In this issue:
- Oscilloscope Patterns and Amplifier Diagnosis
- High-Quality Circuits: Tone Compensation
- U.h.f. Television Antennas
- Servicing u.h.f. TV
- TV Signal Tracing Practices and Problems
- Heterodyne Freqmeter Uses Transistors
- Automatic Headlight Dimmer

Experimental Communication with Light Beams
(See page 4)
Look at the Selling Power of the RCA Radio Battery Package

SMART RCA package design means faster sales, greater inventory turnover for radio dealers and servicemen selling RCA Radio Batteries. This outstanding package styling is another example of the powerful sales appeal of the Radio Battery for the Radio Trade.

Call your RCA Battery Distributor for fast, reliable service. Stock, sell and promote RCA Batteries—the Radio Battery for the Radio Trade.

SMART DESIGN
RCA Radio Batteries are colorfully styled to catch the customer's eye when displayed in store windows, on counters, in merchandisers, and on shelves. You can use this valuable design in reminding customers to buy RCA Radio Batteries.

STEEL-ENCASED (certain types only)
Special steel casings on RCA Battery types VS216, VS236, VS036, VS035, VS084, VS085, and VS086 protect their contents—control bothersome swelling, resist leakage, and damage from shock. This important feature will help you sell more of these RCA Battery types.

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Consumers everywhere recognize RCA as the "greatest name in radio." The RCA trademark stands for experience in the marketing of quality products for radio. It is your assurance of immediate customer acceptance.

REPLACEMENT AID
You see, at a glance on the side of the RCA Battery carton, which portable battery types of other manufacturers it will replace. This is another way RCA Batteries help you turn every customer inquiry into a battery sale.

REPEAT BUSINESS PROMOTION
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GOOD JOBS AWAIT THE TRAINED RADIO-TV TECHNICIAN

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- Broadcasting
- Radio Manufacturing, Sales, Service
- Television Manufacturing, Sales, Service
- Laboratories: Installation, Maintenance of Electronic Equipment
- Electroluminescent, Call Systems
- Garages: Auto Radio Sales, Service
- Sound Systems and Telephone Companies, Engineering Firms
- Theatre Sound Systems, Police Radio
- And scores of other good jobs in many related fields.

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MEMBER Audit Bureau of Circulations

Vol. XXIV, No. 10

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Maid Rae George is here shown operating one of Leslie Gould's latest light-beam transmitters, in typical Connecticut terrains.

Color original by Avery Slack

Give

enough!

FEATHER SERVICES


SUBSCRIPTION RATES: In U. S. and Canada, $1.00 a year; $5.00 for two years; $6.00 for three years; single copies 35. All other foreign countries $2.50 a year; $5.00 for two years; $6.00 for three years.


F. W. Gernsback, President.

A. H. Gernsback, Editorial Director.

C. A. Gernsback, Circulation Director.

B. J. Gernsback, Advertising Manager.

Address all editorial, advertising, and business correspondence to Radio-Electronics, Jupiter Avenue, P to G stvs., Philadelphia 6, Pa., or 25 West Broadway, New York 7, N. Y.

SUBSCRIPTIONS: Address correspondence to Radio-Electronics, Subscription Dept., Erie Avenue, P to G stvs., Philadelphia 6, Pa., or 25 West Broadway, New York 7, N. Y. When ordering a change of address forward an address label from a recent internal to allow one month for change of address.

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LEFT: At Home You Build and Keep A Jewel-Bearing Multi-Meter... an extremely handy meter. Together with the Oscilloscope, it can also help you "learn while you learn"—servicing in your spare time.

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OCTOBER, 1953
If knowledge came in containers, almost anyone could pioneer in the design and development of Electron Tubes — might even match RAYTHEON'S remarkable record of achievement in the industry.

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That's why you can use Raytheon Radio and Television Tubes — today and tomorrow — with complete confidence that you are using the finest. Ask your Raytheon Tube Distributor for them.
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Job offers like these to our graduates every month
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*See our special feature on "How to Pass FCC License Examinations" (does not cover exams for Amateur Licenses, as well as a choice of Amateur sets and an old-time new book, 'How to Pass FCC License Examinations."

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

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

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

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3. Plus These Other Outstanding Features
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   • Operates at upwards of 350 feet from control point
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Eliminates need for stub mast assembly. Mounts directly on chimney, and below chimney crown, protecting drive unit from soot and corrosive fumes.

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

VP TUNING
Only the Superotor with double lock stop, permits “finger tip” Vernier Precision tuning.
TRIPPLETT 630 Volt-Ohm-Mil-Ammeter "speaks" for itself in any company

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

The Single Switch

Further indication of the practical skill and engineering "know-how" behind Triplet 630 is the Single Switch. Its simplicity of operation assures no burn-outs thru momentary memory lapses. There is instant switch-

ing to desired circuit thru a single 2 1/2" knob flush with the face panel. The molded switch itself embodies the most advanced engineering techniques. Fully enclosed, the silvered contacts are kept permanently clean. Its rugged construction means stronger performance and longer life.

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

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

Ranges

D.C. Volts: 0-12-60-300-1200—at 20,000 Ohms/Volt (For Greater Accuracy on TV and other High Resistance Circuits.)

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(For Direct Reading of Output Levels.)

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D.C. Milliamperes: 0.00-—at 250 Millivolts.

D.C. Ohms: 0-12-—at 250 Millivolts.

*Megohms: 0-1-100—(4,444,400,300 center scale).

Output: Condenser in series with A.C. Volt ranges.

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

Get a Triplet 630 into your own hands at your distributor.

U.S.A. Dealer Net $3950

TRIPPLETT ELECTRICAL INSTRUMENT COMPANY
BLUFFTON, OHIO

TRIPLETT

14
ANOTHER CBS-HYTRON CTS-RATED* FIRST

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

RUN-AWAY PLATE CURRENT

FORGET:

HIGH-VOLTAGE ARC-OVERS

SHRINKING TV PICTURES

Replace 6BQ6GT with New Work-Horse

CBS-HYTRON 6CU6

MECHANICAL FEATURES OF 6CU6

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

Cut your call-backs by up to 40 per cent with CBS-Hytron 6CU6. It's directly interchangeable with the 6BQ6GT. It's rated the same as the 6BQ6GT. But the new CTS-Rated 6CU6 will live under 6BQ6GT maximum ratings. How? The 6CU6 has generous margins of safety for: plate dissipation...plate current...high-voltage insulation...and high-line protection. The older 6BQ6GT is a good tube. But remember it was originally designed for 10- and 12-inch TV sets. Today it carries the load in 21-inch sets. Furthermore, it must combat the accumulated dissipation caused by: line-voltage variations...faulty receiver adjustment...and shifting values of components due to age and overload. Result: the 6BQ6GT may actually be operated well above its maximum ratings in many TV receivers.

In the new CBS-Hytron 6CU6, you have a tube that takes this rough treatment. And continues to ask for more. High voltage and heat meet their match. The weakest link in the TV tube line-up becomes the strongest. And your call-backs plunge downward. Bet you can't wait to try the CTS-Rated 6CU6. We couldn't. It's a honey! Watch for it soon at your CBS-Hytron distributor's.
For years the accepted way to connect wires to telephone apparatus was with solder. Now, Bell Laboratories engineers have discovered how to make connections faster and better—without solder.

Solder, they reasoned, wouldn't be needed if wire and terminal could be kept tightly pressed together. But, for economy, this had to be done with the wire alone—without complicating screws and springs.

They found the answer in using a properly dimensioned terminal with sharp edges... whipping the wire around it under high tension. The terminal bites into the wire, locking it securely into position. Thereafter the squeezed edges maintain a contact pressure of at least 15,000 pounds per square inch—even under vibration that cracks soldered joints.

The new connections can be made in half the time—a big money-saver in the billion connections that Western Electric makes each year for the Bell System. It's another example of the way Bell Telephone Laboratories works continually to keep costs low.
things are NOT as they seem...

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

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

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

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

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

Philip S. Rand receiving special citation.

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

THE COMPATIBLE COLOR TV set is no longer just around the corner. The FCC in its tentative adoption of color TV standards as proposed by the National Television System Committee has opened the way for compatible color TV sets to appear in retail stores by next spring, according to statements made by RCA in its petition to the FCC supporting NTSC standards. Objections may come from the three-dimension color TV advocates, such as Dr. Allen Du Mont and U. A. Sanabria, president of American Television, Inc., Chicago, who said he would oppose the NTSC standards. Already on record in support of the new standards are NTSC itself, an industry-wide committee of engineers and scientists created in 1951: RCA and NBC in a joint petition; Philip S. Rand, Sylvania Electric Products, Inc.; General Electric; and Motorola. Hazeltine, a research laboratory which has had an important part in color TV, told the FCC it also would support the new standards.

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

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

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

In addition, WSBG-T, Sarasota, moved from channel 2 to channel 3; and WROV-TV (27), Roanoke, Virginia, went off the air.

An error in listing a construction permit was made in our August issue. The given call-WJAR (Taco, Wash.) should be KMO.

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

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

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

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

RADIO-ELECTRONICS
I Will Train You at Home
For Good Pay Jobs, Success in
RADIO-TELEVISION

Practice Broadcasting
with Equipment I Send

As part of my Communications
Course I send you kits of parts to
build the low-power Broadcasting
Transmitter shown at the left.
You use it to get practical experi-
ence "on the air," performing
procedures demanded of
Broadcasting Station Operators.
An FCC Commercial Operator's
License can be your ticket to a
clean future; my Communications
Course gives you the training you need to
gain your license. Mail card below and
see in my book other valuable
equipment you build.

Practice Servicing
with Equipment I Send

Nothing takes the place of PRAC-
TICAL EXPERIENCE. That's why
NRI training is based on LEARN-
ING BY DOING. You use parts I
furnish to build many circuits com-
mon to Radio and Television. With
my Servicing Course you build a
modern Radio (shown at right).
You build a Multitester which you use to
help fix sets while training. Many
students make $10, $15 a week extra
fixing sets in spare time starting a
few months after enrolling. All
equipment is yours to keep. Card
below will bring book showing other
equipment you build.

AVAILABLE TO
VETERANS
UNDER G.I. BILL

Good Jobs, Good Pay, Success
in Radio-TV! SEE OTHER SIDE

CUT OUT AND MAIL THIS CARD NOW
Sample Lesson & 64-Page Book
Both FREE

This card entitles you to Actual Lesson on Servicing,
shows how you learn Radio-Television at home. You'll
also receive my 64-Page Book, "How to Be a Success
in Radio-Television." Mail card now!

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Television is Growing Fast
Making New Jobs, Prosperity

More than 25 million homes now have Television sets
and thousands more are being sold every week. Well
trained men are needed to make, install, service TV sets.
About 200 television stations on the air with hundreds
more being built. Think of the good job opportunities
here for qualified technicians, operators, etc. If you're
looking for opportunity get started now learning Radio-
Television at home in spare time. Cut out and mail
postage free card, J. E. Smith, President, National Radio
Institute, Washington, D. C. OUR 40TH YEAR.
Train at Home to Jump Your Pay as a RADIO-TV Technician

Get a Better Job—Be Ready for a Brighter Future in America's Fast Growing Industry

Training PLUS opportunity is the PERFECT COMBINATION for job security, good pay, advancement. When times are good, the trained man makes the BETTER PAY. GETS PROMOTED. When jobs are scarce, the trained man enjoys GREATER SECURITY. NRI training can help assure you and your family more of the better things of life.

Radio-Television is today's opportunity field. Even without Television, Radio is bigger than ever before. Over 3,000 Radio-Broadcasting Stations on the air; more than 115 million homes and Automobile Radios are in use. Then add Television. Television Broadcast Stations extend from coast to coast now with over 25 million Television sets already in use. There are channels for 1,500 more Television Stations. Use of Aviation and Police Radio, Micro-Wave Relay, Two-Way Radio communication for buses, taxis, trucks, etc. is expanding. NRI training includes Television principles coming in Industry, Government, Communications and Homes.

My Training is Up-to-Date

You Learn by Practicing

Get the benefit of my 40 years experience training men. My well-illustrated lessons give you the basic principles you must have to assure continued success. Skillfully developed kites of parts I furnish "bring to life" the principles you learn from my lessons. Read more about equipment you get on other side of this page.

Naturally, my training includes Television. I have, over the years, added more and more Television information to my courses. The equipment I furnish students gives experience on circuits common to BOTH Radio and Television.

Find Out About the Tested Way to Better Pay

Read at the right how just a few of my students made out who acted to get the better things of life. Read how NRI students get $10, $15 and more fixing Radios in spare time starting soon after enrolling. Read how my graduates start their own businesses. Then take the next step—mail card below.

You make absolutely no risk. I even pay postage. I want to put an Actual Lesson in your hands to prove NRI home training is practical, thorough. I want you to see my 64-page book, "How to Be a Success in Radio-Television" because it tells you about my 40 years of training men and important facts about present and future Radio-Television job opportunities. You can take NRI training for as little as $8 a month. Many graduates make more than the total cost of my training in two weeks. Mailing postage free card can be an important step in making your future successful. J. E. Smith, President, National Radio Institute, Washington, D. C. OUR 40TH YEAR.

I TRAINED THESE MEN

Handicapped but Successful

"I am now Chief Engineer at WHAK. My left hand is off at the elbow, and if he wants to—R. J. Halley, Weston, W. Va.

Control Operator, Boston spares time

"I received my Territorial warrant last summer. Now with WEAN as a full-time operator, my commission is complete." R. Arnold, Rumford, R. I.

Has Growing Business

"Am becoming expert Technician. Without NRI, I can never have been so successful.

Has Own Television-Television Shop


Get First Job thru NRI

"My first job was with KDLR. Now Chief Engineer of Radio Equipment and Fire Dept." T. Norton, Hamilton, Ohio.

Find Out What RADIO-TV Offers You

SAMPLE LESSON and 64-PAGE BOOK

Both FREE

Start Soon to Make $10, $15 a Week Extra Fixing Sets

Keep your job while training. Many NRI students make $10, $15 and more a week extra fixing neighbors' Radios in spare time starting a few months after enrolling. I start sending you special booklets that show you how to fix sets the day you enroll. The multistester help you with parts I furnish helps discover and correct troubles.

Do You Want Your Own Business?

Many NRI trained men start their own successful Radio-Television services. I have business contracts with capital earned fixing Radios in spare time. My book tells how you can be your own boss. Joe Travers, a graduate of mine, in Asbury Park, N. J., writes: I've come a long way in Radio and Television since graduating. Have my own business on Main Street!"
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ultra-modern facilities TO SERVE YOU BEST

FREE!

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1954 ALLIED
268-PAGE CATALOG

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- Test Instruments
- High-Fidelity Equipment
- Custom TV Chassis
- AM, FM Tuners and Radios
- Recorders and Supplies
- P. A. Systems, Accessories
- Amateur Station Gear
- Builders' Kits, Supplies
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Fastest Service in Electronic Supply

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You'll want the one complete Buying Guide to Everything In Electronics—268 pages packed with the world's largest selection of quality equipment at lowest, money-saving prices. See all the latest releases in custom TV chassis, TV antennas and accessories; AM and FM tuners and radios; everything in High-Fidelity custom components; latest P. A. Systems and accessories; recorders and supplies; Amateur receivers, transmitters and station gear; specialized industrial electronic equipment; test instruments; builders' kits; huge listings of parts, tubes, tools, books—your choice of the world's most complete stocks of quality equipment. ALLIED gives you every buying advantage: speedy shipment, expert personal help, lowest prices, liberal terms, assured satisfaction. Get the 1954 ALLIED Catalog. Keep it handy—and save time and money. Send for your FREE copy today.

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TV and HI-FI SPECIALISTS

To keep up with developments in High-Fidelity and TV, look to ALLIED. Count on us for all the latest releases and largest stocks of equipment in these important fields. If it's anything in High-Fidelity or Television—we have it in stock!
A NEW MEMORY DEVICE which combines the features of high speed with a potentially huge information storage capacity, was described by Dr. Rajchman of RCA at a symposium on digital computers sponsored by the Argonne National Laboratory. The device consists basically of 10,000 tiny ring-shaped magnets woven on thin wires. The high-speed electronic memory device promises to help solve scientific and economic problems too vast and too complex for the present capabilities of electronic computers. Dr. Rajchman said the new device offers significant advantages for computers of the future because it can memorize a bit of information in a few millionths of a second; it can store 10,000 "bits" of information at one instant; it potentially has a very high degree of reliability; and it promises to be relatively cheap, as memories for computers go.

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

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

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

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

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

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

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

Are you satisfied with the position you now hold? Do you feel you're worth more money? Are you pleased with yourself, your work, your associates ... and your future? What does the next year hold for you ... and the year after that?

Are you content merely to plod along through the best years of your life ... or do you want to get into more pleasant work ... hold a well-paid job ... perhaps establish your own business?

If you are looking for a Real opportunity ... If you want to Grow with a Growing Industry ... If you want to grasp the success that should be yours, then we say to you, Study TV Servicing.

Everyone knows that Television is the fastest growing industry today. Opportunities are going begging for men who have the training and ability to grasp them. Now is the time to start on the road to success in TV Servicing.

Study at Home in your spare time
The RCA Institutes Home Study Course in TV Servicing is easy to learn. You progress rapidly, step by step, as you learn the procedure of servicing and trouble-shooting TV receivers and installing TV antennas. Hundreds of pictures and diagrams help you understand the how-it-works information and the how-to-do-it techniques.

A Service of Radio Corporation of America
The RCA Institutes TV Servicing course was written and planned by instructors with years of specialized experience in training men. You get up-to-the-minute information, too, because you study right at the source of the latest developments in Television. Your lessons are carefully examined and accurately graded by competent teachers who are interested in helping YOU to succeed.

RCA Institutes is licensed by the University of the State of New York ... an affiliate member of the American Society for Engineering Education ... approved by leading Radio-Television Service Organizations.

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SYLVANIA TUBES JUST
CAN'T BE BEAT FOR QUALITY!

WHY SYLVANIA PRODUCTS
MEAN BETTER BUSINESS!

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

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

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

So, if you want recognized quality working on your side . . . sell
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Television keeps telling
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Sylvania's popular nation-wide television
show "Beat the Clock" continues to tell
millions of your customers week after
week, all through the year, about the
unbeatable quality of Sylvania products.

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YOUR ELECTRONIC EQUIPMENT
Demands Highly Specialized
WIRE

THE MANUFACTURERS AND SERVICE MEN WHO SERVE BEST

Specify Belden
WIRED MAKER FOR INDUSTRY
This book will save you 30 Minutes a day

FIND TUBE RATINGS, CONNECTIONS IN SECONDS
This big new Westinghouse Ready-Guide is a completely new kind of handbook of receiving tube data. Designed to save time for busy servicemen and engineers, eliminates "squinting" at tiny data listings.

BIG - BOLD - CLEAR
Just 9 tube types are listed on each 8½" x 11" page. Not 30 or 40 tiny type listings as in most condensed data books. Best of all, large clear base diagrams are located on the same page as ratings. Bothersome cross referencing, footnotes cut to the bone.

COMPLETE, ACCURATE, UP-TO-DATE
This new Westinghouse Ready-Guide lists complete data on receiving tubes which account for more than 98% of tube usage. 48 pages. 385 pictures and diagrams. 342 types listed.

SPECIAL: 3 for $1.00
This Ready-Guide is being sold at less than cost as an introductory offer only. Price is only 35¢ - 3 for $1.00. Order from your nearest RELIATRON Tube Distributor or mail coupon below.

ONLY 35¢
- COMPLETELY NEW
- FIRST EDITION
- JUST OFF THE PRESS

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

RADIO BUSINESS

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

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

<table>
<thead>
<tr>
<th></th>
<th>July</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Manufacturers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased prices</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>Decreased prices</td>
<td>21</td>
<td>16</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Product Group</th>
<th>No. of Mfrs.</th>
<th>No. of Products</th>
<th>No. of Mfrs.</th>
<th>No. of Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antennas &amp; Access.</td>
<td>7</td>
<td>30</td>
<td>6</td>
<td>21**</td>
</tr>
<tr>
<td>Capacitors</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0**</td>
</tr>
<tr>
<td>Controls &amp; Resistors</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sound &amp; Audio</td>
<td>13</td>
<td>141**</td>
<td>5</td>
<td>16**</td>
</tr>
<tr>
<td>Test Equipment</td>
<td>3</td>
<td>25**</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Transformer</td>
<td>2</td>
<td>134**</td>
<td>1</td>
<td>20**</td>
</tr>
<tr>
<td>Tubes</td>
<td>6</td>
<td>13**</td>
<td>4</td>
<td>5**</td>
</tr>
<tr>
<td>Wire &amp; Cable</td>
<td>0</td>
<td>0**</td>
<td>0</td>
<td>0**</td>
</tr>
</tbody>
</table>

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

This data is based on the reports of leading manufacturers and distributors, and includes only the most active product categories.

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

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

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

Vaco Products Co., Chicago, introduced new shelf brackets for mounting...
ATTRACTION YELLOW MOLED PLASTIC SHELL
Non-inflammable. Will not burn or melt under soldering iron or flame.

BONDED SEAL
Positive, heat resistant, non-inflammable bond seals leads and shell, locks out humidity.

FIRMLY SECURED LEAD
Can't be pulled out, even under soldering iron heat.

ASTRON
BLUE-POINT
MOLDED PLASTIC PAPER
Capacitors

Yes, the ASTRON BLUE-POINT's tighter seal and tougher shell give you heat and moisture protection to a degree never before possible—providing a longer life and greater dependability than has ever been achieved in a molded plastic capacitor! BLUE-POINT is a capacitor you can rely on completely, under every condition.
BLUE-POINT is suitable for continuous operation at 85°C. The bonded seal uses a special thermo-setting, heat-resistant, non-inflammable bonding agent—positive protection against moisture. Solder leads as close to the capacitor as you like—they won't pull out! Every BLUE-POINT is clearly marked with voltage and capacitance, bears outside foil identification. Every BLUE-POINT is tested and guaranteed. Look for the ASTRON BLUE-POINT when you buy capacitors from your jobber, or if he doesn't carry it, send us his name. Insist on ASTRON BLUE-POINT, the capacitor you know you can depend on. Order a supply today.

For complete performance characteristics, specifications and listings, write for Bulletin AB-20A

ASTRON CORPORATION
255 Grant Ave., E. Newark, N. J.

OCTOBER, 1953
in Merit’s line but complete coverage where it counts!

Keep inventory at a minimum, profits high with Merit’s designed - for - action line. Among the new, quick-turnover items recently added: flybacks for Motorola replacement, a new series of yokes and TV power transformers. Find Merit’s complete line listed in John Rider’s Tek-File and Howard Sam’s Counter Facts and Photo Facts—Tape Marked* to help you.

And! Be sure to get Merit’s new, really complete Replacement Guide.* Forty pages of replacement data and schematics, including IF-RF coils, an exclusive Merit feature.

*originated by Merit

RADIO BUSINESS

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

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

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

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

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

Heppner Manufacturing Co., Round Lake, Ill., is offering a new sample rack holding 12 ion traps ranging from 25 to 58 gaussies. It is available, without charge, to engineers engaged in TV set manufacture.

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

Production and Sales

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

New Plants and Expansions

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

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

Herlee Corp., ceramic capacitor man- ufacturing affiliate of Sprague Electric Co., moved its operations to its new plant in Grafton, Wis.

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

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

Tri-Go Manufacturing Co., completed a new addition to its plant at Griggsville, Ill. Included is 54,000 sq. ft. of manufac- turing space and a new laboratory.

International Resistance Co., Phila- delphia, is building a new plant in Boone, N. C.

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

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

Sylvania Electric Products, Television Picture Tube Division, Seneca Falls, N. Y., is perfecting methods and increasing facilities for the mass pro- duction of aluminized picture tubes. At the same time, H. Ward Zimmer, Syl- vania president, announced the estab- lishment of an Electronic Defense Lab- oratory to be located in temporary quarters in Mountain View, Calif.

Teletronics Laboratory, Inc., com- pleted a new engineering building ad- jacent to its manufacturing plant in Westbury, N. Y.

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

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

Business Briefs

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

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

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

Wilys Motors, Inc., Electronics Division, Toledo, Ohio, has entered the television transmitter field.
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WANTED: INERTIALESS SPEAKERS

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

By HUGO GERNSBACK

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

*See Radio-electronics, November 1951
OSCILLOSCOPE PATTERNS and AMPLIFIER DIAGNOSIS

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

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

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

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

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

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

Phase Shift.

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

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

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

Finding the phase angle

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

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

Distortion

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

The movement could be imagined as...
Fig. 3—Setup for injecting phase shift into either X or Y plate feed circuits.  

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

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

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

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

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

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

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

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

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

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

Fig. 6 shows the arrangement applied with switching for frequencies of 100, 1,000, and 10,000 cycles. An
extra switch is provided so the phase shift network can be inserted or removed at will. This enables the frequency applied to the amplifier to be swept through the frequency spectrum without deliberate phase shift, switching over to the phase-shift arrangement at the preset frequencies of 100, 1,000, and 10,000 cycles for more detailed investigation of the pattern at these points.

**Fig. 6—Three-frequency shift network.**

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

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

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

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

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

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

**Loudspeakers**

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

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

Since even the finest of loudspeakers fall considerably short of perfection, the best way to place one in a system is to listen to several within your potential price range, know a little about speakers in general, and then make your choice to take advantage of whichever one within your spending range does best. The listening and initial selection can be done in any of the many audio equipment salesrooms throughout the country, most of which are run by electronics jobbers. Fig. 1 shows a portion of the audio room at a New York electronic parts distributor. Most of the items are actually connected to a central distribution panel so that the customer can listen to as many systems as he wishes, each composed...
of components of his choice and put together in a few seconds at the distribution panel. Unless mail order is the only means, good audio equipment should not be bought without giving an audience at a showroom and comparing it to other models. This is especially true of speakers. Since speakers fall short of perfection, each speaker and each system has to a large extent its own sound character. The only way to get the best from a system is to choose the one whose sound suits you.

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

**Speaker structure**

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

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

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

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

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

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

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

**Speaker quality factors**

The description we have just given illustrates the essentials of speaker construction. Most speakers, big and little, are made and indifferent, not in the same way. What, then, makes the differences between speakers?

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

Electromagnetic speakers once were common. They had no permanent magnets; the field was created by a large coil of wire in the same position as the magnet in present-day speakers. It was excited by direct current either from a special power supply or from the B supply of the set. Electrodynamic speakers are subject to hum from the field supply, and they waste power. Avoid them for high-quality systems. Voice coils are invariably of low impedance, never higher (except in very special cases) than about 16 ohms. The reason is that higher impedances could be obtained only by more turns. That would increase the weight of the coil and restrict its ability to move quickly in response to high frequencies. It would also, of course, cause overshoots and lags. The nominal a.c. impedance of a voice coil has no relation whatever to the quality of a speaker, but its actual ohmic resistance does.

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![Fig. 2-Cutaway view of modern loudspeaker.](image-url)
Ideally the impedance should be pure inductance, since a pure reactance consumes no power. The power fed to the speaker should be used to move air, not to cause heat in the voice coil. Even a small amount of ohmic resistance in a voice coil creates a surprising loss of efficiency.

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

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

The cone is important because it is the air mover. Its salient features are material, shape, and mounting. Little can be said about cone material because manufacturers choose it without telling the buyer what they have chosen. In general the cone is made of paper and not a very tough paper at that—in fact, when it is not inherently soft and fibrous, it tends to be somewhat brittle. For some unknown reason cones are not usually moistureproofed. So, when handling a speaker, be extremely careful not to let anything touch the cone, back or front, and rest it on a flat surface, face down. I have handled hundreds of speakers and I always treat what beneficial, since it approximates the beginnings of a small exponential horn, which is the best way to couple the speaker to the air (more on this subject in the next installment).

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

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

Fig. 4—Front of speaker. Note right angle fold and accordion pleats at edge. them gently. While radio-set or public-address speakers can be re-coned by most service technicians, high-quality units require factory repair. Since a new cone is necessary if the old one has even a small rip, hole, or uneven spot from moisture, take care! When mounting speakers in cabinets or on baffles, cut a piece of heavy wire mesh—quarter-inch squares are good—and mount between speaker and panel.

Shapes and mountings of cones differ greatly among manufacturers. In general, cones either have straight sides or are flared. The flare, which can be seen plainly in Fig. 2, seems to be some-

Fig. 5—Loudspeaker using completely pleated cone for maximum flexibility.
The greatest villain in the picture as far as h.f. response in triodes is concerned is the feed-through provided by plate-grid capacitance and the Miller effect. The effective capacitance is the product of the actual grid-plate capacitance times the amplification factor of the tube. Thus, if the tube has a gain of 12, and a grid-plate capacitance of 3 µf, the effective capacitance becomes 36 µf. The reactance of this capacitance at frequencies higher than 10 kc becomes low enough in relation to the grid resistance to result in considerable attenuation of these frequencies.

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

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

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

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

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

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

**Inverse feedback**

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

The conventional amplifier, as exemplified by the Williamson circuit for instance, uses a single feedback loop. Better results can be achieved by using two loops. One would be an **internal loop** to flatten the response of the amplifier exclusive of the output transformer, to maintain dynamic and frequency balance, and to cancel part of the distortion. The second would be an **over-all loop** for correcting the response of the output transformer, further reducing distortion, and wiping out any bumps or slopes in the over-all response.

In the virtual direct-coupled amplifier we have been developing here, the internal loop can be very profitably carried from the plates of the output tubes to the cathodes of the voltage amplifier. Because the cathode resistors of the voltage amplifier are 120,000 ohms, we can easily keep down the phase shift in the loop, and indeed we can correct the phase shift produced by the single coupling capacitor. For 10% feedback we can use a 1.2-megohm feedback resistor. If we now select a capacitor which gives us the same time-constant as the interstage coupling capacitor—resistor network, we achieve what amounts to neutralization of the interstage coupling capacitance. This is true because the two capacitances produce phase shifts in opposite directions—the interstage coupling capacitor produces a phase shift and, the feedback capacitor increasing gain at very low frequencies. For exact neutralization the feedback factor should equal the gain between the interstage capacitor and the output tube plates; and by a coincidence, 10% feedback to a pair of 12A7s produces a feedback factor of 5 which is almost exactly the voltage gain of the big output triodes, or tetrodes used as triodes. Actually, it is not necessary to neutralize precisely, and even a considerable under- or over-neutralization will be satisfactory in practice. So in the case of the amplifier with self-bias we could use a 0.25-μf feedback capacitor, yielding an approximate time-constant of 0.25 second, and in the case of the amplifier with fixed bias, a 0.5-μf capacitor, yielding a time-constant of 0.5 second (Fig. 4). The phase shift in the feedback loops would begin at about the same point, but would go in the opposite direction from the shift caused by the interstage coupling capacitance. The final result would be the extension of the low-frequency response to around 1 cycle in the fixed-bias amplifier, and to 2 cycles in the self-biased amplifier.

With a 12A7 as the voltage amplifier, 10% feedback will provide 14 db of effective feedback. This is more than enough to extend the high-frequency response at least another octave and probably two octaves. This will make the over-all response from input of the cross-coupled inverter to output-tube plates nearly flat from 1 or 2 cycles to beyond 100,000 cycles. Moreover, since this feedback loop includes the two stages responsible for the largest part of the distortion—the output tubes and the voltage drivers—the 14 db feedback produces an improvement of 5 times in distortion characteristics. Finally, if we match the resistors and capacitors in the feedback loop, we will achieve dynamic and frequency balance. So long as we deliver equal signals to the grids of the 12A7 voltage amplifier, which we can easily do with the balancing control in the cross-coupled input, the loop will maintain that balance over the dynamic range of the amplifier.

**Over-all feedback loop**

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

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

The total feedback, as far as the output and driver stages are concerned, would be 30 db or more. This would reduce distortion by a factor of 30 or considerably below 1/16 at maximum output. 14 db should be sufficient to take care of any remaining imperfections in the response of the best grade of output transformers.

**Cheap output transformers**

An ordinary public address-type output transformer and about 20 db of over-all feedback in the over-all loop will produce results in this circuit which are about as good or better than those obtained with high-priced transformers attached to conventional narrow-band amplifiers. After all, it doesn't much matter whether the phase shift takes place in the output transformer or in the rest of the amplifier. An amplifier with considerable phase shift in the output transformer but very little in the amplifier itself will have an over-all performance very nearly comparable to that of an amplifier with a wide-range transformer and a narrow-band amplifier. There are other factors, such as core saturation, to be sure; but for many purposes, particularly that of obtaining acceptable high-fidelity reproduction at the lowest cost, an amplifier employing the measures we have discussed here with a public address-type transformer will be practically indistinguishable from the great majority of today's high-grade high-fidelity amplifiers employing high-priced transformers but possessing poor internal bandwidth.

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

**Fig. 3—The Ultra-Linear approach.**

**Fig. 4—The phase shift at low frequencies is neutralized in this circuit,** obtained with high-priced transformers attached to conventional narrow-band amplifiers. After all, it doesn't much matter whether the phase shift takes place in the output transformer or in the rest of the amplifier. An amplifier with considerable phase shift in the output transformer but very little in the amplifier itself will have an over-all performance very nearly comparable to that of an amplifier with a wide-range transformer and a narrow-band amplifier. There are other factors, such as core saturation, to be sure; but for many purposes, particularly that of obtaining acceptable high-fidelity reproduction at the lowest cost, an amplifier employing the measures we have discussed here with a public address-type transformer will be practically indistinguishable from the great majority of today's high-grade high-fidelity amplifiers employing high-priced transformers but possessing poor internal bandwidth.

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**Fig. 3—The Ultra-Linear approach.**

**Fig. 4—The phase shift at low frequencies is neutralized in this circuit,** obtained with high-priced transformers attached to conventional narrow-band amplifiers.
The "goodness" of an amplifier is not shown by its circuit diagram. Circuits have no inherent magic properties, but are merely the tools with which the designer seeks to achieve a certain result, and different designers—provided always that they have the same high standards in view—may achieve the same results by different means.

—D. T. N. Williamson

High-Quality Circuits

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

By JOHN K. FRIEBORN

Tone control

The Bogen model DB20 amplifier uses a tone-control circuit (Fig. 1) which apparently has not yet been used in any other American amplifier, although it is similar to one published in England. It allows independent bass and treble control, with maximum boost and attenuation as shown in the curves of Fig. 2.

Fig. 1—The Bogen DB20 tone control.

Fig. 2—DB20 control characteristics.

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

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

Loudness control

Two recent amplifiers present different solutions to the old problem of tone-compensated volume control or, as it is now called, loudness control. Both solutions consist of a tone-compensated "loudness control" used in conjunction with an uncompensated volume control. The loudness control used in the remote-control unit of the Stromberg-Carlson model AR-425 custom amplifier is a continuously-variable type, as shown in Fig. 3. The three potentiometers are ganged and move together in the direction indicated when the loudness is decreased. The attenuation due to R1 and R2 is increased and the attenuation due to R3 is decreased. C1, shunting R2, provides relative treble boost, and
the circuit consisting of C2 and R6 provides bass boost. This circuit is similar to the IRC loudness control, except for the addition of R6 and a change in the values of the capacitors. The attenuation characteristic for the circuit of Fig. 3 at several settings is given in Fig. 4.

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

The loudness contour selector, as it is called, in the Bogen model DB20 amplifier, is a step-type control. (Fig. 5.) Unlike most previous step-type loudness controls, this circuit provides for not only bass but treble as well as bass compensation. As the loudness is reduced, the amplitude of treble signal voltages is reduced more than bass, because of the shunting effect of C1 around R1 and C2 and R3 around all the components between step 3 and ground. Hence, there is a relative bass boost. On the other hand, there is also some treble boost, since C3 and C4 by-pass high-frequency signals around R4, R5, R6, and R7, which attenuate the lower-frequency signals. The over-all characteristic is shown in Fig. 6.

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

Since there are considerable differences, not only between the actual frequency compensation characteristics of various loudness controls but also between the instructions given by various manufacturers for the use of their controls, it might be useful to sum up briefly the principle involved and a simple method of using any loudness-volume control combination. When any combination of sounds, such as a musical performance, is heard at one volume level and then again at a lower level, if the actual acoustical power of every note is reduced by the same ratio, on the second hearing there will seem to be an extra reduction in the volume of the high-frequency notes and a still greater reduction at low frequencies, compared to frequencies between about 1,000 and 5,000 cycles. If a sound is reproduced at the same loudness level as it originally occurred, no compensation is required, but if it is reproduced at a lower level, there should be some bass and treble boost.

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

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

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

**Sideband cutting compensation**

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

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

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

**Fig. 7—Sideband compensation circuit, Stromberg-Carlson SR-401 radio tuner.**
WELL-REGULATED screen-voltage source is essential to minimum distortion and maximum audio fidelity. The screen voltage must be stabilized to hold the plate dissipation at the proper level under all signal conditions. A voltage-regulated bias supply is desirable for good linearity, high output, and high efficiency, particularly in circuits which draw grid current over a part of the input signal cycle.

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

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

Hartley 20-watt amplifier

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

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

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

A grid bias regulator

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

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

Altec Lansing voltage regulator

In most circuits using cold-cathode voltage-regulator tubes, the tube (or several in a series) is used as a bleeder to stabilize the voltage at a given point in the circuit. In the Altec Lansing model A-333A amplifier, the voltage regulator tube OA3 (VR75) is a part of a voltage divider which supplies the preamplifier-equalizer and the screens of the 6L6-G power amplifier tubes. The circuit is shown in Fig. 4. The voltage divider consists of the OA3 and the 100,000-ohm resistor in series between the 400-volt B plus line and ground. The constant drop across the OA3 reduces the voltage to 325 at its cathode. The 1,200-ohm and 10,000-ohm series-dropping resistors and the 40- and 20-ohm capacitors provide additional filtering and drop the voltage to 320 and 235 for the 6L6 screens and the preamplifier.

Bogen bandwidth control

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

The response-determining portions of the AM-901 tuner are shown in Fig. 5. The 6BE6 is the converter, the 6BA6 is the i.f. amplifier, and the 12AX7 is the diode detector and audio cathode follower. S1 is a 6-circuit, 4-position function selector switch. Position 1 is OFF, 2 is PHONE, 3 is NARROWBAND AM, and 4 is WIDEBAND AM.

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

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

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

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

Section 81-c of the selector switch varies the response of the audio signal at the output of the cathode follower. In the WIDEBAND position, L1 and C3 form a parallel-tuned 10-ke heterodyne filter which traps out whistles and interference which occurs when adjacent-channel stations are received simultaneously. Throwing the switch to NARROWBAND AM converts the cathode follower output circuit to a modified M-derived filter which begins to cut off at about 5 kc, thus eliminating a lot of the noise and mokey-chatter which may occur in localities where co-channel interference exists. The i.f. circuits are converted to conventional mutual-inductance types by shorting out the .01-µf capacitor when good selectivity is required.

The Blackout tuning indicator

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

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

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

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

END
**EXPERIMENTAL COMMUNICATION WITH LIGHT BEAMS**

By ERIC LESLIE

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

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

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

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

**Two light modulators**

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

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

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

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

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

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

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

**The receiver**

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

**Construction**

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

**Applications**

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

**Light-beam communication, free from electrical disturbances, is highly applicable for short-range work**
Fig. 1, left—The gate-type modulator. As the voice coil moves the lower vane, it "crosses" a larger or smaller area of the upper one, cutting off light proportionately. Modulation is "negative."

Fig. 2, below—The transmitter with light-gate modulator. A is the handle which moves mirror C down into the dotted-line position for sighting an image on ground glass B, or up out of the way for transmitting. D the hood around the ground glass, E the main lightproof case of the instrument, F a 3-inch aperture, G a 4½-inch lens with 20-inch focus, H the lamp in its housing, and I the modulator. A lens system may be made by adding a lens at F and means to vary the distance between it and lens G.

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

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

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

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

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

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

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

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

Fig. 7 — Probe circuit RC time constants.

Fig. 8 — Schematic of balanced probe.

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

Fig. 5 — Diagram of probe signal circuits.

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

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

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

Fig. 13 — Vibrating contacts short and un-short the vertical input of scope.
Use of crystal probe gives excellent results in video testing

By Engineering Staff, Scala Radio Co.

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

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

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

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

When sweep wave envelopes of i.f. signals on the scope screen are viewed by overloading the vertical amplifier with the signal under test, the pattern shown is due to the time-constant of the scope input circuit, (C + C1)(R1 + R2). The total input capacitance C + C1 charges through R1 and discharges through R1 + R2. Unless this charging and discharging can take place with sufficient rapidity, there will be negative peak clipping of the waveform displayed on the scope screen. R1 must be large enough to prevent r.f. signal voltage entering the scope circuits.

The time-constant can be reduced by decreasing the value of C1. The cable capacitance, C1, is usually much larger than the scope input capacitance C1. In 1 time-constant interval, the cable can charge up to 63% of the peak value of a square wave. If there have been previously charged, will be able to discharge in 1 time-constant interval to 37% of the peak value of the initial charge.

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

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

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

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

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

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

Since these test leads would have to be 25 or 30 feet long to make a test of a 25-or 30-foot length of lead, other test setups may be found more convenient when using a scope without a built-in horizontal phasable sweep. The probe and scope can be connected at the generator end of the line, if desired, as shown in Fig. 12. In this case, the generator has an r.f. output cable which is terminated in a center-tapped load. This center point is connected to the ground system of the test setup, as shown; the load resistor R then does.
not need to be center-tapped, and the scope is conveniently swept from the generator, as indicated by the leads between them in Fig. 12. This arrangement can be applied conveniently, especially when the load R may represent a remote point such as an antenna, whose mat-h to the lead-in is to be tested.

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

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

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

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

**FOLDING DIPOLE TYPE ANTENNAS CAN BE DE-ICED**

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

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

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

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

BY KEN KLEIDON*

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

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

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

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

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

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

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

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

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

The mechanical aspects of a u.h.f. tuning device will vary from one unit to another but should not offer a great deal of trouble when service is required.

Varied mechanical arrangements have been employed for v.h.f. tuning, dial stringing, control positions, picture tube mounting, etc., and have not proved difficult to the average service technician. Mechanically, servicing should not prove any more difficult than with the average v.h.f. tuner.

Special servicing techniques

The servicing techniques used when working with a v.h.f. tuner must be observed when attempting to service a u.h.f. unit. In dealing with ultra-high frequencies, stray capacitances and inductances have a great effect than with v.h.f. Much more care must be observed not to move or rearrange components or mechanical parts, as distributed capacitance or inductance may be changed and thereby offset the alignment. Also, when a part replacement is necessary, the same lead lengths must be maintained and the part must be replaced in the same physical location. Another important factor which sometimes has been overlooked in v.h.f. servicing is to obtain the exact part replacement. This is of the utmost importance in u.h.f. servicing. The manufacturer’s replacement parts guide should be consulted and the recommended part obtained. Complete service information is contained in the manufacturers’ u.h.f. service manuals. Carefully read and digest this information before attempting adjustments or replacement of components. The manuals usually contain a circuit description for a clearer understanding of the operation and function of the various components. Alignment instructions, or instructions to return the unit to the factory for repair or alignment, are included.

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

Alignment of Raytheon’s u.h.f. tuner could not be classified as simple nor could any other u.h.f. tuning unit. However, due to its design and construction, alignment can be performed in the field if necessary. If a pre-i.f. amplifier can easily be realigned by connecting a 25-mc unmodulated signal to the junction of L5 and C2 (Fig. 3), connecting a v.t.v.m. at the video detector output of the receiver, and adjusting the cascode input grid coil (see Fig. 4) for maximum v.t.v.m. reading. The two r.f. cavities may be aligned with respect to the oscillator by simply loosening the pulley-positioning screw.
(Fig. 4) and rotating the r.f. drive pulleys for the sharpest and clearest picture while viewing a u.h.f. program. Complete tracking over the entire u.h.f. band requires accurate test equipment, as well as a detailed alignment procedure (which cannot be presented in this space). Therefore, unless both are available, adjustment of the r.f. tracking screws, oscillator trimmer screw, or shorting bar should not be attempted.

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

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

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

The design of Raytheon's u.h.f. tuner enables servicing without removing it from the TV chassis. Convenient service check points have been provided, as illustrated in Figs. 3 and 4, for measuring the crystal current, oscillator plate voltage, and oscillator grid current. To determine whether the oscillator is functioning, both the oscillator plate voltage and grid current can be checked. With a voltmeter connected between the point indicated and ground or chassis, a reading of approximately 90 volts should be obtained if there are no defects in the voltage supply source or oscillator plate line. To measure the oscillator grid current, a Simpson model 200 multimeter, or equivalent, in the 100-microampere scale position, should be placed across 22-ohm resistor R2, with the positive meter lead to ground. A reading of 10 to 30 microamperes should be obtained if the oscillator is functioning normally. The crystal current (oscillator injection current) can be measured by placing a meter (type indicated above) on the 100-microampere scale across 22-ohm resistor R10, with the positive lead to ground. A reading of 5 to 40 microamperes should be obtained if the oscillator and crystal are functioning normally.

When attempting to service a u.h.f. tuning unit, it may prove helpful to keep in mind that when trouble occurs in the oscillator section, the picture will generally disappear and when there is a defect in the r.f. or mixer stage a decrease in signal will usually result. When the oscillator section is suspected, the tube should be substituted, grid current, plate, and filament voltages should be checked, and all components in the circuit should be inspected. When the r.f. or mixer section is suspected, the circuits should be inspected, and tracking, alignment, and crystal current should be checked, and the crystal replaced if necessary. A defective crystal may cause varied effects in the picture and should not be overlooked as a possible source of trouble. Crystals are also the greatest source of noise generated in the majority of tuning units.

Noise results in undesirable snow appearing in the picture, and crystal substitution to obtain an increase in picture quality may prove beneficial in some cases. Using an ohmmeter to check a crystal detector will prove to be an unreliable method. Direct substitution is the only positive check. The majority of crystal detectors in present u.h.f. tuning units are soldered into place, and overheating may cause damage. So take care when replacing a crystal. One of the most positive ways to avoid overheating of the crystal, is to hold the crystal with a pair of long nose pliers while soldering. The pliers will absorb most of the heat, preventing damage to the crystal.

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

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

Fig. 5 (Above)—The "weak-picture" condition.
The large number of new homes built in the past few years has created many line-voltage problems. The power companies are improving their facilities, but the servicing technician will find many areas where the additional evening load drops the line voltage, often to 100 volts or lower. This often results in poor brilliance, insufficient picture size, and occasionally sync instability because of the change in line voltages which occur. (Rarely these effects may be found in the daytime, as when a room air conditioner is used in an adjacent apartment.) When a receiver is serviced or installed in the morning or afternoon, the line voltage may be normal. The technician may find that, if he adjusts the picture size to fill the mask at that time, it will shrink during the evening. Sometimes only the top or side of a picture may be affected, depending on the degree of change in sweep amplitude and the idling voltage through the yoke. A change in the latter can cause picture shift as well as general shrinkage.

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

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

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

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

Other devices which can be used are the Varrtran units. Type V-O is designed for operating a receiver drawing current up to 2 amperes at 250 watts, and the output voltage is variable from 0 to 130. A 570-watt unit is also available, type V-17.

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

**Bleached picture**

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

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

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

**Cascade tuner**

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

These faults you described are probably caused by the fact that the sound take-off coil in the original tuner has not been replaced in the new installation. The Standard Coil Products Company has a replacement coil available, part number XM-752. Refer to page 05 of the January, 1955 issue of Radio-Electronics for full information on the use of this coil.

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

**Sweep angle**

I have used an RCA 211D2 yoke in the conversion of a Raytheon C1104M receiver. I have changed the original 12L44A tube to a 19EP5 rectangular type. I evidently have a mismatch because the left side of the picture is expanded and linearity is poor for both the vertical and horizontal sweep. I have been told that since I am using a 70-degree tube and a 70-degree yoke, I also need a 70-degree transformer. Would this give me a better horizontal match and improve results? Please list the matching transformers for the yoke which I already have. L. T., Cicero, Ill.

The rectangular tubes do have a 70-degree deflection, as your friend told...
you. This refers to the angle which the beam must sweep to fill the picture mask properly. When such tubes are used, it is necessary to use a wide-angle yoke and a transformer to match. If this isn’t done, poor linearity, insufficient sweep, and other troubles occur.

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

- RCA 224T1 (for a 6BQ6 horiz. output tube)
- RCA 230T1 6CD6
- RCA 231T1 any
- RCA 222T1 any

Definition

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

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

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

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

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

Synchroguide check

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

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

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

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

Adjacent-channel interference

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

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

Oscillator slug

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

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

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

Bottom foldover

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

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

By E. AISBERG

Sixth conversation, second half:
Will learns about synchronization.

Hey, you—keep in step!

WILL—And now isn't it about time to take the wraps off that mysterious "synchronization"?
KEN—I think so. You know already that the line and frame sweeps at the receiver have to keep in exact step with those at the transmitter. The beginning of each line (and each frame) have to be synchronized rigorously at transmitter and receiver.
WILL—I can see that if they got out of step, you'd get a program something like a piece of music played by an orchestra with every instrument a few seconds behind the one beside it.
KEN—Well, let's not try to develop an optical analogy to your musical program. Actually, the transmitter sends out, along with the video signals, short signals (or pulses) to mark the end of each line, and a longer series of pulses to mark the end of each image.
WILL—And it's these pulses you apply—through capacitor C1—to the thyratron grid? (See last month's installment for figure.)
KEN—Exactly. You have to arrange your circuits so these pulses are positive when they reach the grid—so that each one makes the grid less negative for a short instant.
WILL—I don't quite see what's going on. Does the tube amplify these pulses?
KEN—No, Will. You're just forgetting the effect of the grid on the anode breakdown voltage.
WILL—Of course! When a positive pulse arrives, the grid becomes less negative, and the ionization voltage drops.
KEN—So the normal period of oscillation of the horizontal oscillator is made just a little longer than the time the transmitter takes to make one line (and the vertical oscillator's period a little longer than the time needed to make one field). In other words, the normal frequency is a little lower than the line or image frequency. Then, just before the anode voltage reaches the ionization point, a pulse comes and makes the grid less negative. So the tube discharges prematurely, triggered by the synchronizing pulse.
WILL—I think I have it O.K. Say a thyratron has a control ratio of 20 and a grid bias of 15 volts negative. The ionization voltage would then be 300. If the synchronization pulse is 1 volt positive, the ionization voltage will be 280 instead of 300 volts, and the tube will discharge quicker than it would if there were no pulses.
KEN—You have it 100%.
WILL—It wasn't so hard! I had a good example to go by. While I was taking swimming lessons on my vacation, the instructor synchronized the divers.
KEN—Huh?
WILL—When they got out to the end of the board and were ready to jump, most of them would hesitate. Then he'd just expedite them with a firm push on the back. And then they'd make beautiful parabolic curves!

Saturated diodes to pentodes

KEN—Speaking of curves, this business of getting a sawtooth wave by charging and discharging a capacitor is fine, except that the sawtooth we end up with isn't quite linear—it has a curve to it. Now we've got to get back to the job of making that exponential curve as straight as possible.
WILL—Can't we find some method of keeping the current that goes into capacitor C constant? Then the voltage would rise in exact proportion to time, and we'd have a linear sawtooth.

RADIO-ELECTRONICS
KEN—Maybe you could work out such a scheme. Can you figure out just how you'd limit the current?
WILL—You'd have to replace the charging resistor with something that wouldn't let more than a certain definite amount of current through. How about using a tube—or rather its plate-cathode resistance—for the job?
KEN—That would work, Will. For instance, you could use a diode (preferably a direct-heating type) working at saturation. All the electrons emitted by the filament reach the plate, and so any increase in plate voltage can't increase the current flow. You could regulate the amount of current flow within limits by adjusting the filament voltage.
WILL—But why do you want a direct-heating diode?
KEN—Because a direct heater saturates much more definitively and sharply than an indirectly heated cathode. But if you don't like filament heaters, you can use an ordinary cathode-type pentode.
WILL—Do you work it at saturation, too?
KEN—The term wouldn't be correct, but the result is the same. You know how the plate-voltage/plate-current family of curves of a pentode looks. For any screen voltage, the plate current rises with plate voltage up to a certain point, then changes very little as the plate voltage goes on up. If you work the pentode on that flat part of the curve, it would charge a capacitor at a constant-current rate. Take a look at this schematic. The pentode replaces the charging resistor R. The screen voltage is regulated with a potentiometer P in series with a resistor R4. C3 is a decoupling capacitor.
WILL—These saturated diodes and constant current pentodes remind me of the bed of that old Greek bandit who used to trim off travelers who were too long for it or stretch them out to size if they were shorter than the bed.

The art of using curves

KEN—You're talking about Procrustes. Yes, it is a sort of inflexible way of doing things. As a matter of fact, it's more common to straighten out the curves afterward, in the amplifier tube that we need anyway, to bring our sawtooth waves up to the amplitude we want.
WILL—But how can an amplifier linearize a curved sawtooth wave?
KEN—It's easy. We make it distort a little, so it curves them in the opposite direction! Remember, Will, the most important thing in life is to be able to profit not only from the virtues and good points people or things may have, but also from their very faults and vices! What could be worse than a tube with such a crooked characteristic that it actually deforms the voltage it amplifies? But in this case that very fault becomes an advantage.
WILL—In other words, we have an amplifier tube with a curved grid-voltage/plate-current characteristic. And this curvature is exactly opposite to the curve of the sawtooth wave itself. If our sawtooth generator produces a wave that has a curve, all we have to do is feed this curved—or nonlinear—sawtooth into an amplifier that will bend the wave in the opposite direction. The result will be a practically straight sawtooth.
KEN—Here's a little drawing that will show that even better than you can describe it. The curves of the amplifier and those of the sawtooth oscillator may not balance each other exactly, but the compensation is good enough for any practical use.
WILL—Well, now that I've got all that down pretty pat, I suppose the moment has come to tell me that neither thyatron time-bases, constant-current tubes, nor linearizing amplifiers were ever used in television?
KEN—Not quite, Will. All of them have been used at one time or another, and some are still being used. Even if they weren't, I wouldn't have wasted your time, because the thyatron time-base is almost universal in oscilloscopes, and you'll use them a lot if you expect to do much with television receivers. But I must admit that there is a much more common type of time-base, and I can tell you now that it really is used in most TV sets. But we'll have to put that off till our next conversation.

(TO BE CONTINUED)
BRINGING forth an antenna for television is much like bringing forth a baby into the world. This brand new baby is bound to be bigger and bouncier than big brother v.h.f. Now that it no longer needs the warmth of the researchers' bassinet, it is casting off its blankets and starting to flex an unusually large pair of biceps for one so young.

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

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

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

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

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

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

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

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

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

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

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

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

* JFD Manufacturing Co., Inc.
Its horizontal directivity is not all that may be desired. As has been found with v.h.f. antennas tested on u.h.f., minor lobes in the horizontal plane are numerous and vary with frequency. On the high end of the u.h.f. band the lobes are numerous and large enough to make the antenna usable as an omnidirectional job.

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

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

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

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

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

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

The desirability of a combination u.h.f.-v.h.f. antenna based on the old reliable conical, resulted in further improvements on the conical and the u.h.f. triangular dipole. The new dipole for use with the conical has an angle of 35° and is cut to favor the upper portion of the u.h.f. spectrum. The nominal impedance remains 300 ohms over most of the band. However, the actual impedance is higher rather than lower as compared to that of the 70° triangular dipole. Since the power curve falls off at a much slower rate for higher impedance, a gain advantage is obtained over 80% of the u.h.f. band with this design.

To permit coupling of the conical with the triangular dipole (or other u.h.f. antennas), a coupling network was designed to permit connection and use of a single down-lead. It is designed to match a 300-ohm balanced transmission line. High-Q silver-printed circuits minimize any reflections and insertion losses. An improved match is effected with the conical on the low u.h.f. channels, which results in an increase in gain of 2 to 3 db. The schematic Fig. 1 is a simplified version of the network. The antenna coupler consists of a group of tuned circuits. Each circuit — being parallel-resonant — will offer a high impedance to the band of frequencies to which it is tuned, while offering an inductive or capacitive shunt to frequencies below or above its band. The Q of the printed circuits enables the antenna coupler to present a constant impedance of 300 ohms to the transmission line over the low u.h.f., high u.h.f., and v.h.f. bands. Since it is hermetically sealed, the antenna coupler maintains stable circuit constants despite constant exposure to the elements.

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

The proper composition of the silver compound permits the design of the desired Q for proper bandwidth.

Looking down from the rooftops of America, u.h.f. is looking up! Technicians: There will be plenty of ultra-high business, every bit of it new! END
TELEVISION is expanding rapidly in Europe. Regular daily programs of all kinds are broadcast in Great Britain, France, and Germany. These include kinescope recordings and live pickups of plays, concerts, variety programs, sports, and special events.

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

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

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

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

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

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

Several instances of exceptionally good dx have been reported and certified by photographs. For example, the Paris and London programs have been received in Belgium, Holland, and Italy, and Russian telecasts have been picked up in France. American TV signals were reported seen on one occasion, but unfortunately this has not been verified, since it lasted for only a few minutes. Belgium, as yet, has no stations of its own in operation, but plans to establish separate systems with different standards for the French- and Flemish-speaking sections of the country. Receivers in Belgium which are designed for the French 819-line standard have been experiencing severe co-channel interference between Lille and Paris. These stations were assigned the same frequency in the belief that the distance between the two cities—approximately 150 miles—and the "official" service coverage were enough to prevent any co-channel interference. But many points in Belgium (and France as well) are about the same distance from both cities, and exceptionally good transmission over the flat terrain has created the interference problem. (In the United States the same type of unforeseen co-channel interference was one of the factors that led to the television "freeze" and ensuing changes in several channel assignments.—Editor)

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

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

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

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

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

The only city with two regularly scheduled stations is Paris, with the old 441-line, picture transmitter on 46 mc (sound on 42 mc), and the new 819-line picture transmitter on 185.25 mc (sound on 174.1 mc).
Here is an inexpensive salesman who can cover lots of territory fast. Every door is open to him.

By B. W. WELZ

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

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

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

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

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

Slanting the story

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

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

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

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

Other advantages

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

Another advantage of postal cards is follow-up. If a product moves slowly you can give it a shove with a series of postal cards—a series that doesn't end until the product is sold. Lots of big businesses today owe their rise to persistent follow-ups. Anyone who was ever on their mailing lists will never forget the stream of postal cards he got. Mr. Postal Card can sell your services, too. Let him tell why people should bring their repairs to you instead of to the next guy. Remember to make your best selling point very clear, whatever it is—experience, low cost, reputation—make an impression with it. And remember—keep the buyer's view in mind, like the boss did with his TV sets. Convince people that your selling point is an advantage to them.

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

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

END
midget portables and their PROBLEMS

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

By PAUL BOLLER

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

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

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

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

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

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

Fig. 1—The circuit of the RCA BX37 is similar to that of most 3-way portables. Some sets may have a 1T4 i.f. amplifier, IS4, a 1S4 detector and first a.f., and a 3S5 or 1S5 output tube in place of those shown in the diagram above.

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

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

Estimates

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

Service procedure

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

Done on a clean bench, blowing dirt out does a better job than sucking it out with a vacuum cleaner, because you

don't have to empty a messy dust bag to hunt for some little special screw that may have disappeared up the hose.

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

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

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

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

The RCA "Yachtsman" 3-way portable.

OCTOBER, 1953
Battery-only sets. Make the same filament-voltage and drop-out tests by using a nearly used-up A battery. A poor oscillator tube or changed oscillator grid resistor will show up in these tests. Abnormal filament voltages across one or more tubes in series hookups can stop you in your tracks if you are unfamiliar with the fact that some tubes change their filament resistance as they get old. Try a whole new set of tubes. Naturally there are many other causes of incorrect voltages at the filaments.

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

Fig. 2—Audio amplifier check point.

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

Alignment

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

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

A good method of signal injection is to couple the r.f. to the set with a loop of about two turns of heavy wire, the loop around six inches in diameter, placed near the receiver. As the oscillator-trimmer setting is not usually affected by the position of the batteries and the antenna loop, special precautions are seldom needed when adjusting it. But the r.f. trimmer is very critical. The ideal way to adjust it is (with the batteries and receiver loop in normal position) through a hole in the cabinet.

Some sets have them. Naturally the ear will have to be used as the output indicator, as it's almost impossible to make connections to the speaker with the cabinet shut. In spite of the handicaps, an accurate adjustment can be made if a weak r.f. signal with low modulation is used. Listen to the hash, rather than to the modulation; it increases as the modulation decreases. Never place a hand or object very close to the receiver loop, nor should the latter be placed on a metal bench top. The r.f. alignment affects tracking and thus selectivity and gain. All adjustments should be made at the frequencies recommended by the manufacturer.

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

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

END
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OCTOBER 1953
Another new, outstanding instrument design so typically characteristic of Heathkit operation in producing high quality instrument kits at the lowest possible price. A new, improved model Impedance Bridge Kit featuring modern cabinet styling, with slanted panel for convenience of operation and interpretation of measurements, four instruments in one compact unit entirely AC line operated. No bothersome battery replacements.

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

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

**Heathkit Audio Wattmeter Kit**

**Model AW-1**

$29.50

Shipping WT. 6 LBS.

A new Heathkit design for the audio engineer, serious hi-fi enthusiast, recording studio, or broadcast station; the Heathkit Audio Wattmeter Kit. This specialized instrument instantly indicates the output level of the equipment under test without requiring the use of external load resistors. All readings are taken directly from the calibrated scales of a 4 1/2" 200 microampere Simpson meter.

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

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

**Heathkit Laboratory Generator Kit**

**Model LG-1**

$39.50

Ship. WT. 16 LBS.

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

The circuit features a 6A4 high frequency oscillator, a 6AV3 amplifier with grid modulation, 12AU7 400 cycle oscillator and modulator, OB2 voltage regulator tube, and a selenium rectifier for the transformer operated power supply. The smart professional instrument appearance and over-all flexibility of operation will prove a decided asset to any industrial or educational laboratory. The Heathkit Laboratory Generator sets a new level of operation, far superior to any instrument in this price classification.

**Heathkit Impedance Bridge Kit**

**Model IB-2**

$59.50

Shipping WT. 15 LBS.

Another new, outstanding instrument design so typically characteristic of Heathkit operation in producing high quality instrument kits at the lowest possible price. A new, improved model Impedance Bridge Kit featuring modern cabinet styling, with slanted panel for convenience of operation and interpretation of measurements, four instruments in one compact unit entirely AC line operated. No bothersome battery replacements.

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

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

**Features**

- Simpson 100-0-100 microampere meter.
- Completely AC operated.
- Built-in phase shift generator and amplifier.
- Battery type tubes, no warm-up required.
- Newly designed two section CRL dial.
- Single knob D, Q, and DQ functions.
- Special impedance matching transformer.
- New modern cabinet styling.
- .5% precision resistors and silver mica condensers.

HEATH COMPANY • Benton Harbor 20, Mich.
HEATHKIT OSCILLOSCOPE KIT

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MODEL O-9

$59.50

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

Announcing the insert addition to a brilliant series of Heathkit Oscilloscopes, the new Model O-9! This outstanding instrument incorporates all of the features developed and proven in the production of well over 50,000 kits, in addtion to a host of new design features for outstanding performance. This new scope features a brand new (10 turn) commercially available SUP1 cathode ray tube for long focusing life, high intensity, and freedom from hysteresis. The 5" CRT tube is the stand-ard size for design and industrial laboratories, development engineers, and service men. The only size CRT tube offering a wide range of types, colors, phosphors, and persistence. The added diversity in vision enables the user to choose the CRT tube best suited to his particular requirement. Vertical Amplifier - New extended band width vertical amplifier with sensitivity of 0.05 volts per inch, down 3 db at 2 mcs, down only 3/5 db at 5 mc. Three step vertical input attenuation, quality ceramic variable capacitors for proper input compensation, provisions for calibrated 1 volt peak-to-peak reference, with calibrated screen for direct reading of TV pulses.

Heathkit LOW CAPACITY PROBE KIT

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

Heathkit VOLTAGE CALIBRATOR KIT

The Heathkit Voltage Calibrator provides a convenient method of making peak-to-peak voltage measurements with an oscilloscope by establishing a relationship on a comparison basis between the amplitude of an unknown wave form and the known output of the voltage calibrator. Peak-to-peak voltage values are read directly on the calibrated panel scales. To offset line voltage supply irregularities, the instrument features a variable voltage regulator tube. With the addition of the Heathkit Voltage Calibrator, it is possible to measure all types of complex wave forms within a voltage range of 0.1 to 100 volts peak-to-peak. A sensitive signal position on the panel switch bypasses the calibrator completely and the signal is applied to the oscilloscope input thereby eliminating the necessity for transferring test leads.

Heathkit SCOPE DEMODULATOR PROBE KIT

In applications such as trouble shooting or aligning TV, RF, IF, and video stages, the Heathkit Scope Demodulator Probe will faithfully reproduce square waves up to 500 mc. This is the ideal all around, general purpose oscilloscope for educational and industrial use, radio and TV serv-icing, and any other type of work requiring the instantaneous reproduction and observation of actual wave forms and other electrical phenomena.

Heathkit ELECTRONIC SWITCH KIT

The basic function of the Heathkit S-2 Electronic Switch Kit is to permit simultaneous oscilloscope observation of two separate traces which can be either separated or superimposed for individual study. A typical example would be observation of a signal as it appears at both the input and output stages of an amplifier. It will also serve as a square wave generator over the range of switching frequencies often providing the necessary wave form response information without incurring the expense of an additional instrument. Continuously variable switching rates in three ranges from less than 10 cps to over 2,000 cps. Individual controls for each input channel and a position control. The five tube transformer operated circuit utilizes two 6SN7, two 6SN7, and one 6X5 tubes. Buy this kit and enjoy increased versatility of operation from your oscilloscope.

HEATH COMPANY • Benton Harbor 20, Mich.
The beautiful Heathkit Model V-6 VTM, the world's largest selling kit instrument, now offers many outstanding new features in addition to retaining all of the refinements developed and proven in the production of over 100,000 VTM's. This is the basic measuring instrument for every branch of electronics. Easily meets all requirements for accuracy, stability, sensitivity, convenience of ranges, meter readability, and modern styling. It will accurately measure DC voltages, AC voltages, offers tremendous ohmmeter range coverage, and a complete db scale for a total of 53 meter ranges.

New 1.5 volt full scale low range provides well over 23½" of scale length per volt. Upper DC scale limit 1,500 volts. DC ranges 0-1.5, 3, 15, 30, 150, 500, 1,500 volts full scale. AC ranges 0-1.5, 3, 15, 50, 150, 500, 1,500 (1,000 volts maximum). Seven ohmmeter ranges from 1 ohm to 1,000 megohms. For added convenience a DC polarity reversing switch and a center scale zero adjustment for FM alignment.

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

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

**Heathkit 30,000 VOLTS DC PROBE KIT**

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

No. 336-B

**Heathkit PEAK-TO-PEAK PROBE KIT**

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

No. 338-B

**Heathkit RF PROBE KIT**

The Heathkit RF Probe used in conjunction with any 11 megohm VTVM will permit RF measurements up to 250 mc. ± 1%. A useful, convenient accessory for those occasions when RF measurements are desired. The RF probe body is housed in volt new, smartly-styled polished aluminum probe body featuring two-color polystyrene probe ends and a low-capacity flexible shielded test lead. The kit is complete with all necessary material and a detailed assembly sheet as well as instructions for probe operation.

No. 305-B

**Heathkit AC VACUUM TUBE VOLTMETER KIT**

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

The large 200 microamphere Simpson meter has clearly marked and easy to read meter scales. Ten voltage ranges covering from .01 rms full scale to 500 volts rms full scale, with frequency response + 1 db from 20 cycles to 50,000 cycles. Instrument input impedance 1 megohm, ten db ranges from -52 db to +52 db. For stability and good linearity characteristics the meter bridge circuit features germanium diodes. Attractive instrument styling, a companion piece for the popular Heathkit VTVM and the new AW-1 Audio Wattmeter.

No. 336

**Heathkit 30,000 VOLTS DC PROBE KIT**

**MODEL V-6**

**$24.50**

SHIPPING WT. 6 LBS.

**Features**

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

**Heathkit AC VACUUM TUBE VOLTMETER KIT**

**MODEL AV-2**

**$29.50**

SHIPPING WT. 5 LBS.

**HEATH COMPANY - Benton Harbor 20, Mich.**
CHECK THESE Features

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

The most important Heathkit announcement of the year, the new 20,000 ohms per volt Heathkit Multimeter, Model MM-1.

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

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

DB coverage from —10 db to +65 db.

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

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

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

HEATHKIT BATTERY TESTER KIT

The Heathkit Battery Tester measures all types of dry batteries between 1½ volts and 150 volts under actual load conditions. Readings are made directly on a three color Good-Weak-Replace scale. Operation is extremely simple and merely requires that the test leads be connected to the battery under test. Only one control to adjust in addition to a panel switch for "A" or "B" battery types. The Heathkit Battery Tester features compact assembly, accurate meter movement, and a three deck wire-wound control, all mounted in a portable rugged plastic cabinet. Checks portable radio batteries, hearing aid batteries, lantern batteries, etc.

MODEL BT-1
$8.50
SHIP. WT. 2 LBS.

HEATHKIT HANDITESTER KIT

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

MODEL M-1
$14.50
SHIPPING Wt. 3 LBS.

HEATH COMPANY • Benton Harbor 20, Mich.
Here is the new Heathkit Battery Eliminator necessary for modern, up-to-date operation of your service shop. The Heathkit Model BE-4 furnishes either 6 volts or 12 volts output which can be selected at the flick of a panel switch. Use the BE-4 to service the new 12 volt car radios in addition to the conventional 6 volt radios.

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

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

**Heathkit VIBRATOR TESTER KIT**

Your repair time is valuable, and the service use of the Heathkit Vibrator Tester will save you many hours of work. This tester will instantly tell you the condition of the vibrator being checked. Checks vibrators for proper starting and the easy to read meter indicates quality of output on a large 5-20 volt scale. The Heathkit VT-1 checks both interupter and self rectifier types of vibrators. Five different sockets for checking hundreds of vibrator types.

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

**Heathkit Technical Application Bulletins**

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

**NEW Heathkit VARIABLE VOLTAGE ISOLATION TRANSFORMER KIT**

The new Heathkit Isolation Transformer Kit provides line isolation for AC-DC radios (not an auto transformer), thereby eliminating shock hazard, hum problems, alignment difficulties, etc. The output voltage is variable from 90 to 130 volts AC and is constantly monitored by a panel mounted AC volt meter. Use it to increase AC supply voltage in order to induce breakdown of faulty components in circuits thereby saving service time. Use it also to simulate varying line voltage conditions and to determine the line voltage level at which oscillator circuits cease functioning, particularly in three-way portable radios. Rated at 100 watts continuous output and up to 200 watts maximum intermittent operation. A useful radio and TV service tool.
Proudly announcing an entirely new, advanced model TV and FM Sweep Generator, the Heathkit Model TS-3. This new design provides features and combinations of functions not found in any other service type instrument. Every design consideration has been given to the requirements of the TV service man to provide a flexible, variable sweep source with more than adequate RF output and complete frequency coverage throughout the TV and FM spectrum.

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

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

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

The Heathkit TS-3 incorporates many design features commonly found in more expensive units, as well as many unique features not usually found in other instruments. For example, the oscillator operates entirely on fundamentals, there is complete freedom from spurious oscillation and parasitics normally encountered in beat frequency type oscillators.

The instrument, in addition to being a radio frequency signal generator, is a unique combination of sweep and marker oscillator. It is a sine wave oscillator and generator, the Heathkit TS-3 Model 230-8, and the Heathkit TS-3 Model 411-4.

Sweep generator: Sweep generator is a sine wave oscillator and generator, the Heathkit TS-3 Model 230-8, and the Heathkit TS-3 Model 411-4.
The new Model TC-2 Heathkit Tube Checker features many circuit improvements, simplified wiring, new roll chart drive and illumination of roll chart. The instrument is primarily designed for the convenience of the radio and TV service man and will check the operating quality of tubes commonly encountered in this type of work. Test set-up procedure is simplified, rapid, and flexible. Panel sockets accommodate 4, 5, 6, and 7 pin tubes, octal and loctal, 7 and 9 pin miniatures, 5 pin Hytron and a blank socket for new tubes. Built-in neon short indicator, individual three-position lever switch for each tube element, spring return test switch, 14 filament voltage ranges, and line set control to compensate for supply voltage variations, all represent important design features of the TC-2. Results of tube tests are read directly from a large 4½” Simpson three-color meter, calibrated in terms of Bulb Good. Information that your customer can readily understand. Checks emission, shorted elements, open elements, and continuity.

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

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

The new Heathkit Tube Checker will prove its value in building service prestige through usefulness — simplified operation — attractive professional appearance. Don’t overlook the fact that the kit price represents a savings of $40.00 to $50.00 over the price of a comparable commercially built instrument. At this low price, no service man need be without the advantages offered by the Heathkit Tube Checker.
An entirely new type of signal tracer incorporating a combination of features not found in any other instrument. Designed expressly for the radio and television service man, particularly for the servicing of AM, FM, and TV circuits. Here in a five tube transformer operated instrument are all of the useful functions so necessary for speedy, accurate isolation of service difficulties.

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

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

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

**MODEL AT-1**

$29.50

**SHIPPING WEIGHT 16 POUNDS**

Here is the latest Heathkit addition to the ham radio field, the AT-1 Transmitter Kit, incorporating many desirable design features at the lowest possible dollar-per-watts price. Panel mounted control board, stand-by switch, key click filter, AC line filtering, good shielding, etc. VFO or crystal excitation — up to 53 watts input. Built-in power supply provides 425 volts at 100 ma.

This kit features pre-wound coils, single knob band switching, 52 ohm coaxial output, plug-in chassis provisions for VFO or modulator and rugged clean construction. Frequency range 80, 40, 20, 15, 11, and 10 meters. Tube line-up 6A67 oscillator-multiplier, 6L6 amplifier-doubler, 5U4G rectifier. Physical dimensions 8½" high x 13½" wide x 7" deep.

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

**NEW Heathkit ANTENNA COUPLER KIT**

**NEW** Heathkit Antenna Coupler, specifically designed for the Heathkit AT-1 Transmitter. The Antenna Coupler can be used with any 52 ohm coaxial input — up to 75 watts power. Low pass filter with cut-off frequency of approximately 36 mc — L section tuning network — beam tuning indicator — rugged, compact construction — transmission line type variable condenser, and high Q coil are all outstanding features. The AT-1 has both bandwidth and capacity tuning for maximum operating versatility. Dimensions 8½" wide x 4½" high x 4½" deep.

**Heathkit ANTENNA IMPEDANCE METER**

**MODEL AC-1**

$14.50 SHIP. WT. 3 LBS.

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

**Heathkit COMMUNICATIONS RECEIVER KIT**

**MODEL AR-2**

$25.50 SHIP. WT. 12 LBS.

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

Frequency coverage is continuous from 535 kc to 35 mc in four ranges. For added convenience, various ham bands have been separately identified in respect to their relative placement on the slide rule tuning scale. A chassis mounted, 3½" PM speaker is included with this kit. Tube line-up 12BE6 mixer oscillator, 12BA6 IF amplifier, 12AV6 detector AVC audio, 12BA6 BFO oscillator, 12A6 beam power output, 5Y3GT rectifier.

**RECEIVER CABINET**

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

**CHECK THESE NEW FEATURES**

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

**Heathkit GRID DIP METER KIT**

**MODEL GD-1B**

$19.50 SHIP. WT. 4 LBS.

The invaluable instrument for service men, hams, and experimenters. Useful in TV service work for alignment of traps, filters, IF stages, peaking compensation networks, etc. Locates spurious oscillation, provides a relative indication of power in stages, showing stage to stage losses, correcting TVI, measuring C, L and Q of components, and determining RF circuit resonant frequencies. With oscillator energized, useful for finding resonant frequency of tuned circuits. With the oscillator not energized, the instrument acts as an absorption wave meter. Variable meter sensitivity control, head phone jack, 500 microampere Simpson meter. Continuous frequency coverage from 2 mc to 350 mc. Pre-wound coil kit and rack, new three prong coil mounting. 6AF4 high frequency tube.

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

HEATH COMPANY • Benton Harbor 20, Mich.
Another outstanding example of successful Heathkit engineering effort in producing a Q Meter Kit within the price range of TV service men, schools, laboratories, and experimenters. This Q Meter meets RF design requirements for rapid, accurate measurement of capacity, inductance, and Q at the operating frequency and all indications of value can be read directly on the meter calibrated scales. Oscillator section supplies RF frequencies of 150 kc to 18 mc. Calibrate capacitor with range of 40 mmf to 450 mmf with vernier of ± 3 mmf.

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

Heathkit INTERMODULATION ANALYZER KIT

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

Heathkit AUDIO GENERATOR KIT

A Heathkit Audio Generator with frequency coverage from 20 cycles to 1 mc. Response flat ± 1 db from 20 cycles to 100 kc, down 3 db at 600 kc, and down only 5 db at 1 mc. Calibrated, continuously variable, and step attenuator output controls provide convenient reference output level. Distortion is less than 0.4% from 100 cps through the audible range. The ideal controllable extended frequency sine wave source for audio circuit investigation and development.

Heathkit AUDIO OSCILLATOR KIT

Sine or square wave coverage from 20 to 20,000 cycles in three ranges at a controllable output level up to 10 volts. Low distortion, 1½ precision resistors in multipler circuits, high level output across entire frequency range, etc., readily qualify this instrument for audio experimentation and development work. Special circuit design consideration features thermistor operation for good control of linearity.

Heathkit AUDIO FREQUENCY METER KIT

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

Heathkit SQUARE WAVE GENERATOR KIT

The Heathkit Square Wave Generator provides an excellent square wave frequency source with completely variable coverage from 10 cycles to 100 kc. This generator features low output impedance of 600 ohms and the output voltage is continuously variable between 0 and 20 volts, thereby providing the necessary degree of operating flexibility. An invaluable instrument for those specialized circuit investigations requiring a good, stable, variable square wave source.
When selecting an amplifier for the heart of your high fidelity audio system, investigate the outstanding advantages offered by the Heathkit Williamson Type Amplifier. Meets every high fidelity audio requirement and makes listening to recorded music a thrilling new experience. This outstanding amplifier is offered with optional output transformer operation, providing either the conventional triode output circuit or the new extended power circuitry in which the screen supply voltage is obtained from separate transformers. Frequency response within ±1 db from 10 cycles to 100 kc. Tube complement—GSN7 cascade amplifier and phase splitter, GSN7 push-pull driver, two 3881 push-pull power amplifiers, one 5V4G cathode type rectifier.

Matching preamplifier available providing three switch selected inputs, correct compensation, and individual bass and treble tone controls. Uses 12AV7 (or 12AX7) preamplifier—12AU7 tone control amplifier.

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

NEW Heathkit 20 WATT
High Fidelity AMPLIFIER KIT
MODEL A-9A
A new 20 watt high fidelity amplifier, designed especially for custom audio installations demanding clear reproduction, adequate power, and flexibility to meet individual requirements. Separate treble and bass tone controls provide up to ±15 db boost or cut. Four switch selected inputs, with the necessary compensation for the service desired. Output transformer impedances of 4, 8, and 16 ohms. Preamplifier, tone control, and phase splitter circuits utilize 9 pin twin triode miniature tubes for low hum and noise level. Two 6L6 push pull power output tubes provide full 20 watts power. Frequency response ±1 db, 20-20,000 cycles. Total harmonic distortion 1% (at 3 db below rated output). Tube line-up: 12AX7 A1 amplifier, 12AU7 voltage amplifier and tone control, 12AU7 voltage amplifier and phase splitter, two 6L6 push pull pentode power output, 5U4G rectifiers. Truly outstanding amplifier performance coupled with low cost.

NEW Heathkit BROADCAST RECEIVER KIT
MODEL BR-2
A new Heathkit for the student, beginner, or hobbyist. If you have ever had the urge to build your own radio receiver, this kit warrants your attention. New high gain miniature tubes and IF transformers provide excellent sensitivity and good signal to noise ratio. A built-in ferrite core rod type antenna has been provided. A chassis mounted 5/4" PM speaker provides excellent tone and volume. Convenient phone input. Can be operated either as a receiver or tuner. Simplified construction manual outlines circuit theory, ideal for students. Tube line-up: 12B66 mixer oscillator, 12B66 IF amplifier, 12AV6 detector-AC-DC beam audio, 12A6 beam power output, 5Y3GT rectifier. CABINET—Proxolin impregnated fabric covered plywood cabinet. Shipping weight 5 lbs. Part number 91-9, $43.00.

HEATH COMPANY • Benton Harbor 20, Mich.
CHECK THESE NEW FEATURES

- Plays all record sizes, all speeds
- Newly developed ceramic cartridge
- Automatic shut-off for both changer and amplifier
- Acoustically correct cabinet enclosure
- Modern attractive styling
- Two 6" PM matched speakers
- Compensated volume control
- Easy to assemble

An entirely new introduction to quality record reproduction, a simple to operate, compact, table top model with none of the specialized custom installation problems usually associated with high fidelity systems. Two matched, synchronized speakers mounted in an acoustically correct enclosure reproduce all of the music on the record. Musical reproduction with the unique sensation of being surrounded by a halo of glorious sound. This spectacular characteristic is possible only because of the diffused non-directional properties of the matched dual speakers. The Heathkit Dual makes listening to fine recorded music a thrilling new experience through naturally clear, life-like reproduction of sound at all levels throughout the tonal system. The performance level is vastly superior to that of the ordinary phonograph or console selling for many, many times the price of the Dual. Record Changer plays all sizes— all speeds— automatic shut-off for changer and amplifier after the last record is played. A wide tonal range ceramic cartridge features a ingenious turn-under twin sapphire stylus for LP or 78 records without turning the cartridge. Simplied, easy to assemble, four tube amplifier features compensated volume control and separate tone control. Proxylin impregnated fabric covered cabinet supplied completely assembled. You build only the amplifier from step-by-step construction. No specialized tools or knowledge required, as full recognition has been given to the fact that many purchasers of this kit enjoy good musical reproduction on a purely non-technical basis, and the construction manual has been simplified to the point where even the complete novice can successfully construct the Heathkit Dual. The price of the Heathkit Dual includes cabinet, Record Changer, two 6" PM speakers, tubes, and all circuit components required for amplifier construction.

HEATH COMPANY • Benton Harbor, 20, Mich.

ORDER BLANK

From

MAIL YOUR ORDER TODAY TO THE
HEATH COMPANY
BENTON HARBOR 20, MICHIGAN

OR PHONE
BENTON HARBOR 5-1175

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OCTOBER, 1953
CAPACITANCE and the RATIO DETECTOR

Understanding circuits through capacitor analysis.

By CYRUS Glickstein

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

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

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

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

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

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

In addition to this action, a second action is taking place simultaneously during the first quarter-cycle (first half of the negative alternation). One-half of the secondary, L2, is in series with L3 across the bottom diode and C2. The two windings act as out-of-phase generators in series. The voltage polarity is such that current flows through the bottom diode V2 and charges C2 as shown in the simplified circuit of Fig. 3. The rectified voltage across C2 will have the polarity shown—negative with respect to ground—and will be -7 (the vector sum of 5 volts across L2 and 5 volts across L3; the two voltages are 90 degrees out of phase). Now in the next quarter-cycle (second half of the negative alternation), the entire secondary is still across R1-C1 as in Fig. 2. Simultaneously, the polarity across L3 reverses and L3 is now in series with L1. L1 and L3 now act as two out-of-phase generators in series and the voltage polarity is such that current flows through the top diode V1. The current path is through V1, R1-C1, and C2 as shown in Fig. 4. Note that
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OCTOBER, 1953
there is 10 volts across R1-C1 and 7 across C2 as a result of the action in the first quarter-cycle. In this second quarter-cycle, therefore, the voltage in C2 is in series-bucking with the voltages across L3 and L1 but this combined total is bucking the voltage across R1-C1. This is illustrated in the simplified schematic of Fig. 5. This means that 7 volts (vector sum of the voltages across L1 and L3) plus the 7 volts across C2 (total -14 volts) is bucking the 10 volts across R1-C1. As a result, there is a difference of 4 volts and C2 discharges 4 volts worth. Since it had -7 volts to start with, this leaves -3 volts across C2. As long as the incoming signal remains at the resting frequency, the voltage across C2 will be -7 volts on the first quarter-cycle and -3 volts on the next quarter-cycle for each half-cycle when the diodes conduct. The average d-c voltage across C2 is -5 volts. That is, a d-c meter placed across C2 cannot measure the instantaneous changes at each quarter-cycle but measures the average level of voltage.

in Fig. 3—Peak voltages across L2 and L3 are rectified and developed across C2. across L1 and L3) plus the 7 volts across C2 (total -14 volts) is bucking the 10 volts across R1-C1. As a result, there is a difference of 4 volts and C2 discharges 4 volts worth. Since it had -7 volts to start with, this leaves -3 volts across C2. As long as the incoming signal remains at the resting frequency, the voltage across C2 will be -7 volts on the first quarter-cycle and -3 volts on the next quarter-cycle for each half-cycle when the diodes conduct. The average d-c voltage across C2 is -5 volts. That is, a d-c meter placed across C2 cannot measure the instantaneous changes at each quarter-cycle but measures the average level of voltage.

In Fig. 4—Diagram showing current flow during second quarter cycle of signal. It is interesting to note that the average d-c voltage across C2 (-5 v) is exactly half the voltage across R1-C1 (-10 v). This is true in every ratio detector at the resting frequency. In fact, when aligning a ratio detector, two equal resistors (R2 and R3) in series are temporarily soldered across R1-C1, to divide the voltage in half. A d-c meter is then placed at the junction of the two resistors (Fig. 6) and the top of C2. The secondary circuit of T1 is then tuned, while applying a signal at the resting frequency, until the meter reads zero—that is, until the voltage across C2 is exactly equal to one-half the voltage across R1-C1.

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

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

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

To illustrate the action at the resting frequency with figures: Assume R1-C1 have 10 volts across them when an instantaneous noise pulse increases the voltage across the secondary to 14 volts (7 volts across each half) and the voltage across L3 to 7 volts. The vector sum of the two voltages is 10 volts, and C2 charges up to this value. Then the 10 volts across C2 is in series with the 10 volts across L1 and L3 bucking the 10 volts across R1-C1. The difference is 10 volts, so C2 discharges to zero. The average voltage across C2 is -10 + 0 or -5 volts as before. It is interesting to note that, no matter what values are chosen, and throughout the change of voltage drop to deviation, any instantaneous increase of voltage across the secondary and across L3 will not change the voltage output across C2 compared with the no-noise condition, provided R1-C1 remain at the original voltage value.

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

In Fig. 5—Simplified circuit of Fig. 4. Some previous explanations of the action in this circuit are based on the assumption that one quarter-cycle, C2 (Fig. 1) charges across the lower diode, but on the next quarter-cycle C2 charges equally in the opposite direction through the upper diode. It is maintained that at the resting frequency the voltage across C2 is zero. It is further assumed that C2 can charge equally through the upper diode because

in Fig. 6—Aligning ratio detector. Secondary is tuned for zero output on meter. C1 has practically zero impedance for r-f. This explanation is defective on at least three counts. (1) Rectified r-f. is no longer r-f. but d-c.; therefore it is incorrect to state that C1 has zero impedance to r-f., since the diodes rectify the r-f. (2) There is a definite d-c. voltage across R1-C1 which cannot be ignored in the explanation of how voltages are developed across C2. (3) The average d-c. voltage across C2 at the resting frequency is not zero but one-half the voltage across R1-C1. The detailed explanation of the circuit in this article takes each of these points into consideration.

in Fig. 7—Voltage across C2 during deviation to one side of resting frequency.
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OCTOBER, 1953
O ONE can proceed to fix any radio simply by reading "how-to-do-it" books. But he can learn enough about specific troubles from an article by an experienced technician so that he may service a set that has similar troubles.

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

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

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

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

3. If this test shows everything normal, switch the ohmmeter to its 2,000-ohm range (or thereabouts) and turn the set on. The meter should now read between 100 and 150 ohms. (If the set has a 110-volt pilot light, this reading may be as low as 50 ohms.) If the meter reads less than 35 ohms, take a look at the pilot light; if it's a 110-volt type remove it and repeat the test.

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

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

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

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

7. I have found that the output tube is the one that's most often intermittent. Test it first, and then the 12S57, 12SK7, 12SQ7, and 3S5 (or their equivalents), in that order. The resistance reading across the filament of an intermittent tube will generally be abnormally high at the instant the test is applied. (Good filaments should read 10 to 15 ohms on 12-volt tubes, and 20 to 50 ohms on 30- and 50-volt types.) A reading of 100 to 300 ohms on any tube filament indicates a probable intermittent. If the complaint is an intermittent set, or you are in doubt about the results of the resistance test, try the tube in the tube tester. Bad- or weak-tube indications, and excessive warmup periods before any reading shows on the tester are all indications of an intermittent heater.

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

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

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

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

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

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

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

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

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

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

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

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

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OCTOBER, 1953
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Portable test instruments offer an excellent opportunity for transistors to do their stuff. Small size and light weight make them ideal.

By RUFUS P. TURNER

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

The basic instrument

The heterodyne frequency meter is well known to commercial radio operators who use it frequently to measure transmitter carrier frequency. Hams use this instrument supplementarily as a c.w. monitor and receiver calibrator. The heterodyne frequency meter is a common instrument in radio-frequency laboratories where it is used to check the frequency of r.f. oscillators and signal generators and as a comparator. The block diagram in Fig. 1 shows the basic arrangement of a heterodyne frequency meter. The r.f. oscillator uses an inherently stable circuit tunable over a single frequency band. Its output is fed into an aperiodic detector or mixer together with the test signal to be measured. The oscillator and test signals (or some harmonics of one or both) produce a beat note which then is amplified by the audio amplifier and monitored with headphones or a visual indicator. The r.f. oscillator is tuned to zero-beat with the signal and the frequency is read off the oscillator dial. The dial may be directly calibrated. The test-signal frequency may be lower than the fundamental frequency range of the oscillator. Its harmonics then beat with the oscillator. Or the signal frequency may be higher than that of the oscillator, in which case an oscillator harmonic will beat with the signal. In this way, we use the instrument over a wide frequency range extending from \( f/n \) to \( nf \), where \( f \) is the oscillator fundamental frequency at some suitable setting, and \( n \) is a multiplier or divisor representing the most remote useful harmonic or subharmonic which will give a sufficiently strong beat note.

Thus, in one commercial heterodyne frequency meter, the oscillator is tunable from 100 to 200 mc, and the useful measurement range (from \( f/n \) to \( nf \)) is 10 to 2,000 mc. (In this instance, the factor \( n \) is 10.)
Transistorized meter

When using a junction transistor in the r.f. oscillator section of a heterodyne frequency meter, the designer is limited by the fact that this type of transistor ordinarily will not oscillate beyond the top of the standard broadcast band. However, by tuning the transistor oscillator from 500 to 1,000 kc., the practical measurement range is found to be 50 kc. or less to 30 mc. Response at the high frequencies is dependent to a great extent upon the strength of the test signal.

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

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

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

(continued on page 90)
THE NEWEST, THE ONLY ONE OF ITS KIND!

8½" OSCILLOSCOPE, PRECISE MODEL #308

Now another great Precise Oscilloscope! The only 8½" Oscilloscope on the Commercial Market . . . in Kit or Wired Form . . . at an unbelievably low price. Designed to bring you true TV picture clarity and laboratory tested accuracy.

ALL THE OUTSTANDING FEATURES OF THE MODEL 300 as shown below, PLUS:

* INTENSIFIER ANODE
* HI-LOW-NORMAL SYNCH. (A Precise First)
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* VOLTAGE REGULATION (A Precise First)

"Seeing is Believing"—Go and See!
your nearest jobber

308K—kit form $129.50

308M—factory wired $199.50

Prices slightly higher in the West. Prices and specifications subject to change without notice.

AMATEUR

Construction

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

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

Base resistors R1 and R2 are the only critical components. Their values vary with individual transistors and must be selected for the particular transistors used. The resistance values given in Fig. 2 worked satisfactorily in the author's instrument and will be good starting values from which to begin tests. Resistor R1 should be selected for lowest collector current which will permit strong oscillation over the entire range of the tuning capacitor. For this test, connect a multirange d.c. milliammeter temporarily in the lead from R1 to the negative terminal of the battery. Note the indicated collector current for each experimental value of R1. To test for oscillation, touch the collector lead of the transistor with the finger. The milliammeter should change reading vigorously. A slight change shows weak oscillation. After each change of R1, make this check at each setting of C6.

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

Calibration

The best final calibration will be obtained with a 100-ke frequency standard. However, follow these steps for the initial calibration: (1) Feed a 500-ke signal to the SIGNAL INPUT terminals.

(2) Set the main tuning capacitor to its full-capacitance position. (3) Plug headphones into the jack and adjust the CALIBRATION trimmer C2 for zero beat. The C9 dial now may be marked 500 ke to this point. (4) Set 1000 ke as a frequency standard for the signal generator. (5) Reset C2, if necessary, to establish a more accurate zero-beat with the standard. (6) Tune C3 slowly from this setting until another standard frequency point is brought in on zero-beat.

(Continued on page 94)
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These are just some of your Certified Quality Service advertisements. They sell you... and without a lot of sell for CBS-Hytron, although CBS-Hytron gladly pays the bill. Why? Because as we build public confidence in Certified Quality Service, we build greater faith in you and more business for you... our customers.

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All-Purpose Crystal MICROPHONE

**MODEL 777**
List Price $21.00

**MODEL 777s** (with switch)
List Price $23.00

(Price includes cradle for mounting on stand)

**Its Versatility and "Hand-a-Bility" make it an ideal low-cost all-purpose microphone**

**LIGHT!** The new "777" Slim-X Microphones are rugged little microphones weighing only 6 ounces! They are designed for good-quality voice and music reproduction. Their versatility and "hand-a-ility" make them ideal for use by lecturers, announcers, instructors, and Hams; for audience participation shows; carnivals; panel and quiz shows; and use with home-recorders. When mounted on either cradle or swivel, the "777" can be removed in a flash (no tools necessary) — simply by lifting it out of the holder. This makes it an ideal "walk-around" hand-held microphone.

**TECHNICAL INFORMATION:** Smooth frequency response — 60 to 10,000 c.p.s.; special-sealed crystal element — for long operating life; high impedance; 7' single-conductor cable, disconnect type. Dimensions: (Microphone only) Length, 4 1/2". Diameter 1". Finish: Rich satin chrome overall.

**NOTE:** Lavaliere cord for suspension of Microphone around neck is included.

**ACCESSORIES FOR "777"**

**MODEL 538 STAND** is a heavy Die-cast base. Includes metal screw machine stud for connecting microphone adapter to stand base.

List Price: $3.30

**MODEL A25 SWIVEL ADAPTOR** features a long-life, high-quality swivel connector. Is lined with a long-life nylon sleeve — for noise-free and scratch-free insertion and removal of microphone.

List Price: $5.50

---

**AMATEUR**

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

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

**Application**

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

When checking a transmitter (and some oscillators), satisfactory coupling into the frequency meter is obtained by using 1 or 2 feet of stiff wire.

---

**Fig. 2—Circuit of the transistorized 50-kc to 30-me heterodyne freq meter.**

**Materials for frequency meter**

**Capacitors:** 1–25 µf, air trimmer; 1–365 µf, single-section tuning capacitor; 1–50, 1–200 µf, midgel mica or ceramic; 1–0.01 µf, mica or ceramic; 1–1.0 µf, 200 volts, metalized paper.

**Miscellaneous:** 2—ckt722 transistors; 1—ckt705 germanium diode; 1—c.p.s.t. toggle switch; 2—resistors

Longer ones may cause interference on nearby broadcast receivers. Ordinarily, such interference is not created because of the low power output of the transistor oscillator stage.

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

END
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PLASTOID Corporation
42-41 24th St., Long Island City, N.Y.

OCTOBER, 1953
INDUCTANCE METER USES HETERODYNE PRINCIPLE

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

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

2. Use an inductance bridge.

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

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

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

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

\[ L = \frac{1}{(6.28 \times f)^2} \]

where \( L \) is in henrys, \( C \) in farads, and \( f \) in cycles per second.

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

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

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

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

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

Materials for inductance meter

Resistors: 1-1 mohms; 1-270,000; 1-100,000; 1-47,000; 1-1,000 ohms; 1/2 watt; 1-500 ohms; 5 watts with semi-adjustable slider; 1-3,000 ohms; 10 watts with semi-adjustable slider; 1-250,000 ohms, potentiometer.

Capacitors: 1-10, 1-50, 1-200, 1-500 muf, ceramic; 1-1000, 1-500 muf, silver mica with tolerance of 2% or better; 1-01, 4-01, 1 pf, 400 volts, paper; 1-25, 25 volts, electrolytic.

Miscellaneous: Tubes (see text), sockets, hardware, hookup wire.

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CONSTRUCTION

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Miscellaneous: Tubes (see text), sockets, hardware, hookup wire.

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

END

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AUTOMATIC HEADLIGHT DIMMER

Electronic headlight dimmer installed. Oncoming headlights actuate dimmer.

By JACK MARLEY

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

All parts used were stock items, except the 931-A phototube and the resistor network. The 931-A can be obtained from any radio supplier and the resistor network may either be purchased from a United Motors radio parts distributor or made up of 220,000-ohm 1/4-watt resistors. The network is very compact and costs only $2.25. Several tries with other tubes showed me that a multiplier type is the best phototube to use. Another unit built around an 868 gas phototube lacked sufficient sensitivity. The gas type, being a single-stage unit, does not have sufficient current flow. The 931-A takes a submagnal 11-pin socket. If one isn't available, use an Amphenol 77-MP11.

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

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

CONTINUED ON PAGE 102

Here's how to SAVE MONEY ON INSTRUMENTS!

- how to do faster, better testing with fewer instruments
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BASIC ELECTRONIC TEST INSTRUMENTS

By RUFUS P. TURNER

The instrument book written especially for SERVICEMEN • AMATEURS • EXPERIMENTERS

SEE WHAT IT CAN DO!

You are shown new uses for VOM's, oscilloscopes, signal generators and other old standbys. You learn how to extend the range of many old instruments. How power drain measurements can be used for TV troubleshooting; how a useful and accurate bridge can be built from a combination of familiar general-purpose instruments; how to calculate shunts and multipliers; how to measure r-f impedences with a simple T-network; how to measure inductance and capacitance with a grid-dip oscillator and scope of other money-saving "tricks."

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OCTOBER, 1953
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Re-entrant Network
(Using Single Lead-In)

Gives ZIG ZAG added Gain over Best of all other Antennas!

*description of Re-entrant Network*

As developed by TRIO, the re-entrant network consists of two paralleled quarter wave transformer sections coupled to each antenna. One transformer provides an efficient impedance match throughout the upper channel coverage of the antenna, the other transformer covers the lower channels. The two transformer sections together offer a practically constant impedance termination to the feed-line, which is not affected by coupling a second antenna and its re-entrant network. Rain or shine, no antenna in America can match the performance of the ZIG-ZAG — on any channel!

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A modern, new addition to TRIO's present facilities adds 24,000 sq. ft. of manufacturing space. A new laboratory, not illustrated, has also been added.

TRIO has on hand, or in the process of shipment from the mills, 60 carloads of aluminum to meet increased production schedules.

Despite these facts, we are not sure we will be able to fill all orders. We suggest you order now.
Outperform on **ALL** Channels!

Gain that is greater by far than that offered by the best of the collinears, conicals and multi-element Yagis, is now offered by famous TRIO ZIG-ZAG antennas!

A sensational new TRIO development — a new re-entrant type impedance matching network — makes possible this tremendous improvement by providing an almost perfect impedance match to the line on every channel! Unlike isolation filters, the ZIG-ZAG re-entrant network has NO insertion loss!

A single feed-line is used, even when stacking for all-channel operation!

Extensive tests were made in all sections of the country, in every conceivable type of terrain. Results prove that the ZZ12L, ZZ16H combination, with their associated re-entrant networks, provides the finest all VHF channel, single lead-in operation yet obtained.

Current shipments of TRIO ZIG-ZAG antennas include the complete network.

For channels 2 thru 6 or channels 7 thru 13 separately, or combined for channels 2 thru 13, TRIO ZIG-ZAG antennas are the hottest ever designed.

New descriptive literature available.

**HIGH GAIN TRIO UHF ANTENNAS**

(4-stack, in actual tests, bests all other types)

The popular TRIO 4-stack bow-tie, in actual field tests, outperformed all other types because it takes advantage of the fact that UHF signals are composed of closely spaced layers of different signal strength. Because of its vertical height, the TRIO 4-stack taps one or more of these varying high density layers at all times — offers consistent high gain day in and day out.

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

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

TRIO Manufacturing Co.

GRIGGSVILLE, ILLINOIS

OCTOBER, 1953
Note horizontal mounting of plate relay.

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

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

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

**Operation**

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

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

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

Fig. 2 is the diagram of a hold cir-
Presenting "RECTIFIER RED" the new product-line color for Federal MINIATURE SELENIUM RECTIFIERS

FEDERAL—the original miniature—is saying goodbye to gray. The new bloom is "Rectifier Red"... a striking color that instantly tells servicemen they’re getting the rectifier efficiency and long life that created tens of millions of profit opportunities for radio-TV servicing... tells them they’re getting the quality that keeps Federal miniatures the best-seller in America’s vast and growing rectifier replacement market!

Look for “Rectifier Red”... get the performance that clicks... the replacement profit that sticks! See your Federal Distributor for Federal miniatures in handy 8-unit kits... in quantity lots... or in individual packages sold through Federal’s self-service rectifier dispenser... on hundreds of counters! See your "FTR" Distributor now, or write to Dept. F-763.

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**THE NEW WALL BAFFE BY UTAH**

The new, luxurious-looking UTONE wall baffles will complement the interior of any restaurant, church, school, home, club, tavern or factory wherever speaker housing is needed.

The quality and construction of UTONE baffles are of the finest, the finest woods matched by the fine production skill of Utah—a pioneer and leader in the sound field for over 30 years.

UTONE baffles are available in three beautiful finishes and four sizes. Many students are getting actual experience with Chicago's TV sets. You can start earning Television money after first few lessons. You learn to test, trouble shoot and repair all types of TV sets.

**NOTE THESE UTONE QUALITY FEATURES**

- Styled by Master Woodworkers
- High Gloss Lacquer Finish
- Beautiful Matching Grill Cloth
- Free of Vibration and Rattles
- Moisture and Water Resistant
- All Joints Mortised and Secured
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---

**CONSTRUCTION**

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

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

**Fig. 2—Additions for more sensitivity.**

**Materials for electronic dimmer**

Resistors: 100-20,000 ohms, 1/2 watt, or use General Motors printed network assembly No. 594322; 0-1.3 megohms, 1/2 watt; 1-1 megohms, 1/2 watt; 1-2 megohms, 1/2 watt.

Capacitors: (Electrolytic) 2-6uf, 1,600 volts, matched to power transformers; scope: 1-33 uf, 400 volts; 1-55 uf, 1,600 volts; 1-65 uf, 200 volts. (Electrolytic) 1-8 uf, 450 volts.

Miscellaneous: 2-auto radio power transformers; 2-4-prog. nonsynchronous vibrators: 1-10,000 ohm s.p.d.t. plate relay; 2-automotive-type horn relays; 1-4-74 or GM 594314; 1-024 or 4X4 or 4X; 1-931A multiplier-type photocell; (5) FE fuse; socket; wire; assorted hardware.

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

We may see the day when all cars will have an electronic dimmer as standard equipment.
This new HICKOK 5" Scope has all the needed characteristics for accurate TV alignment and service work. Designed, built and guaranteed by HICKOK, the Model 665 will perform every function required of it and give long, trouble-free service within the range of its technical characteristics.

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5-tube Super (6 Tube Performance) Installs easily in 15 minutes. Appearance and tone quality equal to expensive radios supplied by car manufacturers.

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BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N.Y.

RADIO-ELECTRONICS
VERSATILE GRID-DIP PROBE

BY I. QUEEN

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

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

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

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

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

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

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

Construction is straightforward, but two points need explanation. The bottom of an acorn tube extends below its socket. Therefore the latter cannot mount directly on the metal box. I
There is one sure way of guaranteeing that any television set will produce the best picture that it is capable of and that is by installing an AMPHENOL antenna. For only with an AMPHENOL quality antenna installation can the customer be assured of better TV picture quality (the electrical qualities of AMPHENOL antennas are unexcelled) and years of trouble-free service (AMPHENOL antennas are sturdy and rugged; they are designed to perform efficiently for years).

Besides providing complete customer satisfaction in the quality of the antenna installed, the dealer has also the advantage of the completeness of the AMPHENOL antenna and accessories line. AMPHENOL makes a variety of types of both UHF and VHF antennas, as well as the famous AIR-CORE Tubular Twin-Lead and every necessary accessory.

see your AMPHENOL distributor

The AMPHENOL film "The UHF/VHF Television Antenna Story" is now available for all dealers to see. By contacting your AMPHENOL distributor you will receive full information on this interesting color presentation of TV signal transmission and comparison of current antenna types. The film is especially valuable in its discussion of the problems of UHF.

A new AMPHENOL aid to dealers is the "TV Antenna Folia", which gives a short version of "The UHF/VHF Television Antenna Story." With Kodachrome illustrations from the film, it is designed not only to help dealers with television problems but to contain, as well, current catalog sheets on AMPHENOL antennas and accessories. Write your AMPHENOL distributor for copies.
added a metal shelf one-half inch below the top of the box. It holds the sockets for coil L and the 955 tube. The shelf may be mounted either with spacers or brackets.

For high frequencies, a ½-inch diameter polystyrene coil is convenient. Be careful in soldering to the pins. More often than not the heat softens the polystyrene and ruins the coil form. I found the following procedure good:

Saw the base off an Amphenol type 24 form (no prongs). This form fits neatly into a 4-prong miniature chassis plug (type 71-48). The two are cemented together or they may be held together by screws. This makes a plug-in coil form with a bakelite base so there is no soldering problem. The chassis plug mates with Amphenol socket type 78-54S.

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

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

---

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

**Materials for probe**

- Resistors: 1-100, 1-1,000, ½ watt.
- Capacitors: 1-50 µuf, mica; 1-1,000 µuf, mica; 1,500 µuf, ceramic; 1-50 µuf, variable.
- Miscellaneous: 1-3-ma r.f. choke; 1-955 tube and socket; 1-4-prong socket (Amphenol 78-54S); 2-coil forms (Amphenol type 24); 2-4-prong plugs (Amphenol 71-45); 1-metal box 4 x 4 x 2 inches; 1-7-prong socket.

---

End
FACTS YOU SHOULD KNOW ABOUT UHF CONVERTERS

Many converters on the market today are unsatisfactory in fringe and shadow areas where signal strength is low. Before you install a UHF converter in these areas you should know these facts:

1. Signal power loss in the preselector seriously affects picture quality. Most UHF converters use sliding-contact shorted line tuners in the preselector with a fixed power loss of 6 db. The Turner converter uses High Q coaxial cavity tuners with no sliding contacts. Signal power loss is cut to 3 db. The resulting low noise figure keeps picture quality high.

2. Oscillator radiation often causes disturbing interference with neighboring sets. In the Turner converter the oscillator tube socket and all associated circuits are inside the coaxial cavity, self-shielded. Removable covers provide a second shield against radiation.

3. High amplifier noise figure can further damage picture quality. The Turner converter uses a special broadband amplifier with Cascode circuits. It retains the preselector signal savings without appreciably increasing the noise figure. The Turner amplifier noise figure is only 4 db.

Whether you're selling converters for installations in shadow or fringe areas or putting one in your own home, remember... the Turner converter often means the difference between good reception and bad.

EXCLUSIVE TURNER FEATURES
- Higher sensitivity
- Extremely low noise figure
- Exceptional frequency stability
- Double shielding
- Hi-Q silver plated coaxial cavities
- No sliding contacts

OTHER MAJOR TURNER FEATURES
Continuous single-knob tuning. Illuminated slide-rule dial. Smaller size: 8½x6½x6½. Use with UHF or combination antennas. Self powered, uses channels 5 or 6. Complete installation instructions. 50-60 cycles AC. Schematic included.

In VHF fringe and shadow areas, the Turner Booster is a superior performer, too.

THE TURNER COMPANY
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ELECTRONICS

CHARACTRON TUBE HAS MANY COMMERCIAL APPLICATIONS

By S. M. MILANOWSKI

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

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

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

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

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

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

Focusing voltage for the Charactron
You'll never see your doctor advertise a special sale on appendectomies ... 
You'll never see your lawyer announce cut-rates for divorce cases ... 
You'll never see your dentist hold a "2-for-1" sale on extractions ... 
AND You'll never see the day when you can take your TV set in for a service "bargain" and be sure you're getting a square deal!

"Bargains" in home electronic service are as scarce as the proverbial hen's teeth! Here's why—

The expert service technician, just like other professional people, must undergo years of study and apprenticeship to learn the fundamentals of his skill. And a minimum investment of from $3000 to $6000 per shop technician is required for the necessary equipment to test today's highly complex sets. Finally, through manufacturer's training courses and his own technical journals, he must keep up with changes that are developing as fast as they ever did in medicine, law, or dentistry. Those best equipped to apply modern scientific methods are almost certain to be most economical for you and definitely more satisfactory in the long run.

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

[Signature]

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

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

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

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OCTOBER, 1953
understanding MECHANICAL FILTERS

Superior filtering and selectivity is obtainable by use of mechanical filters

By LESLIE L. BURNS, JR.

Principles of Operation

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

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

Magnetostrictive conversion

The radio-frequency signals must be converted to mechanical vibrations in

Fig. 1—Conventional i.f. transformer.

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

Fig. 3—Coupling with third tuned circuit.

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

Fig. 5—Mechanical resonator circuit.

Fig. 6—Multisection magnetostrictive rod filter.

Fig. 7—8-circuit mechanical filter designed for 455 kc with bandwidth of 6 kc. Small necks couple circuits together.
OCTOBER, 1953

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Linear Sweep Oscillator — Saw tooth wave 20 cycles to 50 Kc in 5 steps. 60 cycle sine wave also available as well as provision for using external sweep.
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Fig. 9—Heavy slugs couple resonators.

By continuing the process of adding more mechanical circuits we have the arrangement shown in Fig. 6. Here we have six mechanical circuits and two electrical circuits for a total of eight circuits. This arrangement will provide a selectivity curve with a flat top and steep sides suitable for most communications receivers designed for general use.

The bandwidth of this type of arrangement is determined by the relative size of the mechanical resonators to the small coupling necks. The small neck corresponds to weak coupling and produces a narrow band, whereas a larger-diameter neck produces a wider band. To keep the functions of a mechanical filter clearly in mind, imagine each resonator—that is, each large portion of the rod—to be a tuned circuit, and imagine each small neck portion to be like a small amount of mutual coupling. Fig. 7 is an enlarged photograph of an 8-circuit mechanical filter designed for 455 ke with a bandwidth of 6 ke. The small necks coupling the mechanical
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NEW DESIGN

A: SELECTIVITY WITHOUT FILTER
B: SELECTIVITY WITH KTA FILTER
C: WITH MECHANICAL FILTER

Fig. 10—Selectivity of various filters. Circuits together can be easily seen. The interior resonators of this filter are actually 0.4 inch long.

Further design considerations

The resonant frequency of a magnetostrictive rod is determined by its length. A rod of nickel about 1 inch long will be resonant at 100 kc. The relation is:

\[ \text{Length} = \frac{\text{velocity of sound}}{\text{frequency} \times 2} \]

The velocity of sound is different in different materials. In nickel it is \(1.85 \times 10^5\) inches per second, while in Ni-span C the velocity is \(1.89 \times 10^6\) inches per second. Each of the resonators in a mechanical filter is made exactly this length or some multiple of this length so that all will be resonant at the center frequency of the pass-band. In some designs the interior resonators are made just twice as long as the end resonators, but they are still resonant at the center of the pass-band.

Also, other forms than the rod-shaped resonator can be used in mechanical filters. Disc or spherical resonators can be used. Each of these different shapes has advantages that make it suitable for certain frequencies and bandwidths.

The bandwidth of the simple rod-type filter that has been illustrated is determined by the relative size of the coupling neck to the resonator. The relation is:

\[ \text{bandwidth} = \frac{\text{area of neck}}{\text{center freq.}} \text{area of resonator} \]

where the area is the cross-sectional area of the neck or resonator.

Fig. 11—A top-side view of a typical mounting for a mechanical filter.

Fig. 12—The drive coil and permanent magnet can be seen in this bottom view.
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Mechanical filters, like electrical filters, must be terminated for minimum ripple in the pass-band. Termination of a filter for minimum ripple is analogous to terminating a television transmission line for minimum reflections in the picture. Mechanical resistance in the form of mechanical lossy material is attached to the end resonators. (A mechanical lossy material might for example be a piece of rubber glued to the end resonator.) Another method of producing the required mechanical resistance is to attach a long piece of wire coated with some lossy material to absorb the vibrations. With this method it is easy to get exactly the proper amount of mechanical resistance since the diameter of the wire determines the amount of the losses. Fig. 8 shows the end portion of a mechanical filter with a coiled lossy line attached.

Sometimes, when the bandwidth of the filter is not too great, no mechanical resistance in the form of lossy material is necessary, since all the resistance needed to properly terminate the filter is provided by the electrical circuit coupled to the end resonator. Another consideration in mechanical filter design is that, to obtain the flattest pass-band response, the end resonators must contain half the energy of the interior resonators. This is evident in Fig. 7 where it can be seen that the end resonators are half as long as the others and in Fig. 8 where the end resonator has a smaller diameter than the interior resonators.

The circuits of an electrical filter can be coupled by either a mutual capacitance or a mutual inductance. This is true also of the mechanical case. One form of mechanical filter uses heavy slugs to couple the resonators instead of the small necks as has been previously shown. Fig. 9 illustrates this type of filter. Here the small tubes are the resonators, while the slugs form the couplers. The slugs are about 0.2 inch long, while the interior resonators are 0.6 inch long. Again, on this filter the half-energy end resonators can be seen clearly. A filter of this type is fully equivalent to the other form shown, and the choice between the two is purely a matter of the ease of fabrication for the frequency desired.

Applications
A typical selectivity curve is illustrated in Fig. 10, which also shows for comparison the curves obtained in a high-quality communications receiver with and without the crystal filter. The crystal filter here referred to is the type usually found in communications receivers and is designed to provide a sharp band of frequencies with not a flat-topped response such as is provided by a mechanical filter or a band-pass crystal filter employing several crystals.

The electrical circuit diagram for a mechanical filter is given by Fig. 6. A typical mounting for a mechanical filter is illustrated by Figs. 11 and 12 for a 100-kc filter with a 6-kc bandpass. The drive coil and permanent magnet are evident in the underchassis view. Filters for higher frequencies will have much smaller housings. The application of mechanical filters to high-quality receivers will increase as improved designs and better fabrication techniques are developed. It seems unlikely that they will ever be used in the cheap table-model broadcast receivers because the selectivity of these receivers is now satisfactory. However, the better-quality broadcast receivers will use mechanical filters. The big field for the application of mechanical filters is in communications receivers and in military equipment where the stringent selectivity requirements cannot be met by any other type of filter.

References

Circuit-Symbol Stamps
Here's an unusually handy gadget for the technician, engineer, or hobbyist who isn't an expert draftsman but who wants to keep neat schematics. It's a set of 12 1/4 x 1 1/4-inch clear-plexiglas blocks engraved with the basic component symbols that make up practically all electronic circuit diagrams. All you have to do is ink them lightly on an ordinary stamp pad and press them on the paper to produce perfect tube diagrams, resistors, or other common circuit elements.

The set has five tube stamps, covering standard types from diode to pentagrid converter; a fixed resistor and a potentialmeter; fixed and variable capacitors; a basic inductor stamp which can be repeated and inverted as required for transformers or coupled circuits; a contact-rectifier symbol; and a stamp for headphones. (This latter one will probably get relatively little use, and possibly the manufacturer (Precise Measurements Co.) should substitute a more common symbol such as a speaker, line plug, or a transistor.)
**NEW DESIGN**

The transistor continues to make news. As mentioned last month, Sylvania Electric Products has developed two new types of point-contact transistors. One is a tetrode transistor 3N21 that was scheduled to be commercially available about August 15, and the other is a pentode transistor that is expected to become commercially available later this year. Sylvania is the first company to announce that its development work

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The aluminized version, the 24CP4A, gives additional light output because of its metal-backed screen.

24CP4 has deflection angle of 90 degrees.

Recommended operating conditions for the 24CP4 and 24CP4A:
- Anode voltage, 16,000; grid 2 voltage, 300; grid 1 voltage, -33 to -77; focusing coil current, 119 ma; ion trap intensity, 40 gausses. Base-pin connections are for a standard small-shell, 5-pin duodecal socket.
- A new RCA electron tube specially engineered to shake off the "shakes" of airborne and mobile electronic communications equipment has been made available. The new type tube, RCA-VC-1258 thyatron; 6336 twin power triode.

601, is designed specifically for use as a class-A amplifier and control tube in applications where dependable equipment performance hinges on the ability of electron tubes to take abnormal shock and vibration.

The 601 is a medium-mu twin triode which couples the characteristics of the 6J6 with the ability to withstand punishing physical operating conditions.

E.E. or PHYSICS GRADUATE

with an interest or experience in RADAR or ELECTRONICS

Hughes Research and Development Laboratories, one of the nation's large electronic organizations, are now creating a number of new openings in an important phase of operations.

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located in Southern California, is presently engaged in the development of advanced radar devices, electronic computers and guided missiles.

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Scientific and Engineering Staff

Culver City, Los Angeles County, California

RADIO-ELECTRONICS
The new tube has a pure tungsten heater to provide long life under frequent on-off switching operations. Additional insulating material has been applied to the heater to give protection against short-circuits between the heater and cathode under conditions of extreme vibration. Base connections are the same as the G36.

Chatham Electronics Corp. has announced the production of two new tubes. The first, type G36E, is a high-pervenance, high-plate-dissipation twin-tube triode for voltage regulation. Used as a series tube, it will pass 150 ma per section at 40 volts d.c. with minimum bias, and the same current at 200 volts d.c. with a grid bias of -60 volts. The tube features a hard glass envelope and an 8-pin butt stem. Pin connections are the same as those of the 6AS7-G. The filament voltage is 6.3, and it draws 5 amp. Forced ventilation is not necessary at ambient temperature. Mu is 2.7, gm is 14,000 microhms, Rp is 250 ohms. Its life expectancy is 1,000 hours minimum. The second tube, type VC-12S8, is a miniature hydrogen thyratron for pulse generating applications. It is capable of handling peak power up to 10 kw. This tube will fit a standard miniature socket. (See base diagram below.) It is rated at 1,000 peak anode volts, 20 amperes peak anode current, and 40 ma average anode current. Repetition rates in excess of 10,000 pulses per second are possible at reduced ratings.

The VC-12S8 will withstand all shock and vibration tests required of a ruggedized electronic tube.

RCA has announced the production of a tube type 6C6F6. The 6C6F6 is a sharp-cutoff pentode of the miniature type especially designed for use in gain-controlled video if stages operation at frequencies in the order of 40 mc. It is also well suited for use as an r.f. amplifier in v.h.f. television tuners.

The 6C6F6 features controlled plate-current cutoff and very high transconductance (6,200 microhms) combined with low capacity values. It is provided with separate base pins for grid No. 3 and the cathode.

The heater operates at 6.3 volts and 300 ma. The tube may be mounted in any position. The base is of the small-button miniature 7-pin type. In typical operation, the 6C6F6 has a plate voltage of 200, the suppressor grid is connected to the cathode at socket, the screen grid voltage is 150, and the grid bias for a plate current of 35 µa is -6.5 volts. Except for its sharper cutoff, the 6C6F6 is identical to the 6CB6.

END
WITH THE TECHNICIAN

NATESA'S FOURTH MEET
Fourth annual convention of the National Alliance of Television and Electronic Service Associations will be held at the Morrison Hotel in Chicago, on October 9, 10 and 11, reports Frank J. Moch, national president.

More than one thousand members of the thirty-five affiliated state groups are expected to accompany the seventy delegates, with an additional five hundred persons representing Chicago area companies, John Cecchi, convention chairman, estimated.

This year's plans call for both an industry convention and product display and an open forum, to which the public is invited, and where leading authorities on television maintenance and repair will give set owners an opportunity to air their comments on TV repair service.

The Convention entertainment program will be in charge of Phil Levant, with a gala industry banquet scheduled for Saturday night, Oct. 10th. The educational program will feature Donn Mason, nationally known sales training consultant and J. H. Hazlehurst, prominent business consultant and psychologist, both of Chicago.

PENNSYLVANIA LICENSE BILL
Paul V. Forte, executive secretary of the Television Contractors Association, has struck out against Pennsylvania House Bill, HR 839, a law to license television technicians, as "an innocuous piece of legislation." He said it will not accomplish the purpose for which it is intended, to protect the service technician and the customer.

Mr. Forte attacked the bill as unwise and asserted that there is no need for television licensing.

One section of the bill says that just complaints would be recognized and investigated. Mr. Forte said that this was a naive statement, and that there are so many complaints against television service that an entirely large staff would be needed just to read them, much less determine which complaints are just and which are unjust.

PENNSYLVANIA PARLEY
The Federation of Radio Service Men's Associations of Pennsylvania plans to hold an Eastern Conference in Philadelphia in January, 1954, to discuss television-radio servicing and related industry problems. L. J. Helk, spokesman for FRSMAP, said that representatives of similar servicing organizations from Maine to Florida are expected to attend.

MIDDLETOWN ILL
Tom Middleton, former active member in the Philadelphia and Pennsylvania service organizations, has suffered a complete breakdown in health. Tom left Philadelphia for Miami some time ago, with the hope that the climate would improve his condition.

Though his health was poor when he arrived in Florida, Tom became an active influence in the Miami service technicians' organization. His wife has

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ELECTRONIC FUNDAMENTALS AND APPLICATIONS, by John D. Roberts. An easy-to-follow treatment of (a) physical principles underlying electron tubes, (b) characteristics of vacuum tubes, (c) all basic tube circuits. 860 pages. Price, $10.00.

PULSE TECHNIQUES, by S. Moshkovits, and J. D. Roberts. A study of pulse networks, design of pulse networks, pulse shaping and clamp circuits, pulse generation, measurement and instruments, communication systems and aerial navigation aids. 300 pages. Price, $6.65.


INDUSTRIAL ELECTRONIC ENGINEERING, by W. L. Davis and H. R. Weed. Covers industrial timing circuits, servomechanisms, electronic control of motors, radio frequency heating and other important uses of electronics in industry today. 450 pages. Price, $10.35.


FUNDAMENTALS OF ELECTRICAL ENGINEERING, by Fred A. Pumphrey. 668 pages. Price, $8.65.

CIRCUITS IN ELECTRICAL ENGINEERING, by Charles H. Vail. 200 pages. Price, $8.75.

RADIO SERVICING, by A. Marcus. 776 pages. Price, $5.06.

TELEVISION SERVICING, by Walter H. Buchsbaum. 1104 pages. Price. $5.35.

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RADIO-ELECTRONICS
NEW TRADE ASSOCIATION

The formation of the Utah Association of Radio and Television Servicemen has been announced by D. Pieper, general manager. The association was incorporated as a nonprofit, educational unit, with the basic purpose of promoting the welfare, progress, and well-being of the radio and television service industry in the State of Utah.

The aims and objectives of the association include the following: Establishment of suggested minimum rates and charges, assuring all members of fair and equitable returns for work and services performed; promotion of the industry through voluntary beneficial policies and regulations; promotion of legislation that is affirmative and responsive to the growth and progress of the industry as a whole; and initiation of a broad, comprehensive public relations campaign, to better acquaint the public with the industry.

PHILLY LAUNCHES CAMPAIGN

The Television Service Dealers Association of Philadelphia have announced a series of 18 newspaper advertisements promoting TSDA’s members’ facilities. A sum of $1,200 was voted unanimously by the association to cover the costs of the campaign.

TSDA has set up offices at 6021 Ogontz Avenue, with a central telephone system to channel requests for service to the nearest member shop.

A grievance committee has been appointed to investigate all customer complaints. Industrial and Public Relations Committees have also been set up, with Dave Krantz as chairman of the former and Edward Strychowski of the latter.

THE "SERVICE-SAVER"

A new and unique method of helping television technicians diagnose and repair troubles in a television set was described recently by Carroll W. Hoshour, director of Raytheon Sales Engineering.

The new device, which means “more efficient and economical service” for television set owners, consists of a booklet containing photographs of 40 possible troubles that could occur with a TV set's picture is numbered for easy identification. When something goes wrong with the set, the owner calls his service technician and tells him, “My picture looks like number seven, or ten, or twenty-four.”

In the Raytheon Service manual that is distributed to all television technicians, there is also a “Service Saver” section that shows the same numbered 40 conditions, and gives schematic diagrams of the circuits and what causes the trouble, plus a complete list of parts and tubes that might be involved. It also contains hints and kinks for quick repair—what to test, and what component might be causing the difficulty.

THE SMART BUY

More Servicemen are finding that only QUIETROLE, the original, non-conductive, non-inflammable Lube-Cleaner will assure positive quietness to noisy TV and radio controls and switches. It does much, yet, costs so little.

With a TELEMATIC Full Range Filter Kit

SIMPLE — SPEEDY — EFFICIENT
- Eliminates antenna-fed interference!
- Covers full-range both I.F. and R.F.
- Sharpens, steadies picture!
- Fewer service calls!
- Any filter in kit replaceable separately!

FILTER KIT contains 2 Hi-Pass Filters, 4 Wave Traps covering full range of interference signals. Send for FREE booklet on TV INTERFERENCE.
ADJUSTABLE ION TRAP

J. W. Miller Co., 517 S. Main St., Los Angeles, Calif., has developed the new type 2685 single-field adjustable ion trap having a variable gauss range of 32 to 55. The strength of the magnetic field is varied by turning a small screw which moves a slug back and forth in the field of the ion-trap magnet.

TEST SOCKET ADAPTER

Pamona Electronics Co., 524 W. Fifth Ave., Pomona, Calif., has announced the new TVS-1 Deca-Test test socket adapter. The unit permits testing for wires on all circuits going into the television tube socket while the set is in operation.

AUDIO TRANSFORMERS

Triad Transformer Corp., 4555 Redwood Ave., Venice, Calif., has added the JAF coaxial miniature audio transformers to their line. For use with tubes, transistors, or tube amplifying equipment these magnetically shielded, hermetically sealed units cover the audio-frequency range.

NEW DEVICES

UHF CONVERTER

Walsco Electronics Corp., 3725 Exposition Place, Los Angeles, Calif., is introducing the new Walsco multi-channel u.h.f. converter which features the new Furnetone tuning system—a tunnel-type bandspread tuning unit with a double-tuned preselector. The tuned circuits have a constant L/C ratio throughout their range. The oscillator uses a balanced-tube converter for minimum frequency drift. Input terminals are provided for separate u.h.f. and v.h.f. antennas. The cabinet is available in a wide variety of colors to blend with modern interiors.

VHF YAGI

Technical Appliance Corp., Sherburne, N. Y., has announced a broad-band triple-driven v.h.f. Yagi for channels 2-4. The antenna consists of three directors and three driven elements, plus reflector. Gain is of the order of 10 db throughout the low band. Primarily designed for fringe areas receiving two or more low-band channels, the No. 3800 antenna is also recommended for areas in which a channel change is contemplated. This new antenna eliminates the need for multiantenna installations for low-band reception and the ensuing multi-transmission lines and switching devices otherwise employed.

V.H.F. ANTENNA

Wells & Winegard, Burlington, Iowa, has introduced the model C-11 Citizen v.h.f. antenna for fringe areas. Manufacturer claims high uniform gain and good front-to-back ratio.

KAY-TOWNES ANTENNA CO.

BOX 586, ROME, GA.

ON TOP OF THE-STATION RECEPTION, in the FRINGE AREAS OUT PERFORMS all other VHF ANTENNAS!

These "BIG JACK" Antennas are performing with outstanding success in many areas. Near-station installations of the BJ-1 provide a higher gain and clearer picture on all VHF channels in range. The BJ-2, for fringe area installations, has provided excellent reception where other antennas have failed.

Kay-Towmes superior constructions and engineering details plus fringe area "Know-How" make the BIG JACK series the greatest high-gain VHF antennas ever built.

THE BEST SET IS ONLY AS GOOD AS ITS ANTENNA!
CRYSTAL MICROPHONE
Shure Brothers, Inc., 225 W. Huron St., Chicago 10, III., has announced an all-purcrate crystal microphone, the model 777. This unit can be used on a desk or floor stand, in the hand, or around the neck.

The model 777 has a frequency response of 40 to 10,000 c.p.s., a 4 1/2-inch long f-inch wide, and is finished in chrome.

INDOOR U.H.F. ANTENNA
The Hi-Lo Antenna Corp., 3540 N. Ravenswood Ave., Chicago 13, III., has announced their model 303 Twin Arrow indoor antenna for u.h.f. The twin arrows may be adjusted for local areas. The upright and crossbar are gold-colored, and the base is of lightweight brown plastic.

HOME MUSIC ASSEMBLY
Radio Craftsmen, Inc., 4401 N. Ravenswood Ave., Chicago 40, III., has announced a home music assembly for the hi-fi enthusiast. All the units for a complete home music system are provided in a single carton, complete with a changer, mounting board, all necessary connections, and a complete wiring harness. Detailed yet simple instructions, and drawings of typical cabinets, including a horn-loaded corner speaker cabinet.

Included in the assembly, known as the Craftsman CAI are the C10 FM-AM tuner, a C409 10-watt amplifier, a 3-speed automatic record changer, and a 12-inch speaker system with a range of 40 to 16,000 c.p.s.

REPLACEMENT UNITS
The Standard Division of the Chicago Standard Transformer Corp., has added five TV replacement components to the Stancor line. They include a new exact replacement flyback transformer A-85,76, exact duplicate of Hoffman Nos. 5035, used in 25 Hoffman models and chassis, and A-85,26 universal Philco replacement vertical blackline oscillator transformer, A-85,26 can be used in all Philco TV models and chassis built up to the spring of 1953. Two width controls, WC-2 and WC-4, and a tapped linearity coil, WC-2, also have been added.

COLOR CODE UNIT
Centralab, Division of Globe-Union, Inc. 902 E. Keefe Ave., Milwaukee, Wisc., is producing a color code calculator covering both capacitors and resistors. The calculator is printed in full color. By selecting seven rotating wheels, capacitance or resistance, tolerance, and temperature coefficient can be read directly. The calculator covers RETMA color code specifications as normal and extended-range tubular ceramic capacitors and radial or axial-lead resistors.

WALL BAFFLES
Utah Radio Products Co., Inc., Huntsington, Ind., has announced the Utah line of wall baffles. They are obtainable in 6, 9, 12, and 15-inch sizes in brown, red mahogany, limed oak, and unfinished.

OUTDOOR UHF ANTENNAS
Bulu-1
Kay-Townes' BJU antennas are the recognized leaders in the field of superpicture, high-gain, trouble-free UHF-VHF antenna performance! Simplicity but more exacting and effective engineering has resulted in "bug-free" antennas that provide photo-accurate reception. One lead-in wire only. No matching pads or isolation filters . . . no coils or condensers . . . which tend to cut down signals.

THE GREATEST UHF-VHF ANTENNAS EVER BUILT!
FAR-REACHING and PHOTO-CLEAR RECEPTION!
HIGHER GAIN on all Channels 283

THE BEST ALL CHANNEL UHF-VHF ANTENNA AVAILABLE" says Leading Alabama Dealer

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SIMPSON'S NEW MODEL 269 VOLT-OHM-MICROAMMETER!

100,000 OHMS PER VOLT

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RANGES FOR MODEL 269

<table>
<thead>
<tr>
<th>DC Voltage</th>
<th>AF Output Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1.6 volts</td>
<td>0-3 volts</td>
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<tr>
<td>0-8 volts</td>
<td>0-8 volts</td>
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<tr>
<td>0-40 volts</td>
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<tr>
<td>0-160 volts</td>
<td>0-160 volts</td>
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<tr>
<td>0-600 volts</td>
<td>100,000 ohms per volt</td>
</tr>
<tr>
<td>0-4000 volts</td>
<td>0.1 microfarad</td>
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<tr>
<th>Volume Level in Decibels</th>
<th>DC Resistance</th>
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<tbody>
<tr>
<td>-12 to +11 decibels</td>
<td>0-2,000 ohms (18 ohms center)</td>
</tr>
<tr>
<td>+3.5 to +19.5 decibels</td>
<td>0-20,000 ohms (180 ohms center)</td>
</tr>
<tr>
<td>+10.5 to +33.5 decibels</td>
<td>0-200,000 ohms (1800 ohms center)</td>
</tr>
<tr>
<td>+22.5 to +45.5 decibels</td>
<td>0-20 megohms (18,000 ohms center)</td>
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<tr>
<td></td>
<td>0-200 megohms (1.8 megohms center)</td>
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<table>
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<tr>
<th>DC Current</th>
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<tbody>
<tr>
<td>0-16 microamperes</td>
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<tr>
<td>0-160 microamperes</td>
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<tr>
<td>0-1.6 milliamperes</td>
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<td>0-16 milliamperes</td>
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<td>0-160 milliamperes</td>
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<td>0-1.6 amperes</td>
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<tr>
<td>0-16 amperes</td>
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267 millivolts maximum drop

ALSO, SIMPSON'S NEW MODEL 262 VOLT-OHM-MILLIAMMETER!

20,000 OHMS PER VOLT SENSITIVITY $88.00!

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100,000 Ohms per Volt sensitivity

Simpson
ALL-CHANNEL UHF CONVERTER

Employing the newly developed B-T Ultratuner, the B-T Ultravertor, Model BTU-2, provides for reception of all UHF channels on any TV set with quality unmatched by any converter, regardless of price. 'On/off' operation is automatically controlled by the power switch on the TV receiver. Terminals are provided for both VHF and UHF antennas.

Advanced circuit design assures high gain, high stability, and lowest noise performance. A high ratio vernier knob permits easy, accurate tuning on UHF channels from 14 through 83. Tube complement: 6L4, 6AF4, 6A84, and Germanium Diode, 1N72.

Model BTU-2

$39.95

STABLE D.C. AMPLIFIER

Patent No. 2,830,406
(Assigned to Philco Corp., Philadelphia, Pa.)

Direct-coupled circuits must be used for amplifying d.c. or very low frequencies, but unfortunately the gain of any circuit that responds to slow signal variations is also affected by even minor fluctuations in supply voltages. These changes in gain can be minimized by using carefully balanced push-pull stages throughout, large amounts of inverse feedback, and closely regulated power supplies, all of which call for very complex circuit arrangements.

This invention is a single-ended direct-coupled amplifier that is compensated against the effects of changes in supply voltages. The first two triodes (12AX7) are the d.c. amplifier. The third triode (one half of a 12AU7) draws considerably more plate current than the output section of the 12AX7, and determines the voltage drop across R1.

The bias on V2 is the sum of the drop across R1 and the negative voltage from the C supply at the slider of potentiometer Y. If the C supply voltage increases, the grid of V2 goes more negative. At the same time the V3 grid also receives a more negative bias. This reduces the current through R1. At the correct setting of potentiometer Z, the change in V3 current will restore the bias on V2 to normal. V1 is essentially sensitive to changes in the B supply because these variations are amplified by the following stage. Assume an increase in the supply voltage. This increases the V1 plate current and raises the bias on its grid. The increase in bias reduces the cathode current again—but not necessarily to the original level, unless the cathode resistor has a certain critical value. By making the cathode resistor adjustable, a setting can be found that will hold the V1 plate current constant regardless of changes in the B supply voltage.

According to the inventor, circuit adjustments should be made in the following order: First set Y for desired output. Then adjust Z to compensate for drift in the bias supply. Finally, set X to neutralize variations in B voltage.

DELAY CIRCUIT

Patent No. 2,635,185
Robert F. Casey, Pompton Plains, N. J.
(Assigned to Allen B. Du Mont Laboratories, Inc., Clifton, N. J.)

Delay circuits are sometimes troublesome by time-jitter. Harm modulation, thermal variation, voltage drift, and other circuit variations may affect the delay interval and cause erratic operation. The circuit shown here has been engineered to prevent time-jitter. The input signal—a negative pulse—initiates a square-wave output. The wave lasts for a short but definite time. The interval between the leading and trailing edges of the square wave is the desired time delay. It remains constant and under control at all times.

The 2-tube circuit functions as follows:

WITH THE

SCALA MARKER INJECTOR

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SAVE UP TO 75% IN TIME

ON ALIGNMENT

Saves time—Marker size determined by instrument setting only. Not affected by characteristics or defects of circuits being aligned. Only one setup for each section (video I.F., sound I.F., detector or tuner) regardless of number of stages.

Nothing else to buy—can be used with your present marker generator, sweep generator and oscilloscope.

Available at leading jobbers

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2814—9th St., San Francisco, Calif.
Now you can benefit and save money with Supreme amazing scoop of 1953. This one giant volume has all the service data you need on all recent radio sets. A full year of models of all popular makes, home and auto sets, portable radios, communications, changers, and included. The full price for this mammoth 1953 manual is only $2.50. You can save money to buy for a whole year. Other Supreme radio service volumes for previous years (mostly at $2), TV, and UHF manuals are described below and at right.

**SUPREME RADIO MANUALS FOR PREVIOUS YEARS**
Now Supreme manuals are in repair all output tubes, elements, and make more money. Here is your lowest-priced service data. Operate all years, from 1930 to 1953 models, in 13 volumes. Used by 140,000 repairmen. Most volume only $1 each, we from. Average volume $1 (large pages, $5.51 incl. Quality printing, manual-type binding. Amazing value. Or use these manuals to set up all ordered diagrams, parts lists, alignment facts, and service tech at the smallest price per page.

**RADIO-ELECTRONICS**
NEW AMAZING HOME-STUDY COURSE OFFER
Here is the most winning bargain in radio training. For only $3.95 (full price), you receive a complete course of 63 large illustrated lessons on radio, electric, and electronic principles, covering all aspects of the subject. Send today for the price of $3.95, and supply additional help. Includes self-study sections, 42 diagrams, pictures, and diagrams. Contains bound-in-tapen for volume 1951 home-study correspondence course, original volume 1,000, 1,000 pages, 1,000 exercises.

**Sell by all Leading Radio Jobbers**

1. A negative pulse applied to the quadrature grid of the 6SN6 reduces the plate current very little, but "partition action" increases the accelerometer-grid current considerably. The voltage on the accelerator drops and feeds a negative pulse through C1 to the grid of the 6SN6.
2. The triode blocks, and the sudden disappearance of cathode current permits C2 to discharge through L. The time required for C2 discharge depends on the natural resonant frequency of the tank circuit. The discharge places a negative voltage on the limiter grid of the 6SN6.
3. This blocks the gated-beam tube and its plate voltage rises abruptly to the B+ value. This starts the square-wave output. It lasts until the voltage across C2 reverses polarity—that is, becomes positive. The diode now dumps out the oscillation and removes the bias from the limiter grid. The 6SN6 conducts, its plate voltage drops to the original value and there is no further output till the next anoral pulse arrives.

The delay interval depends only upon the natural resonant frequency of L and C. It can be changed by other components or supply voltages.

**FLUORESCENT DISPLAY**
Patent No. 2,635,715
Frank M. Shoemaker, Pittsburgh, Pa.
A fluorescent lamp (even one that's burned out) will glow in an r.f. field. This invention uses this principle for display purposes. Fluorescent tubes are shaped to form characters and are placed in an r.f. field. If the r.f. oscillator is keyed on and off periodically, the characters or letters will blink.

The drawing shows a triode r.f. oscillator tuned to a relatively low frequency (for example 120 kc) to reduce harmonic interference to tolerable limits. Harmonic radiation is reduced further by inductive coupling between circuits and by designing them for high Q. An anti-parasitic resistor is connected in the grid lead. The switch S is opened and closed automatically to flash the sign.

The load capacitance C is made up of strips of metal foil. The r.f. field exists between them.

The fluorescent characters are placed on shelves where they rest within the field. Unlike a neon sign, these letters are not connected to each other or to any source of voltage, so they may be moved about as required and as long as they remain within the r.f. field.

**ARC SUPPRESSION**
Patent No. 2,637,769
When an inductive circuit is interrupted suddenly, the energy stored in the magnetic field induces an e.m.f. which may be many times greater than the original voltage. This induced voltage may force an arc discharge across the opened contacts. Repetition of this cycle will ruin relays or switch contacts and every effort should be made to avoid them. This patent discloses a simple method to suppress arcing.

Fig. 1 applies to d.c. circuits. L may be the winding of a relay or electromagnet. The rectifier is connected so that it cannot conduct while the switch is closed. When the switch opens, the d.c. input circuit is broken and a counter-e.m.f. is induced in the winding L. This induced voltage appears across L with the opposite polarity to the original input voltage but in the right polarity for the rectifier to conduct.

If the rectifier alone were connected across L, it would have to be large enough to dissipate all the energy stored in the winding almost instantly. But by connecting the bias battery in series with the rectifier, L cannot discharge until the induced e.m.f. is greater than the bias voltage. This limits the discharge current through the rectifier, so that a relatively small unit can be used, and the stored energy is dissipated not into the rectifier, but in the battery.

Fig. 2 is a bridge-type suppressor for an a.c. circuit. Here the energy represented by the
LEARN MORE! EARN MORE!

with H. G. CISN'S

SERVICE BOOKS

NEW 1954 EDITION TV CONSULTANT THE TV SERVICEC'EM'S SILENT PARTNER

See, easy-to-use way to solve tricki-
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-duplicate tests. Practical methods
on use of all TV Test Instruments.

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CHEVROLET 985793 RADIO

Several of these sets have been
brung in with complaints of distortion
and intermittent operation. In each case,
the fault was traced to the spark plate
connection which bypasses the 6SQ7
plate. This section of the spark plate
develops a high-resistance to ground
and causes the trouble. When we elimi-
nated this connection from the circuit
the trouble cleared up with no noticeable
effect on reception.—Geo. R. Anglado

DEAD AUTO RADIOS

When servicing dead auto radios, I
have a procedure for checking the
power supply quickly so I will have
more time to track down the trouble
if it is in some other part of the set. The
primary of the transformer supply is
shown in the diagram. This is the
procedure:

1. Check for 6 volts d.c. across the
input to the supply. Measure the vol-
tage at a point between the set and the
fuse. Low voltage at this point when
the 6-volt supply is perfect indicates
excessive voltage drop in the supply
line. Check the fuse holder for high
resistance. If the fuse is blown, check
the vibrator and make a resistance
check to make sure that there are no
shorts in the transformer or filter.

2. Measure the voltage across the
primary of the transformer. There
should be 6 volts a.c. across each half
and 12 volts a.c. across the full primary.
No voltage is a symptom of a defective
vibrator.

3. Measure the voltage between the
rectifier plates. Average a.c. voltage
measurements show 400 volts or more
between the plates and 200 volts or more
from each plate to ground. No voltage
is indicative of a defective transformer.
If a buffer capacitor is connected be-

tween the rectifier plates, it should be
checked for a short or leakage.

4. Measure the voltage between the
rectifier cathode and ground. It should
be 200 volts d.c. or more. Low voltage
is probably caused by a weak or burned-
out rectifier tube.

Loss of signal or d.c. voltage
at other points in the set may be caused
by defective spark plates. Check
the schematic for the location of spark
plates and check each one for a short.—
A. von Zook

RCA KS66 TV CHASSIS

When the set was first turned on,
sound came in normally for a few
seconds and then dropped out when the
raster appeared. There was no evidence
of video modulation on the raster. The
a.c. bias was normal (about 0) until the
raster appeared and then falls to 35
volts negative.

This trouble was caused by an open
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Servicing Horizontal Locks
Curing Intercarrier Buzz
Vertical Sweep Problems
Television Interference

A circuit in resistor R131 (the 2,500-ohm, 10-watt wirewound resistor between the 265- and 145-volt B plus lines). This is a voltage-dropping resistor which supplies reduced B plus voltage to the sync and a.g.c. circuits and holds the cathode of the 6CB6 a.g.c. amplifier at 100 volts positive. The grid of the 6CB6 is supplied with 80 volts positive from another source. When R131 opens, the 6CB6 cathode voltage drops below the grid. This renders the 6CB6 highly conductive to pulses from the horizontal sweep circuit and causes the development of excess a.g.c. bias. Excess bias cuts off the i.f. amplifier and blocks the sound and picture signals.

Replace the resistor to clear up the difficulty.— George DeLaMater

OSCILLATIONS IN PHILCO 6AT
Squeals and birdsies on the high end of the 3- to 6-mc band are usually caused by oscillations in the 6AT converter. This can sometimes be eliminated by trying several 6AT's until you find one which does not oscillate.

If the trouble cannot be eliminated by substituting 6AT's, try replacing the 15,000-ohm oscillator plate-droping resistor (part 72 on the Philco schematic) with a 1-watt resistor of 25,000 to 40,000 ohms. The schematic shows the position of this resistor in the circuit. Use the lowest value which results in an oscillator anode voltage of 70 to 85.

If the converter performance drops off, it is wise to check the oscillator injection gimmick which is mounted on top of the tuning capacitor.

This type of trouble may also occur in other makes and models of old sets when a 6AT is replaced with a new one.— G. P. Oberto

SEARS, ROEBUCK TV SETS
When one of these sets comes in with no high voltage and no obvious defect in the sweep and high-voltage circuits, take a look at the 1B3-GT high-voltage rectifier. In many instances, you will find that someone has installed a G-E 1B3-GT.

G-E 1B3's will not work in many Sears receivers because pins 1, 2, 5, 8, and 8 are connected internally. The socket is wired so that the high voltage is automatically grounded out when this type of 1B3-GT is used.

Substituting a 1B3 of a different brand will usually eliminate the trouble.— Raymond W. Calvert

RADIO-ELECTRONICS
OCTOBER, like September, will produce very little in the way of  
onospheric dx. The early fall is one of the low spots of the year for sporadic-
E skip. October will provide interest to the observer who likes to check the 
effects of weather variations on TV reception. Tropospheric dx will not  
equal the summertime skip, but it often produces steady or nearly steady signals from far beyond the normal range at this season of the year.

The best tropospheric propagation is usually associated with the changing seasons, so it will have passed its peak in the more northerly parts of the country in September. Below the Mason-Dixon Line, October may be at least as good as its predecessor. Worth watching in the North will be the effect of diminishing foliage, particularly where u.h.f. reception was begun during the green-leaf months. The removing of foliage screening may more than make up for the drop in signal levels that will accompany the arrival of cooler weather in the northern states and Canada, particularly in hilly terrain, or in sites where antennas aim directly into dense growths of deciduous trees.

Dx on u.h.f. continues to lag behind v.h.f., due primarily to the relatively poor performance of the majority of u.h.f. receivers. The summer of 1953 brought numerous instances of communication by amateurs using the 420-
mc. band over distances exceeding 300 miles. This was done with power levels that are but a small fraction of those employed in u.h.f. TV transmission on only slightly higher frequencies. The hams have vastly superior receivers and antenna systems, so it seems only a question of time before u.h.f. TV receiving techniques will catch up. When this happens, tropospheric dx of 300 miles or more may be observed on u.h.f.

What the limit of u.h.f. dx will be is anybody's guess, but strong signals on the 420-450-mc band exchanged by hams over distances in excess of 400 miles will give some inclination of the possibilities.

CORRECTION

There is a discrepancy between the diagram and the text of the article "Tube-Filament Checker" on page 90 of the June, 1953, issue. The text specifies a 5-ma meter and the diagram specifies 500 ma. The value of 500 milliamperes on the diagram is correct.

We thank Mr. Allan W. Seely, of Danvers, Mass., for calling this to our attention.

OCTOBER, 1953
Herschel Thomason, radio technician of Magnolia, Arkansas, and father of five-year-old Freddie Thomason, writes the HELP-FREDDIE-WALK FUND as follows:

"...Freddie is really looking forward to getting some arms. Almost every time we sit down to eat, he will tell us that Dr. Kessler is going to make him some hands and that he will be able to feed himself. We are very anxious for next spring to come, for that is when they will start on his arms."

By this time, most of our readers are acquainted with little Freddie, the young son who was born without arms or legs, and for whom life has meant a series of adjustments such as few of us can comprehend. Quite some time ago, he was fitted with artificial legs at the Kessler Institute for Rehabilitation, West Orange, N.J., and he is now learning to walk by himself. Each step forward is a new accomplishment requiring courage and faith, but these are qualities in which Freddie and his family have never been found lacking.

They and we have been encouraged not only by the welcome contributions to the Fund, but by the many expressions of affection and good will that often accompany donations. Typical of such messages are the following:

Received from Patricia L. Nield, Sec'y-Treasurer of The Sunshine Circle of Sacramento, Calif., along with their donation of $10.00: "We, The Sunshine Circle, are thankful that this case has been brought to our attention and that we are privileged to help Freddie attain health and happiness... We seek to reach out and give a touch of warmth, so necessary for the well being of those in need of help. Therefore, along with our gift for Freddie, we send our most sincere and heartfelt thoughts."

And from Frank Gabinovits, of Long Branch, N.J., comes a donation of $2.00 accompanied by this note: "...It is good to hear that he is making progress at Kessler Institute with his legs...Every now and then I'll be only too happy to make a contribution to his progress. I believe in strong legs to work so weak legs can someday walk."

Won't you join our family of friends of Freddie? No donation is too small to receive our sincere thanks and acknowledgement, as well as the heartfelt appreciation of the Thomasons. **Make all checks, money orders, etc., payable to Herschel Thomason.**

Address letters to: **HELP-FREDDIE-WALK FUND c/o RADIO-ELECTRONICS Magazine 25 West Broadway New York 7, N.Y.**

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Some of the larger libraries still have issues of ELECTRICAL EXPERIMENTER on file for interested readers.

**OCTOBER 1919 ELECTRICAL EXPERIMENTER**

"Submarine's Under-water Radio." by H. Gernsback.
"Unique Radiophone Helmet." by H. Gernsback.
"Radio Problems in Aviation," by H. Gernsback.
"Efficient Radio Crystal Detector," by H. Gernsback.
"Can Radio Ignite Balloons?" by H. Gernsback.

**END**
SENSITIVE CAPACITANCE RELAY CIRCUIT

In the most common types of capacitance relay circuits, the relay tube is controlled by the cathode bias of the oscillator tube. In this circuit described by D. H. Sullivan in Radio Constructor (London, England), control bias is obtained from a rectifier coupled to the oscillator plate circuit.

The unit is simple to adjust. Set the sensitivity control R1 so the grid of the relay tube is grounded. Connect a high-resistance voltmeter or v.t.v.m. across R1 and adjust the trimmers across L2 and L3 for maximum indication on the meter. Advance R1 slowly until the relay just opens. When any comparitively large body approaches the metal pickup plate, the rectified capacitance appears across L1 and causes the oscillator frequency to shift. This reduces the r.f. voltage developed across L2 and L3. The rectified bias voltage across R1 drops and causes the relay to operate.

L1, L2, and L3 may be tuned to any convenient frequency as long as it is not too low and is not in the broadcast band. L1 consists of 250 turns of No. 28 wire wound on a 1/4-inch form and tapped 50 turns from the ground end. L2 and L3 are each 200 turns of No. 28 wire wound side-by-side or one over the other on a 1/4-inch form.

Materials for capacitance relay

Resistors: 1-470 ohms, 1-150,000 ohms, 1/2 watt; 1-25,000 ohms potentiometer.

Capacitors: 1-002, 1-01 mf, 1-100 mf mica or ceramic, 3-50 uf air or ceramic variable trimmers.

Miscellaneous: Chassis, 3/8-inch rod or tubing for coil forms, sockets, tubes; 1-plate-circuit relay with coil resistance of 2,000 ohms or more; hookup wire and hardware.

PICTURE TUBE CHECKER

TV service technicians have developed various short-cuts for quickly determining whether the more common picture-tube complaints are caused by defects in the kinescope or in the receiver circuits. A recent issue of Current Flashes (Stromberg-Carlson TV service bulletin) shows how a 6AF6-G or similar twin-beam electron-ray tuning indicator can be used to check the voltages at the picture-tube socket. The diagram is shown in Fig. 1-a. The 6AF6-G socket is wired to a plug which fits the picture tube socket.

Fig. 1-a—6AF6-G is wired to plug.

The performance of the kinescope and associated receiver circuits can be checked by inserting the checker into the socket on the receiver. Indications are as follows: (1) A glowing heater indicates the presence of heater voltage on the C-R tube socket. (2) A bright green glow on the target indicates the presence of first anode voltage. (3) One of the shadows will have sharp areas as in the lower half of Fig 1-b. A properly functioning brightness control will cause the shadow area to vary as the control is rotated. (4) One-half of the target area will have fuzzy or blurred edges as in the upper half.
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RADIO-ELECTRONIC CIRCUITS

half of Fig. 1-b. The blurred edge indicates the presence of video or sync
information, or both. A properly operating contrast control causes the shad-

ow area to vary as it is turned.

Fig. 1-b—Upper half has blurred edges.

On the Stromberg-Carlson models 24
and 119, the eye will overlap, but this
does not prevent the contrast and brightness circuits from being checked
as described above. On the model 317
series, the brightness and contrast
controls affect the voltage on the cath-
de of the kinescope so the operation of
both of these controls will be observed
on the same half of the target.

PROTECTING V.T.V.M.

This circuit shows how a conven-
tional bridge-type v.t.v.m. may be pro-
tected against overloading and possible
burnouts. Resistor R1, the plate load of
V1, is shunted with a small neon lamp.
When the input voltage is zero, the
voltage across R1 is just below the
firing point of the neon lamp. Exces-
sive input to the v.t.v.m. will cause V1
to conduct heavily and the voltage drop

across R1 exceeds the firing voltage
of the lamp. The lamp fires and prac-
tically short-circuits R1 so the full
supply voltage is applied to the plate
of V1. Ordinarily, the needle would
tend to fly off scale in the reverse di-
rection. However, this does not happen
because the most positive voltage is now
applied to the cathode of the 1N34 so
that it does not pass current through
the meter. The neon lamp may be
mounted on the front panel of the
meter to provide an immediate indica-
tion of meter overload.—D. Sacks

OSCILLOSCOPE MODIFICATION

My Eico model 425K scope
performed well, but its trace was not as
sharp as I desired. The spot was oval
instead of round. I incorporated a spot-
shape control which improved the
trace. A 1-megohm potentiometer is the
only component required for the modi-
fication. Pin 7 of the 5BP1 is normally

Watch for the
NOVEMBER ISSUE
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grounded. I lifted it off ground and connected it to the arm of the 1-megohm potentiometer connected between the first B plus lead and ground as shown by the dashed lines in the diagram. I mounted the potentiometer on the chassis, since readjustment is not required until the C-R tube is replaced.

To adjust the control, turn the vertical and horizontal gain controls fully clockwise. Set the horizontal input switch to EXTERNAL and turn down the brightness to prevent burning the screen. Adjust the spot-shape control to produce a spot which is as round as possible while keeping the spot diameter at minimum with the focus control.—Milton Herman

NOVEL PHONO OSCILLATOR

The phono oscillator shown in the diagram will probably provide better quality than those in which the pickup works directly into one of the grids of a pentode or a multigrid converter tube. Since one half of the tube is used as an audio amplifier and plate modulator, it will provide a greater depth of modulation with less distortion.

The oscillator uses a standard Hartley-type broadcast oscillator coil tuned by a 300-uf trimmer capacitor. The designer, writing in Radio-Gen (New Zealand), claims that the output is sufficient to cover a small house.

Power input should be the lowest value that will provide a usable signal at the receiver. Power-supply requirements are slight. Any supply delivering 90 volts or more at a few milliamperes will suffice. A suitable supply is shown below the main diagram. To vary the output, use a semivariable resistor in place of the bleeder. Connect B plus line from oscillator to the slider on the resistor and vary as desired.

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DEMAGNETIZING GUN

The magnetic field surrounding the tip of a Weller-type gun is useful for demagnetizing wrist watches and pocket watches. A special technique is needed for best results. Turn on the gun and place the watch between the tip electrodes or as nearly so as possible. Then slowly draw the watch, taking three or four seconds to get it a foot or two away from the gun (which is left on). Repeat this for each axis of orientation of the watch, and if it happens to be a large one, for each side. Take care to avoid touching plastic crystals with the gun tip while it is hot.

Of course, it is better to take precautions to keep from magnetizing the watches. They should not be brought closer than two or three times the largest dimension to modern magnetic structures, even momentarily. Multimeters, photographic exposure meters, and speakers are among common offenders.

Both wrist and pocket watches should be removed before handling large PM speakers, even when speakers are inside their shipping containers. —Gray C. Tremblay

ANTENNA COUPLER

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RADIO-ELECTRONICS
FINDING V.H.F.-U.H.F. BANDS

Harmonics from the oscillator of an accurately calibrated communications receiver can be a valuable aid in calibrating other receivers and converters designed for use on v.h.f. and u.h.f. bands. First, you must know the receiver's i.f. and whether its oscillator is on the low or high side of the signal frequency. With these facts, the set's oscillator can be used as an accurate signal generator. If the oscillator is above the signal, add the i.f. to the dial reading to get the oscillator frequency. Subtract the i.f. from the dial reading when the oscillator operates on the low side.

This is how a receiver using a high beat might be used to locate the 220-225-mc band which was opened to technicians: Set the receiver dial to 27.045 mc. Add the i.f. (455 kc in this case) to get the oscillator frequency (27.5 mc). The 8th harmonic (27.5 X 8) is 220 mc, the low end of the band. Similarly, tune the receiver to 27.67 mc to find the high end of the band at 225 mc.

Tune to frequencies between 27.05 and 27.67 mc to establish other points in the band. Although we have used the 8th harmonic in the example, other harmonics may be used to calibrate this and other v.h.f. and u.h.f. bands.

We must emphasize that the equipment to be calibrated must first be roughly calibrated with a grid-dip meter, Lecher wires, or a wavemeter to establish the approximate tuning range before attempting spot calibration with the communications receiver.

No direct connection is needed between the two receivers. Laying two short antennas side by side should provide sufficient coupling.—S. H. Beverage, W1MGP

FILAMENT WIRING HINT

In building sets where large filament currents are required, it is often considered necessary to parallel smaller filament transformers to get the required current. However, in such cases it is best to divide the filament into groups and feed each group from a separate transformer. If the transformers are paralleled and their output voltages are not identical under all load conditions, circulating currents flow through the transformers and cause power wastage and possible transformer overload. You also get the advantage of isolation. Frequently undesirable coupling results from common filament supplies.—Charles Erwin Cohn

HANDY GROUND CLIPS

Someday when your wife isn't around, snitch one of her wave-set clips. They make good clamps to ground chassis during tests. I used a Goody clip which is nearly 4 inches long. It grips a large area of the chassis, thus assuring a good ground. There are holes in the clips, so all you have to do is attach a soldering lug and a length of ground wire.—B. W. Wets

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WE'RE LOOKING for surplus inventories of all types of electronic parts—transistors, triodes and pentodes. Assistance in the Radio-TV and electronic field.

SMALL or LARGE QUANTITIES—SEND US YOUR LIST

Submit samples where possible, amount of each item and prices.

NAT ADELMAN
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Please mention RADIO-ELECTRONICS when answering advertisements

CORONA RADIO & TV CO.
136 Liberty St., New York 6, N. Y.

TRY THIS ONE

SPEAKER MATCHING CONTROL

When two 8-ohm speakers are used with an amplifier, one in the cabinet and one at a remote point such as a rumpus room, it is often desirable to energize either one separately or both simultaneously.

For maximum output quality and volume a proper impedance match must be maintained. This is easily done by using a 4-deck, 3-position switch such as a Centralab type 1427. The schematic shows a hookup which can be made in a matter of minutes. Most amplifiers have both 4- and 8-ohm taps. Both of these are used. Placing the switch in position 1 connects speakers 1 and 2 in parallel across the 4-ohm tap. Position 2 connects only speaker 1 to the 8-ohm tap and position 3 connects only speaker 2 to the 8-ohm tap. Thus we have properly matched impedance in all three positions.

This switching circuit can be used with speaker impedances different from those mentioned. The output taps on the amplifier and the speakers used are your guide. Just keep in mind that two 8-ohm speakers in parallel become one 4-ohm unit, and two 16-ohm speakers in parallel become 8-ohms. It's the law of parallel resistances, remember? This system is of course not limited to 2 speakers. If sufficient power is available, you can hook up as many speakers as you wish. Always be sure that the total impedance of the speakers equals that of the transformer.—John E. Howlett

MODIFIED CAPACITOR CHECKER

The capacitor checker in the February issue (bottom diagram on page 115) worked fine but I was not satisfied. It had one feature I did not like. Sometimes we want to check a capacitor for its ability to hold a charge. I could not do this with the original checker because the capacitor automatically discharged when the switch was released.

After some experimenting, I came up with a satisfactory circuit. See diagram. Two s.p.s.t. push-buttons are used instead of the d.p.d.t. switch in the original model.—Harold L. Wilkerson

RADIO-ELECTRONICS
**Send for Your FREE Copy of the NEW 1954 MIDWEST TELEVISION and RADIO Catalog**

**MIDWEST Presents**

For 1954 a Completely NEW LINE of **21” and 27” TELEVISION CONSOLES TABLE MODELS** and **COMPLETE CHASSIS** at **LOW FACTORY PRICES**

YOUR CHOICE OF EITHER 12 CHANNEL VHF or All-Channel VHF-UHF Models

Buy your Television or Radio Direct from the Midwest Factory ... on 30 DAYS TRIAL ... Easy Terms ... and at LOW FACTORY PRICES.

For 34 years Midwest, the world's largest and oldest exclusive Factory-To-You radio and television manufacturer, has served hundreds of thousands of satisfied customers all over the world.

**EASY TERMS — 30 DAYS TRIAL**

**FACTORY-TO-YOU**

Also — Powerful New 1954 World-Ranging **MIDWEST Series 16 RADIOS**

In Beautiful Consoles and Complete Chassis

Once again Midwest offers its famous series 16 five band AM-FM radio chassis and the magnificent new Symphony Grand Radio-Phonograph with 3-Speed Automatic Intermix Record Player. Also, a complete line of clock radios, table radios, and portables.

**MIDWEST RADIO & TELEVISION CORP.**

909 BROADWAY, CINCINNATI 2, OHIO

**WRITE IN NAME AND ADDRESS (PLEASE PRINT) ON COUPON OR 2¢ POSTCARD**

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Please send me your new FREE 1954 Catalog.

NAME _______________________

ADDRESS ____________________

CITY ______ ZONE ______ STATE ______

OCTOBER, 1953
This compact 3-speed phonomotor is ideally suited for both phonographs and combinations in which quality reproduction and limited size are important prerequisites. Incorporating General Industries' novel vertical idler shifting principle, the Model SS provides smooth, dependable performance at all three operating speeds. Moving shift lever to "OFF" position automatically disengages idler wheel from motor shaft during non-operating periods.

Specifications and quantity price quotations on the Model SS, or its companion, the Model DSS, with 4-pole motor for high-fidelity reproduction, will be furnished promptly upon request.

**BATTERY CHARGER-ELIMINATOR**

**QUESTION BOX**

**BATTERY CHARGER-ELIMINATOR**

? Please prepare a diagram of an a.c. operated power supply for charging storage batteries and operating dynamos requiring 6 to 28 volts d.c. at a maximum of 10 amp.—O. H. M., Brentwood, N. Y.

A. Here is the circuit of a power supply which will do the job for you. Transformers for high-current, low-voltage d.c. supplies are usually special items which are not generally available to the consumer. Of course a suitable transformer can be obtained on special order but its cost alone is likely to be greater than that of a complete commercial supply having the same ratings. The transformer should have a large number of taps on the primary and secondary windings to permit adjusting the voltage input to the rectifier to the required value for various d.c. loads and voltages.

To avoid specifying a transformer which would have to be wound to order, we have designed the supply around 10-amp filament transformers having tapped primaries and secondaries. The secondaries are connected in series aiding. The sum of the secondary voltages should not exceed the maximum input to the rectifier. You can use any number of 10-amp transformers as long as you get the required a.c. voltage out of them. Since some UTC series CG filament transformers have dual multivoltage secondaries and multivoltage primaries, the large number of taps available makes them ideal for obtaining the desired a.c. output. Type CG-124 and CG-126 transformers or close equivalents are recommended for CT and TI respectively. The positions of S1 and S2 can be changed independently.

You have a choice of copper oxide, magnesium-cupric sulphide, or selenium rectifiers. The maximum a.c. input voltage for each type depends on the make and type. Manufacturers' data gives the maximum a.c. input to each type when working into inductive, resistive, and capacitive loads. The a.c. voltage rises when the rectifier is not
GLUTTONS for PUNISHMENT

Preferred for their Absolute Uniformity - Superior Qualities and Ultimate Economy

CORNISH WIRE COMPANY, INC.
50 Church Street, New York 7, N. Y.

CODE OSCILLATOR

Several years ago I constructed a code oscillator from a diagram which appeared in Radio-Craft. The oscillator and its diagram were given away when the service. I would like to duplicate this oscillator for a group of boy scouts. The unit used a 117-volt rectifier-amplifier tube and was designed to feed a speaker and several pairs of phones connected in parallel.

A. We believe that this is the diagram that you used. T1 is a push-pull output transformer. A 1-megohm variable grid working into a load, so take care that the no-load a.c. input voltage does not exceed the maximum rating.

The output is not filtered. If a filter is required, try connecting several 500-µf. 50-volt electrolytics in parallel across the d.c. supply between the rectifier and the ammeter. Connecting old storage batteries in series across the output of the supply is an excellent way of obtaining smooth filtering and good regulation. Of course, with variable voltage output, you will have to change the battery connections so that their total terminal voltage equals the output of the supply.

Readers desiring supplies of this type with different voltage ratings can use this circuit as the basis for their design. The current ratings of the transformers and rectifiers should equal or be greater than the maximum current which will be drawn by the load. The maximum a.c. voltage required depends on the type and make of rectifier. Power rectifiers and data on them is rather difficult to obtain in many locations. You can obtain catalogues and data on several companies of supply from: Starless Tarlent Inc., Rectifier Division, Bloomington, Ind.; Radio Receptor Co., Inc., 251 W. 19th St., New York, N. Y.; P. R. Mallory Co., Indianapolis, Ind.; and others.

Select a transformer which will deliver somewhat more than the maximum voltage that you require. Note the a.c. input which it needs for the specified d.c. output, then select your transformer or transformers accordingly.

Remember that the transformer should have as many taps as possible so that the rectifier input can be adjusted to meet actual operating conditions.

LEATHERWING

have been identified with QUALITY since the swaddling days of Radio. The era of television finds them, more than ever, the serviceman's friend.
Presenting . . . at most moderate cost . . .

ESPEY
25th Anniversary "Trophy" Models
AM-FM CHASSIS • TUNERS • AMPLIFIERS

In commemoration of twenty-five years' experience in the manufacture and development of high-fidelity audio equipment, Espey is proud to present its distinguished "Trophy" models. Renowned for beauty of styling and excellence of performance, the new Espey models are so reasonably priced that for the first time magnificent listening pleasure is within the means of all lovers of fine audio reproduction.

Descriptive literature on the new Espey AM-FM chassis, tuners and amplifiers is now available . . . your inquiry is invitec.

SYLVAN A. WOLIN & ASSOCIATES SALES CORP., 409 GRAND AVENUE, ENGLEWOOD, N. J.

fit the right shaft to the right wire-wound control—YOURSELF!

Immediately, conveniently, correctly, economically.
Just select the Clarostat wire-wound control for your electrical needs. Then select any one of 12 Pick-A-Shaft types (or even a high-voltage coupler or nylon shaft) meeting your shaft needs. A slight tap joins them together—rigidly, permanently, satisfactorily. Ideal for radio-TV and industrial purposes.

It's another Clarostat first! These new Clarostat A43, A58 and A10 wire-wound controls take field-attached shafts. And remember, only Clarostat offers 2-, 3- and 4-watt wire-wound controls.

ASK YOUR CLAROSTAT DISTRIBUTOR for these new Pick-A-Shaft wire-wound controls. Ask for new catalog—or write us.

Controls and Resistors
CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE

In Canada: Canadian Marconi Co., Ltd., Toronto, Ontario

ATLAS RADIALS

ATLAS RADIALS

ATLAS RADIALS

With uniform 360° coverage, non-resonant construction, and 100% storm-proofing, ATLAS Radial Driver Unit Projectors often solve the most difficult sound problems—are excellent for reproduction of speech, chimes and music. For complete details on Radials and the famous ATLAS line of Public Address and Microphone Stand Equipment:

WRITE NOW for FREE Catalog 553

ATLAS SOUND CORP.
1443 39th St., Brooklyn 18, N. Y.
In Canada: Atlas Radio Corp., Ltd., Toronto, Ont.

RADIO - ELECTRONICS
resistor varies the pitch and a 50,000-
ohm control varies the headphone vol-
ume. The half-wave power transformer
T2 isolates the unit from the power line
and minimizes the shock hazard. The
transformer may be a Stancor type
PS8415 or equivalent. Note particularly
that the tube heater is connected across
the a.c. line rather than across the sec-
ondary of T2.

OSCILLATOR SWITCHING

? I am constructing a small signal
generator which provides four spot fre-
quencies for checking superhet align-
ment. The circuit (see Fig. 1) requires
a special slide switch which I cannot
obtain. Please modify the circuit so
that I can use a switch which is readily
available.—J. W. S., Hartford, Conn.

A. The diagram in Fig. 2 shows how
the circuit can be wired with a standard
double-pole (two-circuit) rotary switch
having four or more positions.

EXTENSION LOUDSPEAKER

? I plan to add an extension speaker
and separate volume control to my
audio system. Please show how the
switch and volume control may be added
without disturbing the impedance of the
output circuit.—H. W. K., Hager-
town, Md.

A. The diagram shows the circuit you
requested. The L-pad and remote speak-
er should have the same impedance as
the secondary impedance of the output
transformer.

CONICAL ON U.H.F.

? Is it true that conical antennas de-
sign for the regular v.h.f. channels
can also be used on u.h.f.? The par-
ticular one I have in mind has an "X"

OCTOBER, 1953

PHILLIPS TUBE COMPANY

924 Clinton Ave.,
Brooklyn 10, N. Y.
Flower 1-Mile 1.4
Mk has been weakest for Cat.

156

requirement custom GOLD 630...aid

The Taco 4-stacked Bow-Tie Cat. No. 3006 gives more capture area for a stronger, clearer signal in the weakest fringe areas. This UHF array has been proved as the finest for performance and dependability in all UHF areas.

Also available:
Model 3031 Single Bow Tie with screen grid reflector $4.00 List
Model 3032 Dual Bow Tie with screen grid reflector $7.95 List

Ask your Taco distributor for complete details.

TACO
TECHNICAL APPLIANCE CORPORATION • SHERBURNE, N.Y.

the 630
IS STILL THE FINEST TV CHASSIS EVER DESIGNED
...and there is no finer 630 chassis than the GOLD MEDAL

by TECH-MASTER

There is a Tech-Master Custom-Designed, custom-built TV Chassis for every requirement where quality and reliability are the predominant factors.

Write for Detailed Data
TECH-MASTER PRODUCTS CO.
445 BROADWAY, NEW YORK 13, N. Y.

QUESTION BOX

A. Most present-day television antennas will work on u.h.f. because they act as long-wire antennas on the higher frequencies. Losses are greater, however, and the antenna should be well spaced from tin roofs, shade trees, or other possible reflecting or absorbing surfaces. The transmission line should also be spaced from the mast, rain pipes, and other metal objects by 6 inches or more.

Because of the small dimensions necessary for u.h.f., a more efficient antenna could be used. The corner reflector type, rhombic, collinear, and others are most popular on these frequencies. Because half-wavelength spacings are smaller, multiple stacking can also be utilized to increase gain.

(Incidentally, research has disclosed that the two small center arms of the biconical you mentioned actually load down the antenna and decrease instead of improve performance on both the high and low channels. Removing them will give you better signal strength.)

COAXIAL LINES

? I got fairly good results using a home-made v.h.f. antenna in conjunction with a 300-ohm ribbon type transmission line. Since installing a commercial antenna plus an RB-50/U coaxial line, results are inferior to those of the old antenna. The new antenna is several feet higher than the old homemade affair. What is causing the poorer reception?—J. C., United, Pa.

A. You are probably getting a mismatch with the coaxial cable at both the antenna and the receiver. A certain amount of mismatching is permissible when the antenna is connected to the transmission line. However, too great a mismatch results in serious loss of signal, and reflections are set up all along the line. Reflections in a transmission line may cause double images to appear on the picture tube screen just as readily as reflected signals at the antenna itself. Besides this, coaxial-cable transmission lines have higher losses than most 300-ohm ribbon types. Coaxial lines are most useful for their self-shielding properties where local noise levels are extremely high and the losses in the coaxial cable can be tolerated. Type RG-11/U should be used whenever possible, for it has lower losses than other types. The following table gives losses per 100-foot length:

<table>
<thead>
<tr>
<th>Frequency ribbon</th>
<th>Losses per 100-foot length</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG-11/U</td>
<td>300-ohm</td>
</tr>
<tr>
<td>100 mc</td>
<td>5.00</td>
</tr>
<tr>
<td>200 mc</td>
<td>5.29</td>
</tr>
</tbody>
</table>

If you install 300-ohm line with the commercial antenna, your reception will probably improve. You should also make sure the new antenna is properly oriented.
Concord Radio presents the world's most powerful UHF-VHF-FM antenna!

MONEY BACK GUARANTEED

TO RECEIVE All UHF and All VHF STATIONS IN All DIRECTIONS FOR 60 MILES WITHOUT A ROTOMOTOR OF ANY KIND!!

While antenna reception is guaranteed for 60 miles, perfect pictures have been consistently received as far as 160 miles from stations.

All NEW DESIGN FOR '54
- LOW-LOSS SWITCH
- LOW-LOSS PHENOLIC INSULATORS
- USES NEW 4-CONDUCTOR MATCHED IMPEDANCE LINE
- ONLY 10 INCH SPACING BETWEEN ANTENNA BAYS

NEW! POLYMICALENE 4 CONDUCTOR MATCHED IMPEDANCE TRANSMISSION LINE

Implements Both UHF and VHF Performance of any ALL-CHANNEL Antenna

<table>
<thead>
<tr>
<th>Length</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 Ft.</td>
<td>$8.90</td>
</tr>
<tr>
<td>150 Ft.</td>
<td>$13.90</td>
</tr>
<tr>
<td>200 Ft.</td>
<td>$17.30</td>
</tr>
</tbody>
</table>

Minimum quantity 100 ft.

Mfg. solely by
ALL CHANNEL ANTENNA CORP.

New York N.Y.

under license Pat. Nos 2,585,670, 2,609,503, 2,625,655. others pending.

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Concord Radio

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OCTOBER, 1953
Now you can own an intercom that has a thousand uses at a price you would normally pay for a kit. This intercom comes housed in wooden cabinets completely wired and ready to operate. Outfit consists of one master, one sub station and fifty feet of two wire cable. Ideal for home or baby sitter. Perfect for office or factory. Order now as quantities are limited. YOUR COST COMPLETE only **$15.95**

**AC-DC SUPERHET 5 TUBE RADIO KIT**


**STEVE-EL ELECTRONICS CORP.**

Dept. E-10 61 Reade St., New York 7, N. Y. Cortland 7-0086

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**NATIONAL ELECTRONICS**

**BARGAIN OF THE YEAR DUE TO SPECIAL BUY WE MADE.**

**BULK-EARLY**

**STOCKS LIMITED**

Leave it to National Electronics to make a special buy like this. This is the kind of buy you would expect only during the off season, but not in October! Maybe it's one of the leading makers of antennas who wouldn't allow us to use his name because of this low price, these Antennas are engineered to give three divergent channels with high average gain and offer plus-point directionality and a minimum of signal distortion. Extra arrays or pictures in the medium frame and switched in at 10 volts or battery voltages of three others.

**Super-Gain**

**10 ELEMENT TWIN-DRIVEN YAGI**


**Sensational Powermaster ALL DIRECTIONAL TV ANTENNA ELECTRONICALLY** $41.50

**ROUNTS IN DIRECTIONS**

Especially designed for ultra-fine weak signal areas where signals arrive from several directions. Offers extra high gain over your broad-band antenna. Includes on-off switch. 360° rotation by means of control on side of antenna. 6 elements, with 6 matched馈 ends. Complete co-axial cable. Perfect for many there.

**Bargain in All-Channel CONICALS**

3 Hi-gain 2-way 16-element arrays including hi-gain adapters and 2 new TV Hoods. Same, Top Tube. $12.95.

**Order Early**

**ALL ITEMS**

**STANDARD COLORS**

**CORRECTLY**

**SHOWN**

All furnishers indicate that the following are the only colors available, unless otherwise specified.

1. Bright Red
2. Bright Blue
3. Blue Green
4. Black
5. White

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**RECORDING TAPE (PLASTIC BASE) 40% OFF**

WASHINGTON, D. C.: 1,200 ft. plastic tape with plastic reel included. Each reel individually boxed. Choice of many brands. (5/20c, $1.00/20c, $5.00/50c, $10.00/1.00). Additional reels in sets of 50. (9.00) 3.60. (LIST PRICE ON JUMBO TAPES ARE $5.00 EA.)

**ONLY**

**ITEMS**

**STANDARD COLORS**

**CORRECTLY**

**SHOWN**

Each brand is available in one of the following colors:

1. Bright Red
2. Bright Blue
3. Blue Green
4. Black
5. White

---

**STAN-BURN RADIO and ELECTRONICS CO. (C.B. TELEVISION)**

1697 BROADWAY • NEW YORK 19, N. Y.
Les Wildberg, president of Leader Electronics, Inc., Cleveland, announced that his firm, which has been producing special industrial switches, would enter into the manufacture and sale of TV equipment for consumer use. Mr. Wildberg has been in the electronics field for over 30 years. He was the founder and former president of Radiant Corp. Other executives in the Leader organization include George J. Feins, Jr., vice-president in charge of sales, and Ralph Blauvelt, chief engineer.

Vinton K. Ulrich joined David Bogen Co., New York City, as general sales manager replacing W. Walter Jablon, who resigned as vice-president in charge of sales. Ulrich was formerly renewal sales manager of National Union Radio. Mortimer Sumberg of the Bogen jobber sales staff has been upped to the position of distributor sales manager.

Edward P. Atcherley was appointed merchandising manager for renewal tube sales of Sylvania Electric Products, New York City. He was formerly regional sales manager for renewal sales in the Midwest district. Sylvania also announced the appointment of W. T. Buschmann to the new position of product sales manager of radio receiving tubes. He was formerly production requirements and service coordinator for the Radio Tube and TV picture Tube Divisions.

Douglas Carpenter and Jim Hall were appointed chief antenna development engineer and associate antenna test engineer, respectively, for JFD Manufacturing Co., Brooklyn, N. Y. Carpenter was at one time with La Pointe Electronics and Hall with the Civil Aeronautics Administration.

Karl W. Jensen, vice-president of Jensen Industries, Inc., Chicago, was elected chairman of the Electronic Parts & Equipment Manufacturers Association. Theodore Rossman, general manager of Pentron Corp., Chicago, was elected vice-chairman, and Helen
“Save with confidence”

The Lowest Priced Kits on the Market

**EDLIE**

**LOWEST PRICED SIGNAL GENERATOR, BROADCAST BAND**

New simplified circuits provide the following switch tuned, tone modulated frequencies:
1. 655 K.C.-Intermediate I.F. frequency
2. 350 K.C.-High frequency of Broadcast Band
3. 110 K.C.-Low frequency of Broadcast Band
4. Audio tone—for audio amplifier trouble shooting
5. An attenuator control is included for adjustment of the output signal strength. Shipped in small black bakelite cabinet size 6"x6"x3 1/2". Can be used for alignment of all Broadcast Band radio receivers. Completely wired.  **INTRODUCTORY OFFER** Deduct $1.00 if ordered with Kit #1 or #2

**5 TUBE AC-DC SUPERHET KIT**

Kit #1—Five Tube Superheterodyne Kit. A.C.-D.C. contains all components required to construct this latest design, highly sensitive superheterodyne broadcast receiver, complete with black bakelite cabinet (excludes tubes). Only $7.95

**6-TUBE RADIO KIT**

Kit #2—A low-priced 6 TUBE KIT designed for high sensitivity, excellent selectivity and good tone quality. Uses 6S6G, 6L6G, 6X5G, 6SK7, 6557 in an easily constructed circuit. The 6 Tube Kit is shipped with all parts including punched chassis, resistors, condensers, coils, sockets, PM Speaker, hardware, etc. And at a closeout price of only $7.95 & $7.95 tubes and cabinet. Matched set of six tubes for kit $3.25

**PHONO OSCILLATOR**

Not a Kit!

Wireless phonograph oscillator transmits recording of crystal pickups or voice from carbon mike through radio without wires. Can also be used as intercom by using P.M. speaker as mike. Price (excluding tubes) $2.95

With Complete Set of Tubes $3.95

**3-TUBE PHONO AMPLIFIER**

Not a Kit!

An assembled unit ready for installation using tone and volume control and six feet of rubber cord (Not including tubes) $2.95

With Complete Set of Tubes $3.95

**Electronic Code Practice Oscillator & Blinker Kit**

A.C.-D.C. or Battery Operated!

Kit #3—One of the most practical Code Practice Oscillators ever designed, yet one of the simplest to build and operate. Can be used with any number of headphones. Adjustable Pitch Control—Any type of headphone can be used. No warmup time—ready to operate instantly. Simple and safe to operate. Operates anywhere—with A.C. or D.C. power, or from a 90 volt Miniature Battery. Learn Blinker Code with flashing light. Blinker can be used as signaling device. International Morse Code included. All $3.75 each—$3.95 each

Terms: All merchandise shipped F.O.B. New York City, prices are subject to change without notice. Include 20% deposit for C.O.D.'s. WRITE FOR NEW CATALOG—FREE

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**EDLIE Electronics**

154 Greenwich St.
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New York 6, N. Y.

**CONVERTER MODEL RC-600**

**UHF**

$49.95 list

**Regency**

the quarter million dollar converter

RADIO-ELECTRONICS
OCTOBER, 1953

PEOPLE

Staniland Quam, distributor sales manager of Quinnichols Co., Chicago, was re-elected treasurer of the association for her 16th annual term. Kenneth C. Prince was re-named executive secretary.

Edwin A. Freed was named manager of operations of the General Instrument Corp. headquarters plant in Elizabeth, N. J. He was formerly sales manager.

Robert L. Klabin, controller of General Instrument, was elected to manage the company's Siefkes Division plant at Danielson, Conn. C. F. Sullivan, assistant controller, was named acting controller during Klabin's absence. General Instrument also announced the election of Malcolm C. Hutchison as a director of the company. Hutchison is a former vice-president of Irving Trust Co.

Jack H. Fuller, Jr., was appointed to the newly created post of public relations manager for the Allen B. Du Mont Laboratories, Clifton, N. J. He was formerly a technical advertising manager.

Obituary

Fred R. Ellinger, president of Waldom Electronics, Chicago, and Ellinger Sales Corp., Chicago representative firm, died recently in Chicago after a short illness.

Personnel Notes

. . . Jerome J. Kahn, founder and president of Standard Transformer Corp., until its recent merger with Chicago Transformer Corp., withdrew from active management in the newly formed Chicago Standard Transformer Corp.

. . . John J. Sprague, chairman of the Board of Sprague Electric Co., North Adams, Mass., was elected a director of the Massachusetts Business Development Corp., a state agency created to attract industry to Massachusetts.

. . . Harry C. Haggerly, financial vice-president and director of the Metropolitan Life Insurance Co., was elected a director of the Radio Corporation of America.

. . . Carl E. Smith resigned as vice-president in charge of engineering of United Broadcasting Co., Cleveland, to devote full time to expanding his consulting engineering operation, that of Carl E. Smith Consulting Radio Engineers, Cleveland. He also continues as president of Cleveland Institute of Radio Elec.

. . . George A. Hinckley was appointed sales engineer in the Equipment Sales Division of Raytheon Manufacturing Co., Waltham, Mass. He was formerly chief engineer of station WLAW.

R. W. Jensen

E. A. Freed

MONEY-SAVING OFFER

ON THE LATEST AND GREATEST
GHIRARDI TV-RADIO SERVICE TRAINING BOOKS
. . . only $12 for the 2-book set
10-day FREE examination . . . 4 months to pay

Radio-TV CIRCUITRY AND OPERATION
by Ghirardi and Johnson
688 pages, 417 clear illustrations
Price $6.50 separately

Radio-TV TROUBLESHOOTING AND REPAIR
by Ghirardi and Johnson
820 big pages, 419 clear illustrations
Price $6.75 separately

Complete training for FASTER, BETTER SERVICE on any TV or radio ever made!

Ideal for beginners . . . a gold mine of time-saving methods for experienced service men

LEARN CIRCUITS FULLY . . . and watch service "headaches" disappear!

It's a whole lot easier to repair TV or radio receiver when you know all about its circuits and how they work. You locate troubles faster. You work more efficiently. What's more, the basic training you get from Ghirardi's TV & Radio Receiver CIRCUITRY AND OPERATION book is just the thing to fit you for dozens of other television-radio-electronic jobs.

Actually, it's simpler than you may think. There are only a few basic circuits used in modern equipment—just each of these has many variations. You learn to know and recognize them instantly. You learn to locate troubles in far less time and with less trouble.

MAKES THE TOUGHER JOBS EASY!

Here's how this great book on modern circuits covers:

Summaries at the ends of every chapter help you locate the data you need in a hurry. 417 clear illustrations make circuits easy to learn.

See for yourself how much this great book can save you in time or money. Try the 10-day FREE examination.

THE HOW-TO-DO-IT GUIDE to modern service methods

For beginners, Ghirardi's 920-page Radio & TV TROUBLESHOOTING AND REPAIR book makes all the parts of the work amazingly easy to understand. For experienced servicemen it is the ideal way to "brush up" on specific types of work, to find fast answers to specific problems, or to develop better, faster and more profitable troubleshooting methods.

Modern test methods are fully explained. From quick, visual analyses of common troubles, you proceed to learn about "how to know" tests and "dynamic" signal tracing and signal injection techniques. Several problems in handicapped sets are greatly simplified. Step-by-step charts explain professional service procedures almost at a glance.

LEARN MORE—EARN MORE!

Throughout Ghirardi's TROUBLESHOOTING AND REPAIR book is a wealth of practical service ideas. Receiver alignment is made easier than you might have thought possible. Tuning problems, speaker troubles, components and dozens of other subjects are covered fully.

Every step of television repair work is simplified to the utmost degree! You learn to analyze TV picture patterns accurately, to locate troubles faster—even when troubleshooting down "intermittents". Handy summaries with every chapter make the book invaluable for quick reference whenever you are "stumped" by a job. See for yourself! Use the coupon today for 10-day FREE examination of this newest Ghirardi book!

10-DAY EXAMINATION OFFER

DEPT. RE-103, RINEHART BOOKS, INC., TECHNICAL DIVISION, 232 MADISON AVE., NEW YORK 16, N. Y.

Send no money indicative (or 10-day FREE examination. In 10 days I will either send you a free examination or return books paid for and you will owe nothing."

"Radio & TV Receiver CIRCUITRY AND OPERATION TROUBLESHOOTING AND REPAIR"

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HORIZONTAL HARMONICS

Dear Editor:

I have just read, with interest, the letter under the heading "Community TV Troubles" in the May, 1953, issue. This letter brings to mind another radiation problem caused by TV receivers—radiation of harmonics of the horizontal oscillator. This radiation is at its worst in the C-meter amateur band and is detectable and often objectionable throughout the high-frequency communications bands.

About six months ago a neighbor of mine bought a 1958-model 21-inch TV receiver built by a prominent manufacturer. Harmonic radiation from the receiver's horizontal oscillator almost completely blocked the 80-meter band. A phone signal had to be from 30 to 40 db above 89 to be intelligible.

Why is it that hams are required to keep spurious radiations within the limits of good engineering practice and yet television manufacturers are allowed to produce equipment which radiates harmonics with such terrific field strength?

J. N. PHILLIPS, W4SUF
Anniston, Alabama

REMOTE TOOTHACHE

Dear Editor:

Your editorial, "Radar Hazards," in the August issue of Radio-Electronics, was of particular interest to me. It cleared up a mystery which has plagued me since 1943.

While studying 10-centimeter airborne radar gear as part of my training in the R.C.A.F., I noticed that soon after the sets were switched on, I would get a toothache. When the sets were turned off, the toothache would stop. None of the other boys in our group were similarly affected, but then none of them had such a large silver filling as I had. It was inevitable that someone would remark that I had a resonant cavity." By reading your article, it became evident to me that the heat effect was the cause of my discomfort. In closing, let me say that I'm out to anyone who phones or calls me on the day the postman brings my copy of Radio-Electronics.

JACK V. MILTON
Toronto, Ont.

COMMUNITY ANTENNA SYSTEMS

Dear Editor:

I wish to take exception to the conclusions drawn by Mr. E. D. Lucas in his articles on Community Antenna Systems. Unfortunately, his conclusions, as drawn from his own information, do not take into consideration the established facts.

Mr. Lucas, on page 40 of your August issue, recommends the use of broadband amplifier systems over individual channel strip amplifier systems despite the fact that to date there are no commercially successful multi-channel broadband amplifier systems in operation anywhere that compare favorably with individual strip amplifier systems.

OCTOBER, 1953
The use of individual channel-strip amplifiers is a far superior method of solving the problems found in Community Antenna Systems.

In making this statement, consideration has been given to the many interrelated problems inherent in the successful installation and operation of a Community Antenna System. These problems include:

1. **Control of Signal Levels**

With broad-band amplifiers there is no control over individual channels. Even if a broad-band system starts out with individual strips and employs automatic gain control at the antenna site, it is impossible to maintain proper signal level relationships through the miles of cable and the quantity of cascaded broad-band amplifiers that are involved. Cable attenuation is not linear with frequency. Different makes of cable have different temperature variations, which in turn are seldom linear with frequency. In addition, the effects of cable deterioration are not linear.

Thus, the larger the system and the longer it has been installed—the greater the the variations—the greater the need for individual control of each channel signal level in order to prevent the twin evils of snow and cross-modulation. Only individual strip amplifiers can do the job properly and keep each channel at the proper level.

2. **Broad-band Systems Use More Equipment**

Broad-band amplifiers cannot be made with the gain or the high output that can be achieved with strip amplifiers. The gains of the broad-bands are generally about 20 db (40 db by stacking two amplifiers together). These amplifiers are spaced about 4 or 5 to a mile (at maximum rated output). To get 20 db, twelve tubes are used; for 40 db, twenty-four tubes are used.

Jerrold “W” strip amplifiers use only five tubes per channel and have gains of 54 db, outputs of 1.0 volt and are spaced 2,600 feet apart (about two to a mile). Because of the higher output, much greater lengths of feeder lines can be run, further reducing the number of amplifiers to cover any given area.

It can be proven by blueprint layout comparisons that in almost every case, strip amplifier systems will use less than ¼ the number of amplifiers that will be needed in broad-band systems.

3. **Less Maintenance with Strip Amplifier Systems**

Because less equipment is used in strip amplifier systems, there will be less maintenance. If one strip goes out in the strip amplifier system, it only affects one channel; when a broad-band amplifier goes out, all channels are gone.

Much is being made of the fact that in “chain” broad-band amplifiers, the failure of a tube does not affect operation because it only
changes the gain of an amplifier by 1.5 db. This claim is based on theory, not practice.

(a) The channel level balance in a system using these amplifiers is often so critical that failure of tubes in this manner definitely does affect operation and can throw the system into either snow or cross-modulation or both.

(b) A large percentage of 6AK5 tube failures are inter-element shorts. This type of failure stops the entire broad-band system. Furthermore, the vastly greater number of tubes in a broad-band system over a strip amplifier system means that there can be more system-stopping shorts, than the combined total of all tube failures which occur in a strip amplifier system.

(c) Maintenance becomes more complex. Even if it is assumed that the 1.5 db supposition is true, the failure of a tube leaves the subscriber with a useless connection. These tubes are not easily located, and meanwhile the entire system, all channels, are out of operation.

What is true in both theory and fact is that with individual strip amplifiers it is possible to maintain constant gain, even with tubes that are aging. By applying AGC to at least every third amplifier in a system, as tubes age, the AGC takes control. Periodic preventive maintenance checks catch the weakening tubes and the system does not fail (it does not drop the picture into the snow level; it does not cause cross-modulation). Maintenance is reduced tremendously using strip amplifiers, and the customers have better, more constant pictures.

As for shorts, Jerrold is now using the 5654 Military-Industrial version of 6AK5. This tube is ruggedized and pre-selected. Troubles of all sorts are considerably reduced over the use of 6AK5 tubes. But even if a short does occur, it affects only one channel and not the whole system. Customers still have service on the other channels, and the tube failure is easy to locate.

(a) Initial cost using broad-bands is much higher because of the greater amount of equipment.
(b) Operation cost is higher because maintenance is higher.

I think it is important for these facts to be brought to the attention of your readers.

JERROLD ELECTRONICS CORP.
Milton J. Shaff
Pres.
Philadelphia, Penna.

OCTOBER, 1953

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PICTURE TUBE COMPONENTS
Sylvania has issued a 4-page booklet describing tungsten and chemical components for TV picture tubes. Among the components described are screen phosphors, potassium silicate for screen settling, tungsten wire for cathode heaters, and triple carbonate cathode coatings. Free on request from the Tungsten and Chemical Division, Sylvania Electric Products Inc., Towanda, Pa.

RADIO-TV CERAMICS
Stupakoff's latest 4-page brochure includes photographs and descriptive details on glass-to-metal seals, Steatite and other ceramics, printed circuits and ceramic-metal assemblies. A section is also devoted to the characteristics of Kovar glass-sealing alloy.


PICTURE TUBE DATA
Federal's 8-page, 2-color Picture Tube Data Book gives interchangeability considerations, basing diagrams, bolt outlines, and dimensions and electrical characteristics of picture tubes of most manufacturers.

Available free on request to the Vacuum Tube Department, Federal Telephone & Radio Corp., 100 Kingsland Rd., Clifton, N. J.

TRANSFORMER CATALOGS
Stanov's 24-page transformer catalog carries complete electrical and physical specifications on almost 800 transformers for radio, TV, hi-fi, amateur, and other electronic applications. Featured are 25 new units, including 13 TV components and 5 transistor transformers, an increased TV section, and an expanded hi-fi section including miniature audio transformers and more detailed information on the Stanov-Williamson amplifier.

The company's 32-page 1958 TV transformer replacement guide lists replacement information on over 5,600 TV models and chassis. It covers 101 brands in alphabetical order, by model and chassis number.

Both available without charge from the Chicago Standard Transformer Corp., Standard Division, Addison & Elston, Chicago 18, I1.

NON-LINEAR RESISTORS
Bulletin SR-3, IRC Varistors (non-linear resistors) gives comprehensive data on voltage-current characteristics, current ratings, temperature characteristics, dimensions, and typical applications. The 6-page booklet is illustrated with charts and graphs.

KNOB CATALOG

Gee-Lar's 16-page well-illustrated catalog shows and describes hundreds of molded knobs for radio and television equipment. Switches, TV antenna mounts, connectors and other hardware products are also listed.

Ask for Catalog No. 55 from Gee-Lar Mig. Co., 1320 10th Ave., Rockford, Ill.

A.C. ERASURE

Sound-Talk Bulletin No. 24 discusses a.c. erasure of magnetic tape. The 2-page technical bulletin describes the theory and practices of a.c. erasure, and covers such points as orientation, speed, and number of passes required.

Free by Minnesota Mining and Manufacturing Co., 900 Funqure St., St. Paul 6, Minn.

LINE AND SLIDE SWITCHES

Stackpole's line and slide switches for radios, TV sets, appliances, small motors, toys, instruments and similar equipment are described in a 16-page bulletin, RC-949.

Included are specifications, dimensions, and application data for seven new line switches recently developed for use with Stackpole variable composition resistors.


SELENIUM RECTIFIER

Westinghouse's new type K Maamp selenium rectifier is described in a new 8-page booklet. Although developed for magnetic amplifier circuits and sensing devices this rectifier may be used whenever improved rectifier characteristics are needed.

The booklet includes the description of several new rectifier types and electrical characteristics; graphs showing reverse current leakage limits and forward current-voltage drop under various conditions.


ELECTROLYTIC CAPACITORS

Astron has issued a new catalog supplement for its expanded line of twist-prong electrolytic capacitors. Included are capacitor numbers, capacitance and voltage ratings, case sizes, and list prices of all standard twist-prong capacitors for radio and TV replacement needs.

Copies of Supplement AC-3A obtainable from Astron Corp., 255 Grant Ave., E. Newark, N. J.

DECIMAL EQUIVALENTS

Meyercord has printed a time-saving decimal showing decimal equivalents in 64ths. Designed for application to slide rules, T-squares, drawing boards, desk tops and other similar equipment, the 5 x 1 1/4 inches. The figures are printed in shades of black and red type on a white background.

Free on request to the Meyercord Co., 5328 W. Lake St., Chicago 44, Ill.

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FREE GIFT - Send a copy of our newly published 'Radio/TV Catalog' FREE. Get a copy of our newly published catalog FREE, to any one.

This repair manual differs basically from any we have read. It is prepared for persons who know absolutely nothing about radio or the use of tools. In simple language and with the aid of clear illustrations, it teaches how to solder, test tubes, read meters, and some of the fundamentals of business. It emphasizes the test, removal and replacement of parts, batteries and tubes. The latter come in for special attention. The author points out that they are suspect and may cause all troubles. This book does not cover trouble-shooting or trouble-localizing as most books do.

Interesting and practical chapters also include pickups and needles, antennas, tuning devices, and service-call suggestions.

The author of this book is highly optimistic. He states that anyone who reads the manual becomes qualified to repair 75% of all radio-TV sets. Also, he feels that the life of an independent radio man is a happy one. He notes that the service technician can smoke, relax, listen to music while working, take a day off at will, and even write his own pay-check.

Unlike most books that are purportedly written for the novice, this text is written to scrupulously maintain an even elementary level. The author defends his position, that of preparing the reader to handle 75% of all service troubles, by very carefully covering the rudiments of day in and day out radio routine. Since the majority of receiver breakdowns are the result of tube failures and obvious defects such as resistors that have burned, the ability to test tubes and check for shorted or open capacitors should enable the beginner to handle most routine problems.

The book is recommended to technicians' helpers who want to know something about radio. Radio-TV owners may also find it useful and practical.

—IQ

TV TROUBLE TRACER, Volume 2. Published by Harry G. Gisin, 200 Clinton Street, Brooklyn, N. Y. 5 1/2 x 8 1/2 inches, 16 pages. Price 50¢.

This booklet can be helpful to TV owners and can save time for service technicians. It lists 40 typical TV troubles. They include vertical roll, insufficient width, ghosts, foldover, ion spot, etc. Each symptom is followed by probable causes and remedies.

The author has devised a novel time-saving method for localizing troubles due to defective tubes. He lists over 500 different tubes from more than 40 manufacturers. A tube lineup is given for each model, and each tube is associated with a significant letter, such as H for horizontal, B for brightness, S for sound. Thus if tube trouble is suspected, it is easy to locate the one that is responsible.

—IQ

This book will help beginners, students and applicants for radio licenses. It is an orderly presentation of facts relating to tubes of all types. Tubular construction, the calculation of constants, examples of applications are clearly shown. Large graphs show how to calculate amplification factor, plate resistance and mutual characteristics. The last few chapters cover transmitting and special types. One chapter describes how to use a tube manual effectively.

Each of the 12 chapters is divided into paragraphs which are numbered. This makes it easy to remember or note material which a reader may want to review or remember. Also it is easier to find information in the index.

Each chapter ends with review questions.—IQ

ALIGNMENT TECHNIQUES by Art Liebscher. Published by John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N.Y. 8 x 5^1/2 inches, 123 pages. Price $2.10.

This book is devoted entirely to the sweep alignment method of testing and adjusting TV receivers. It discusses markers and illustrates many sweep techniques. Chapters show how to align video and sound i.f. amplifiers, discriminators and video amplifiers. The author suggests testing the video channel in two steps: square-wave methods for the i.f.; sweep technique for the h.f. He shows how to do this effectively. The last chapter is a brief presentation of other h.f. alignment. The entire subject is well covered, but there are no schematics or block diagrams to show how test equipment is set up.

The author introduces a novel and efficient method for oscillator alignment. He applies a standard i.f. signal to the first detector along with the local oscillator signal. The beat generates a "supernormal" near the carrier frequency. By varying the frequency of the oscillator, the supernormal will approach the carrier marker along the sweep curve. When the oscillator is correctly set, the supernormal and carrier markers will coincide. Alignment is quickly done since the same i.f. may be used on each channel.—IQ


Tubes or "valves" give best results when used in appropriate circuits. Therefore circuit information is as important as tube data. This book gives both. All tube types designed between 1945 and 1950 are included. Equivalent American types exist for practically any Philips tube, so the reader may convert and utilize the data.

The text includes all necessary average and maximum values, warm-up time for rectifiers, coupling between diode plates, microphony, etc. Circuit information includes coil design, recommended schematics (with component values), how to eliminate hum, shielding, etc. Large tube graphs are drawn for each type of tube. The last 40 pages offer a description of Philips test instruments.—IQ


Man has learned how to generate, distribute and utilize electricity, but has made little headway with nature's own brand, lightning. However, much of the hazard of lightning has been minimized. We know how to protect ships, buildings and power lines to a great extent. This book gives a full account of our present knowledge of lightning, its causes and effects. Beginning with early times, the book describes the superstitions and fears connected with thunderbolts. It lists important fires and explosions caused by them. The invention of the lightning rod by Franklin changed all this. The lightning experiments which led up to this invention are given in some detail. The book describes the safest spots inside a building and out-of-doors when lightning strikes. It details the latest methods for protecting buildings, telephone lines, ships and aircraft. Equipment used to record and investigate lightning is described.—IQ

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Member of the Technical Staff
Bell Telephone Laboratories, Inc.

About the Author

Mr. Black was graduated in 1945. Mr. Blackburn was graduated from the University of Illinois in 1945. He then joined the United States Navy. He returned to the University of Illinois in 1948 and received his Master's degree in 1949. He then became a member of the technical staff at Bell Telephone Laboratories. He is currently working on the development of high-speed communication systems. Mr. Blackburn is author of several technical papers and has been awarded several patents in the field of communications and electronics.

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Into All Your Jobs

Whenever Mallory FP Capacitors go into a service job, your customers can be sure of more hours of entertainment...you can be sure the job is done right...once and for all. For all your service work, you'll get better results with Mallory Capacitors. They are engineered to meet the electrical requirements of any TV or radio set. They'll give performance that is equal to...and often better than...the original equipment.

What's more, Mallory FP Capacitors are the only fabricated plate capacitors available to the replacement market. You can depend on them to give longer life at higher temperatures and greater ripple currents. They will give trouble-free performance at 185°F (85°C).

Any way you look at it, dependable service work builds satisfied customers. The next time you order capacitors, ask for Mallory FP's. They will put an end to call-backs due to capacitor failure...yet they cost no more.

For plastic tubular replacements, specify Mallory Plascaps®. Their improved moisture proofing will put an end to shorts. No off-center cartridges...leads are permanently secured.
Have you hung up your shingle?

It pays to keep good company... and it's good business to advertise the good company you keep.

Thousands of dealers and servicemen are using the sales-magic in the RCA name to instill confidence in their customers. Identifying your name with RCA pays off in dollars and cents.

And it's so easy to do... because RCA's new Dealer Identification Program provides you with a handsome "shingle" with your name on it, that you'll be proud to display in your shop. When a customer sees this Dealer Identification Plaque he knows you are using the best tube products available.

So, we ask... "Have you hung up your shingle yet?" If not, be sure to see your RCA Tube Distributor today and learn how you can qualify for a Registered Dealer Plaque at no extra cost.

Unlock the door to bigger profits

Here's your key to better business... RCA's dynamic Dealer Identification Program. Ask your RCA Tube Distributor for your copy of the colorful, 16-page booklet "A Magic Pass-Key to Customer Confidence." It tells you how—for the first time—you can become a Registered Dealer... and get extra sales benefits.