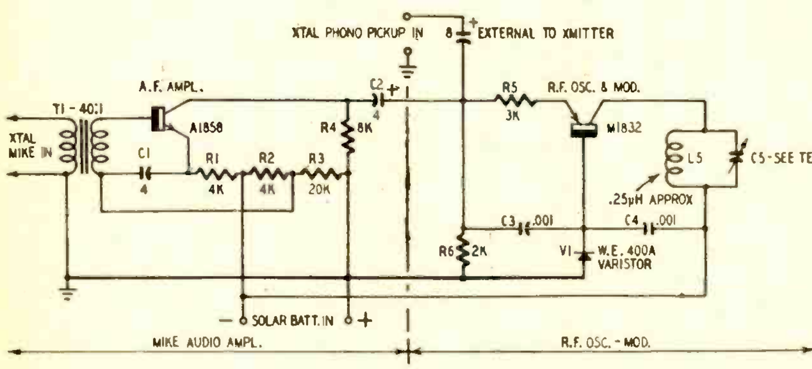


Fig. 4—Schematic of the transistor-operated FM radiophone transmitter.

A schematic diagram of the transmitter is shown in Fig. 4. The audio amplifier is needed only when the transmitter is used with the crystal microphone. A crystal phonograph pickup with a suitable step-down transformer will modulate the transistor oscillator directly. The audio amplifier uses an A1858 junction transistor in a grounded-emitter circuit to take advantage of the high audio current gain available with this type connection. The d.c. operating point of the junction transistor is stabilized by R1 in the emitter circuit and the fixed potentiometer made up by resistances R2 and R3 across the solar battery terminals. This potentiometer is adjusted so that the IR drop across R2 is equal to the product of the emitter resistance R1 and the approximate collector current desired—in this case 250 microamperes. C1 is an audio bypass capacitor. A high ratio step-down transformer T1 is used to match the high-impedance crystal microphone to the low-impedance transistor input. The output of the audio amplifier is resistance-capacitance coupled to the input of the oscillator modulator by the resistances R4 and R6 and the capacitance C2.

How it oscillates

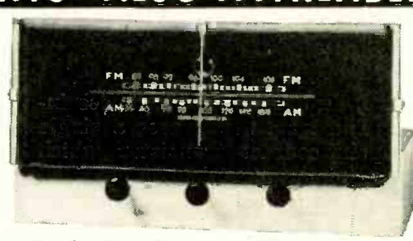
Examination of the oscillator modulator circuit shows no apparent source of the coupling required to produce and maintain oscillations and no visible means of producing frequency modulation. The coupling required for oscillation is provided by the parasitic emitter-to-collector capacitance of the transistor, its socket, and external connections. Since in-phase coupling is required to produce CW oscillations, it would appear that coupling through a capacitor with its approximately 90-degree phase shift would not be satisfactory.

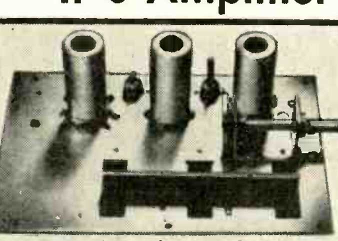
The reason the phase of the coupling is correct and also the means by which frequency modulation is obtained is understood when the behavior of the current gain of the transistor is examined as a function of frequency. The magnitude of the current gain of a transistor is not constant with frequency. It begins to decrease as frequency is increased toward and beyond a certain critical point called the cutoff frequency. Accompanying this decrease in current gain, there is a corresponding phase shift in the current gain of the transistor. The transistor oscillates at a frequency well above its critical cutoff frequency where this phase shift is the right order of magnitude to compensate for the phase shift in the emitter-to-collector coupling capacitance. Although the value of the emitter-to-collector capacitance is not critical it is possible to make it too large for oscillation in the v.h.f. region. It is therefore important to keep the oscillator circuit assembly and wiring compact and not increase this capacitance by long emitter and collector leads.

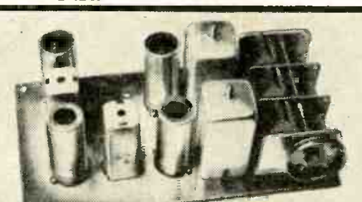
The tank coil L5 is not critical. A half-dozen turns of No. 22 copper wire wound on a ⅜-inch diameter mandrel at about 10 turns to the inch is satisfactory. This coil is then tuned to the desired oscillating frequency with tank capacitor C5. The parasitic capacitances of the transistor also contribute to the tank circuit capacitance. In addition the oscillator oscillates slightly off the exact tank circuit resonant frequency. The tank circuit frequency is therefore adjusted only approximately in the initial assembly and is tuned to the proper frequency when the circuit is actually oscillating. An adjustable trimming capacitor is included as part of C5 to obtain a total range of frequency oscillation of about 10 megacycles.

The FM system

Frequency modulation is obtained because the cutoff frequency of the transistor is not constant with operating point but shifts when the operating point of the transistor is changed.







ELECTRONICS

The phase shift of the transistor current gain also changes as a result of this shift in cutoff frequency. This change in phase shift requires the frequency of the oscillator to change to keep the oscillator coupling in proper phase at the oscillation frequency. When an audio signal is fed into the emitter of the transistor oscillator, the operating currents of the transistor are changed in accordance with the instantaneous magnitude of the audio signal. This changes the cutoff frequency of the transistor which in turn changes the frequency of oscillation of the oscillator in accordance with the change in instantaneous magnitude of the audio signal as explained above. This is frequency modulation by means of transistor current gain frequency-cutoff shift.

The function of R5 in the emitter circuit of the oscillator is not immediately apparent. It is used to prevent relaxation oscillations which may occur in v.h.f. point-contact transistors. These potential relaxation oscillations are due to emitter-to-ground capacitance combined with positive feedback through the internal base resistance of the transistor. The resistance R5 is placed directly on the transistor emitter terminal to isolate all other connections to the emitter and limit the emitter-to-ground capacitance to that due to the parasitic capacitance of the transistor and its socket. By holding down the total emitter-to-ground capacitance, the potential relaxation oscillations are avoided.

The diode V1 in the base of the oscillator provides emitter bias without recourse to a second potential source. R6 provides a d.c. emitter current path for the oscillator transistor which is of sufficiently high resistance to avoid shunting the audio input.

C3 and C4 are radio frequency bypass capacitors to return the v.h.f. frequencies in the emitter and collector directly to the base without passing through the biasing circuits.

The voltage and current required to operate the solar transmitter are only 4 volts and 3 milliamperes respectively. This represents a total power requirement of only 12 milliwatts. A 10-cell Bell solar battery of the type illustrated on the front cover has a normal open-circuit voltage of 5 and a total power output of about 250 milliwatts. That is why the transistor transmitter can be operated from such a battery even when the weather is cloudy.

No antenna is shown coupled to the oscillator tank circuit. This is deliberate, to limit the range of transmission to the few hundred feet required for experimental and demonstration purposes. With a suitable antenna and under ideal conditions this range could probably be extended to a distance of several miles. A standard commercial FM receiver is now being used to receive the signals transmitted by the solar-powered transmitter. END

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Special circuits prevent FM oscillator drift and alignment loss

By ROBERT GRODINSKY*

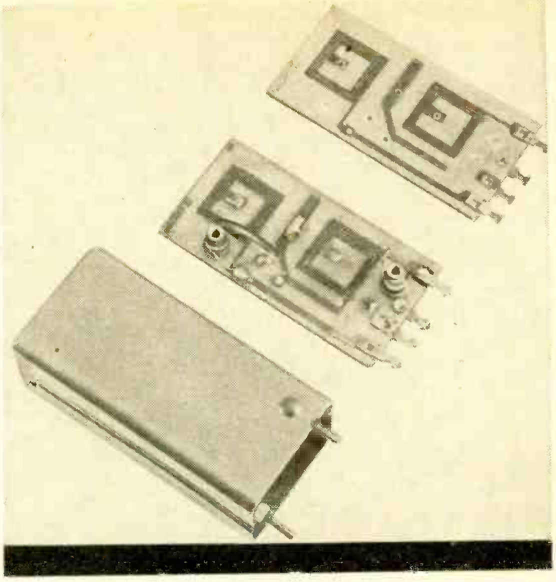

Fig. 1—Printed i.f. transformers

LACK of stability in the 100 mc band used by FM has always been a problem to the set designer. The first commercial FM sets suffered from oscillator drift which made necessary a warmup period and constant retuning. The use of automatic frequency control circuits and temperature-compensating components eliminated this type of drift in most commercial sets by 1948.

A second type of instability, and one more difficult to correct, is loss of alignment in the r.f. and i.f. circuits over a long period of time. I.f. circuit stability depends upon thermal effects, capacitive changes due to tubes, and the mechanical stability of the i.f. transformer design. A printed type i.f. circuit eliminates the thermal and mechanical factors, and if the design values are properly chosen, capacitive changes due to tubes can be greatly minimized.

In designing i.f. circuits for FM reception, bandwidth must be considered in a way not recognized several years ago. The relationship between phase modulation and frequency modulation is well known, but the fact that the phase shift produced in a tuned circuit creates distortion in an FM system was recognized only a few years ago.[1] Since the phase angle varies along the slopes of a tuned circuit, this is equivalent to frequency modulation which was not contained in the original signal. Extraneous modulation of this type is distortion. For example, in an i.f. system whose 6-db bandwidth is 200 kc, the intermodulation distortion is generally at a minimum of 0.5%. In an i.f. system of 125 kc bandwidth, the distortion is 1.5%. The ideal bandpass for minimum distortion is one in which there is little or no phase shift over the full working range, which in commercial broadcasting means a bandwidth of 150 kc without phase shift. Since phase shift and amplitude variation go hand in hand, this requires a flat-topped bandpass characteristic.

Flat-topped i.f. transformers have been designed for many years. However, to obtain an accurately controlled coupling factor in the transformer is difficult with standard wire-wound slug-tuned type of construction. The difficulty in manufacturing is due to the coupling factor or "QK" of the coils, a function of inductive and capacitive coupling. In a standard slug-tuned type of coil the physical relationship of the slugs to each other influences, to a large measure, the K or coupling factor. Tuning the circuits by adjusting the slugs changes the coupling, thus the same transformer may produce undercoupling in one set and overcoupling in another although properly tuned in each case. Capacitive tuning would help correct this, but the spacing of the primary and secondary coils must be very closely controlled during manufacture. The printed type i.f. circuit offers a definite advantage here since the coil spacing can be controlled in production to very close tolerances.

Printed circuit

The i.f. circuit which evolves from these considerations is seen in Fig. 1. Fig. 2 is a picture of the Craftsmen C900 tuner in which these printed i.f. transformers are used. The coil itself is of two-sided construction, that is, coil elements are photo-etched on both sides of the base material. This type of coil is more expensive to make than one etched on only one side, but it is necessary to obtain the Q's needed for this design. Silver mica tuning capacitors are wired directly to the board as are the ceramic trimmers. The base material is glass melamine, chosen for its extremely low moisture absorption and small coefficient of thermal expansion. The thickness of the base material is held to close tolerances since this controls the mutual inductance between opposite sides of the board. The operating center frequency is 20.6 mc. The bandpass of a single i.f. transformer is shown in Fig. 3. The markers pictured are 20.6 mc, plus and minus 150 kc. In manufacturing, each i.f. transformer is individually adjusted for this flat-top characteristic. As can be seen, the flat portion of the nose easily extends plus or minus 75 kc.

The tuning capacitor used is 50 μμf. Though this results in a lower impedance, and therefore a lower gain per i.f. stage, the input or output capacitance of the i.f. tubes used in this circuit then represent only 8% of the total capacitance. This means that normal tube variations in capacitance represent only 0.5% of the total. Since most commercial i.f. amplifier designs today use capacitors of about 25 μμf, the stability in terms of tube replaceability is improved by more than 2 to 1.

The i.f. of 20.6 mc was chosen to minimize interference. When an i.f. of 10.7 mc is used, the most common interfering image is the one where two stations, spaced approximately 10.7 mc apart, heterodyne in the mixer circuit and interfere with one another. Since the FM band is only 20 mc wide, using a 20.6-mc i.f. eliminates this possibility. It also allows the operation of several sets simultaneously from one antenna since in no case can one set's oscillator be picked up by another set.

Standard printed circuit etching techniques are used in the manufacture of these i.f. transformers except that the degree of control must be greater than that used for less critical circuits,

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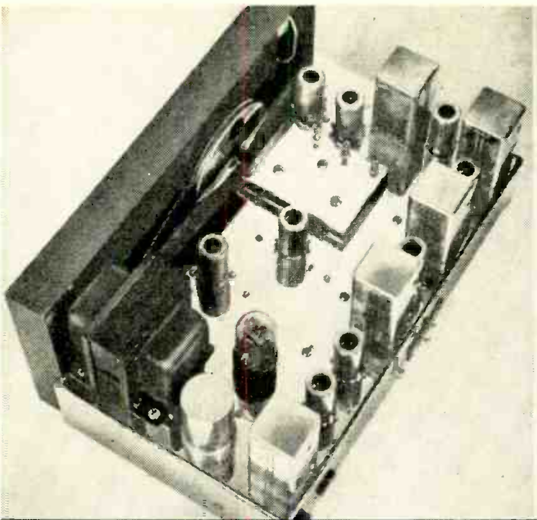
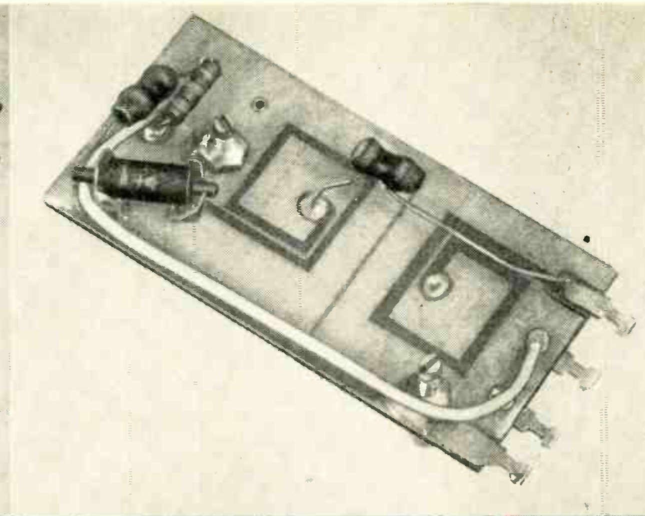
[1]J. J. Hupert, "A method of evaluation of the quasi-stationary distortion of FM signals in tuned interstages," Proc. National Electronics Conference (Chicago); 1952.





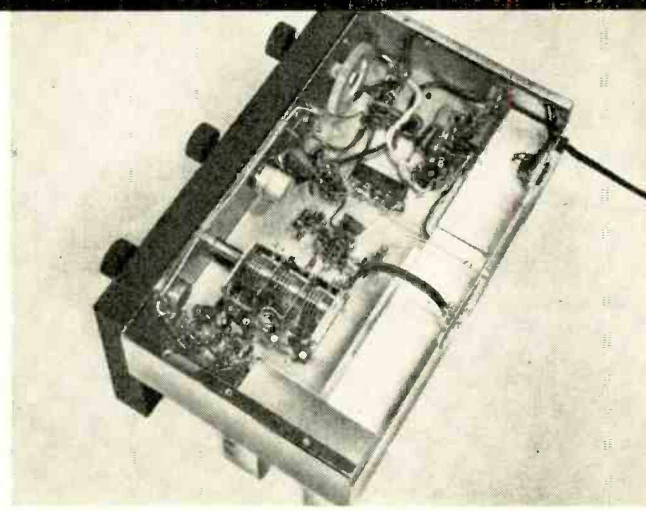


Fig. 2—Top, the Craftsman C900 tuner.
Fig. 4—Top right, discriminator circuit.
Fig. 5—Right, Plates shield i.f. strip.

such as etched wiring. The fact that both sides of the base material have to be in register also complicates their manufacture. After etching, the coils are separated and punched. Hand assembly is used for the capacitors and trimmers, after which the coils are baked for 20 hours to eliminate moisture, and then wax-dipped. Each coil is checked in a test jig which simulates the circuit in which it is to be used. The coils are prealigned by a sweep generator and marker signals. By checking each coil for bandwidth and coupling, final alignment of the i.f. strip in the set is greatly simplified.

The discriminator transformer is also a two-sided type of printed coil. The construction is similar to that of the i.f. transformer except that the unit also contains load resistors and

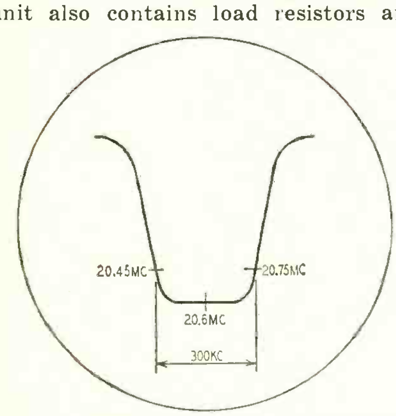


Fig. 3—Bandpass of single i.f. transformer. Center frequency is 20.6 mc.

the detector diodes. (See Fig. 4.) Using such a completely shielded, self-contained type of discriminator-detector minimizes the possibility of the high-level i.f. voltages coupling back into an earlier stage and causing regeneration. The peak-to-peak bandwidth of the discriminator is extremely wide —425 kc—to assure almost perfect linearity over an FM channel. In production, each discriminator is aligned for minimum intermodulation distortion. Because of the low phase shift in the i.f. stages and the excellent discriminator linearity, over-all distortion can be held to 0.1% or less for a deviation of plus or minus 75-kc. This magnitude of distortion is far better than the best broadcasting equipment used today. Thus, this tuner becomes one of the strongest links in the chain of FM reception.

Even though the bandpass characteristic of each individual i.f. strip is properly adjusted, the over-all i.f. characteristic will not be perfect unless regeneration in the i.f. strip is made extremely small. Any regeneration present will produce phase shift and distort the bandpass characteristic. Therefore, the bypassing and physical layout of the i.f. strip is a very important part of securing low-distortion FM reception. Neutralization of each i.f. stage is one technique used to minimize regeneration. One of the most common and worst forms of regeneration is due to the high-level energy of the limiter and discriminator circuits coupling or "blowing back" into earlier stages. In the C900 this effect was minimized by building a completely enclosed i.f. strip. Fig. 5 is the bottom view of an assembled chassis. The plates are used to enclose the discriminator, limiters and i.f. strip completely. This shielding along with the corner of the chassis provides a waveguide whose cutoff frequency is about 380 mc. As in all waveguides, the transmission below cutoff frequencies is very small, thus the blow-back form of regeneration is greatly reduced. In addition to this, a 20.6-mc filter is inserted in the audio output of the discriminator so that no intermediate frequency is fed back through the receivers' audio amplifier.

To complement these excellent low-distortion characteristics of the i.f. strip and discriminator, high sensitivity and amplified a.f.c. were built into the front end. The C900 contains a cascode r.f. stage. This type of dual-triode input results in the lowest possible input-circuit noise and therefore the highest sensitivity of any circuit in use today. Over-all sensitivity of the C900 is 2 microvolts for 30 db of quieting. To insure correct tuning, an a.f.c. circuit which includes a d.c. amplifier is used. The effective correction factor of this circuit is 30 db. This means an initial tuning error of 75 kc, for example, will be reduced to 2.5 kc. Convention a.f.c. used in most sets today provides a maximum of 14 to 15 db of correction which, under the same circumstances, would reduce a 75-kc tuning error to 13 kc.

(The 30 db figure referred to is the voltage ratio of the d.c. voltages out of the discriminator with and without a.f.c., with the system deliberately off tune. Since the discriminator represents a linear transfer function between frequency and d.c. voltage over its operating range, the ratio of d.c. voltages corresponds to the frequency ratio. I illustrate this by indicating that an initial tuning error of 75 kc with no a.f.c. would be reduced to 2.5 kc when the a.f.c. is full on. This was based on approximating the 30 db as a 30 to 1 voltage ratio. It seems an obvious analogy to use db's of a.f.c. correction in the same sense that one uses db's in negative feedback.)

The amount of correction can be controlled from the front panel. This is preferable to an a.f.c. off-on switch in that it allows any desired degree of a.f.c. to be used when receiving strong or weak channels instead of disabling the a.f.c. completely. In spite of the degree of a.f.c. correction, the pull-in, pull-out range has been held down by designing the a.f.c. amplifier for sharp-cutoff characteristics.

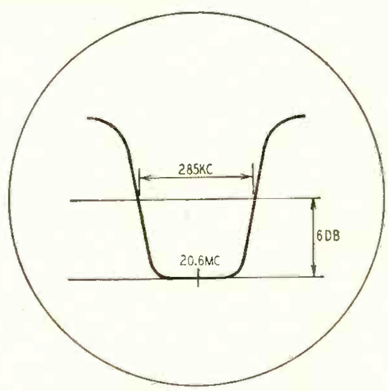
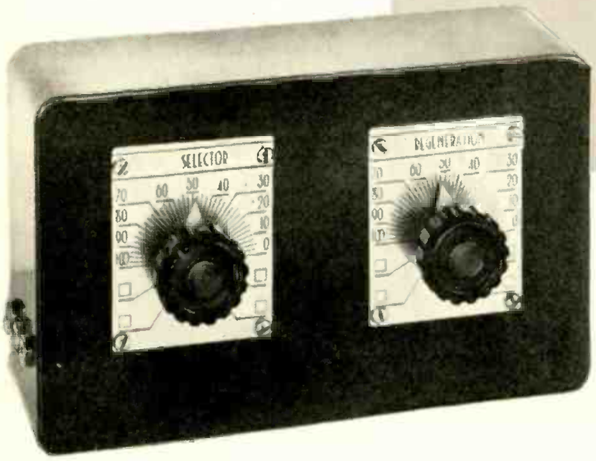


Fig. 6—The over-all i.f. bandwidth.

Automatic volume control is included in this design to maintain the i.f. bandpass characteristics during large signal inputs. Without a.v.c. the first three i.f. circuits would detune due to Miller effect if allowed to draw grid current. This would degrade the flat-top i.f. bandpass curve (Fig. 6). The a.v.c. voltage is generated in a grid-limiting R-C network in the grid circuit of the third i.f. amplifier. The negative a.v.c. voltage thus generated is filtered and applied to the input grid of the cascode r.f. amplifier. Since approximately 70 microvolts of input signal is needed to generate a.v.c. voltage, the full gain of the receiver is available to assure adequate early quieting.

The combining of all these features results in an FM tuner which possesses high stability and sensitivity and near perfection of distortion reduction; a tuner which poses a challenge to the broadcast industry to reduce FM transmitter distortion to approximately the same degree. END

REGENERATIVE TRANSISTOR RECEIVER



This sensitive and selective unit contains regenerative detector and audio amplifier

By DR. WILLIAM H. GRACE, JR.

THIS compact regenerative receiver has given more than ample earphone volume on broadcast stations located several hundred miles away. When used with a 60-foot outside antenna, stations well beyond 1,000 miles have been repeatedly heard right through the numerous superpowered N. Y. C. locals. This indicates its sensitivity and selectivity. The receiver makes a reliable receptor for emergency use during power failure should a sudden air attack occur. Though built for use with earphones, many of the local broadcasting stations can be received at moderate room volume on a 10-inch PM speaker with a suitable matching transformer.

Construction

A black bakelite meter case was used for the cabinet, the outside dimensions being 3.75 x 6.25 x 2 inches. The set is built within the cabinet rather than on a separate panel. This construction simplifies the assembly and permits mounting the smaller components on a little shelf directly above the trimmer capacitor. This small variable capacitor is the regeneration control and provides the necessary capacitance feedback for oscillation. The shelf is suspended by small-sized L-brackets, very easily attached by hex nuts to the projecting machine screws that hold the dial plates in position on the front of the panel. This idea works nicely and eliminates the drilling of extra holes in the cabinet.

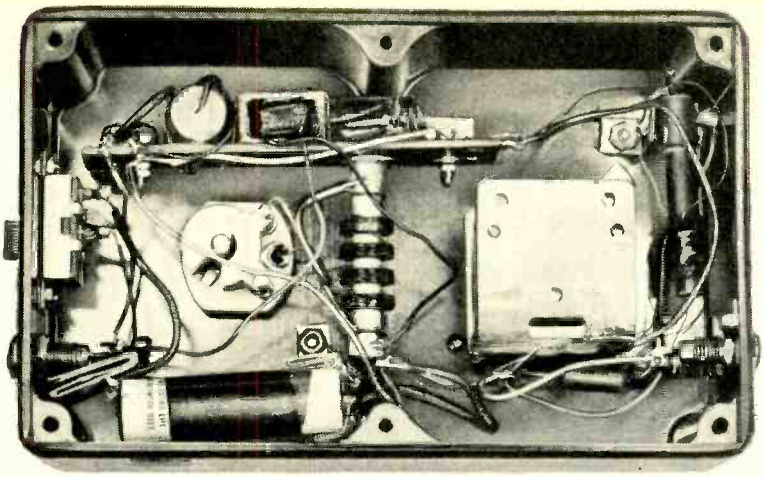
The circuit is a standard grounded-emitter type with the first transistor acting as a regenerative detector and the second as a transformer-coupled audio amplifier (Fig. 1). Both transistors are Raytheon junction type CK 722, that operate satisfactorily on only 4.5 volts. Other types of transistors would likely work as well or better; the CK722's were chosen because of their availability and lower cost. These crystal triodes are durable and have a long life if reasonable precautions are taken to prevent burnouts. The negative side of the battery must be connected to the collectors as indicated in the diagram. Transistors—and the manufacturer's specifications — often vary widely; newer models may run more consistent in this respect. I found it advisable to hook the circuit up breadboard style to test the transistors in operation before assembly in the cabinet, as the transistors are soldered directly in the circuit (no sockets being used).

The antenna requirements of any practical emergency receiver must be flexible. Thus, two separate antenna connections have been provided. On the left side of the cabinet are 3 phone-tip jacks. The two nearest the rear are for antenna connections, the third is for ground. In series with J1 and the main tuning capacitor (C3), is C1, one of the antenna coupling capacitors. The J1 connection is used only with a short, 20- or 25-foot antenna, plus a ground connection. It is often possible to obtain good results with J1 connected to the shell of a floor lamp or table lamp, the shell of a telephone box, or to one side of an a.c. outlet. No ground connection is made if any of the above antenna substitutes are used. This precaution is necessary because of the possibility of a short in C1. There will be only a very slight loss in volume by so doing. Capacitor C2 is in series with J2; this connection is used when a longer outside antenna (60 to 100 feet) is available. Two 3-foot lengths of flexible wire, phone tips at one end and alligator clips at the other, furnish the actual connection from set to antenna and ground. Of course, the greatest volume and best dx will be obtained with an efficient outside antenna as high above ground as possible.

Inductor L1 is a standard Ferri Loopstick coil; and L2 is approximately 5 turns of No. 30 enamel wire, wound directly over the cardboard covering of the Ferri coil. The constructor should experiment with a greater or lesser number of turns on L2. In general, a few turns more than 5 will give greater volume and less selectivity, while fewer turns result in slightly lessened volume but increased selectivity. Incidentally, if oscillation is not obtained, reverse the leads to L2; this is the same as reversing the leads to the tickler coil in a regenerative tube receiver. The coil is mounted in the upper right-hand corner of the cabinet, rear view. The projecting dial plate screw again becomes useful.

The choke prevents r.f. from entering the audio circuit. Smooth regeneration will not take place if this choke is omitted. I found it convenient to mount the choke on the under side of the shelf just to the right of the trimmer capacitor.

The audio transformer is connected *backward*, that is, the high impedance winding is in the collector circuit. This is done to satisfy the impedance requirements of the transistors which can be considered to be opposite to tube triodes in respect to input and output impedances. The colored wire leads shown in the diagram are for the UTC type SSO-2 subsubouncer transformer. In conventional circuits using trans-



Internal view. The transistors are near the ends of the mounting strip.

former coupling with transistors, a base resistor is indicated from the base to the minus side of the battery. But with the particular CK722 used in this case no advantage seemed to be gained. The builder should experiment with this connection. The exact value of this resistor can best be found by test; any value between 220,000 ohms and 2 megohms may prove suitable.

Both transistors, C5 and C6, and the audio transformer were mounted directly on the shelf. Capacitor C6 could well be of greater value, but the value suggested does work satisfactorily. If better base response is desired, shunt this capacitor with one of equal value. The objection to using a larger value, say 5 μf is that the actual physical size of such a capacitor prevents getting it into the cabinet.

The battery switch and the phone output jacks are mounted at the right side of the cabinet, front view. Any type of battery switch may be used; a sliding type was chosen because it happened to be at hand. It is a good precaution to mount the switch so that the ON position is as obvious as possible. In this way there will be less chance of forgetting to turn off the set.

The battery requirements of this receiver are easily met by 3 penlite cells. The cells are taped together edgewise, connected in series to furnish 4.5 volts. The minus lead from the battery goes to one switch terminal, the positive lead to ground. The cells are soldered, as far as their leads are concerned, directly into the circuit since they will seldom need replacement because of the very low current drain of the two transistors. The total drain for both transistors is about 1 ma, hence the cells should last almost their normal shelf life with average use. A convenient way to anchor the cells is with two more L brackets fastened again to the two projecting machine screws from the dial plates. Small pieces of folded cardboard wedge the three cells to prevent them from slipping sideways.

Capacitor C3 is a miniature 365-μμf tuning capacitor. A standard broadcast capacitor could be used, but I found the smaller one easier to mount.

Operation

With only two controls the operation of the receiver is simplicity itself. The left-hand knob controls the frequency; the right-hand knob controls the volume, by varying the degree of feedback. It is comparable to the operation of any other regenerative-type of tuner. No other volume control was used in the circuit. If still greater volume is required it would be an easy matter to add a second stage of audio amplification. In this case a separate volume control would be necessary, and space on the front of the cabinet has been provided for this control just between the two dial plates.

Regeneration

Failure to obtain regeneration may be due, in the majority of instances, to incorrect coil connections. Fig. 2 shows the exact method of connecting L1 and L2. If there is any doubt as to which is the *start* of the winding on the Ferri Loopstick and which is the *ending*, the following may prove helpful. Using a sharp knife, remove the cardboard covering protecting the coil winding. The starting and ending lead will now be visible. Care must be taken in doing this, or the coil winding will be damaged.

Another common cause of failure to obtain regeneration is due to the actual variation in the transistors themselves. Some CK722's are good oscillators and good rectifiers, others are not as efficient as detectors, and still others do not seem to oscillate or regenerate at all. Fortunately, a large percentage of those tested perform very well. We should realize that these transistors were not designed for regenerative purposes. CK722 transistors were built as low-power audio amplifiers and are for low-frequency purposes. However, they will work very nicely over most of the broadcast band as r.f. rectifiers. When a particularly good one is found it acts as a very sensitive detector just at the point of oscillation. In fact, when operated under the conditions described the sensitivity is remarkable and regeneration is fairly stable.

About the only other common or likely cause for lack of regeneration is a gross error in the circuit hookup. Worn-out dry cells will also produce poor results.

This receiver is very simple to construct, using the minimum number of parts and but two transistors. It will prove an interesting introduction to the transistor field for anybody interested in these modern devices. The performance of this little rig proved ample reward for the few hours needed for its assembly. END

Parts for regenerative receiver

1—14 μμf, 1—.001 μf, mica or ceramic capacitors; 2—1 μf, miniature, paper capacitors; 1—50 μμf, trimmer capacitor with 1/4-inch shaft; 1—365 μμf, miniature, tuning capacitor; 1—transformer, primary impedance 10,000 ohms, secondary impedance 90,000 ohms, (UTC SSO-2 subsubouncer); 1—Ferri-Loopstick, bracket mounting type; 1—coil, 5 to 7 turns of No. 30 enameled wire; 1—r.f. choke, 2.5 mh; 2—Raytheon CK722 transistors; 1—case, 3.75 x 6.25 x 2 inches (Waldon utility case, model BC-138; panel, BB-137); 5—phone-tip jacks; 3—penlite cells; 1—s.p.s.t. switch; 6—small L brackets; 2—phone tips; 2—alligator clips.

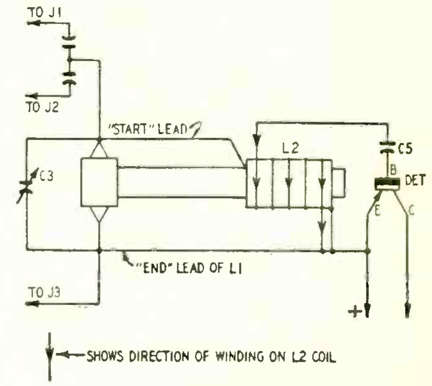


Fig. 2—Diagram of L1-L2 connection.

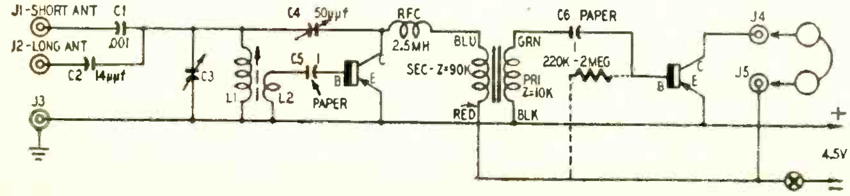


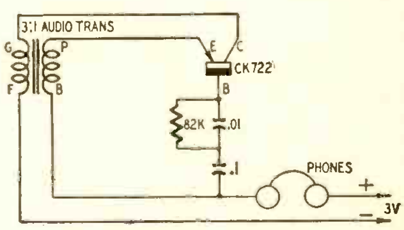
Fig. 1—Schematic of the 2-transistor radio. Circuit is grounded-emitter.

RADIO

TRANSISTOR DOT MAKER

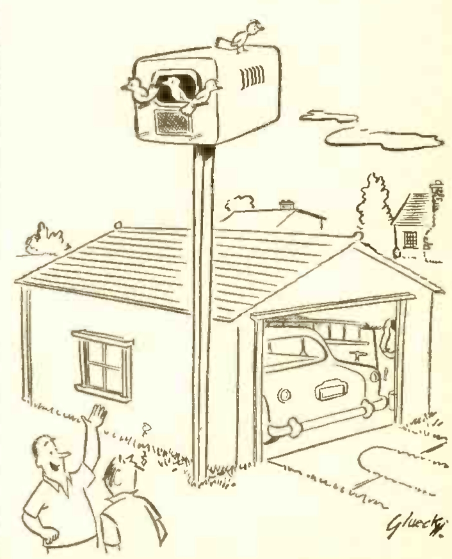
A series of dots gets more attention and is less tiring than a continuous tone. It can be used to modulate a signal generator or as a standby signal while adjusting a phone transmitter, wireless phono attachment, or intercom. A dot generator can also be used as a signal source for remotely controlling a model plane or for speed key practice without a Vibroplex or other automatic key. One of the simplest possible dot generators can be made with a junction type transistor and an audio transformer. (See diagram).

The transformer is connected in a conventional feedback circuit. If it has



a third winding (as in a transceiver transformer) the added coil may be used as the output winding. The transistor base is isolated by a capacitor. Thus the oscillations build up, are blocked, and so on. With values shown, the dot rate is 2 a second. The power supply may be a 3-volt battery.

When the voltage is increased, the sound level increases, and the dots become more crisp. They become shorter with respect to the spaces between them. The rapidity of dots increases when a high resistance shunts the collector and base. For example, an 8.2-megohm resistor doubles the dot rate.



"It's an old seven inch set—"

JUNCTION TRANSISTORS for high-frequency oscillators

Using the junction transistor as an i.f. and r.f. oscillator

By I. QUEEN
EDITORIAL ASSOCIATE

JUNCTION TYPE transistors are made and sold as low-frequency, low-power units. Catalog specs usually call for a certain minimum gain at 1 kc or perhaps 5 kc. No high-frequency specifications are given, but it is known that frequency response begins to droop early. Therefore it may surprise many readers to find that the junction transistor is efficient as an i.f. and r.f. *oscillator*. I have carried on many experiments with the CK722. Of several tried, all oscillated easily in the i.f. range near 400 and 500 kc. For most transistors tried, less than 1 volt was sufficient power supply. About half could oscillate above 1 mc! These active units required about 3 volts at this high frequency.

Transistors cannot be made as uniform as vacuum tubes. All transistors are efficient at audio frequencies, but even there it is usual to choose a bias resistor for the particular unit in the circuit. At intermediate and radio frequencies the nonuniformity is even more important. Substituting one transistor for another may call for retuning, changing the applied voltage, or even redesigning the circuit. Often, the circuit must be designed around the transistor.

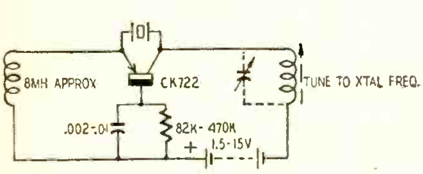


Fig. 1—Crystal oscillator circuit.

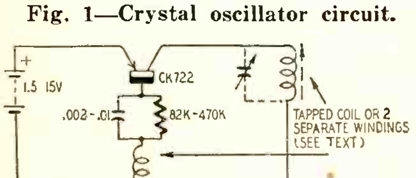


Fig. 2—A self-controlled oscillator.

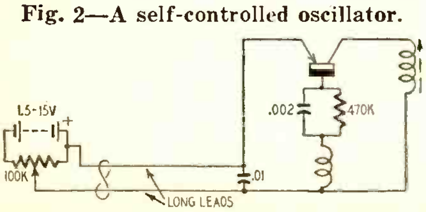


Fig. 3—Using resistance control.

If you plan high-frequency experiments with a CK722 or similar transistor, and if you have access to several units, determine which are most active at r.f. or i.f. The more sluggish transistors may be set aside for a.f. circuits. Fig. 1 is a typical circuit for a crystal oscillator. Fig. 2 is a self-controlled oscillator. The values shown were found to work well for the particular transistors used. The base resistor, voltage supply, and base capacitor may need adjustment for best operation of your particular transistor.

In Fig. 1, the collector coil has to be tuned to approximately the crystal frequency. Due to transistor loading, the adjustment may vary with the transistor used. I obtained good results using a slug-tuned coil rather than a conventional capacitance-tuned tank.

The tank in Fig. 2 may be a single winding with an intermediate tap, or it may have two separate windings. The collector portion may be 3 or 5 times as large as the base winding. The windings must be correctly polarized. Connect them so that an electron starting out at the base will travel in the *same* direction around both coils to reach the collector. In other words, the winding should have the same effect as a single coil with an intermediate tap. If capacitor tuning is desired instead of slug-tuning, connect as shown by dotted lines in Fig. 2.

A broadcast oscillator coil is not suitable for a junction-transistor oscillator. Its frequency range is too high. Instead, use an antenna coil with primary, if you want a broadcast-band oscillator. A 455-kc i.f. transformer also makes a good tank. If used as is, it generates a signal near 300 kc. By removing turns, you can reach the broadcast band with it. As turns are taken off, monitor the frequency on a nearby receiver. The oscillator frequency equals the difference between consecutive beats. For example, if you hear signals at 600, 900 kc, etc., your frequency is 300 kc.

It is a good idea to leave a milliammeter or microammeter in series with the battery during experiments on the transistor oscillator. It offers a means of measuring the input to the transistor, and can indicate if the circuit is oscillating. Maximum input to a CK722 is 5 ma, but 1 or 2 ma is generally sufficient for a low-power oscillator. I obtained ample output in most circuits with an input of only 100 μa. In any case, the current is controlled by the base resistance and the applied voltage, and depends on the individual transistor. A lower base resistance increases the current input and the power output.

Ordinarily, the amount of oscillating current differs from the nonoscillating flow. In a typical case, a current of 44 μa flowed when the circuit was oscillating. In the nonoscillating condition, this dropped to 40 μa. This circuit used a 470,000-ohm base resistance and 3 volts input. With a small base resistance, the oscillating value will be *less* than the nonoscillating current. For example, in the above circuit a 40,000-ohm resistor raised the oscillating current value to 0.5 ma. When not oscillating, it climbed to 0.65 ma. In any circuit the oscillations may be killed by simply shorting out one or both tank coils.

Knowing the oscillating and the nonoscillating current values can save much time. For example, if you are trying to increase frequency by removing coil turns, you can watch the meter to see whether oscillations are still present. After a while, the difference (between oscillating and nonoscillating readings) will narrow down. This shows that you are approaching the frequency limit of your transistor.

One remarkable thing about a transistor self-controlled oscillator is its stability. When properly designed, its signal will be clear as a crystal tone. A slug-tuned high-Q tank, using no shunt capacitance gives a better signal than most heavily capacitance-loaded tube oscillators. This is evidently due to the loading of the transistor itself. It is only when the oscillations are on the verge of dying out that the tone sounds poor. This can happen if you use too low a voltage on the transistor, or if you operate it too close to its frequency limit. It happened here during an experiment when I was using low voltage on a transistor oscillating near 700 kc, and the r.f. signal was modulated by spurious whistles, and hum. The trouble was that I had my meter on the 40-μa range to measure the very low input current. On this range the meter has a resistance of 2,500 ohms. When I switched to the 1-ma range (100 ohms) the signal immediately became pure unmodulated r.f. again.

The base resistance of a self-controlled oscillator has a considerable effect on frequency. With one circuit I obtained a frequency of 780 kc. The base resistor was 470,000 ohms and the base capacitor 500 $\mu\mu$f. Changing the resistance to 40,000 ohms dropped the frequency to 700 kc. No other circuit change had been made. The lower base resistance also increased current input from 50 μa to 600 μa from the 1.5-volt battery. Obviously the output power also increased considerably.

Battery voltage affects frequency to a great extent. The following table illustrates this. The tank was a slug-tuned pair of coils wound over the same half-inch core. The collector winding had about 75 turns No. 28 enamelled wire and the base winding about 30. Each was close-wound with 7 turns per layer. The coils were about ⅛ inch apart.

Voltage	*Frequency*	*Current*
1.5	700 kc	50 μa
3.0	770 kc	120 μa
4.5	800 kc	200 μa
10.0	830 kc	650 μa

The frequency control can be operated at a distance. For example, I used a remote 100,000-ohm potentiometer across a battery (Fig. 3). A .01-μf capacitor bypassed the leads where they connect to the oscillator itself. Thus the remote network (potentiometer and battery) are bypassed. Of course, the power increases as we raise the frequency. If the circuit is to be used as a frequency modulator its output may be fed into a limiter to keep the power constant.

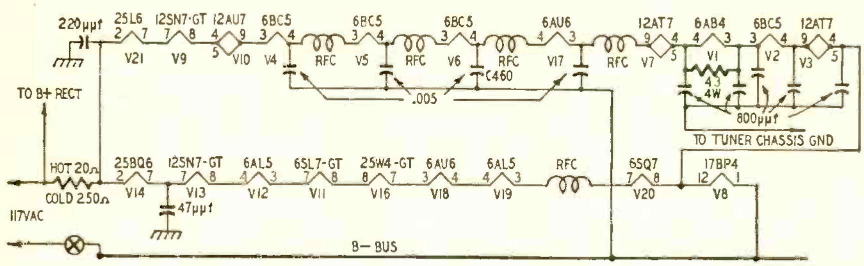
Frequency may also be controlled by a resistance in series with the battery. A 1,000-ohm resistor shifted frequency from 610 to 600 kc. This method is not suitable for remote control. It seems that the capacitance between leads cancels out some of the resistive effect. Unless the resistor is right at the circuit, much of its effect is lost through this capacitance.

The combination of an active transistor high-voltage supply (4.5 or more) and a high base resistor gives rise to an unusual effect. The circuit goes into multiple oscillations like a superregenerator or multivibrator. The output is composed of a strong carrier (at the frequency of the tank coil) and numerous sidebands. These frequencies may be spaced by about 3 kc or less. Thus, as the band is tuned, one signal comes in just as the next is leaving, so there is a more or less continuous signal. With a certain adjustment here, we obtained the carrier at 800 kc. The sidebands occupied a width of about 200 kc on either side. These sidebands are maximum near the carrier and become weaker as we tune away from it in either direction.

Of course the multiple signal appears on the short-wave bands as harmonics. Thus we hear a maximum signal at 1.6 mc, 2.4 mc, etc. In each case the noise signal is maximum near these frequencies but drops off to zero on either side. For a good noise signal, adjust the circuit so that the individual side frequencies merge or blend to become continuous. Such a noise is fine for alignment or adjustment of a receiver, and for many test purposes. END

G-E 17 SERIES TV SETS

A G-E 17T1 came in with no raster. A check showed the picture tube and the heaters of V1, V2, V3, V7, and V17 were not lighted. The heaters of these tubes lighted when the socket was removed from the picture tube. An ohmmeter check made with the tubes removed from the string beginning with V21 and ending with V3 (see diagram) showed a short from pin 4 of V6 to the B minus bus. Filament bypass capacitor C460 was shorted. The replacement is a .005-μf, 450-volt ceramic capacitor. The manufacturer's part number is RCW-3014.



This service note may be applied specifically to the 17T2, 17T3, 17C103, 17C104, 17C105, 17C107, 17C108, and 17C109 receivers and applied generally to other G-E receivers using the same type of series-parallel heater circuit as in the diagram.—*Harry C. Keller*

WESTINGHOUSE H-130

Several of these sets have been brought in with the complaint that they would receive only one station. The trouble was traced to a leaky 0.1-μf capacitor between the oscillator tuning capacitor and the high end of the oscillator coil. Replacement restored normal reception.—*Ernie Gig*

STROMBERG-CARLSON TV SETS

Resistor tolerances in the a.g.c. delay networks in 621A, 622, 624, and 625 TV receivers may give some sets a tendency to produce long streaks of ignition noise instead of small dots.

This can be corrected by adjusting the a.g.c. potentiometer slightly, or, in extreme cases, by connecting a 2.2-μh r.f. choke (Stromberg-Carlson part 114693) between the input terminal and the a.g.c. terminal on the printed i.f. strip.—*Current Flashes*

STEWART-WARNER 9209-W

A yellowish-brown burnt spot developed on the face of the picture tube and led to the set being brought in with the complaint of an ion burn.

After examining the situation, we removed the stain from the face of the picture tube with Ivory soap.

When the set got very hot, a yellow waxlike substance leaked off the picture tube's rubber insulating ring and gave the same appearance as a burn on the phosphor coating.—*G. P. Oberto*

CROSLEY 386, 387, 393 CHASSIS

If the focus control in chassis 386, 387, 393, and 394 arcs, disconnect the lead from the control's center arm and insert a 470,000-ohm, ½-watt resistor in series with it. Be careful that the lead does not short to the chassis or other component.

This resistor is not included in chassis prior to those coded 386-J, 387-H, 393-F, and 394-F.—*Crosley Service Department*

TV ANTENNA FOR TRAILER

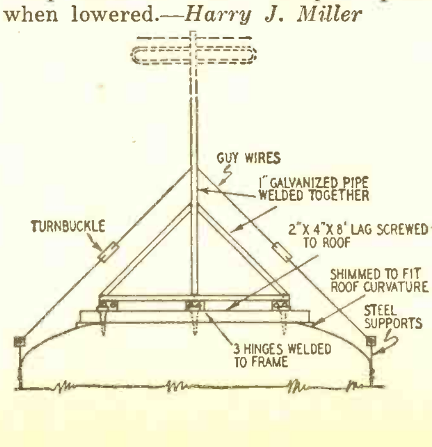
A trailer owner called me out to install a TV antenna and mast atop his mobile home. He specified that the mast should be capable of being raised or lowered in about two minutes and should lie flat on the roof when lowered.

We made up a 20-foot mast of 1-inch galvanized pipe and welded a second piece of pipe crosswise at one end. This tee forms the base of the mast. Diagonal pipe braces were then welded from the ends of the base to a point on the mast as shown in the drawing, and 3 large T-hinges were welded to the mast base.

Next, 3-inch lag screws were used to fasten an 8-foot 2" x 4" timber crosswise the roof directly over a load-bearing closet partition about one-third of the way back in the 30-foot trailer. Shim blocks, cut to follow the curvature of the roof, were fastened under the ends of the 2 x 4 to plumb the mast and to help distribute its weight over as wide an area as possible.

When the base is bolted to the beam, the mast pivots freely on the hinges and can be raised or lowered at will. Four guys with turnbuckles are fastened through holes in steel anchor plates fastened to the corners of the trailer.

Once installed, raising and lowering the mast is a 2-minute job for one man. Just slacken off the turnbuckles, remove the hooks from the holes in the front anchor plates, and then slowly lower the mast to the roof. A simple hook-strap holds the mast firmly in place when lowered.—*Harry J. Miller*



TECHNICIANS' NEWS

PLAN TV PROGRAM

Two of Philadelphia's top advertising agencies, with the cooperation of two of the nation's leading parts manufacturers, are preparing the script for a 13-week TV program, to be sponsored by the Philadelphia Council of Radio and Television Service Associations. Cost of props and talent will be paid by the council. The program is designed to promote goodwill between the public and the service industry, and to answer the questions that confront the TV set owner, due to his lack of understanding of the product he purchased and what may be expected from it.

The council is also concérned with another form of advertising—the bait advertising by unscrupulous TV and radio service concerns. Charles Knoell, vice-president of the Television Service Dealers Association reported to the council that his association is preparing an anti-bait advertising bill for presentation to the City Council. T.S.D.A. has been investigating the problem for 6 months. In the same investigation, it has also been looking into other forms of unethical advertising, and has been studying evening and Sunday work by employed service technicians and others operating from private homes and back-alley shops.

AD QUIZ CIRCULATED

The Utah Association of Radio and Television Servicemen has circulated among its membership a questionnaire on advertising practices. Among the questions asked are: What is the best type of advertising in your area (TV, Radio, Newspaper, TV Weekly)? How much do you want to spend on advertising per month? How often should advertising be run? A number of other queries were made. The questionnaire also asked if members favored State or City licensing, and for suggestions as to what qualifications a shop should have to obtain a license.

With the questionnaire, the Utah association put out a two-page mimeographed letter, including a call to the June meeting and a triblute to the officers who had served the Association during its first year.

NEW DETROIT GROUP

The Electronic Service Association, a non-profit organization under the laws of the State of Michigan, has been formed in the Detroit area, according to a report by Robert Aronson of the association's publicity committee. The group is open to anyone engaged in the full-time servicing of radio, television or electronic equipment.

Officers of the association are Ralph L. Carew, president; Joseph Rosson, vice-president; George Sturman, recording secretary; T. T. Czarnecki, corresponding secretary; and Peter Wroblewski, treasurer. END

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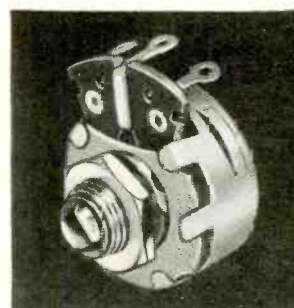

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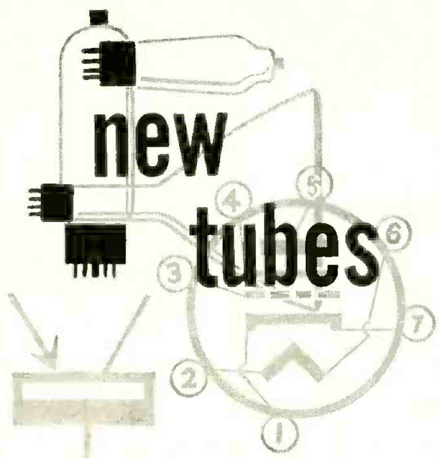
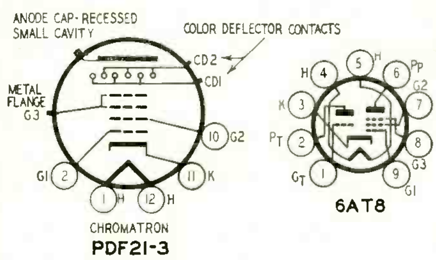


and Transistors

CHROMATIC Television Labs announces the PDF 21-3, a C-R tube for color TV reception. The tube is a direct-view single-gun rectangular-glass-bulb Lawrence type. (See diagram.)



The PDF 21-3 produces a picture size of 14.5 by 11 inches. The single-gun construction provides a bright picture without color fringing when receiving black-and-white or color transmission. The fringe-free pictures are obtained automatically and there is no need for electrical or mechanical convergence equipment or adjustments.

Other design features include low scanning-power requirements, automatic registration, and an anode supply of 18,000 volts, similar to that used in large-screen black-and-white sets.

Sylvania has introduced a new short, 21-inch, all glass, rectangular, aluminized picture tube, the 21ATP4.

The tube has a gray filter-glass spherical faceplate. It is electrostatically focused and uses magnetic deflection. The deflection angle is 90° and the overall length of the tube is 20⅜ inches.

Recommended operating conditions for the 21ATP4 are: anode voltage, 16,000; grid 2 voltage, 300; ion trap field strength, 35 gausses. The capacitance between the external conductive coating and anode is 1,500 to 1,800 $\mu\mu f$.

RCA has announced the 6AT8, a triode-pentode converter. The multiunit tube is a 9-pin miniature containing a medium-mu triode and a sharp-cutoff pentode. It is designed for use as a combined oscillator and mixer in television receivers using an intermediate frequency in the 40-mc range.

The 6AT8 has the same electrode structure as the 6X8 but has a different

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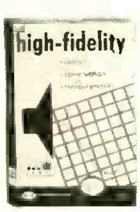

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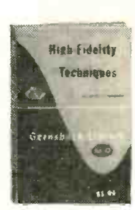

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NEW DESIGN

basing arrangement to permit shorter connections to the coils in the various designs of turret tuners. Except for a very slight change in some of the interelectrode capacitances, the characteristics and ratings of the 6AT8 are the same as for the 6X8. The basing arrangement is shown in the diagram.

A phototube electronically "allergic" to spots before its "eyes" has been announced by RCA. Designed for production-line inspection of soft-drinks, medical solutions, and similar translucent liquids, the light-sensitive tube reacts to even minute, transparent impurities.

The phototube, the 6405/1640, has a high sensitivity to red and near-infrared radiant energy and is especially useful with an incandescent light source.

The 6405 has a non-hygroscopic base that maintains a high resistance between anode and cathode. As a result, more output for a given light input is obtainable under high-humidity conditions.

An interesting RCA development is the 5AUP24, a 5-inch C-R tube designed for use as the flying-spot scanner in a color video-signal generator. Color television signals may be generated by scanning Kodachrome slides or similar transparencies.

This new tube features a metal-backed phosphor with a spectral-energy emission characteristic peaked in the blue-green region and with sufficient range to provide usable energy over the visible spectrum for generating color signals from color transparencies. Because of the extremely short persistence of the phosphor, very little equalization is needed to minimize blurring or trailing in the reproduced picture; hence the signal-to-noise ratio is good.

The tube face is made of a special, non-darkening glass, and has an optical quality that will not limit the performance of a high-quality objective lens needed to provide maximum resolution.

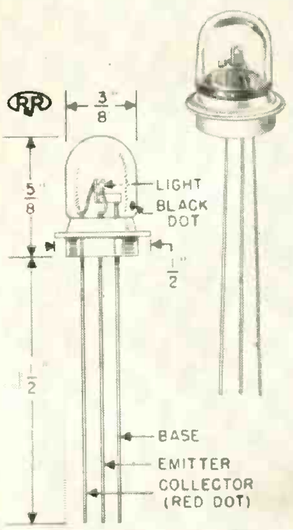
Other features of the 5AUP24 include a high-resolution gun of the electrostatic-focus type; 40° deflection angle to minimize deflection defocusing and provide high corner resolution; an external conductive coating on the neck that, when grounded, prevents corona between the yoke and neck; a built-in capacitance to serve as a supplementary filter capacitor; and an external insulating coating on the bulb cone to minimize sparking over the bulb during conditions of high humidity. The maximum anode rating for the 5AUP24 is 27,000 volts.

Radio Receptor Co. has announced a new miniature p-n-p photo transistor, type RR66. It was developed for use in automobile headlight dimmers, but is equally useful in a large variety of industrial equipment.

The light-sensitive element is hermetically sealed in a glass bulb and is connected to three leads that emerge from a glass header. The spectral response covers the visible range and extends far

NEW DESIGN

into the infra-red so that it is especially useful in black-light applications.



RR-66 PHOTO TRANSISTOR

An 8-ounce "flyweight" power triode designed for airborne communications, with high-power output at ultra-high frequencies was announced by RCA.

The new tube, the 6383, has a maximum plate dissipation of 600 watts and can be operated with full plate voltage and plate input at frequencies up to 2,000 mc.

The u.h.f. triode is designed for both liquid and forced-air cooling to provide maximum efficiency at high altitudes. Under normal temperature and atmospheric conditions, the tube can be cooled with distilled water. In the water-freezing cold and rarefied air of high altitudes, the tube can be cooled efficiently with chemical coolants.

The "flyweight" power triode features a coaxial-electrode structure for use with circuits of the coaxial-cylinder type. This structure permits effective isolation of the plate from the cathode, and makes the tube particularly suitable for cathode-drive circuits. END

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35 YEARS AGO IN THE AUGUST 1920 ISSUE OF SCIENCE AND INVENTION (ELECTRICAL EXPERIMENTER)

New York University Field Radio
Wireless Telephony on Shipboard
A War-Time Radio-Detective, by Pierre H. Boucheron
Magnavox Boosts Radio Signals

NEW PATENTS

SUBAUDIO TRANSMISSION

Patent No. 2,670,460
Roswell W. Gilbert, Montclair, N.J.
(assigned to Weston Electric Instrument Corp.)

Radio signals can be transmitted easily on an a.c. power line. Hams, engineers, and experimenters have used such lines to carry speech, generally on a carrier frequency of about 100 kc. At this high frequency line losses are likely to be high, due to unpredictable capacitance to ground and other conductors. If control signals only are to be transmitted, a very low frequency (for example 0.1 to 10 cycles) is more efficient. These low frequencies introduce the problem of designing suitable filters so that several frequencies may be transmitted at the same time. A 50-henry coil wound for a Q of 50 (at 1 cycle) would weigh hundreds of pounds. This inventor solves the problem. He shows how to design a very-low-frequency filter using ordinary d'Arsonval-type moving coils.

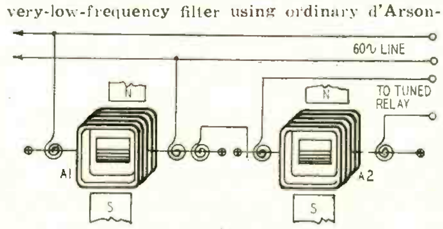

Fig. 1

A pair of moving-coil assemblies, A1 and A2, whose natural frequencies are f1 and f2 respectively are shown in Fig. 1. These frequencies differ slightly, but both are approximately the same as the frequency to be transmitted over the lines. A1 is connected across the power line as shown. It is coupled to A2 through a spiral spring. A1, A2 are the mechanical equivalent of a pair of coupled coils. With sufficient coupling, this network will have a frequency response like that shown in Fig. 2. If the carrier signal is approximately f1 or f2, the coils will go into vibration. The steep sides of the curve show that when the carrier frequency is outside this range, there will be no response.

A1 acts as a motor which vibrates when the coil is excited by the line signal. A2 acts like a generator and supplies current when its coil vibrates between the magnet poles. This output energizes a relay tuned to a frequency between f1 and f2.

The bandpass response has two advantages over that of a conventional resonance curve. The wider band means that tuning will not be critical

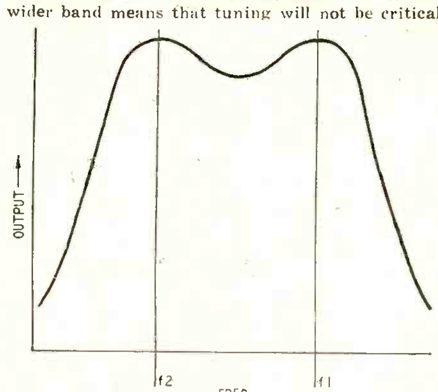

Fig. 2

either at the transmitter or receiver. The bandpass curve has steeper sides, so selectivity is higher. Thus there is room for more signals to be transmitted over the same line without interference.

CONTINUITY TESTER

Patent No. 2,677,100
Bud R. Hayhurst, Auburn, Wash.
(assigned to Boeing Airplane Co.)

This instrument tests fuses without removing them from the circuit or even shutting off the power. A buzzer creates a local magnetic field. This field cuts the fuse (if it is not burned out) and induces a.c., which is measured.

When SW is closed the buzzer chops the battery current, creating a.c. across L. The a.c. is fed to the potentiometer. Equal and opposite current flows through each half of the trans-


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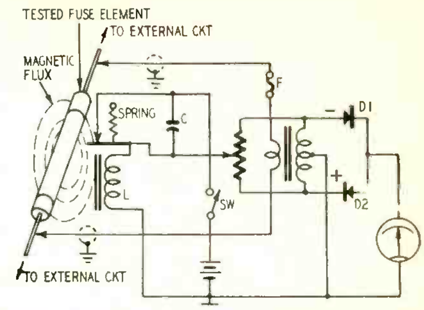

former secondary, returning through its center tap to ground. Due to cancellation, no current is indicated at the meter.

If the fuse is not blown, a.c. is induced in it and current flows through the primary winding. Current is transferred to the secondary and since this flows in one direction it unbalances the condition described above. D1 and D2 rectify the a.c. and current is indicated at the meter. Any d.c. in the fuse circuit cannot possibly effect the test.

Should the tested fuse element be blown out or otherwise defective, so that it does not form a continuous conductor, the only voltage applied to the selenium rectifiers is the reference voltage, and the meter current will be zero.

A protective device F is included to guard against possible damage due to high voltage in the tested circuit. C is used to minimize sparking across buzzer contacts.

SMOOTHING NETWORK

Patent No. 2,677,054
Sidney B. Cohen, Brooklyn, N.Y.
(assigned to Sperry Corporation)

This network uses no tuned filters. It suppresses rapid fluctuations of signal, while passing slower changes, thus making it useful in servo systems. As shown in Fig. 1, E_{in}, the a.c. signal, is in series with resistor R. While the signal remains steady, so does the output, E_{out}. When E_{in} varies, however, the impedance Z_{in} (reflected) varies and controls the output signal. E_{out} is always a smoothed-out version of the input, since Z_{in} varies inversely as the *rate of signal change*.

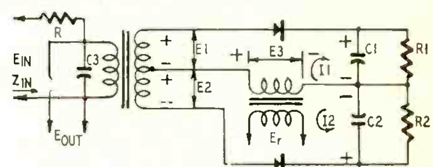

Fig. 1

In Fig. 1, E_r is an external signal at the same frequency as E_{in} (for example, 400 cycles). It induces a reference voltage E3. Two other voltages, E1 and E2, exist only when the signal varies. E3 is the largest of the 3 voltages so it controls conduction of the rectifiers. Conduction is possible only when E3 has the polarity indicated. The polarity of E1 and E2 depends upon the signal. When E_{in} *increases*, their polarity is as shown. It is reversed when the signal amplitude drops.

The secondary circuit is a phase detector which passes current only in the direction of the arrows (I1, I2). Therefore C1 and C2 can only *charge* through the rectifiers. Discharge must take place through R1 or R2. The capacitors charge to an average value, E3, when the signal is steady (while E1 and E2 are zero).

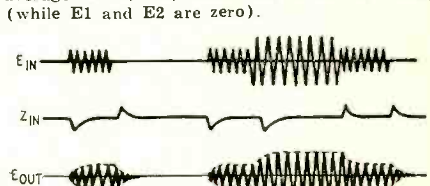

Fig. 2

Assume a signal increase. E1 and E2 are induced as shown. E1 *adds* to E3 and I1 begins to charge C1. Since E2 *subtracts* from E3, C2 discharges from its voltage value E3 through R2. The only current through the transformer secondary is I1. It creates a flux which *opposes* that of the primary. Thus the effective inductance of

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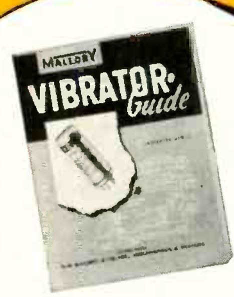

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NEW PATENTS

the primary, and its impedance, is lowered.

When E_{in} decreases, E1 and E2 reverse polarity. Then only I2 flows through the secondary. It creates a flux which *adds* to that in the primary and Z_{in} increases.

Fig. 2 shows typical waveforms. Z_{in} varies only while E_{in} is changing. When the signal is constant, the output is controlled by R and the average value of Z_{in}.

Charging currents into C1 and C2 are in pulse form, so C3 is added to help the smoothing action across the transformer primary.

FOUR-COLOR KINESCOPE

Patent No. 2,669,671

Lewis B. Headrick, Lancaster, Pa.
(Assigned to Radio Corp. of America)

Most TV technicians know about 3-color kinescopes used for color reception. Here is a new kine that reproduces 4 colors: *white* in addition to the primary colors, red, green, and blue. The white gun is located at the axis of the tube (Fig. 1). It aims straight toward the screen

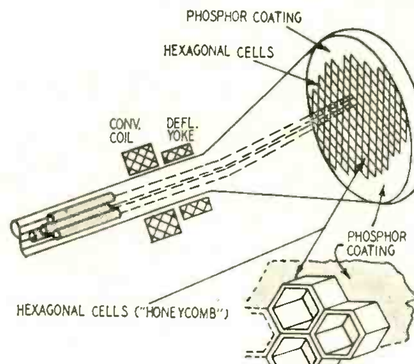


Fig. 1

whose plate is coated with white phosphor. The other guns surround the central one and are spaced by 120°. These aim electrons at a small angle to the axis as in conventional color tubes. The inner foundation plate of the tube face holds banks of hexagonal cells (Fig. 2). Two adjacent sides of each hexagon are coated to glow with one of the primary colors. For example, the blue gun aims electrons so that they hit only the two adjacent sides coated with blue phosphor.

This kinescope must be used with video signals that contain two types of information: detail and color. Detail is contained in the higher frequencies which are delivered to the white gun. The color information is mainly low frequency and it energizes the other guns. For color pictures all four guns are excited.

This tube seems to have advantages where black-and-white pictures are to be received often.

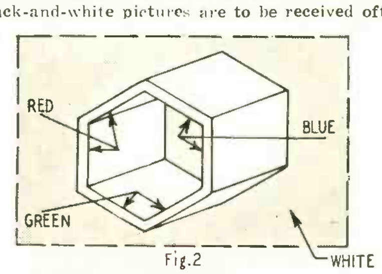
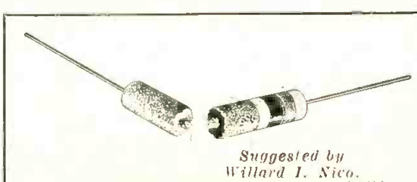


Fig. 2

In these cases only the central gun need be excited and the video signals may be conventional black-and-white information. This is simpler than the present color setup where black-and-white pictures require elaborate color circuits, and white is the result of mixing red, green, and blue in proper proportions. END



Suggested by Willard I. Nico, North Hollywood, Calif.

Piece de Resistance

THE #630 TV RECEIVER remains unmatched for quality and performance • • • RCA designed and developed this set quality-wise *not* price-wise • • • The original 10" set retailed at $375.00 • • • Subsequent TV sets serve to prove the sacrifice of quality for price • • • what better proof can there be of its superiority than the fact that it is the choice of TV engineers and TV technicians! Herewith we offer you—YOUR BEST BUYS IN TV!—All you pay is the price shown • • • Excise taxes have already been paid by us.

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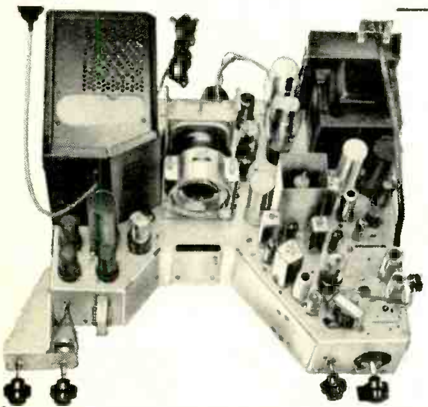
A KIT or any **CHASSIS** with any **CABINET** AND ANY SIZE **PICTURE TUBE**



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#630 Super Deluxe TV CHASSIS

with . . . **U. H. F.**

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COMPLETE READY TO PLUG IN AND PLAY—Similar in characteristics and features to the TV KIT at left • Manufactured especially for us by Regal Electronics Corporation • No efforts or expense have been spared in workmanship or materials, to make this #630 SUPER DELUXE TV CHASSIS the Best obtainable for fringe areas, clarity and all-around-performance, regardless of price. Customers report reception better than 200 miles • Each Set is factory aligned and air-tested • All parts carry the RMA three month guarantee • Our mass volume of business on this CHASSIS (numbering thousands of pleased customers) now makes it possible for us to reduce the price to.................... only **$157.97** (less CRT)

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27" GOLD MEDAL 2430-9 TV CHASSIS, Complete, ready to plug in and play, including your assigned U.H.F. station. **90° deflection, operates all 24" or 27" rectangular and 30" round picture tubes.** The last word in TV achievement • Ideal for wall or custom-cabinet mounting • Detailed technical data mailed on request, however with the knowledge that this CHASSIS is a 30-tube #630 with both TECH-MASTER'S and OUR guarantee, you need not hesitate sending your order in now.

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VHF entitles you to 1 UHF Station Free. UHF/VHF includes tuner for 82 channels.

	UHF/VHF	VHF
MODEL 2430: For picture tubes up to 24". Audio connection for optional use of external amplifier.	$249.50	$189.50
MODEL 2431: Same as 2430, but with True Fidelity Push-Pull audio amplifier.	259.59	199.50
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MODEL 1930: Similar to 2430 with slight modifications including area control switch at rear of chassis and cadmium plated finish instead of nickel.	224.95	179.50
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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 an air cushioned carton from FACTORY to YOU!

The VOGUE Most Popular Table Model

H-25", W-26", D-22"

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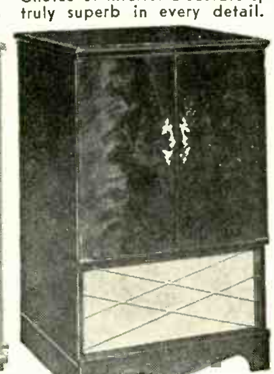

H-40", W-27", D-23"

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The TOWN & COUNTRY Patterned after the popular credenza. Available for all size picture tubes 14" to 27"

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BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A. New York 7, N.Y.

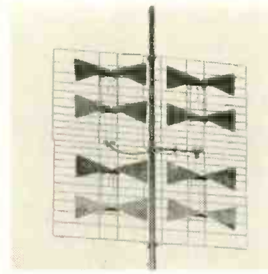
TELEPHONE COrtland 7-2359

NEW DEVICES

U.H.F. ANTENNA

Channel Master Corporation, Ellenville, N.Y., has announced the development of a new super-fringe u.h.f. antenna, the *Twin Multi-Bow,* model 410-8.

This is an 8-bay bowtie and screen antenna. It has a large screen area, 1,640 square inches, which contributes to the antenna's very high gain, which



ranges from 12½ to 16½ db. It also gives the antenna a very high front-to-back ratio with a very narrow forward lobe.

Since each dipole is exactly the same distance from the antenna feed points a constant phase connecting harness assures equal current and phase distribution in each dipole over the entire u.h.f. range. This feature—plus 2-stage stacking transformers—results in a flat high-gain level over the entire bandwidth. All harness connections are riveted to the dipoles for positive electrical contact. The dipoles are constructed of aluminum sheet for added strength and improved broadband characteristics.

TV U.H.F. CONVERTER

General Instrument Corp., 829 Newark Avenue, Elizabeth, N.J., has introduced an all-channel u.h.f. converter called *Tuck-A-Way* which can be installed behind, on either side, on top of and (in the case of certain table models) below the television set. The dial and switch are positioned on top. The switch is of the button type. To in-

stall, one simply plugs the set into the converter, plugs the converter into the wall socket and connects the antenna leads to the converter. It is then ready to tune. Opening and sliding out the heavy chassis is unnecessary.

LINE-LOK STANDOFFS

IE Manufacturing Co., 325 N. Hoyne Ave., Chicago, Ill., has announced a new line of *Line-Lok* standoffs. This new design offers many improvements including a cam type separator which keeps the in-

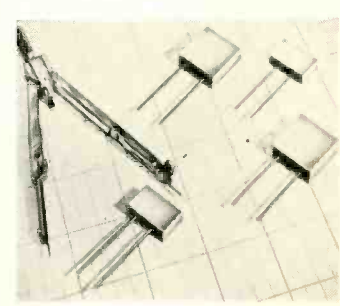
sert firmly against the stem, interlocking side lips to prevent splitting and to maintain a constant locking pressure, and open-end drains that act as an outlet for dust and prevent moisture traps.

The standoff is of the hinge-type design. It clicks open, snaps shut, stays locked in position. It is adaptable for holding most u.h.f. and v.h.f. installations, including the flat line, open line, tubular round and oval line. Pure polyethylene insert isolates the transmission line from the zinc-plated metal stem and produces efficient low-loss performance.

MICA CAPACITORS

Cornell-Dubilier Electric Corp., South Plainfield, N. J., has announced the development of a new style of midget mica capacitor in the form of an encapsulated unit. The capacitor section is separately processed in its entirety and then inserted and sealed with *Permabond* resin fill into a premolded case (capsule).

The new *Super Micadon* will house five to six times the capacitance now possible in CM-20 and CM-30 cases. Two sizes are available: type 5A is 51/64 x 15/32 x 7/32 inches; type 1A



is 53/64 square x 9/32 inches. They occupy only about one-third the space formerly required for the same capacitance, and the life expectancy has also been increased. The capacitors are designed with flat, clinched wire leads, giving improved voltage breakdown safety and enabling over-all inductance to be reduced greatly.

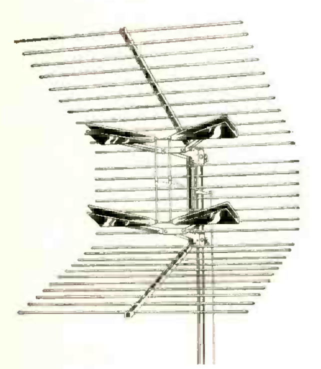
AMPLIFIER KITS

Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif., has introduced four new amplifier kits. They cover the range from 10 to 40 watts with the HF-12 delivering 10 watts

output. The HF-18, Williamson type, all-triode amplifier delivers 16.5 watts, and the HF-40 auditorium amplifier delivers 40-55 watts. A preamplifier featuring a complete record equalizer and new tone control, designated HF-3, is also provided as a kit. The kits include all necessary transformers, chokes, sectional chassis and complete instructions for assembly—including photographs, drawings, and decals.

CORNER REFLECTOR

Radelco Manufacturing Company, Cleveland, Ohio, is now introducing a new dual-corner reflector, model US-152, with all-metal insulators to free the antenna from variations in received signal strength due to weather conditions. It works equally well in both wet or dry weather and provides positive assurance of high sensitivity



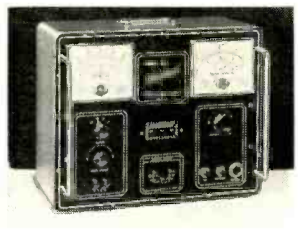
over the entire u.h.f. band. The dipole is supported directly by the mast, and the reflector is constructed entirely of horizontal elements. It discriminates against unwanted vertically polarized signal. The dipole spacing is a full half wave.

NOISE GENERATOR

The Hickok Electrical Instrument Co., 10531 Dupont Ave., Cleveland 8, Ohio, announces the new model 755 universal noise generator for measuring noise factor in radio receivers, tuners, and converters. The unit has a built-in v.t.v.m. with zero-center scales of 0 to 0.1, 0.5, 1.0, and 5.0 volts, and a means of canceling out positive or negative contact potentials up to 1 volt. The output section of the instrument has a decibel meter reading 0 to 19 db with 75- and 300-ohm receiver inputs and 0 to 17 db with 50-ohm inputs. Frequency output is flat from 10 to 250 mc.

The noise diodes are in the probe, thus making it unnecessary to balance out capacitances to the generator. A special u.h.f. head with 50-ohm impedance is available for frequencies between 100 and 1,000 mc.

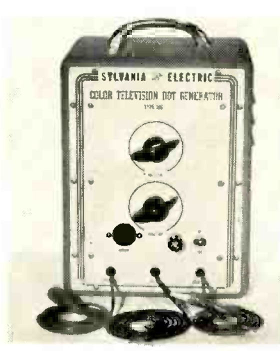
The instrument measures 16½ x 13¾ x 8 inches and weighs



25 pounds. Power consumption is 50 watts from 115-volt, 60-cycle lines.

TV DOT GENERATOR

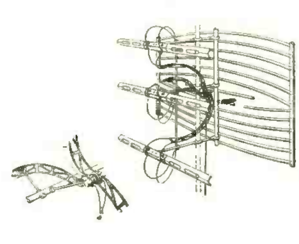
Sylvania Electric Products, Inc., 1740 Broadway, New York, N.Y., has announced a new color TV dot generator, type 506. It provides a pattern whereby the beams of a color cathode-ray tube of the 3-gun type may be



properly converged by the service technician. Sync is coupled directly from the receiver. A wide range of dot spacing is provided for convergance and linearity adjustments. Positive gating and triggered multivibrators assure undistorted output. Test leads permanently fasten to the front panel. It is designed for 105–125-volt, 50–60-cycle operation.

THIRD-DIPOLE KIT

Davis Electronics, P. O. Box 1247, Burbank, Calif., has announced an easy-to-install third dipole which can be used to improve signal reception of a Davis *Super-Vision* antenna on

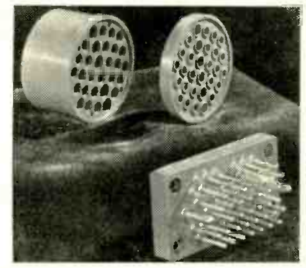


many channels, particularly channels 4, 5, 6, and 7. The kit contains an extra dipole and all necessary accessories as well as installation instructions.

NEW DEVICES

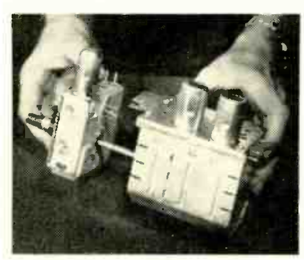
DIALL 51-01

Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif., announces Diall 51-01, a thermosetting-molding compound having *diallyl phthalate* as its principal resin and asbestos as its principal filler. It is currently used for inserts in connectors, solenoid parts, etc. Its main advantage over current materials are its high dimensional stability (.00041–.00101 inch per inch lifetime shrinkage), higher heat resistance (400° to 450° F. continuous exposure), better resistance against cracking during soldering operations, and higher impact strength.



ALL-CHANNEL TV TUNER

Sarkes Tarzian, Inc., Tuner Division, Bloomington, Ind., announces the new UV-13 all-channel v.h.f.-u.h.f. TV tuner. The unit consists of the V-13 v.h.f. tuner and the U-13 u.h.f. tuner plugged together with concentric control shafts to make an all-channel tuner 4¾ inches deep, 3 17/64 inches high, and 3 5/16 inches wide. The V-13 is a turret-type cascode tuner with a 6BZ7 r.f. amplifier and 6U8 mixer-oscillator. Its output is link-coupled for a 41-mc i.f. system. Power and antenna connections are made to pin-type terminals. Soldered connections are not used for installation.



The U-13 is a capacitance-tuned u.h.f. tuner using a resonant coaxial cavity. It may be installed at the factory or in the field. The U-13 slips over the shaft of the V-13 and plugs into the front of it. Two screws hold the assembly together. When a u.h.f. channel is tuned in the V-13 becomes a 2-stage i.f. amplifier.

Three concentric tuning knobs are used for coarse and fine tuning of v.h.f. and u.h.f. channels.

40-MC I.F. STRIP

Allen D. Cardwell Electronics Productions Corp., (Subsidiary of Chesapeake Industries, Inc.), Plainville, Conn., announced the development of a 40-mc printed circuit i.f. amplifier for monochrome TV receivers using intercarrier systems.

This unit includes a new laminate, used on both the base and transformers to improve electrical characteristics and mechanical rigidly and reduce the usual brittleness. The transformer windings are etched on both sides of the laminate. Aluminum discs are threaded into center-tipped nylon inserts. The insert prevents any possibility of the formerly bothersome shorting of turns.

AM-FM TUNER

Freed Electronics & Controls Corp., 200 Hudson Street, New York 13, N. Y., has announced its new Freed-Eisemann AM-FM superheterodyne radio tuner, model 750, which incorporates high-fidelity performance with sufficient sensitivity to provide optimum reception even in fringe areas. The AM and FM circuits are designed for maximum gain at minimum noise. The unit contains a whistle filter which eliminates interstation whistles.

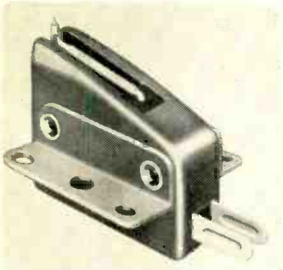
NEW SUPER METER

Superior Instruments Co., 2435 White Plains Rd., New York 67, N.Y., has announced a new *Super Meter*, model 670-A. It includes a built-in isolation transformer which reduces the possibility of meter damage by 50%. It will measure capacitance, reactance, inductance, and decibels. It also includes a *Good-Bad* scale for checking the quality of electrolytic capacitors at 150 volts.

The d.c. volt range is 7.5, 15, 75, 150, 750, 1,500, and 7,500. The a.c. ranges are 15, 30, 150, 300, 1,500, and 3,000. Output volts: 15, 30, 150, 300, 1,500, and 3,000. There are five current ranges: 1.5, 15, and 150 ma, and 1.5 and 15 amperes. Resistance ranges are 1,000 and 100,000 ohms and 10 megohms. Capacitance can be measured from .001 to 1 µf and from 1 to 50 µf; reactance from 50 to 2,500 ohms and from 2,500 ohms to 2.5 meghoms; inductance from 0.15 to 7, and from 7 to 7,000 henries. Decibel ranges of −6 to +18, +14 to +38, and +34 to +58 are included.

HI-FI CARTRIDGES

Astatic Corp., Conneaut, Ohio, has announced a new high-fidelity cartridge, model 51-1-J, called the *Con-Am*. Since this cartridge has no magnets, it can be used



over a steel turntable without affecting needle pressure. Hum pickup is also reduced. The response is 30 to 15,000 cycles per second on the RCA 12-5-51V test record. Output is 0.70 volts, nominal, on RCA 12-5-31V at 1,000 cycles per second. Compliance is 10-6 cm/dyne. One replaceable stylus is furnished, with diamond or sapphire tip, and with one-mil tip radius for slow speed recordings or three-mil tip for 78 r.p.m.

3-WAY LOUD-SPEAKER

University Loudspeakers, Inc., 80 Kensico Ave., White Plains, N. Y., has announced a new 3-way high-fidelity loudspeaker system called the *Companion*. It employs a combination of woofer, mid-range and tweeter reproducers together with a full-fledged inductance - capacitance type dividing network; and is housed within a balanced double-port bass chamber. The system itself consists of a *Diffusicone*-8 and a University model 4401 tweeter system.

An electrical crossover network separates the low and middle from the high frequencies. The woofer section of the *Diffusicone*-8 has a heavy-duty diaphragm capable of large low-frequency excursion without acoustic breakup; and the mid-range *Diffuser* section provides two separate and concentric horn radiators which achieve wide angle radiation through the diffraction ring terminating the mouth area of the diffusion system. The tweeter is a driver unit with a light-weight phenolic diaphragm, an Alnico V magnet, and a wide-angle horn. A balance control is provided in

the network to adjust the tone quality of the system to fit the program material being played.

The *Companion* is equipped with a Sessions electrical preset clock which tells time and permits the speaker to be used to automatically turn on and off the radio, phonograph, or tape recorder, or any other appliance.

U.H.F. CONVERTER

Blonder-Tongue Laboratories, Inc., 526 North Avenue, Westfield, N. J., has put on the market their new model 99 low-noise all-channel u.h.f. converter for class A signal areas.

The 300-ohm impedance match throughout provides maximum signal power and clarity. The tuned input tracks with the oscillator and eliminates spurious

responses and suppressing radiation. There is one-knob tuning over the entire u.h.f. band, with output to the TV set on channels 4, 5, and 6. A selector knob switches reception from u.h.f. to v.h.f.

The oscillator circuit is thermally compensated for drift-free operation. The converter has a built-in power supply and employs an Ultratuner. It uses a 6T4 tube, crystal diode mixer, and selenium rectifier, and operates on 117 volt, 60-cycle a.c.

LIGHTNING ARRESTOR

Radion Corp., 1130 West Wisconsin Ave., Chicago 14, Ill., has introduced its new LA-75 lightning arrestor which handles all types of conventional lead-in: open, flat, jumbo, oval, and perforated.

The mounting strap is an integral part of the arrestor. No separate strap or bracket is required. The arrestor can be mounted on a wall, or any pipe up to 1½ inches. One end of the mounting strap is designed to grip the No. 8 ground wire generally used by service technicians to ground an arrestor. The grip is operated by the mounting screw.

TV REPLACEMENTS

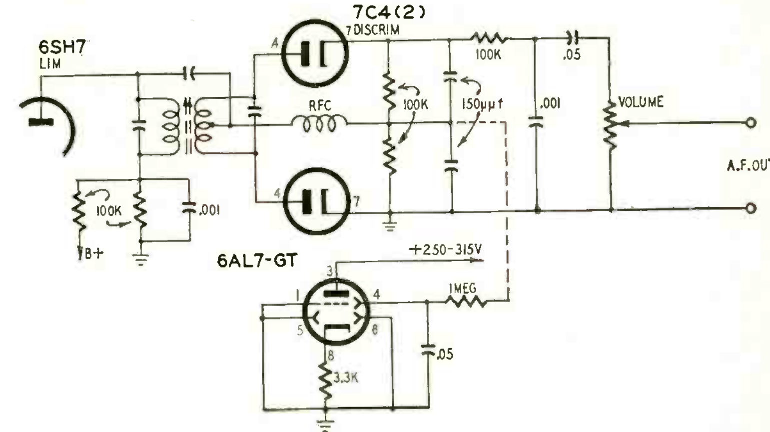
Chicago Standard Transformer Corp., Addison & Elston, Chicago 18, Ill., has announced the addition of 38 new television transformer replacements. These replacements include 23 power transformers, 8 vertical output transformers, 5 width and linearity controls, 1 deflection yoke, and 1 filter choke. The power transformers are exact replacements for Motorola, Philco, RCA, Zenith, Silvertone, and many other types. END

All specifications given on these pages are from manufacturers' data.

6AL7-GT IN FM TUNER

I would like to add a 6AL7-GT tuning indicator to a Heathkit FM-2 FM tuner. Please show the necessary connections.—S. K., Mount Vernon, N. Y.

A. The dashed line shows the connection between the 6AL7-GT and the discriminator circuit in the tuner.



IMPROVING ALL-WAVE SETS

I have two all-wave radios that I want to convert into amateur communications receivers for use by the high-school science club. One set is an RCA 3BX-671 and the other is an a.c. type of unknown make using a 5Z3, 42, 75, 6D6, and 6A7. Please show how I can add electrical bandspread tuning and beat-frequency oscillators to these sets. —E. O. C., Mamaroneck, N. Y.

Connect a small ganged air trimmer capacitor across the sections of the main tuning capacitor for bandspread tuning. The trimmer or bandspread capacitor should have the same number of sections as the main tuning capacitor. A maximum capacitance of about 25 μμf per section will be about right. A small FM tuning capacitor should work nicely. The amount of bandspread increases as the maximum capacitance of the bandspread capacitor is decreased. A good vernier or slow-motion dial drive on the bandspread capacitor makes tuning easier.

The diagram at *a* in Fig. 1 shows a b.f.o. circuit for use in battery and 3-way receivers. The b.f.o. coil may be a J. W. Miller type in the 012, 112, 512, 612, or 912 series. Select one that tunes through the i.f. of the receiver.

Modifying the filament circuit of a 3-way portable to include the b.f.o. tube necessitates major changes in the receiver. The simplest solution is to use a separate battery—a standard size D flashlight cell will do for the b.f.o. tube as shown in the diagram at *a*.

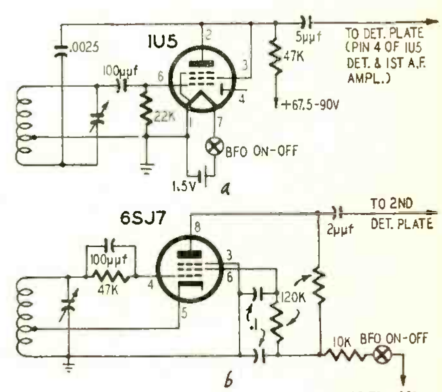


Fig. 1

Fig. 1-b is the circuit of a b.f.o. suitable for use in an a.c. receiver. The coil specifications are as in Fig. 1-a.

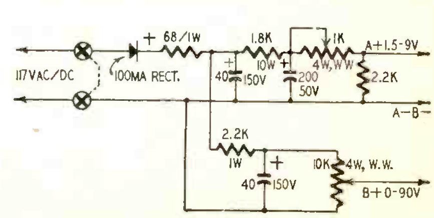
BATTERY ELIMINATOR

Please print a circuit of a battery eliminator for a portable battery radio using a 90-volt B battery and a 4.5-volt A battery.—E. W., Brooklyn, N.Y.

The eliminator in the diagram operates from a.c. or d.c. lines and delivers up to about 9 volts at 50 ma for series-connected filaments and up to 90 volts or so at 15 ma for plates and screens.

Most battery sets use the chassis as the common negative return. Therefore, it is important that the chassis of the set should be fully enclosed in a non-conductive cabinet with no exposed screws or other metal connecting the chassis to the outside. If the set has exposed hot points that cannot readily be insulated, insert a 115-volt, 75-ma half-wave type transformer between the line and rectifier input. If you can't find a suitable transformer, use two 6.3-volt, 3-amp transformers back-to-back.

Before connecting the eliminator to the set, adjust the 1,000- and 10,000-ohm output controls to deliver correct voltages to dummy loads equal to the loads imposed by the A and B circuits in the set. In a 4-tuber, connect a 90-



ohm, 1-watt resistor across the A terminals and an 8,200-ohm, 2-watt resistor across the B terminals, and then adjust the controls for correct voltages.

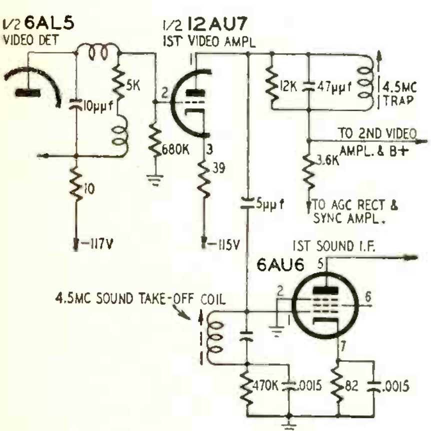
Turn off the eliminator, remove the two dummy loads, and then connect the eliminator to the receiver. Turn on the set and eliminator and touch up the settings of the voltage controls.

To adjust the eliminator for sets with higher filament voltages and different B voltages, calculate the values of the dummy load resistors by dividing the voltage by load current. The B supply drain is about 11 ma for 4-tube sets and 15–16 ma for 5-tube models.

TV INTERCARRIER CONVERSION

I installed a cascode tuner in an RCA TA-128 TV receiver. It works nicely on v.h.f. channels but I cannot eliminate separation of picture and sound on channel 16. I'd like to convert this set to an intercarrier type but I can't find a suitable point for the sound take-off and input to the first 4.5 mc sound i.f. amplifier.—D. R., Mount Morris, Michigan.

First, we recommend that you try touching-up the i.f. alignment and substitute different 6J6's in the tuner and see if you can't find one that minimizes drift. If these steps do not help, conversion to intercarrier sound may be the solution to the problem.



Replace the 21-mc sound i.f. interstage and discriminator transformers with 4.5-mc equivalents. Disconnect the grid of the 6AU6 first sound i.f. amplifier from the tap on the 21-mc sound take-off and remove the 470,000-ohm resistor and .0015-μf capacitor from the bottom of this coil. Connect this R-C network and a 4.5-mc sound take-off coil in the grid circuit of the first sound i.f. amplifier as shown in the diagram.

Connect the plate of the first video amplifier to the grid of the first sound i.f. amplifier through a 5-μμf ceramic capacitor. Keep the sound take-off lead short. If you have sound bars in the picture with the 4.5-mc trap peaked, try using low-capacitance coaxial cable for the sound take-off lead.

Realign the i.f. circuits to give optimum intercarrier performance. END

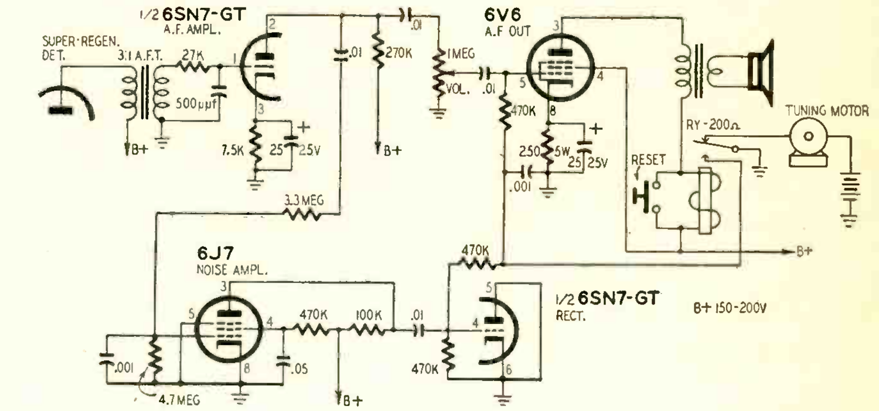
AUTOMATIC BAND SCANNING

When an r.f. carrier is tuned in on a superregenerative receiver, the hiss level drops. The stronger the signal, the weaker the hiss. A New Zealander uses this hiss to control the motor of an automatic tuning circuit on a 2-meter receiver. This relieves the operator of the tiring task of tuning endlessly from one end of the band to the other while waiting for the band to open and let dx through.

The diagram shows the control circuits of a 2-meter receiver described in *Radio and Electronics*. The motor connects to the tuning capacitor through a dial-drive system which permits the band to be scanned at a reasonably slow rate.

The output of the detector is transformer coupled to one-half of a 6SN7-GT used as an audio amplifier. The output of this stage is R-C coupled to the control grids of the 6V6 a.f. output stage and the 6J7 noise amplifier. The coupling network in the grid circuit of the 6J7 is designed to favor the hiss frequency range. The noise amplifier feeds a half-wave rectifier using the remaining half of the 6SN7. The rectifier develops a negative voltage used to bias the 6V6 to cutoff.

The motor control relay is in the plate circuit of the 6V6 audio output stage. In the absence of a superregenerative hiss audio signal, the 6V6 is cut off and the motor circuit is completed through the back contacts on the relay. The motor drives the tuning capacitor through a speed-reducing pulley system. When the set tunes across an unmodulated carrier the hiss level drops and decreases the output of the bias rectifier. The 6V6 conducts and energizes the relay coil. The motor circuit then opens and the control line shorts to ground at the bottom end of the 470,000-ohm resistor in the 6V6 grid circuit. The relay remains energized.



To start the motor scanning again, the operator closes the momentary switch to short-circuit the relay coil and complete the circuit to the motor.

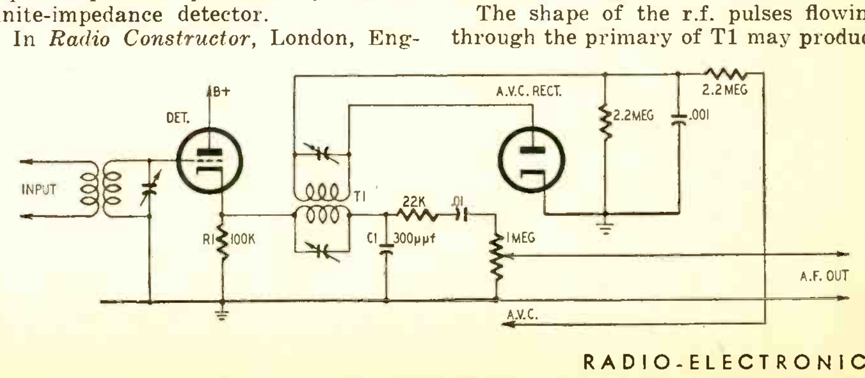
If the set tunes across a modulated signal, the audio has the same effect as hiss on the control circuit, so the motor continues to scan until the set tunes across the carrier during a break or pause in modulation.

NOVEL A.V.C. CIRCUIT

An infinite impedance detector is often used in high-fidelity AM tuners because its high input impedance does not load the tuned circuit feeding it. One disadvantage of this circuit is that a.v.c. voltage cannot be readily supplied by it. When a.v.c. is required, the usual expedient is to capacitance-couple a diode rectifier to a winding on the last i.f. or r.f. transformer. In either case, the a.v.c. diode loads the tuned circuit and nullifies the advantage of high input impedance provided by the infinite-impedance detector.

In *Radio Constructor*, London, England, G. A. French shows an interesting solution to the problem of obtaining a.v.c voltage from an infinite-impedance detector without loading the input circuit. He uses an additional i.f. transformer (T1) in the cathode circuit of the detector between load resistor R1 and r.f. filter capacitor C1. (See diagram.) In this arrangement, the detector input circuit is not affected. The secondary of T1 feeds a conventional half-wave rectifier that develops the a.v.c. voltage.

The shape of the r.f. pulses flowing through the primary of T1 may produce

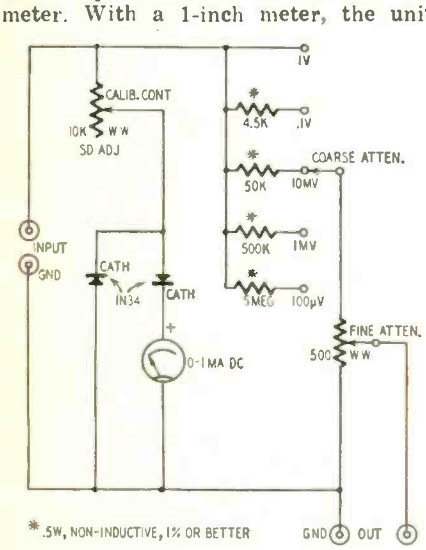


a higher a.v.c. voltage when the secondary is connected in a certain way. Try reversing the leads to the secondary winding for a higher a.v.c. voltage.

AUDIO MICROVOLTER

When checking distortion or making frequency runs on audio equipment, the technician may find that the generator's output attenuator is not sufficiently accurate to drop the signal to the level normally found at the input of preamplifiers and high-gain a.f. amplifiers. This difficulty can be eliminated by using an accurate external attenuator consisting of step and continuously variable elements and a meter for setting the input to a predetermined level. Such a device is called a *microvolter*. The simple one described here, through the courtesy of Cornell-Dubilier Electric Corp., is sufficiently accurate for most servicing and experimental uses.

The unit can be constructed in a metal utility box. The smallest dimensions depend on the diameter of the meter. With a 1-inch meter, the unit



can be constructed in a 7 x 5 x 3-inch box without cramping.

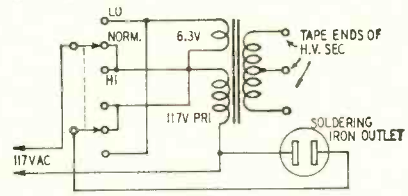
The microvolter is calibrated by applying a 1-volt r.m.s. signal to the input terminals and adjusting the 10,000-ohm calibration control so the meter reads exactly half-scale. This control should be fitted with a slotted shaft and lock nut which prevent the setting from being changed accidentally.

The coarse attenuator provides outputs from 100 μv to 1 volt in six steps when the fine control is set to maximum resistance. The fine attenuator is a 500-ohm linear wirewound potentiometer. Use an accurate ohmmeter or bridge to set the control so there is exactly 500 ohms between the arm and the lower terminal. Mark this point 10 on a dial scale. Decrease the resistance in 25-ohm steps and calibrate the remainder of the scale in one-half points. For example: 475 ohms is 9.5, 450 ohms is 9.0, 425 ohms is 8.5, 400 ohms is 8 and so on. END

TRY THIS ONE

SOLDERING IRON CONTROL

I use this control unit to regulate the heat of my bench soldering iron so it is always ready for instant use but not hot enough to burn the tip. The control is made from an old power transformer and a heavy-duty double-pole 3-position switch. The 6-volt winding is polarized so it is in series-aiding



with the primary.

The LOW position keeps the iron hot without burning when it is not being used and the HIGH position is for extra heat when needed.—*Leonard Pfeiffer*

SUBSTITUTE PHONE JACK

A surplus J-26 extension phone jack is an acceptable substitute when a panel type is not available. Remove the shell and run a nut upon the threaded shank. Push the shank through the hole in the panel or chassis and anchor it in place with another nut. These jacks have been available on the surplus market for considerably less than panel types, so I recommend them whenever cost is a factor and space permits their use.—*Harold J. Weber*

HOLDER FOR TEST LEADS

Test leads are troublesome to carry whether they are wound around the meter or just tossed in the tool box. Here is a way to keep them from snarling. A neat little carrying case for leads can be made from an empty plastic bottle of the type used for spray cosmetics. Cut out the bottom, then wind the leads about the fingers into a small roll, and push the roll into the plastic case.

Enough of the wire will be contained to make a neat package and keep it from unrolling.—*Hugh Lineback*

TAILOR-MADE BANDSPREAD

Most commercial communications receivers do not have bandspread that is satisfactory for all kinds of reception. If it is good for single sideband, or for c.w. with a sharp i.f. amplifier and peaked audio system following it, it takes forever to tune through an AM phone signal. Conversely, if it permits quick and easy scanning of the phone bands, it is far too critical and fatiguing for really sharp c.w or single sideband. What is obviously called for is various degrees of bandspread, each suited to particular operating conditions.

The answer is extremely simple with a home-grown receiver. The easiest way to build a front end for a ham-band receiver is to use plug-in coils, broadband the r.f. and mixer stages, and separately tune the high-C local oscillator with a really good tuning capacitor and dial. These two items cannot be too good. With this sort of arrangement, all that is required to provide both good c.w. and phone coverage for a given band is two plug-in coils for the oscillator, each tapped appropriately for a given degree of bandspread, as shown in Fig. 1. Any standard oscillator circuit may be used, but the vari-

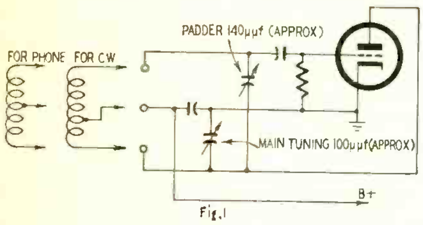


Fig.1

ous forms of the Hartley oscillator lend themselves well to this application. Note that the lower the main tuning capacitor is tapped on the coil, the greater the degree of bandspread. The tapping point for the desired bankspread can be found experimentally.

With a commercial bandswitching receiver using a tracked front end, the problem is different. Since coils cannot readily be tampered with, the solution must be reached via changes in capacitance. If the receiver has a separate bandspread capacitor that does not

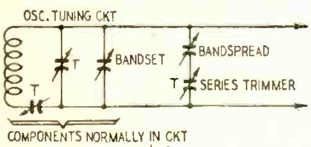


Fig.2

provide enough spread on some bands, you can improve it by connecting a good variable trimmer (an APC type or equivalent) in series with it. Sets that do not have electrical bandspread can be improved by adding a good variable capacitor of about 35 to 50 µµf in series with a good ceramic or air trimmer of about 100 µµf across the main oscillator tuning gang as shown in Fig. 2. The series trimmer can be set for the desired spread on one band or any portion of it. Additional trimmers can be

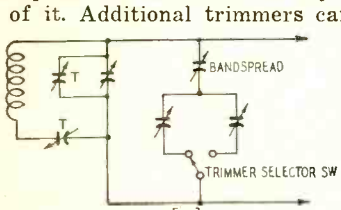


Fig.3

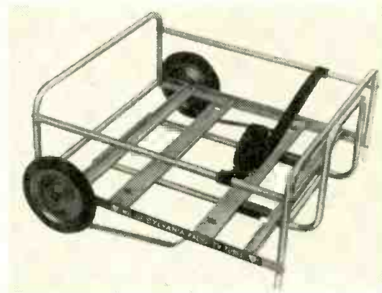
switched in as in Fig. 3 to provide varying degrees of spread for different bands or operating conditions. Some front-end gain is lost if the r.f. and mixer stages tune very sharply, but this will not usually matter if there is sufficient intermediate frequency and audio gain.

Remember that smooth tuning, stable calibration, and good resetability can be obtained only by using the best available capacitors and dial and by rigid mechanical construction. — *Wm. Bruce Cameron, W8IVJ* END

BUSINESS

Merchandising and Promotion

Sylvania Electric Products, New York City, is conducting a three-month



sales promotion campaign for service technicians. The promotion which began June 1 makes it possible for distributors and technicians to acquire an aluminum *Classy Chassis* TV set carrier for a specified amount of orders and sales.

RCA Tube Division, Harrison, N. J., is offering service technicians a free nine-lesson home study course on color television with the purchase of a specified quantity of RCA receiving tubes, between May 1 and November 15, 1954. The course was prepared by RCA Institutes, RCA Laboratories Division, and the RCA Service Company.

Walsco Electronics Corp., Los An-

geles, designed a new point-of-sale display which houses the complete line of Walsco chemicals. The top two shelves have an automatic feed device by which individually spring-loaded tracks automatically slide another bottle forward, after one has been removed.

Pyramid Electric Co., North Bergen, N. J., announced the winners in its $5,600 prize contest for service technicians in which duplicate awards were given to distributors who serviced the winners. Stanley A. Mol, Dickson City, Pa., service technician, won the top prize of $2,000. Fred P. Pursell, Scranton, Pa. distributor, won the duplicate award. Second prizes of $500 each went to Jack E. Burrell and Radio Product Sales Co. both of Los Angeles. Third prize, $100 each, went to R. Don Weaver and Mid-States Electronic Co., both Chicago.

CBS-Hytron, Danvers, Mass., brought out a new pliers kit which is available free to service technicians with the

purchase of CBS-Hytron receiving tubes from July 1 through August 31.

General Electric Tube Department, Schenectady, N. Y., announced a new "successful service management" program for TV and radio service technicians. This is described in a 318-page loose-leaf binder covering business practices, merchandising, and technical data. The program is available through G-E tube distributors.

General Cement Manufacturing Company, Rockford, Ill. developed a new counter display for its alignment tools. The display may be used as a serve-yourself merchandiser as well as for easier inventory and stock-taking purposes.

Ward Products Corp., Cleveland, is now packaging its automotive antennas in brilliantly colored boxes displayed in floor and counter racks.

Duotone Corp., Keyport, N. Y., is merchandising a new broadcast quality pencil microphone made by Philips of Holland in an attractive green-and-black velvet-lined package.

BUSINESS

Hallicrafters Co., Chicago, announced the winners in its recent round-the-world sales contest for distributor salesmen. First prize winners were: Roger Duclett of Century-Elcon Distributors, Minneapolis; T. H. Biglieri of Kaemper & Barrett, San Francisco; and Leo Turner of A. F. Epting Appliance Company, Charlotte, N. C. The winners and their wives were awarded a 28-day round-the-world trip.

Federal Telephone and Radio Company, Clifton, N. J., instituted a unique packaging program for merchandising its germanium diodes for replacement use by service technicians. Three packages and two types of dispensers were designed.

John F. Rider Publisher, New York City, designed a new revolving book merchandiser as a sales aid to distributors who handle its books.

Show Notes

The 1954 **Western Electronic Show & Convention** will be held August 25-27, 1954 in the Pan Pacific Auditorium in Los Angeles. More than 100 high-level technical papers will be presented in approximately 27 separate sessions.

The 1955 **IRE Show** will once again be held in the Kingsbridge Armory, Bronx, N. Y. on March 21-24.

Calendar of Events

1954 Western Electronic Show and Convention, August 25-27, Pan Pacific Auditorium, Los Angeles, California.

British National Radio Show, August 25-September 4, Earls Court, London, England.

Production and Sales

RETMA reported that 1,904,718 TV sets had been manufactured during the first four months of 1954 compared with 2,827,821 during 1953. In the same period, 3,326,800 radios were manufactured compared with 4,993,720 for the 1953 period.

RETMA reported cathode-ray tube sales by manufacturers at 2,690,519 for the first four months of this year as against 3,705,997 for the 1953 period. 106,026,920 receiving tubes were sold by manufacturers during the first four months of 1954 compared with 163,401,355 in 1953.

New Plants and Expansions

Sylvania Electric Products, New York, announced plans for the construction of a 210,000-square-foot building in Williamsport, Pa., for use by the Radio Tube Division as a centralized packaging area and for finishing operations in tube manufacture. The company has also begun operations in a new 110,000-square-foot warehouse and sales office which it leased in Teterboro, N. J. Several sales and service facilities previously situated throughout the metropolitan New York area have been consolidated in the new building.

General Electric's Heavy Military Electronic Equipment Department will lease two new buildings now under construction in Syracuse, N. Y.

(*Continued on page* 114)

BUSINESS

Jensen Industries, Inc., phonograph needle manufacturer, moved both its factory and office headquarters to Forest Park, Ill., a west-side suburb of Chicago.

American Phenolic Corp., Chicago, established a Canadian subsidiary, Amphenol Canada Limited, with a manufacturing plant and offices in Toronto, Ont. The company maintained a Canadian branch during World War II.

Sperry Corp., New York City, will build a $600,000 plant for the development and production of electronic tubes in Gainesville, Fla.

General Instrument Corp., Elizabeth, N. J., organized a Canadian subsidiary, General Instrument — F. W. Sickles of Canada Ltd. which purchased Watt Electronic Products, Ltd., with a plant in Kitchener, Ont.

Micamold Radio Corp., Brooklyn, N. Y. opened the first of two branch factories to be built in Tazewell, Va.

Business Briefs

. . . **Gramer Transformer Corp.**, purchased Halldorson Transformer Corp., both located in Chicago, according to a joint announcement by James M. Blacklidge, president of Gramer, and L. S. Racine, president of Chicago Standard Transformer Corp., the Halldorson parent corporation. Blacklidge said that there would be no basic personnel changes in the Halldorson organization and that the line would continue to be available to the distributor trade. Gramer had previously announced its entry into the distributor field with a line of "Tinyformers."

. . . **RETMA** has mailed brochures outlining its recommended course for TV technician training to industrial and trade school supervisors throughout the country.

. . . **Raytheon Manufacturing Company**, Waltham, Mass., has joined eight other companies in participating in a cooperative electrical engineering course at Massachusetts Institute of Technology. Under the plan MIT engineering students do practical work in the firms' laboratories and factories. Upon graduation they will simultaneously be awarded degrees of Bachelor of Science and Master of Science.

. . . **NEDA's** Board of Directors recommended the appointment of a committee to investigate the possibilities of cooperative buying.

. . . **Tele-Matic Industries**, Brooklyn, N. Y., which has filed for an arrangement under Chapter XI of the Bankruptcy Act, is continuing operations, with a greater concentration of its line of TV accessories planned.

. . . **NEDA** Board of Directors recommended a constitutional change whereby new members would be admitted to the association without the present requirement that they be in the distributor business for two years.

. . . **Channel Master Corp.**, Ellenville, N. Y., has negotiated with Nikoh Tube Co. to market its Tele-Tube welded steel tubing for TV masts. END

PEOPLE

Ralph L. Weber, secretary of Gramer Transformer Corp., Chicago, was named executive vice-president. He also retains his position as secretary. **Burt Anderson**, former general sales manager, was promoted to vice-president in charge of sales. **Fred R. Cooper**, former chief engineer, was elected vice-president in charge of engineering.

Ralph L. Weber

Allen J. Dusault was appointed sales manager of the Transistor Division of CBS-Hytron, Danvers, Mass. He has had over ten years experience in sales and advertising in the electronics field.

A. J. Dusault

Marshall L. (Mike) Remund was named jobber sales manager of Jensen Industries, Chicago. He will co-ordinate sales and merchandising programs from the factory to Jensen representatives and their parts jobber accounts.

M. L. (Mike) Remund

Charles Golenpaul, vice-president in charge of distributor sales of Aerovox Corporation, New Bedford, Mass., was elected president of "Radio's Old Timers." **Sam Poncher**, president of Newark Electric, Chicago, became secretary of the organization. **Ray L. Triplett**, founder and president of Triplett Electrical Instrument Co., Bluffton, Ohio, the retiring president of Radio's Old Timers, was presented with a plaque as a testimonial to his service to the industry and the organization.

R. Triplett (left) and C. Golenpaul.

Thomas C. Soby was named advertising and sales promotion manager of

PEOPLE

Allen D. Cardwell Electronics Productions Corp., Plainville, Conn. He was formerly commercial sales manager of the company before leaving it for a year to serve as field engineer and government contract coordinator for Press Wireless Manufacturing Corp.

Thomas C. Soby

Peter Buttacavoli, technical supervisor of the Teleset Service Department of Allen B. Du Mont Laboratories Television Receiver Division, Clifton, N. J., was promoted to manager of field technical services.

P. Buttacavoli

Obituary

Herman A. Bernreuter, vice-president and general manager of Simpson Electric, Chicago, passed away recently after a long illness.

Personnel Notes

. . . **Ewen C. Anderson,** former vice-president, Commercial Department, RCA, was elected executive vice-president, Commercial Department, with headquarters in New York City. Other promotions include: **Dr. Elmer W. Engstrom,** former executive vice-president RCA Laboratories, to executive vice-president, research and engineering, in addition to continuing as head of the RCA Laboratories. His headquarters will be in New York City. **Dr. Irving Wolff,** former director of research, to vice-president, Research, RCA Laboratories, Princeton, N. J. **Dr. D. H. Ewing,** former director of the RCA Physical and Chemical Research Laboratory, to administrative director, RCA Laboratories; and **O. B. Hanson,** former vice-president and chief engineer of NBC, to the RCA staff as vice-president, Operations Engineering.

. . . **George W. Bailey,** executive secretary of the IRE, was elected president of the Armed Forces Communications Association.

. . . **J. P. Driscoll,** former sales representative for the Central District of Sylvania Electric Products, Electronic Products Sales Division, in Chicago, was transferred to the Buffalo-Rochester, N. Y., area. **T. R. Swenson,** formerly sales representative in the Metropolitan New York District, was transferred to the Boston area for the Electronics Sales Division. **R. S. Schoedler,** formerly in Government sales, was appointed New York Metropolitan sales representative.

. . . **Bernard S. Cahill** joined Syntronic Instruments Inc., Addison, Ill., as vice-president and chief engineer. He was formerly with Pioneer Electric & Research Corp.

PEOPLE

. . . **William P. Short** was appointed general manager of the Electronics Division of Gabriel Company, Norwood, Mass. He will also continue his position as assistant to the president of the parent firm.

. . . **Joseph T. Zuravleff** has been transferred to the Chicago District Sales office of Erie Resistor Corp. He was formerly a sales correspondent in the home office in Erie, Pa.

. . . **J. R. Pittle** joined U. S. Wire & Cable Corp., Union, N. J., as sales manager. He was formerly an executive with a wire mill in the Metropolitan New York area.

. . . **Joseph Roche** joined CBS-Columbia, Service Department, Long Island City, N. Y., as publications manager. He formerly held a similar position with Allen B. Du Mont Laboratories. Roche is co-author of the Video Handbook and the Radio Data Book.

. . . **John Hoder** has been promoted to art director of the Ward Products Division of the Gabriel Company, Cleveland, Ohio.

. . . **Henry G. Baker**, vice-president of RCA and general manager of the Instrument Department, will now serve as vice-president and general manager of the newly formed RCA Victor Television Division. **James M. Toney**, former director of distribution of consumer products, was appointed general manager of the new RCA Victor Radio and Victrola Division.

. . . **Daniel Echo** was named to head the newly formed sales office for industrial cathode-ray tubes of the Technical Sales Department of Allen B. Du Mont Laboratories established at the cathode-ray tube plant in Clifton, N. J. He has been with the company for the past three years. **Robert H. Dolbear** heads a similar office for multiplier phototube sales in the Du Mont tube manufacturing plant in Passaic, N. J. He was formerly field service engineer for the Electronic Division of the Curtiss-Wright Corp.

. . . **Joseph Weinberg** was named purchasing agent for Industrial Television Inc., Clifton, N. J. He was formerly with Boonton Radio Corporation.

. . . **Donald E. Smith** was appointed Midwestern District Sales Manager for CBS-Hytron, with headquarters in St. Louis. He will handle sales of CBS-Hytron radio and TV tubes in Missouri, Kansas, and portions of Illinois and Indiana.

. . . **Stanley W. Horrocks** was named general manager of the Special Products Division of Aerovox Corp., New Bedford, Mass. He was formerly with RCA.

. . . **Jerome R. Meltzer** was promoted to assistant sales manager of the new Distributor Sales Department of the Semi-Conductor Division of Radio Receptor Co., New York, N. Y. He was formerly a sales engineer for the company. END

ELECTRONIC LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. All literature offers void after six months.

TUBE BROCHURES

General Electric has issued four new brochures on tubes. One deals with recommended types for AM and FM television receivers, giving characteristic reference charts as well as an interpretation of technical data.

Another brochure describes *Five-Star* tubes which are high-reliability receiving types for any critical application. Essential characteristics of the entire line is included in convenient chart form.

Lighthouse tubes for dependable v.h.f. and u.h.f. performance are described in another brochure which features technical data on the GL-2C39-B and essential characteristics on a complete line of lighthouse tubes.

Another brochure describes the GL-6265—A *Five-Star* version of the 6BH6.

Available gratis from General Electric, Tube Department, Schenectady 5, N.Y.

GERMANIUM DIODES AND TRANSISTORS

Radio Receptor Co., Inc., has issued an 8-page catalog, Bulletin No. G-23, which describes their complete line of germanium diodes and germanium transistors. The catalog is fully illustrated with charts, voltage curves, and diagrams, and lists product applications. Thirty-two different germanium diodes are listed, including four JAN types and nine hermetically sealed diffused p-n-p junction transistors.

Available upon request to the Sales Department, Radio Receptor Co., Inc., 251 West 19 Street, New York 11, N.Y.

ANTENNA CATALOG

Miller Television Co. has put out a new catalog showing over 400 antenna models and over 100 accessory items. Among the models described are bi-focal, v.h.f. and Yagi types.

Available gratis from Miller Television Co., 2840 Naomi, Burbank, Calif.

RADIO AND TV COILS

J. W. Miller Co. has put out 32-page catalog No. 55. It describes television components and coils, adjustable r.f. coils and chokes, FM and v.h.f. components, i.f. transformers, all-wave coils, radio interference filters, receiver-coil kits, and other radio accessories. A complete index and price list of all the equipment described is given.

Available gratis from J. W. Miller Co., 5917 S. Main Street, Los Angeles 3, Calif., and distributors.

ELECTRONIC LITERATURE

ANTENNAS AND ACCESSORIES

Channel Master Corp. has issued a 16-page loose-leaf catalog which illustrates and describes both v.h.f. and u.h.f. antennas, masts, towers, mounts, inter-action filters, and general accessories. Most of the antenna information is supplemented by technical data, including gain curves, horizontal polar patterns, etc.

Available free from Channel Master Corp., Ellenville, New York.

PLASTIC FILM CAPACITORS

Electronic Fabricators, Inc., has announced the availability of their 4-page Technical Publication 154 which contains complete information on the *EFCON* type MH miniature plastic film close-tolerance capacitors. This two-color bulletin contains complete descriptions, specifications, dimensions, test data, and characteristic curves for the MH capacitors.

Available free on request to Electronic Fabricators, Inc., 682 Broadway, New York 12, N. Y.

HI-FI RESISTORS

International Resistance Co. has issued an 8-page catalog No. F-1. Forty-three different types of MP high-frequency resistors are described, giving their characteristics, construction, individual specifications, applications, and installation. The catalog includes photos, charts, and graphs.

Available free from International Resistance Co., 401 N. Broad Street, Philadelphia, Pennsylvania.

PANEL LAMP CHART

United File-O-Matic, Inc., has issued a panel lamp chart which is numerically arranged and is a composite listing of all panel and flashlight lamps manufactured by General Electric, National Carbon, Radio Corporation of America, Raytheon, Sylvania and Tung-Sol. Simply by checking the lamp number on the chart the following information becomes available: manufacturer, bulb type, base, volts, amps, and bead color. All bulb types are illustrated with physical dimensions.

Available free from United File-O-Matic, Inc., 106 Lafayette St., New York 13, N. Y.

QUARTZ CRYSTALS

General Electric Co. has announced the publication of a new 6-page booklet entitled *Quartz Crystals* which contains all pertinent information needed for ordering quartz crystals. Such variables as crystal holder type, temperature range, frequency tolerance over temperature range, and calibration are shown in the tables.

Available free on request to the General Electric Co., Germanium Products, Electronics Park, Syracuse, N. Y. END

BOOK REVIEWS

TELEVISION SERVICING COURSE, compiled by M. N. Beitman. Published by Supreme Publications, 1760 Balsam Road, Highland, Ill. 8½ x 10¾ inches, 192 pages. Price $3.00.

The author's aim in preparing this book is aptly told in the subtitle "Practical Television Training for Home-Study." It is not a fix-it-yourself book for the unskilled. The author assumes a working knowledge of radio servicing techniques and instruments and has slanted the material to enable persons with such knowledge to get into practical TV servicing in a minimum of time.

The first eight lessons (chapters) introduce the reader to basic television theory and practice. They discuss the basic TV receiver with general descriptions of the purpose and functions of the various circuits and controls.

Lessons 9 through 14 consist of a well-correlated compilation of technical service information abstracted from service literature prepared and issued by the leading TV receiver manufacturers. The selection of material is such that the reader gets detailed discussions on the operation of almost every type of circuit used in modern TV sets, and detailed alignment instructions on four popular TV receivers. In this group are splitcarrier and intercarrier sets with 25- and 45-mc i.f.'s. The detailed circuit analyses given here are far more valuable to the novice TV technician than the uneven coverage which so many modern authors give to complex TV circuitry. The trend in many modern TV servicing manuals and texts seems to be to discuss some types of circuits in great detail and ignore or pass over others.

The novice TV service technician will find this book a worthwhile introduction to circuit complexities of, and servicing techniques for, modern TV sets. The experienced TV technician will find it a quick and easy way to master the theory of the many circuit developments and variations now used by set manufacturers.—*RFS*

HOW TO INSTALL & SERVICE AUTO RADIOS, by Jack Darr. 5⅜ x 8¼ inches, 116 pages. Price $1.80. SPECIALIZED AUTO RADIO SERVICE MANUAL, Volume 1-A. 8½ x 11 inches, 182 pages. Price $3.00. Both books are published by John F. Rider Publisher, Inc., 480 Canal St., New York 13, N. Y.

Darr has done an excellent job of introducing to the service technician with limited experience on automobile installations the problems of installing and servicing auto radios. He does not pretend to give the reader a general course in radio servicing or to tell him which ear to lie on while flat on his shoulders working under an automobile's dashboard, but he does answer many questions of importance.

His book is divided into three sections. The first, "Installing Auto Radios," discusses antenna types, control heads, techniques and procedures for eliminating noise by bonding, by-passing, and suppressing; speaker installations, and special techniques and practices for making installations in commercial vehicles such as trucks and buses.

The second section of the book is devoted to special servicing and trouble-shooting methods that apply directly to auto radios. The power supply, speakers, tuning mechanisms, spark plates, realignment techniques, and preventive maintenance are discussed adequately enough to help considerably those service technicians who lack auto radio experience.

"The Auto Radio Service Shop" is the concluding section. It covers special alignment and hand tools, test instruments, parts inventories and business records and concludes with a discussion on earning and holding customer respect and good-will, essential to the success of any business.

Darr's simple matter-of-fact style makes his material easy to read and to understand. All pertinent points are adequately illustrated with photos and drawings.

The Specialized Auto Radio Manual is a useful addition to the library of a radio service shop handling auto radios. It consists entirely of manufacturer's diagrams and service and installation information on radios used in Ford, Lincoln, and Mercury automobiles—1950 through 1954.—*RFS*

THE WEAR AND CARE OF RECORDS AND STYLI, by Harold D. Weiler. Published by Climax Publishing Co., 17 East 48th St., New York 17, N. Y. 5 x 7 inches, 56 pages. Price $1.00.

The weakest link in the entire chain of a high-fidelity system is the stylus. Costing less than any other reproducing component, misuse of the stylus leads to unnecessary record wear and destruction of the very thing for which a high-fidelity setup is designed—high fidelity. Based upon his personal experience and investigation the author has a number of suggestions on stylus life and record care.—*MC* END

PHOTOGRAPHS

RADIO-ELECTRONICS can use good photographs of service benches, service shops, high-fidelity audio layouts, and any other interesting and original radio-electronic devices.

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Full information on subject photographed will increase their acceptability.

The Editor, RADIO-ELECTRONICS
25 West Broadway, New York 7, N. Y.

EDITORIAL

(*Continued from page* 29)

Editor, RADIO-ELECTRONICS

(4) "About your article, 'Wanted: Technicians,' about good pay and others. In your April editorial you mention *specialists of the highest order!*

"Then you go on to say *high grade men* who must know all there is to be known about electronics (a thorough understanding of all phases of electronics). They must know, as you say, math, physics, transistors, etc. Also, you go on to say, *not necessarily college education*, but knowledge of *everything* connected with the art.

"Is there any one man living today *who knows all!* Even engineers themselves are only good at one line. It takes a lifetime and a long grey beard before one can even approach your *so-called know-it-all* superior man or technician."

Henry Chew
Los Angeles, California

Answer: We refer you to our answer *to letter number 3.*

Editor, RADIO-ELECTRONICS

(5) "I only have one question, sir. Where can I get specialized education? I want to be a top-notch electronics technician, but I don't know where to start.

"Could you send me a list of schools, regardless of where they are, so that I can make a choice."

A. A. Dauplaise
San Francisco, California

Answer: You *are the only one who can really answer your question. Every technician and every engineer has certain inclinations towards certain electronic endeavors. Some men specialize in transmission, others in antennas, still others in hundreds of different electronic phases.* Pick out a particular phase in electronics that appeals to you most, *and specialize in it. You will then not be disappointed. Write also to your State Dept. of Education and to U.S. Education office for lists of schools giving radio and electronic instruction.*

Editor, RADIO-ELECTRONICS

(6) "I became interested in the controversy regarding the shortage of specialists.

"I believe that specialists are individuals who have the intelligence, interest and ability to do the particular work in an outstanding manner. They cannot be made solely by so much education or by so many years of practical experience. I agree with Mr. Gernsback's editorial that the present practice is to take young men and start them off with a low salary, and they advance step by step in learning and wages. The selection of these men is usually done through the screening of applications. As a result, only a few out of the many employed become outstanding, *since applications do not show intelligence, interest, or ability, and, besides, are easy to falsify.* Quite often the starting pay is low for this type of work. The more ambitious or energetic type of person will turn to other types of employment, leaving the less desirables to choose from.

"One solution to this problem is to subject the prospective employé to a series of tests that will show his intelligence, interest and ability—give this smaller selected group a considerable increase in starting pay. The result will be more and better specialists."

Thomas L. Bartholomew
Bridgeport, West Virginia

Answer: *The above letter is self-explanatory and can give many employers as well as readers food for thought.*

Editor, RADIO-ELECTRONICS

(7) "I have worked with radio and elec-

tricity since the 1920s. I have a B.S. degree, an E.E. degree, and a Master's degree in Physics. Am a Registered Professional Engineer, and a member of four engineering societies. I frequently take refresher courses in math, and physics at Northwestern and Illinois Tech. Also hold a first-class commercial phone license.

"I have done consulting work throughout the United States and Mexico. I have written books on electricity and electronics, some under my own name, some under another. My present income ranges from $10,000 to $15,000.

"Frankly, I think that is a damned small income for the years I have spent learning my profession. *But—most of my friends in this business fail to come close to this.* Men with a background equal to my own—or better—are existing on $100 a week, or a trifle better.

To learn first-hand the kind of jobs that are open to competent engineers, I answered ads for electrical and electronic engineers. Despite the glowingly worded advertisements, I have yet to receive an offer as high as $6,000 a year. The harsh truth is that if I were forced to seek employment, I could earn more as a truck driver than I could in my own profession.

"I am forced to the conclusion that the widely advertised shortage of competent engineers is largely a myth. This belief is bolstered by the dozens of ads inserted in the *Chicago Tribune* each week by Electronic Engineers seeking employment."

Name Withheld by Request
Des Plaines, Illinois

Answer: *We cannot quite agree with our learned correspondent that the shortage of engineers is a myth. If this were true, would the firms continue to advertise right along? We rather believe that our reader has not been too successful in bringing himself forcefully to the notice of those concerns who can use his fine knowledge best. We admit, it is not always possible to connect with the right industry and the right employer at the right time. Here, again, what we said at the beginning of this editorial holds true. One must everlastingly keep at it to bring oneself to the notice of those who can best use one's services. This may take a long time, ingenuity, a lot of push, and much work.*

Editor, RADIO-ELECTRONICS

(8) "Perhaps all the unfavorable comment you've received regarding the editorial would have been avoided by entitling the piece, '*Wanted: Engineers.*'

"The only person I know of in the electronics field who are in position to command high salaries are graduate engineers. The technicians are, and will remain, salaried about the same as milk peddlers, truck drivers, etc. This really isn't too bad, because if a radioman gets disgusted enough with his lot, he can always shift to truck driving. In addition, he can supplement his income by repairing television and radio sets on the side."

Robert Barg
Webster, New York

Answer: *Perhaps it is best to refer our correspondent to our opening remarks.*

Editor, RADIO-ELECTRONICS

(9) "I would like to state that I have been in the communication field for 28 years. My service has not by any means been confined to one item of the field. I have done all the jobs they have and I consider myself a first-class man in my line. If I did not know my business, I would not receive the top pay of $300.00 a month for my services. I can shoot trouble on wire, radio, and what circuits have you. I carry a first-class am-

EDITORIAL

ateur radio license as well as a 2nd class commercial license, both for over ten years.

"I taught radar and radio theory for the Navy during the last war (at no salary during my spare time). I have all the primary education plus 4 years of college, Electrical Engineering, 3 years of Chemical Engineering, plus a correspondence course in Electrical Engineering, all graduated except the Chemical Engineering.

"I don't know why we can't face the fact that Mr. Kaiser's letter is more truth than poetry. I have found that the large corporations do not want the man with ideas, rather they want a machine, who is willing to keep going on $200.00 to $300.00 a month and be happy that they even let him in the field. If Mr. Kaiser can get in with a starting salary of $200.00 a month, he had better grab it. I started with $80.00 a month and am not over $300.00 yet.

"You mention also that companies are looking for men with ideas. Well, from my experience and many experiences of friends, *they don't want them from the common fellow.* If suggested, it is either too expensive, not practical, or if you have done it on your own, you did not do it according to company specifications, so remove same. Ten years later, it comes out of the laboratories as a wonderful idea, a project made up by the super-minds of the laboratories. They will not admit, however, that the idea was placed there by you and developed.

"Check the communication companies, radio companies, airlines, or what have you, and see how right I am. For several years, I have tried them all, tried to improve myself in salary and otherwise, but have met failure all the time. Sure, I can get $200.00 to $300.00 a month anytime, but I want to improve, not sit on a log."

Daniel F. Lill
Evanston, Wyoming

Answer: *We feel that the best reply to this correspondent is to be found in our answer to letter number 7. And for the record, we have seen repeatedly checks from $1,000 up, given by a large eastern laboratory for suggestions from employees.*

Editor, Radio-Electronics

(10) "I think the whole thing revolves around a misunderstanding of the qualifications for being a "technician." The word has different meanings to various people in the industry. The recent editorial "Specialization" only added to the confusion.

"There is a tendency on the part of some companies to advertise for "technicians" when they really want full-fledged engineers (at technician's salaries?). When desiring such help, other companies ask for engineers or men *with equivalent experience.* There can be no misunderstanding there. Or, they may request jr. engineers. Again, no confusion. Many a good technical man has answered a "technician" ad, only to discover that he must have the educational background of an engineer.

"Naturally, no fast line can be drawn between the two fields. *They overlap.* But a technician is fundamentally a person possessing some special skill, while an engineer is a designer and constructor. From the engineer evolves the creations, upon which the technician applies his skill. The engineer creates the machine, and the technician helps to get it working and keep it working. It requires a different background for these tasks. Many great creative engineers cannot be trusted to put a screwdriver into their creations. Most excellent trouble-shooting technicians do not understand the mathematics of the very circuits they are setting in order. It is rare to find a man of both creative and practical abilities. An engineer may, by his training, be a top-notch technician. But the reverse is not true. A technician is rarely capable of walking in and replacing an engineer.

"*Young man, if you have the ability to be an engineer, run, do not walk, to the nearest college!* The field is wide open. By hook or by crook, get your degree and then special-

RADIO SCHOOL DIRECTORY

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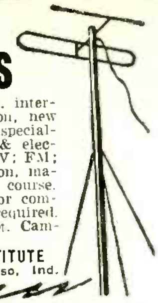

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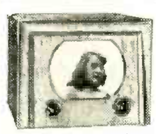

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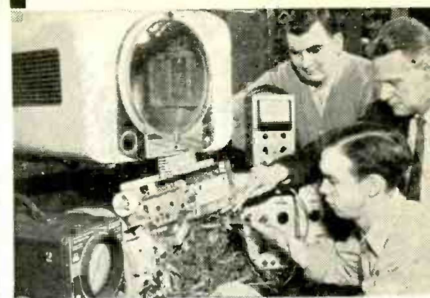

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EDITORIAL

ize. And I mean SPECIALIZE. Learn everything there is to know about one thing. Don't try to learn all about everything, because only God knows that. Take tubes, or transistors, or wave guides, or left-handed allen-screws, *but specialize.* You will have an excellent chance for a rewarding career. If you don't specialize, and learn a good deal about a lot of things, you will only qualify for mediocrity. In electronics, it takes a lot of knowledge to be mediocre, but the salary is true to form."

Robert M. Decker
Lyndhurst, New Jersey

Answer: *An excellent explanation and a better answer to hundreds of letters which we received, than we could possibly write ourselves. We endorse most of the points.*

Editor, RADIO-ELECTRONICS

(11) "Perhaps a short history of my own experiences would help to show what I mean. I took a correspondence course in radio when I was fourteen. When I was sixteen, I worked for a radio shop part-time for sixty-five cents per hour. This was 1944, when most beginning wages for factory workers was thirty to forty cents more. I graduated from high school in 1946, and worked two years for a take-home pay of thirty-five dollars weekly. I started my own shop in the basement of an electrical appliance store and did little better for two more years. Then a job came along for sixty-five a week, and not too long after, a raise to seventy-five. Then came the Army, from which I was discharged last October. I started my own shop again in a strange town. My shop is now beginning to show signs of life. By the end of this year, I hope to show a good profit. It took five years to double my beginning wage. It may take another five years to double it again. If it takes that long, I will still be only thirty years old. *It isn't today we must think of, but tomorrow. You can't start at the top of the ladder of success.* You must first put your foot on the bottom rung. The climb will be tiring, but rewarding; and in the electronics field, the climb is getting higher every day. The sooner you can begin, the better."

Jack Buss
Tacoma, Washington

Answer: *Still another phase of the same question in general, except that this correspondent is his own boss. The letter is most revealing.*

Editor, RADIO-ELECTRONICS

(12) "Recently I answered an ad appearing in amateur radio publications, offering positions for electronics technicians. I felt I met the requirements as listed in the ad, but I followed their instructions and wrote for more information. Instead I received just a standard employment application form and a curt note to fill it in. Their answer to my application was a rude statement that they wanted no part of me. No explanation of where I lacked anything in meeting their requirements. Through much effort on my part, they finally said I was rejected because I have no industrial electronics experience. An item that never appeared in their ad.

"Now I ask you, how can I gain industrial electronics experience to obtain such a position if I cannot get the job to get the experience?

"What am I supposed to do? Throw 20 years of experience and thousands of dollars in education down the drain and go hunt for a job in some other field where my talents might more adequately be rewarded."

Walter R. Whitcomb
Albany, Wisconsin

Answer: *We have an impression that the presentation of this correspondent was inadequate. We point to the first part of the editorial which may give the remedy.* END

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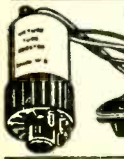

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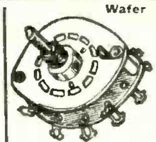

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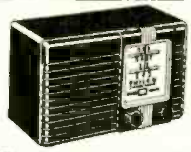

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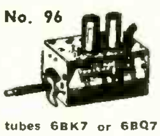

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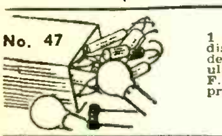

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Type	Price	Type	Price	Type	Price	Type	Price
OA2	.74	**6AU6**	**.46**	**6Y6G**	**.48**	14A4	.69
OA4	.68	6AV5GT	.83	7A4	.47	14A5	.59
OB2	.81	**6AV6**	**.40**	7A5	.59	**14A7**	**.63**
OC3	.72	**6AX4GT**	**.65**	7A6	.69	14AF7	.59
OD3	.70	6B4	.54	**7A7**	**.69**	**14B6**	**.63**
OZ4M	**.65**	**6BA6**	**.49**	**7A8**	**.68**	14B8	.63
1A5	.49	**6BA7**	**.57**	7AD7	.79	14C7	.79
1A7GT	**.47**	**6BC5**	**.54**	7AF7	.53	14E6	.75
1AX2	**.62**	6BD5	.59	7B4	.44	14E7	.88
1B3GT	**.73**	**6BD6**	**.45**	7B5	.45	14F7	.65
1C5	.43	**6BE6**	**.51**	7B6	.69	14H7	.59
1E7	.29	6BF5	.41	**7B7**	**.49**	14J7	.30
1G6	.24	6BF6	.37	7C4	.59	14N7	.84
1H4	.30	**6BG6G**	**1.25**	**7C5**	**.69**	**14R7**	**.79**
1H5GT	**.49**	**6BH6**	**.53**	**7C6**	**.59**	14S7	.89
1L4	**.46**	**6BJ6**	**.49**	7E5	.59	14W7	.30
1LA4	.59	**6BK5**	**.80**	7E6	.30	14X7	.69
1LA6	**.69**	**6BK7**	**.80**	7E7	.59	14Y7	.62
1LC5	.59	**6BL7GT**	**.83**	**7F7**	**.79**	19BG6	1.39
1LC6	.79	**6BN6**	**.59**	7G7	.89	**19T8**	**.69**
1LD5	.59	**6BQ6GT**	**.98**	**7H7**	**.59**	19V8	.79
1LE3	.59	**6BQ7**	**.90**	7J7	.79	24A	.39
1LG5	.69	**6BZ7**	**.90**	7K7	.69	**25AV5GT**	**.83**
1LH4	**.69**	**6C4**	**.40**	7L7	.59	**25BQ6GT**	**.98**
1LN5	**.59**	**6C5**	**.39**	**7N7**	**.69**	**25L6GT**	**.51**
1N5GT	**.67**	6C6	.58	**7Q7**	**.66**	25W4GT	.59
1P5GT	.57	**6CB6**	**.54**	7R7	.89	**25Z5**	**.66**
1Q5GT	.58	**6CD6**	**1.11**	7S7	.79	25Z6	.49
1R5	**.62**	6CF6	.64	7V7	.89	26	.45
1S4	.59	6CS6	.51	7X6	.54	27	.39
1S5	**.51**	6D6	.59	7X7	.70	32L7	.89
1T4	**.58**	**6E5**	**.48**	**7Y4**	**.69**	35	.58
1U4	**.57**	6F5GT	.39	7Z4	.59	**35B5**	**.52**
1U5	**.50**	**6F6**	**.59**	12A6	.54	**35C5**	**.51**
1V	.43	6G6	.42	12A8GT	.61	**35L6GT**	**.51**
1X2A	**.63**	**6H6GT**	**.41**	**12AL5**	**.37**	**35W4**	**.47**
2A3	.30	**6J5GT**	**.43**	12AQ5	.52	**35Y4**	**.54**
2W3	.38	**6J6**	**.52**	**12AT6**	**.41**	**35Z3**	**.59**
2X2	.49	**6J7**	**.43**	**12AT7**	**.72**	35Z4	.47
3A4	.45	6K5	.47	**12AU6**	**.46**	**35Z5GT**	**.47**
3E5	.46	**6K6GT**	**.45**	**12AU7**	**.60**	36	.39
3LF4	.69	**6K7**	**.44**	**12AV6**	**.39**	42	.42
3Q4	**.48**	**6L6**	**.64**	**12AV7**	**.73**	45	.55
3Q5GT	**.49**	6L7M	.68	12AX4	.67	45Z3	.44
3S4	**.58**	6N7M	.63	**12AX7**	**.63**	45Z5	.49
3V4	**.58**	**6Q7**	**.45**	12AY7	.99	**50A5**	**.55**
5U4G	**.55**	6R7	.69	12AZ7	.59	**50B5**	**.52**
5W4GT	.50	**6S4**	**.48**	**12BA6**	**.49**	**50C5**	**.51**
5Y3GT	**.37**	6S78	1.90	**12BA7**	**.60**	**50L6GT**	**.61**
5Z3	**.45**	6S7M	.79	12BD6	.45	50Y6	.49
6A6	.51	6S8GT	.53	**12BE6**	**.51**	50Y7	.50
6A7	.69	**6SA7GT**	**.55**	12BF6	.39	55	.49
6AB4	**.44**	6SD7GT	.41	**12BH7**	**.63**	56	.49
6AC5	.69	6SF5GT	.46	**12BY7**	**.65**	57	.58
6AC7M	**.86**	6SG7GT	.41	12BZ7	.65	58	.60
6AF4	**.90**	6SH7GT	.49	12C8M	.34	70L7	.97
6AG5	**.56**	6SJ7GT	.41	12H6	.56	75	.49
6AG7M	**.99**	**6SK7GT**	**.53**	12SC7M	.63	76	.44
6AH4	**.57**	**6SL7GT**	**.48**	12J5	.42	77	.57
6AH6	**.73**	**6SN7GT**	**.59**	12J7	.49	78	.47
6AJ5	.65	**6SQ7GT**	**.46**	12K8	.59	80	.43
6AK5	**.55**	6SR7GT	.45	12Q7	.59	83V	.68
6AK6	**.59**	6SS7GT	.42	12S8GT	.62	84/6Z4	.46
6AL5	**.42**	6T4	.99	**12SA7GT**	**.65**	85	.59
6AM8	.78	**6T8**	**.80**	12SF5	.50	117L7	.99
6AQ5	**.50**	**6U5**	**.57**	12SG7	.51	117P7	.99
6AQ6	**.37**	6U6	.59	12SJ7M	.67	**117Z3**	**.37**
6AQ7	**.70**	**6U8**	**.78**	**12SK7GT**	**.63**	117Z6	.69
6AR5	**.45**	**6V6GT**	**.50**	**12SL7GT**	**.57**	807	.99
6AS5	**.50**	**6W4GT**	**.47**	**12SN7GT**	**.52**	866A	1.39
6AS6	**$1.49**	**6W6GT**	**.57**	**12SQ7GT**	**.56**	Hi-Po #567	1.39
6AT6	**.41**	**6X4**	**.37**	12SR7M	.49		
6AU4GT	**.68**	**6X5GT**	**.37**	**12V6GT**	**.46**		
6AU5GT	**.82**	**6X8**	**.75**	**12X4**	**.38**		

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Radio-Electronics does not assume responsibility for any errors appearing in the index below.

All Channel Antenna Corp. 126
Alliance Mfg. Co. Inside Front Cover
Allied Radio Corp. 17
American Electric Heater Mfg. Co. 107
American Microphone Co. 100
American Phenolic Corp. 104
American Television and Radio Co. 89
Amplifier Corporation of America 113
Arkay Radio Kits, Inc. 124
Astatic Corp. 18
Atlas Sound Corp. 82
Audel Publishers 90
Barry Electronics Corp. 128
Belden Manufacturing Co. 97
Bell Telephone Labs. 26
Blonder-Tongue Labs. 12
Brooks Radio & TV Corp. 101, 115
Cannon Electric Co. 110
Capital Radio Engineering Institute 22
Centralab—Division of Globe Union 90, 112, 122
Century Electronics Co. 124
Channel Master Corp. 7
Chicago Standard Transformer Corp. 123
Clarostat Manufacturing Co. 91
Cleveland Institute of Radio Electronics 11
Collins Audio Products Co., Inc. 90
Columbia Electronics Corp. 124
Concord Radio 82
Cornell-Dubilier Electric Corp. 95
Cornish Wire Co. 90
Coyne Electrical & TV Radio School 94, 105, 126
DeVry Technical Institute 9
Dorian Electronics 117
Edlie Electronics 96
Electric Sweeper Service Co. 98
Electro-Voice Inc. 6
Electron Tube Wholesalers, Inc. 124
Electronic Instrument Co. 28, 93, 124
Electronic Measurements Corp. 102
Federal Telephone & Radio Company 83
General Industries Co. 98
General Test Equipment 124
Good, Inc., Don 117
Halldorson Transformer Co. 121
Heath Co. 65-68
Hudson Specialties Co. 120
Hughes Research & Development Labs. 82
Indiana Technical College 116
Instructograph Co. 117
International Correspondence Schools 13
International Rectifier Corp. 113
Jackson Electrical Instrument Co. 20
Jensen Industries 109
Jones & Laughlin Steel Corp. 119
Karlson Associates 109
Leotone Radio Corp. 122
MacMillan Co., The 120
Mallory & Co., Inc., P. R. 99
McGraw-Hill Book Co. 110
Moss Electronic Distributing Co. 74, 75
Muzak Corp. 79
National Electronics of Cleveland 94
National Radio Institute 3, 129
National Schools 5
Opportunity Adlets 115
Orradio Industries, Inc. 111
Oxford Electric Co. 126
Penman Electronics 98
Philco Corp. 24, 25
Precise Development Corp. 108, 109
Precision Apparatus Co., Inc. 92, 95
Progressive "Edu-Kits," Inc. 103
RCA Institutes, Inc. 15
RCA Victor Division (Radio Corp. of America) Back Cover
Rad-Tel Tube Co. 127
Radelco Manufacturing Co. 88

RADIO SCHOOL DIRECTORY

PAGE 125

Baltimore Technical Institute
Candler System Co.
Capitol Radio Engineering Institute
Grantham School of Electronics
Indiana Technical College
Indianapolis Electronic School
Milwaukee School of Engineering
RCA Institutes, Inc.
Tri-State College
Valparaiso Technical Institute
Video Specialties
Western Television Institute

Radio Television Training Ass'n. 27
Raytheon Manufacturing Co. 10
Rider, Inc., John F. 100
Rinehart & Co., Inc. 88, 109
Rose Company 122
Sams & Co., Inc., Howard W. 16, 94
Sarkes Tarzian, Inc. 86
Service Instruments Co. 128
Shure Brothers, Inc. 16
Sprayberry Academy of Radio 63
Stan-Burn Radio and Electronics 116
Steve-El Electronics Corp. 113
Stuart Electronic Distributing Co. 86
Sylvania Electric Products 19
Tab 130
Technical Appliance Co. 73
Teltron Electric Co. 116
Terado Co. 106
Tipco Company 128
Transamerica Electronics 88
Transvision, Inc. 92
Triad Transformer Corp. 96
Trio Manufacturing Co. 21
Triplett Electrical Instrument Co. Inside Back Cover
Tri Tech 124
Tung-Sol Electric Co. 8
United Catalog Publishers 123
V.A. Enterprises 116
Ward Products Corp. 23
Webster Electric Corp. 71
Windsor Electronic Tube Co. 93
Winegard Co. 14
Zingo Products 94

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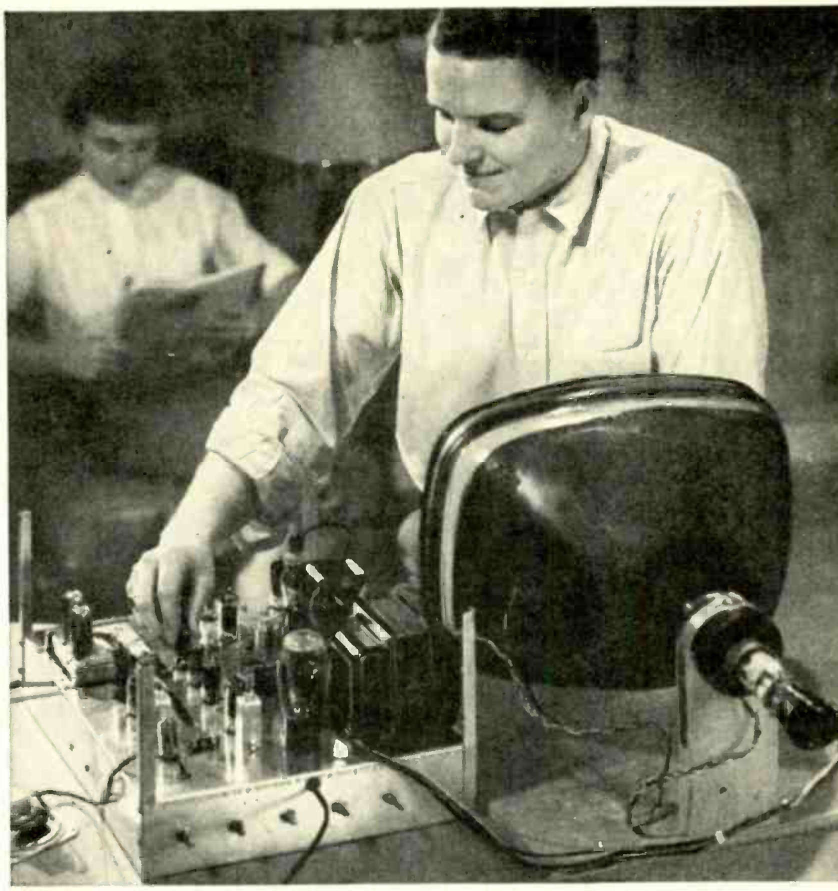

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