In this issue:

Automatic Gain Control

Miniature Transistor Hearing Aid

Attenuator Design

Servicing TV With a Wattmeter

Merry Christmas!
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.

Famous RCA Monogram
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.

Business Promotion
Space is provided right on the RCA Battery carton for you to stamp your name and address. In this way you can advertise your own store... remind the battery user to come back to you for fresh replacements.

RCA Corporation of America
HARRISON, N. J.
ADVANCE! Raise your earning power—learn
RADIO-TELEVISION-ELECTRONICS
by SHOP-METHOD
HOME TRAINING

GOOD JOBS AWAIT THE
TRAINED RADIO-TV TECHNICIAN
There is a place for you in the great Radio-Television-
Electronics industry when you are trained as National
Schools will train you at home!

Trained technicians are in growing demand at good pay
—in manufacturing, broadcasting, television, communications, radar, research laboratories, home Radio-TV service,
and other branches of the field. National Schools Master
Shop-Method Home Training, with newly added lessons
and equipment, trains you in your spare time, right in
your own home, for these fascinating opportunities.
OUR METHOD IS PROVED BY THE SUCCESS OF
NATIONAL SCHOOLS TRAINED MEN, ALL OVER
THE WORLD, SINCE 1905.

EARN WHILE YOU LEARN
Many National students pay for all or part of their train-
ing with spare time earnings. We'll show you how you can
do the same! Early in your training, you receive "Spare-
time Work" Lessons which will enable you to earn extra
money servicing neighbors' and friends' Radio and Tele-
vision receivers, appliances, etc.

National Schools Training is All-Embracing
National Schools prepares you for your choice of many
job opportunities. Thousands of home, portable, and auto
radios are being sold daily—more than ever before. Tele-
vision is sweeping the country, too. Co-axial cables are
now bringing Television to more cities, towns, and farms
every day! National Schools' complete training program
qualifies you in all fields. Read this partial list of opportu-
nities for trained technicians:

Business of Your Own - Broadcasting
Radio Manufacturing, Sales, Service & Telecasting
Television Manufacturing, Sales, Service
Laboratories: Installation, Maintenance of Electronic Equipment
Electrolysis, Cell 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.

TELEVISION TRAINING
You get a complete series of up-to-the-
minute lessons cov-
ering all phases of re-
pairing, servicing and
construction. The same
lesson texts used by resi-
dent students in our
modern and complete Television broadcast studios, lab-
oratories and classrooms!

MASTER ALL PHASES!
Get Master Shop-Method
Home Training from
an Established Prac-
tical Resident School
with its own Training
We Bring National Schools To You!

You also receive this Multitester

Signal Generator
Audio Oscillator
T.R.F. Receiver

FREE! RADIO-TV BOOK
AND SAMPLE LESSON!
Send today for
National Schools' new,
illustrated Book of Opportu-
nity in Radio-Television-
Electronics, and an actual
Sample Lesson. No cost—
no obligation. Use the
coupon now—we'll
answer by return
airmail.

APPROVED FOR
VETERANS
AND NON-VETERANS
Check coupon below

NATIONAL SCHOOLS
LOS ANGELES 37, CALIFORNIA • ESTABLISHED 1905
IN CANADA: 193 E. HASTINGS STREET, VANCOUVER, B.C.

GET FACTS FASTEST! MAIL TO OFFICE NEAREST YOU!

MAIL ORDER CATALOG
NATIONAL SCHOOLS, Dept. RO-123
4000 S. Figueroa Street or 323 West Polk Street
Los Angeles 37, Calif. or Chicago 7, Ill.

Send FREE Radio-TV Electronics book and free sample
lesson. No obligation, no salesman will call.

NAME
ADDRESS

CITY
ZONE
STATE

Check here if interested in Resident School Training at Los Angeles.

VETERANS: Give Date of Discharge.
**RADIO - ELECTRONICS**

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

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MEMBER Audit Bureau of Circulations

Average Paid Circulation over 173,000

RADIO-ELECTRONICS, December 1953, Vol. XXXIV, No. 12. Published monthly at Erie Ave., Y to G Sts., Philadelphia 32, Pa.; Gernsback Publications, Inc., Entered as Second Class Matter September 26, 1948, at the Post Office at Philadelphia, Pa., under the Act of March 3, 1879. SUBSCRIPTION RATES: In U. S. and Canada, and in N. Y. possessions, $5.00 for one year; $6.00 for two years; $8.00 for three years; single copies $1. All other foreign countries $1.50 a year; $9.00 for two years; $11.00 for three years.

EXECUTIVE, EDITORIAL AND ADVERTISING OFFICES: 35 West Broadway, New York 7, N. Y. Telephone: Red-R 2-6932. Gernsback Publications, Inc. Hugo Gernsback, President. Lee Robinson, General Manager. Lee Robinson, Sales Manager. G. A. Aliqo, Circulation Manager. Alexander Roche, Assistant. This magazine is not subject to per-copy tax. Copyright, 1953, by Gernsback Publications, Inc. The right to reprint this magazine and to advertise in it, or to translate it into all languages, is reserved to Gernsback Publications, Inc. No part of this magazine may be reproduced without the permission of the copyright owner. POSTMASTER: Send form 3579 to RED-R 2-6832.

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Average Paid Circulation over 173,000
Now! Work over 300 practical projects with these parts...

...to help you learn

TELEVISION

RADIO-ELECTRONICS Now... at home in spare time you can get BOTH the very training and subsequent Employment Service you need to help you start earning real money in America's thrilling, multi-billion dollar opportunity field of Television-Radio-Electronics. Now that television is coming into almost every community, here is a chance of a lifetime to prepare to cash in on one of television's great expansions.

D.T.I.'s amazingly practical home method enables you to set up your own HOME LABORATORY. You get many electronic parts which you mount on individual bases with spring clip connectors. Tops for experimenting! Add or remove parts in a jiffy. No wasted hours of soldering and unsoldering for each project. You spend minimum time to get maximum knowledge of important circuits that really work. In fact, you get exactly the same type of basic training equipment used in our Chicago training laboratory—one of the nation's finest.

Build and keep this VALUABLE TEST EQUIPMENT Your home laboratory projects also include building and keeping a versatile 5 inch Oscilloscope and precision Jewel Bearing Multi-Meter. These quality commercial test instruments help you earn while you learn and will prove mighty valuable, should you later decide to start your own full time TV-Radio service business. You also build and keep a quality 21 inch TV set.

D.T.I. Provides EVERYTHING YOU NEED to master TELEVISION In addition to your home laboratory and easy-to-read lessons, you can use HOME MOVIES—a wonderfully effective and exclusive D.T.I. training advantage. You watch hidden actions as you learn fundamentals... become “movie clear,” helping you learn faster... easier... better.

Full time Residential training in D.T.I.'s great Chicago laboratories also available. MAIL COUPON TODAY for all facts. (If subject to Military Service, you'll especially welcome the information we have for you.)

DeForest's Training, Inc., Dept.—RE-12-J
2533 N. Ashland Ave., Chicago 14, Ill.
I would like your valuable information-packed publication showing how I can get started toward a good job or my own business in Television-Radio-Electronics.

Name_________________________Age__________
Street_________________________Apt.__________
City_________________________Zone__________State__________

DECEMBER, 1953
It takes the WORLD’S Newest PICTURE TUBE PLANT...

Equipped with the WORLD’S LARGEST SETTLING MACHINE...

A BAKE OVEN as Big as They Come...

And the WORLD’S LARGEST EXHAUST MACHINE...

to make the WORLD’S Finest TELEVISION PICTURE TUBES...

RAYTHEON PICTURE TUBES

The only way to make large screen (21", 24" and 27") TV Picture Tubes of unsurpassed quality is to make them with equipment especially designed to handle and produce them. That's why Raytheon built and has in operation this miracle of a picture tube plant, which houses the world's finest, largest and most advanced equipment and methods for making large size Picture Tubes. This magnificent new plant is one more indication of Raytheon's dedication to a single ideal — to continue to supply you with the finest quality Television and Radio Tubes the world has ever known.
**DECEMBER, 1953**

[Image of advertisement]

**FREE**

**TELLS HOW—**

**WE GUARANTEE**

TO TRAIN AND COACH YOU AT HOME IN SPARE TIME UNTIL YOU GET

**YOUR FCC LICENSE**

If you have had any practical experience with Sutherlands, Army, Navy, radio repair, or experimenting.

Here is your guarantee:

If you fail to pass your Commercial License exam after completing our course, we guarantee to continue training without additional cost to you, or refund the entire tuition you paid, if you elect to do so. You must take your first test for this examination within 90 days after completing your course.

**TELLS HOW—**

**OUR AMAZINGLY EFFECTIVE JOB-FINDING SERVICE HELPS CURE STUDENTS GET BETTER JOBS. HERE ARE JUST A FEW RECENT EXAMPLES OF JOB-FINDING RESULTS:**

**GETS CIVIL SERVICE JOB**

"Thanks to your course I obtained my 2nd phone license, and am now employed by Civil Service at Great Lakes Naval Training Station as an Equipment Specialist.


**GETS STATE POLICE JOB**

"I have obtained my 1st class ticket (thanks to your school) and since receiving same I have held good jobs at all times. I am now Chief Radio Operator with the Kentucky State Police."

Edwin Healy, 304 E 3rd St., London, Ky.

**GETS BROADCAST JOB**

"I wish to thank your Job-Finding Service for the help in securing for me the position of transmitter operator here at WCAE, in Pittsburgh.


**GETS AIRLINES JOB**

"Due to your Job-Finding Service, I have been getting many offers from all over the country, and I have taken a job with Capital Airlines in Chicago, as a Radio Mechanic.

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

HERE'S PROOF FCC LICENSES ARE OFTEN SECURED IN A FEW HOURS OF STUDY WITH OUR COACHING AT HOME IN SPARE TIME:

<table>
<thead>
<tr>
<th>Name and Address</th>
<th>License</th>
<th>Lessons</th>
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<tr>
<td>Lee Worthy, 2211 W. 64th St., Chicago, Ill.</td>
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<tr>
<td>Clifford E. Vogt, 30 W. 19th St., Chicago, Ill.</td>
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<td>Francis X. Paerch, 304 E. 1st St., Chicago, Ill.</td>
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<td>Scott B. Klett, 204 E. 2nd St., Chicago, Ill.</td>
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CARL E. SMITH, E.E. Consulting Engineer, President

**CLEVELAND INSTITUTE OF RADIO ELECTRONICS**

Desk RE-59, 4900 Euclid Blvd., Cleveland 6, Ohio

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**MONEY MAKING FCC LICENSE**

**COMMERCIAL-RADIO OPERATOR**

**INFORMATION INCLUDED IN OUR TRAINING AND COACHING**

**T V ENGINEERING**

**EMPLOYERS MAKE JOB OFFERS LIKE THESE TO OUR GRADUATES EVERY MONTH!**

Letter from nationally-known Airlines. "We would also appreciate it if you would place the following additional advertisement in your bulletin— Wanted (Superintendent of Communications) Salary $600.00 per month.

Letter from nationally-known airframe manufacturer. "We need men with electronic training or experience in radar maintenance to perform operational check-out of radar and other electronic systems...electrolyte salary...amounting to $320.00 per month.

Letter from nationally-known Airlines. "We are contemplating placing...an Airline Ground Radio Engineer. Starting salary $385.00 per month.

"These are just a few of the examples of the job offers that come to us. If you are contemplating one of these fields, it might be a good idea to take a look at our course and see if we can be of help to you!"

**Ours is the only home study course which supplies FCC-type examinations with all lessons and final tests.**

**MAIL COUPON NOW!**

[Address and coupon information]

---

**FREE**

**MONEY MAKING FCC LICENSE**

**COMMERCIAL-RADIO OPERATOR**

**INFORMATION INCLUDED IN OUR TRAINING AND COACHING**

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[Address and coupon information]

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**FREE**

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**Ours is the only home study course which supplies FCC-type examinations with all lessons and final tests.**

**MAIL COUPON NOW!**

[Address and coupon information]
A NEW TV COLOR TUBE, the CBS-Colortron, was demonstrated at Danvers, Mass., October 5. The new tube is based on the familiar shadow-mask principle, in which the red, green and blue beams are channelled into the right paths by a perforated sheet placed behind the fluorescent screen. The new tube features a greatly simplified method of mounting the mask and fabricating the tube, which the manufacturer believes will eventually bring the price of color tubes down to about 30% higher than black-and-white. Full technical data on the new tube appears in the New Tubes article, page 108.

A few days later, a large press corps watched the first major CBS Television Network color program under the NTSC standards, on receivers installed in the Waldorf-Astoria Hotel, New York City. The same show was viewed in black-and-white on home receivers throughout the nation.

The first public demonstration was disappointing in some respects, especially when compared with the earlier one at Danvers, but shortcomings were charged off by CBS spokesmen to transmission difficulties inevitable in a new system. In a second demonstration, at the FCC color hearings held a few days later, the tube gave an excellent account of itself.

The original CBS demonstration, used field-sequential cameras. Their outputs were combined in a device called the Chromacorder, a piece of equipment developed by the CBS under the direction of Dr. Peter Goldmark. The Chromacorder translated the picture signal received from the cameras into the standard NTSC signals, which were then supplied to the transmitter.

AUDIO CONVENTION held by the Audio Engineering Society in New York City October 14, 15, 16 and 17 was the largest to date. During the four days of the convention, members heard 29 papers, presented in seven half-day sessions. The subjects ranged from music in the home through multi-channel or stereophonic music to the design of loudspeakers, including a paper on an electrostatic tweeter.

At the Audio Fair, held concurrently with, but independently of, the convention, more than 23,000 people registered, to view the displays of 144 exhibitors occupying four floors of the Hotel New Yorker. As in last year's exhibition, binaural and stereophonic music made a strong bid for attention. Other significant features were the increasing importance of tape, manifested by the large number of tape and tape recorder exhibits; and the development of high fidelity toward the needs of the home; indicated by the wide variety of equipment. Speaker systems alone varied over a price range of almost 30 to 1, and appeared in sizes varying from furnished-room to concert-hall types.

NAVY JET PILOTS can now depend on a new electronic device to determine whether or not they are approaching a carrier at a safe speed for landing. The new radar speed-measuring equipment, apparently an adaption of the Doppler radar principle, was developed by the Raytheon Manufacturing Co. It is installed on a carrier and "watches" the approach of a plane coming down for a landing. It then warns the landing officer if the aircraft's speed is too fast or too slow. The officer then signals his orders to the pilot, either guiding him down to a landing or waving him off for another try.

AN ALL-TRANSISTOR hearing aid which operates for one month on a 15-cent battery has been reintroduced by the Zenith Radio Corp. The company had started production of an all-transistor hearing aid last December, but soon stopped production. While the transistors had performed satisfactorily in the laboratory, company spokesmen reported, some of them did not hold up under field tests and failed after a few days of use.

Transistors used in the current hearing aid are said to be "many times as resistant to failure" as those produced during the company's early field tests.
Again proving tube-design leadership...

40% OF 1952's NEW RECEIVING TUBES WERE G-E DEVELOPMENTS...TWICE ANY OTHER MAKE

Fourteen out of thirty-five registered new receiving-tube designs—40%—were G-E, in the last calendar year, 1952. As still further proof of leadership...new G-E types numbered more than twice those of any other manufacturer!

Outstanding research and development by General Electric have given to the TV-radio industry its newest, most advanced tubes. You can be sure, when servicing latest-model receivers, that G-E tubes are available for every need—that G-E leadership in tube development brings you the finest obtainable product. Every working day, you will receive extra dividends in superior performance and reliability.

You can expect more new and improved tubes from General Electric in the months ahead—types that will make your work easier and cut callbacks. Keep in touch with your G-E tube distributor for forthcoming new-tube announcements, each with a profit message for you! Tube Dept., General Electric Co., Schenectady 5, N.Y.

Shown below: a few of the many new G-E tubes that are making money for service dealers.

You can put your confidence in...

GENERAL ELECTRIC

December, 1953
...put this PROOF right into your customer's hand!

BE SURE TO ENTER THE CQS CONTEST

If you are using the CBS-Hytron Certified Quality Service Kit, you are eligible to enter. You simply fill in 25 words or less why you like the CQS Plan. As an eligible entrant, you get a famous CBS-Hytron Soldering Aid free. And you have a chance to win one of these 10 BIG prizes:

FIRST PRIZE:
FORD PANEL TRUCK
Second Prize: $1000 in Savings Bonds
Third Prize: 600 in Savings Bonds
Fourth Prize: 500 in Savings Bonds
Fifth Prize: 400 in Savings Bonds
Sixth Prize: 300 in Savings Bonds
Seventh Prize: 200 in Savings Bonds
Eighth Prize: 100 in Savings Bonds
Ninth Prize: 50 in Savings Bonds
Tenth Prize: 25 in Savings Bonds

Remember, your CBS-Hytron distributor's salesman can also win other big prizes. Be sure to write his name, too, on your Contest entry. Entry blanks are available in your CQS Kit...or from your CBS-Hytron distributor. Beat the closing date, Dec. 15, 1953.

PROVE to your customer he can put his confidence in you.
Lay all the facts before him. Hand him this Certified Quality Service Tag. The Tag he has been reading about in LIFE-POST ads sponsored for you by CBS-Hytron. The same ads (and there'll be more) that are prompting him to ask where he can find you, his Certified Quality Service dealer.

With this simple, easy-to-use Tag, do what your customer wants. Certify that your itemized charges are fair. Certify that your service...your ability...and your equipment guarantee him dependable, top-quality TV and radio repairs. Give your customer tangible proof that you are giving him his money's worth. Win his confidence. And you will gain more business...more profits. Put your convincing Certified Quality Service Tags to work right away.

GO A STEP FURTHER
Tie in with the whole Certified Quality Service Plan as advertised in LIFE and the POST.

They are all part of the Certified Quality Service Kit. This Kit, including 250 CQS Tags imprinted with your name and address, is available on a special offer from your CBS-Hytron distributor. Or you can write for details on how to order direct. You can order more CQS Tags from your distributor, whenever you need them.

GO STILL FURTHER
Keep in close touch with your CBS-Hytron distributor. Watch soon for additional supporting material to identify you as a Certified Quality Service dealer:

1. CQS Illuminated window sign
2. CQS metal flange sign
3. CQS direct-mail postal cards
4. CQS newspaper mats, etc.

CBS-HYTRON, Main Office: Danvers, Mass.

A Division of Columbia Broadcasting System, Inc.

A member of the CBS family ... CBS Radio • CBS Television

Columbia Records, Inc. • CBS Laboratories • CBS-Columbia, Inc. • and CBS-Hytron

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

RADIO-ELECTRONICS
Here comes opportunity ... ready or not!

- Prepare now for the new Radio-TV-Electronics boom. Get in on VHF and UHF . . . aviation and mobile radio . . . color TV . . . binaural sound! The International Correspondence Schools can help you!

If you've ever thought about Radio or Television as a career . . . if you have the interest, but not the training . . . if you're waiting for a good time to start . . . NOW'S THE TIME!

No matter what your previous background. I.C.S. can help you. If Radio-TV servicing is your hobby, I.C.S. can make it your own profitable business. If you're interested in the new developments in Electronics, I.C.S. can give you the basic courses of training you need. If you have the job but want faster progress, I.C.S. can qualify you for promotions and pay raises.

I.C.S. training is success-proved training. Hundreds of I.C.S. graduates hold top jobs with top firms like R.C.A., G.E., DUMONT, I.T.&T. Hundreds of others have high ratings in military and civil service. Still others have successful businesses of their own.

With I.C.S., you get the rock-bottom basics and theory as well as the all-important bench practice and experimentation. You learn in your spare time—no interference with business or social life. You set your own pace—progress as rapidly as you wish.

Free career guidance: Send today for the two free success books, the 36-page "How to Succeed" and the informative catalog on the course you check below. No obligation. Just mail and mail the coupon. With so much at stake, you owe it to yourself to act—and act fast!

I.C.S., Scranton 9, Penna.

INTERNATIONAL CORRESPONDENCE SCHOOLS

Without cost of obligation, send me "NOW TO SUCCEED" and the booklet about the course BEFORE which I have marked X.

ART
- Commercial Art
- Fashion Illustration
- Fashion Illustrating
- Advertising
- Clothing Pattern Drafting
- Apparel Designing
- Interior Designing

AUTOMOTIVE
- Automotive Mechanics
- Auto Body Repairing
- Auto Body Refinishing
- Auto Body Refinishing
- Diesel—Gas Engines
- Diesel—Gas Engines

AERONAUTICS
- Aeronautical Engineering
- Aircraft Engine Design
- Airplane Drafting
- Aircraft Drafting

AIRCRAFT
- Airplane Drafting
- Aircraft Drafting
- Aircraft Designing
- Aircraft Drafting
- Aircraft Drafting

CIVIL, STRUCTURAL,
- Drafting, Building Design
- Drafting, Building Design
- Drafting, Building Design
- Drafting, Building Design
- Drafting, Building Design

ENGINEERING
- Drafting, Civil Engineering
- Drafting, Structural Engineering
- Drafting, Mechanical Engineering
- Drafting, Electrical Engineering
- Drafting, Chemical Engineering

PRODUCT DESIGN
- Product Design
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- Product Design
- Product Design

ELECTRICAL
- Electrical Engineering
- Electrical Engineering
- Electrical Engineering
- Electrical Engineering
- Electrical Engineering

INDUSTRIAL ELECTRONICS
- Industrial Electronics
- Industrial Electronics
- Industrial Electronics
- Industrial Electronics
- Industrial Electronics

COMMERCE
- Bookkeeping
- Business Management
- Business Management
- Business Management
- Business Management

COMPUTING
- Computer Programming
- Computer Programming
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- Computer Programming
- Computer Programming

COMMUNICATIONS
- Electronic Communications
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- Electronic Communications

MISCELLANEOUS
- Plumbing
- Electrical Refinishing
- Electrical Refinishing
- Electrical Refinishing
- Electrical Refinishing

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Mail to: INTERNATIONAL CORRESPONDENCE SCHOOLS, Box 2082-A, Scranton, Penna.

DECEMBER, 1953
SEVENTY-ONE NEW TV stations have gone on the air between our last report in this column and October 10.

KAFT-TV Bakersfield, Calif. 29
KKVH-TV Sacrament Valley, Calif. 33
KEMO-TV Kansas City, Mo. 16
KEKD-TV Wichita, Kans. 2
e KERO-TV Bakersfield, Calif. 19
KEYT Santa Barbara, Calif. 19
KFAC Monroe, La. 2
KFEG-TV St. Joseph, Mo. 10
KFSD-TV San Diego, Calif. 2
KGTV-Albuquerque, N. M., 7
KHQA-TV Hannibal, Mo. 2
KHSU-TV Chico, Calif. 12
KLEM-Eureka, Calif. 13
KIVA Yuma, Ariz. 2
KJEO Los Angeles, Calif. 1
KMBC-TV Kansas City, Mo. 1
KMBW-TV Fresno, Calif. 47
KMOX-TV St. Louis, Mo. 10
KOAT-Albuquerque, N. M. 7
KOP-T Portland, Oregon 2
KOPH-TV Butte, Mont. 24
KRDQ-Abilene, Texas 7
KRDG-Colorado Springs, Colo. 13
KSBW-TV Salinas, Calif. 2
KVOA-TV Tucson, Ariz. 4
KLAM-TV Butte, Mont. 2
KTVV Springfield, Mo. 5
WACH-Washington, D.C. 9
WATE-Knoxville, Tenn. 25
WBAB-TV Buffalo, N. Y. 2
WBFS-Boston, Mass. 17
WCAN-Milwaukee, Wis. 2
WCHA-Chamberlain, S. Dak. 46
WCBB-St. Louis, Mo. 30
WEAR-Pensacola, Fla. 3
WECT-TV Wilmington, N. C. 33
WEHT Henderson, Ky. 40
WENS-Pittsburgh, Pa. 16
WGMG-TV Quincy, Ill. 10
WHB-TV Kansas City, Mo. 9
WHRG-TV Memphis, Tenn. 12
WINS-Ann Arbor, Ohio 24
WLS Chicago, Ill. 31
WPXE-Dayton, O. 11
WILK-TV Wilkes-Barre, Pa. 14
WILLS-TV Lansing, Mich. 34
WIRK-West Palm Beach, Fla. 14
WISP-Augusta, Ga. 6
WJL-T Louisville, Ky. 31
WKIN-T Charleston, S. C. 48
WMAZ-Macon, Ga. 36
WHIN-St. Paul, Minn. 11
WMT-TV Cedar Rapids, Ia. 10
WNOK-Columbia, S. C. 18
WOKY-Milwaukee, Wis. 19
WPRV-Providence, R. I. 26
WBPK-T Rockford, Ill. 16
WROL-TV Nashville, Tenn. 13
WJSX-Winston-Salem, N. C. 2
WSAV-TV Harrisburg, Pa. 3
WTAT-Cambridge, Mass. 30
WTAP-Parkersburg, W. Va. 15
WTCN-Minneapolis, Minn. 12
WTOB-Winston-Salem, N. C. 26
WTOK-Meridian, Miss. 21
WTVK-Knoxville, Tenn. 26
WTVH-Poeia, Ill. 19
WVEC-Hampton-Norfolk, Va. 15
KFIX-TV Nampa, Idaho (Channel 6) has discontinued operations. As of October 10, there were 284 television stations—196 v.h.f., 88 u.h.f. (in operating in the U.S.)

BING CROSBY ENTERPRISES may be forced to release their VTR (Video Tape Recorder) system to the television industry by early 1964 due to demands by the Government plus competition from other firms. RCA, for example, announced a demonstration of their tape recording system for December 1.

Frank Healey, executive director of the electronic division of BGE, said that various federal agencies were interested in VTR for radar, moving target and guided missile programs, and are pressing for quick development.

He said GE, Magnacord, RCA, Armour Research Laboratory and Ampex are working on video tape recording, but that BGE hopes to be first.

TWO FM PROGRAMS on a single channel are made possible by an invention demonstrated by Major Edwin H. Armstrong and John Bose at Columbia University recently. The system provides for at least two high-quality FM programs on an existing FM channel. The second, or side, channel operates as a subcarrier of 27.5 kc, which is frequency-modulated ±5 kc by the electronic program. The side channel in its turn modulates the main carrier ±20 kc. The frequency range of the second channel is 8,000 cycles, and the 15,000-cycle range of the main channel is unimpaired. The signal-to-noise ratio of the side channel is 10 to 25 higher than that of the main channel, but still meets the FCC specifications for a normal FM broadcast station. Interference between the two channels was virtually inaudible.

Four or six extra tubes are needed in the receiver to extract and demodulate the side carrier. These follow the regular discriminator and comprise a 27.5-ke i.f. system followed by another discriminator. A separate audio amplifier must be used of course. The additional equipment may be attached to an existing FM set, though Major Armstrong pointed out that only receivers with excellent noise discrimination characteristics could be used.

The new transmission system immediately suggests the possibility of binaural broadcasting without the cumbersome two-channel setups now required. Major Armstrong suggested other uses, that he said might be the means of putting FM on a paying basis. Since the side channel can carry a program entirely different from the main one, it might provide a special news, sports or other service, to a specialized audience, while the main channel could be used for high-fidelity music or other type of general program. Revenues from the special program would offset costs of the general one.

RADIO HOMES outnumber those with electricity, the census bureau reports. The bureau discovered that 96.7% of all homes have radios, with only 94% having electricity. The difference indicates battery sets in use.

The report points out the rapid increase of radios in the home, from 40% in 1930 to 83% in 1940 to almost one or more in every home by 1950. Television in the home was still relatively new in 1950, the bureau said, adding that the census showed about 5,000,000 sets, mostly in urban homes.

TOKYO TV STATION TOKYO, the first television station in Japan, has begun broadcasting. The Tokyo unit is the anchor station of a very extensive telecommunication plan, by which all forms of communications will be transmitted by single radio-relay system using microwave stations situated on mountain top locations.

The equipment used in the Tokyo station was bought from RCA and is fully paid for. The entire network is expected to cost about $15,000,000 in combined currencies.
NEW HOME OF ALLIED RADIO

ultra-modern facilities TO SERVE YOU BEST

FREE!

get your value-packed

1954

ALLIED

268-PAGE CATALOG

The World's Largest Stocks

- TV and Radio Parts
- 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
- Equipment for Industry

Fastest Service in Electronic Supply

Send for it today!

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.

SAVE ON EVERYTHING IN ELECTRONICS

ALLIED RADIO
World's Largest Electronic Supply House

ALLIED RADIO CORP., Dept. 2-M-3
100 N. Western Ave., Chicago 80, Illinois

☐ Send FREE 268-Page 1954 ALLIED Catalog

Name:

Address:

City, State:

DECEMBER, 1953
WHY SYLVANIA PRODUCTS MEAN BETTER BUSINESS!

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

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

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

So, if you want recognized quality working on your side . . . sell Sylvania! Call your local Sylvania Distributor for the latest fall prices and money-making promotion offers, or write to: Sylvania Electric Products Inc., Dept. 8R-1712, 1740 Broadway, New York 19, N. Y.
CREI prepares you quickly for success in

The future is in your hands!

The signs are plain as to the future of the trained men in the electronics industry. It is a tremendous industry, and—at the present time there are more jobs than there are trained men to fill them. But—when there's a choice between a trained and untrained applicant, the trained man will get the job. Your biggest problem is to decide on—and begin the best possible training program.

CREI Home Study ... The Quick Way to Get There.

Since 1927, CREI has given thousands of ambitious young men the technical knowledge that leads to more money and security. The time-tested CREI procedure can help you, too—if you really want to be helped. CREI lessons are prepared by experts in easy-to-understand form. There is a course of instruction geared to the field in which you want to specialize. You study at your convenience, at your rate of speed. Your CREI instructors guide you carefully through the material, and grade your written work personally (not by machine).

Industry Recognizes CREI Training.

CREI courses are prepared, and taught with an eye to the needs and demands of industry, so your CREI diploma can open many doors for you. Countless CREI graduates now enjoy important, good-paying positions with America's most important companies. Many famous organizations have arranged CREI group training for their radio-electronics-television personnel. To name a few: All America Cables and Radio, Inc.; Canadian Aviation Electronics, Ltd.; Canadian Broadcasting Co. Corporation; Columbia Broadcasting System; Canadian Marconi Company; Hoffman Radio Corporation; Machlett Laboratories; Glenn L. Martin Company; Magnavox Company; Pan American Airways, Atlantic Division; Radio Corporation of America, RCA Victor Division; Technical Appliance Corporation; Trans-Canada Air Lines; United Air Lines. Their choice for training of their own personnel is a good cue for your choice of a school.

Benefits Felt Right Away.

Almost immediately, you feel the benefits of CREI training. Your employer, when informed of your step toward advancement only at your request), is certain to take new interest in you and in your future. What you learn in CREI Home Study can start helping you do a better job immediately.

CREI also offers Resident Instruction

at the same high technical level—day or night, in Washington, D. C. New classes start once a month. If this instruction meets your requirements, check the coupon for Residence School catalog.

INFORMATION FOR VETERANS

If you were discharged after June 27, 1950—let the new G.I. Bill of Rights help you obtain resident instruction. Check the coupon for full information.

Get this fact-packed booklet today. It's free.

Called "Your Future in the New World of Electronics," this free illustrated booklet gives you the latest picture of the growth and future of the gigantic electronics world. It includes a complete outline of the courses CREI offers (except Television and FM Servicing) together with all the facts you need to judge and compare. Take 2 minutes to send for this booklet right now. We'll promptly send your copy. The rest—your future—is up to you.

MAIL COUPON TODAY

CAPITOL RADIO ENGINEERING INSTITUTE
Dept. 1412 3224 15th St., N.W., Washington 10, D.C.
Send booklet "Your Future in the New World of Electronics" and course outline.
CHECK __ TV, FM & Advanced AM Servicing __ Aeronautical Radio
FIELD OF __ Practical Radio Engineering
GREATEST __ Broadcast Radio Engineering (AM, FM, TV)
INTEREST __ Practical Television Engineering
NAME

Street

City

State

Check—__ Residence School __ Veteran

DECEMBER, 1953
During October, 82 of the leading 400 manufacturers of RadioElectronic-Television parts and equipment made changes in their lines. There was an increase in "change activity" as compared to September.

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

<table>
<thead>
<tr>
<th>Product Group</th>
<th>Increased Prices</th>
<th>Decreased Prices</th>
<th>New Products</th>
<th>Discontinued Products</th>
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<tbody>
<tr>
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<td>No. of Mfrs.</td>
<td>No. of Products</td>
<td>No. of Mfrs.</td>
<td>No. of Products</td>
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<tr>
<td>Antennas &amp; Access.</td>
<td>4</td>
<td>5**</td>
<td>7</td>
<td>22*</td>
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<tr>
<td>Capacitors</td>
<td>0</td>
<td>0**</td>
<td>3</td>
<td>41*</td>
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<tr>
<td>Controls &amp; Resistors</td>
<td>2</td>
<td>48*</td>
<td>1</td>
<td>3*</td>
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<tr>
<td>Sound &amp; Audio</td>
<td>6</td>
<td>15**</td>
<td>3</td>
<td>3**</td>
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<td>Test Equipment</td>
<td>3</td>
<td>615*</td>
<td>1</td>
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<td>Transformer</td>
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<td>18*</td>
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<td>Tubes</td>
<td>7</td>
<td>806*</td>
<td>6</td>
<td>58*</td>
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<tr>
<td>Wire &amp; Cable</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>8*</td>
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Comment: The total number of manufacturers making changes in their lines has increased since last month's report. Among these manufacturers reporting changes, the emphasis continues to be placed on price changes, a trend that has been evident for the last three months.

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

Merchandising and Promotion
United Motors Service Division of General Motors, Detroit, has inaugurated a series of electronics service classes for United Motors electronic distributors and the service personnel of their dealer accounts. The first classes will be held in the new Detroit Training Center, the first of 35 such training schools to be built across the country. Erie Resistor Corp., Erie, Pa., devised a new method of packaging its style different types are packed in a cardboard box for convenient stocking.

CBS-Hytron, Danvers, Mass., developed a new Certified Quality Service Plan built around a service tag attached to the consumer's TV set. In connection with the new plan, CBS-Hytron is sponsoring a contest for radio and TV service technicians and for distributor salesmen. First prize for technicians is a Ford panel truck. The contest closes December 15.
MY GRADUATES ARE EARNING GOOD PAY!

"I'll always be grateful to my training which helped me get my present fine position as Assistant Parts Manager." — Norman Weston

"Thanks to your training, I qualified for a good job as a Receiver Tester." — Paul Frank Seier

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

"I'm making good money in my own business, repairing and installing radio and TV sets — thanks to your training." — Irwin Polansky

YOU, TOO, CAN MAKE BIG PAY IN TELEVISION

NO EXPERIENCE NECESSARY

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

ENSUFRG EQUIPMENT TO SET UP YOUR HOME LABORATORY! As part of your training, I give you ALL the above equipment you need and more to prepare for a better PAY TV job. You build and keep a professional COMPLETE BIG SCREEN TV RECEIVER in tube, takes any size up to 21 inches... also a Super-Het Radio Receiver, RF Signal Generator, Combination Voltmeter-Ammeter, Ohmmeter, C-W Telephone Transmitter, Public Address System, A-C-D Power Supply. Everything supplied including all tubes!

MORE MONEY AND A CAREER ARE WAITING FOR YOU HERE!

EXPERT FM-TV TECHNICIAN TRAINING! SAVE VALUABLE TIME! My FM TV Technician Course can save you months of training if you have previous Armed Forces or civilian radio experience! Train at home with kits of parts, plus equipment to build BIG SCREEN TV RECEIVER, and FREE FCC Coaching Course! ALL FURNISHED AT NO EXTRA COST!

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

NEW! PRACTICAL TV CAMERAMAN & STUDIO COURSE! (For men with previous radio and TV training) I train you at home for a big pay job — the man behind the TV camera. Work with TV stars in TV studios or "on location" at remote pick-ups! A special one-week course of practical work on TV studio equipment at Pierce School of Radio & TV, our associate resident school in New York City, is offered under your graduation.

MAIL COUPON FOR 4 FREE AIDS! NO OBLIGATION WHATSOEVER!

VETERANS!

My schools fully approved to train veterans under new G.I. Bill! If discharged after June 27, 1950 — CHECK COUPON! Also approved for RESIDENT TRAINING in New York City at Pierce School of Radio and Television... qualifies you for full subsistence allowance up to $160 per month. Write for details.

RADIO-TELEVISION TRAINING ASSOCIATION
52 EAST 19TH STREET, NEW YORK 3, N. Y.
Licensed by the State of New York Approved by the VA

DECEMBER, 1953
able to service technicians at a nominal cost. Jumbo window posters of the ad are available to jobbers for distribution to their service technician customers. Blonder-Tongue Laboratories, Westfield, N. J., is using an attractive yol-

low and black display easel as a point-of-sale display in its current sales promotion program. The easel provides for the mounting of one of the company's Ultravertor u.h.f. converters.

The General Electric Tube Department awarded $2,500 as the first prize in its recent "Write Your Own Ticket" contest for radio and TV service techni-
cians, to George Champlin, Centralia, Wash. A. L. Champigny, advertising and sales promotion manager for the Tube Department, said that this year's entries far exceeded those received in the first contest held in 1952.

Brach Manufacturing Co., Division of General Bronze Corp., Newark, N. J., announced a new 3D advertising program to introduce its new line of TV products, according to Ira Kamen, Brach vice-president.

Raytheon Manufacturing, Newton, Mass., held another of its "How to Inter-

"To find and follow the better way... Out at the vision... Dr. George Ellery Hale crime the great "American Idea" that resulted in the creation of the "Glass Giant of Palomar"—world's largest telescope—together new light from the farthest stars for the searching eye of science.

With us, the "American Idea" is, by directed effort and applied know-how, to continue to lead in bringing you electronic products of the highest quality.

INSIST ON AMERICAN MICROPHONES
D-33 Broadcast
D-22 Public Address
Send for FREE catalog 46

American microphone co.
370 South Fair Oaks Ave. • Pasadena, 1, Calif.

mits the service technician to check phonograph needles right in the machine.

Recoton Corp., New York City, announced plans for one of the biggest advertising campaigns in its history on its complete line of phonograph needles.

Production and Sales

RETMA reported that TV production of 4,784,285 TV sets during the first eight months of 1953 was at the highest level on record for that period. 8,322,638 radio sets were produced as against only 6,558,303 for the 1952 period

New Plants and Expansions

Aerovox Corp., New Bedford, Mass., merged its Wilkor resistor manufacturing operation with the ceramic capacitor operation of the Hi-Q Division. Wilkor moved from Cleveland to the three Hi-Q plants at Olean and Franklinville, N. Y., and Myrtle Beach, S. C. The combined operation will be known as the Hi-Q Division of Aerovox, but the Wilkor name will continue to be used on all resistor products.

Pyramid Electric, North Bergen, N. J., capacitor manufacturer will open a new plant in Gastonia, N. C., which will provide 160,000 square feet of additional space.

Channel Master Corp., Ellenville, N. Y., marked its sixth year of operation by opening a $1,500,000 manufacturing plant and a $500,000 aluminum extrusion mill.

General Electric Electronics Division established a new Commercial Equipment Department. William J. Morlock, general manager for commercial equipment activities, was appointed general manager of the new department.

Leader Electronics, Inc., manufacturer of the Superotor rotator, moved to new larger quarters at 2925 East 55th St., Cleveland, Ohio.

Pioneer Electronics Corp. formally opened its new West Angeles plant with ceremonies attended by civic and industrial leaders. The company plans to produce 1,000 picture tubes per day.

Audio Devices, New York City, acquired the assets and good-will of Advance Recording Products, Long Island City, N. Y.

Cal-Tronics Corp., Los Angeles test equipment designer and manufacturer moved to a new plant in the Imperial Industrial District at 11307 Hindry Avenue.

Precise Development Corp., Ocean- side, N. Y., acquired an additional building in that community.

Arcturus Electronics, Newark, N. J., plans to begin the manufacture of television picture tubes at a newly acquired plant in Easton, Pa.

Radio Condenser Co. has begun operations in part of its new 90,000- square-foot manufacturing plant in Camden, N. J.

The RCA Victor Tube Department acquired a new warehouse in Dallas, Texas, to speed service to distributors of RCA tubes, parts, and batteries in the Southwest. The new warehouse will be under the management of John Cavallaro.
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 experience putting a station "on the air," performing procedures demanded of Broadcasting Station Operators. An FCC Commercial Operator's License can be your ticket to a better job and a bright future; my Communications Course gives you the training you need to get 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 PRACTICAL EXPERIENCE. That's why NRI training is based on LEARNING BY DOING. You use parts I furnish to build many circuits common to Radio and Television. With my Servicing Course you build a modern Radio (shown at right). You build a Multimeter 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.

Television is Growing Fast
Making New Jobs, Prosperity

More than 25 million homes now have Television sets and thousands more are being sold each 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.

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!

NO STAMP NEEDED! WE PAY POSTAGE

Mr. J. E. SMITH, President,
National Radio Institute, Washington 9, D. C.
Mail me Lesson and Book, "How to Be a Success in Radio-Television." (No Salesman will call. Please write plainly.)

NAME ___________________ AGE ______
ADDRESS ___________________
CITY _____________________ ZONE ___ STATE ______

VETS write in date of discharge BCDEF
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 home 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 1,600 more Television Stations. Use of aviation and Police Radio, Micro-Wave Relay, Two-Way Radio communication for bus, taxicabs, trucks, etc. is expanding. New uses for Radio-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, they are是我 furnishing "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 earn $10, $15 a week extra fixing Radio in spare time starting soon after enrolling. Read how my graduates start their own businesses. Then take the next step—mail card below.

You take 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" which 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 $5 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

The men whose messages are published below were not born successful. Not so long ago they were doing exactly as you are now...reading my ad! They decided they should become MEN OF MORE...so they could EARN MORE...so they acted! Mail card below now.

I Trained These Men

Handicapped but Successful

"I am now Chief Engineer at WBAW. My left hand is still at the wrist. A man can do if he wants to." J. A. Halley, Weston, W. Va.

Control Operator, Station WN

"I received my license and worked on ships. Now I'm a control operator. NRI furnished me the opportu. Arnold, Rumford, R. I.

Has Growing Business

"I am becoming expert Technician as well as Radio-Television without your courses it would be impossible." Joe Barnes, Broxton, Ky.

Get First Job Thru NRI

"My first job was with KULY. Now Chief Engr. of Radio Equipment for Police and Fire Dept. T. Norton, Hamilton, Ohio.

Find Out What RADIO-TV Offers You

SAMPLE LESSON and 64-PAGE BOOK
Both FREE

Cut out and mail postage-free card today!

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 am sending you special booklets that show you how to fix sets the day you enroll. The multimeter you build with parts I furnish helps discover and correct troubles.

Do You Want Your Own Business?

Many NRI trained men start their own electronics Radio-TV sales and service business 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 Ashbury Park, N. J., writes: "I've come a long way in Radio and Television since graduating. Have my own business on Main Street."
ASTRON SM* CAPACITORS

These SAFETY MARGIN capacitors offer the assurance of greater all-around built-in dependability because of the most exacting engineering specifications. To you, as it does to thousands of other service men, SM* means absolute customer satisfaction.

ASTRON SM* TWIST PRONG
dry electrolytics are individually tested and guaranteed. They have earned wide acceptance by original equipment manufacturers. For quality replacement, you can rely on Astron's high standards of quality manufacture. Your jobber stocks all popular replacement ratings. Catalog AC-3A lists all available SM twist prong ratings.

ASTRON SM* BLUE-POINT*
fabulous new member of the Astron line, offers the "tightest seal and toughest shell" in molded plastic paper capacitors. They give outstanding performance under the most adverse temperature and moisture conditions. Look for the eye-catching yellow jacket with the easy-to-spot Blue-Point end seal. Write for Bulletin AB-20A for the complete story.

DEPEND ON—INSIST ON
ASTRON
Manufacturers of a complete line of capacitors and filters for every television, radio and electronic application.

ASTRON CORPORATION 255 GRANT AVE., EAST NEWARK, NEW JERSEY

In Canada: Charles W. Polston, 1926 Gerrard St., East, Toronto

DECEMBER, 1953
CHANNEL MASTER introduces a basically new type of VHF antenna

CHAMPION*

the highest gain all-channel VHF antenna ever developed!

Featuring the unique new "Tri-Pole"

TRIPLE-POWERED DIPOLE

The "Tri-Pole" is a new antenna system in which the Low Band folded dipole also functions as three folded dipoles tied together in phase on the High Band. This is the heart of the Champion, the secret of its phenomenal performance on all 12 VHF channels.

The CHAMPION is another great development of the world famous Channel Master laboratories.
the CHAMPION is the most sensitive all-channel VHF antenna ever designed!

Stacked CHAMPION provides:
11-13 dB High Band gain
6½-7½ dB Low Band gain

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ELECTRONICS vs. ATOMIC BOMBS

... The atomic threat will be countered by electronics...

By HUGO GERNSBACK

"The greatest weakness of any atomic bomb lies in its delivery." This obvious axiom is frequently lost sight of now when our country is becoming frantic in elaborate defense measures and where there is little agreement upon the most effective means to use. Let us therefore consider the means now at our disposal.

RADAR Radar is only of limited use as a warning agency. Unless it is far removed from our vital centers, it becomes useless. That means a permanent radar chain installation high up North in the polar regions if we are to have the necessary several hours warning to alert our interceptors. Obviously we can have no such chains in the North Atlantic and Pacific unless we use hundreds of radar-equipped ships. Such ships, however, are cumbersome and the cost is high.

In 1950, the writer proposed Stratoradar planes. These are huge planes circling at great heights, scanning the horizon 24 hours a day. We need only 6 strato-radar planes to cover a line of 3,000 miles, each plane scanning 500 miles. Such a scheme is now seriously considered for the so-called "D.E.W." (Distant Early Warning).

HOMING GUIDED WEAPONS These can be used either from the ground or from the air. They can be fired from antiaircraft guns, from the ground, or from interceptors. The guiding is done electronically by the missile itself.

Yet imagine the highly complex situation when an enemy fleet numbering hundreds of bombers should appear over our country. Even with long distance warning and all our present available radar and other defenses, not every guided missile can possibly make an effective hit on an enemy bomber.

We would need tens of thousands of interceptor fighters to wipe out such an attacking air armada. And we must not forget that the enemy bombing planes are armed too—and conceivably will have guided weapons against our own defending planes.

This was the case over England and over Germany during World War II. The unpleasant fact remains that at best, according to our informed military experts, we can only hope at present to shoot down 70% of the attacking aircraft. Thus, out of 300 planes, 90 will get to the target. To be sure, not all the attacking planes would carry atom bombs. Let us say only 10% do. Nine attacking planes, therefore, would finish their mission. Ponder also the fact that one solitary H-Bomb could wipe out not only a city the size of New York, but severely damage all surrounding cities over a radius of 100 miles.

But that isn't the whole story. Consider also the destroyed enemy aircraft. Herefore these were only casualties to the enemy. Today, if an H-Bomb carrier is shot down even 20 miles from a large city, that city may be destroyed as completely as if it had been bombed by the enemy.

To be sure, the enemy is aware of all these possibilities, and realizes that if he attacks us we will repay him in kind, plus interest. Nevertheless, the stark reality remains that if we are successfully attacked, dozens of our large cities will be completely wiped out with fatalities and casualties running between 10 and 40 million persons.

From these facts—dozens of others could be cited—it should become obvious that our vital needs are:

1. Far-flung and numerous bases and abundant air-power to attack the enemy with overwhelming blows as a powerful deterrent. Fortunately, this gigantic arm is now in the making.

2. A comprehensive and well-equipped D.E.W. (Distant Early Warning) system that will be efficient. Present day radar is so poor due to technical limitations that—according to the scientists at McGill University who worked out the Canadian Arctic radar interception system—at best only 80% of attacking enemy planes could be detected. This calls for vast new research in radar improvement. It also means complete reorientation of radar itself.

3. New electronic interception and direct electronic combatting means. It is here our most powerful and effective future defense lies. History has always recorded that every new weapon ever developed in history has a successful counter. The attacking H-bomber—or for that matter the transoceanic guided missile—will be check-mated in time. And you may be sure it will be by electronic means.

Electronic guided atom or H weapons will envelop and destroy clouds of hundreds of enemy attacker planes in the stratosphere.

Thermic-Radar will burn and explode enemy aircraft—and in the more distant future—track and destroy even transcontinetal guided missiles. We have already made a modest beginning in the use of thermic radar as reported first in our August 1953 issue. We reprint only one passage from that article, entitled "Radar Hazards":

"Photoflash bulbs were fired (by microwave Radar) at a distance of 323 feet. At 300 feet audible and visible sparking was apparent when metallic chips were shaken in a paper bag. With high power radar, these and other spectacular effects can be duplicated at even greater distances.

It would appear from the few facts cited here that our entire future defense and our survival as a nation may well rest on electronic means. Our electronic engineers, our physicists and scientists will come up with the right answers at the right time. They always have in the past.

The Editors and Staff of Radio-Electronics

Wish You a Merry Christmas and a Prosperous New Year.

DECEMBER, 1953
BUDGET REMOTE LINE AMPLIFIER

This tried and tested low-cost amplifier is ideal for schools or semiprofessional use

By GEORGE L. AUGSPURGER

WE HAVE often pointed out that the slogan “something for nothing” belongs among the “famous last words” as far as audio work is concerned. Yet, we have to admit that few persons or institutions can afford to buy equipment on a “price is no object” basis. Schools especially are plagued with the necessity of trying to stretch scanty budgets for broadcast or recording studios.

Arizona State College at Tempe recently installed a wired-wireless radio station. While the transmitter is no more than a glorified phono oscillator, the school has managed to set up fairly complete studio and control facilities. In such a college radio setup a great deal of work consists of remote broadcasts from the gymnasium, auditorium, chapel and similar points. One day when we were inspecting the KASC facilities, the station engineer, Tom Voss, remarked that he would like to have a miniature remote amplifier capable of reasonable fidelity that could easily be carried to remote locations and operated by student members of the radio staff.

We told him that it would be possible to build such an item in a small, light case for about $50, and to prove our point we sketched a schematic of a simple three-stage circuit.

“Will that do the job?” asked Tom.

We assured him that it would.

“Will it have enough gain?”

We did some quick mental calculating and replied that it wouldn’t have any to spare, but that it should have enough. (Mistake number one!)

“And a single-ended output will be able to send plenty of signal into the line?” inquired Tom dubiously.

“Oh, yes,” we said, “After all, you don’t need extreme fidelity and we can slap in a little feedback if we have to.” (Mistake number two!)

“All right,” said Tom. “One of our engineers is looking for a special project in an electronics course. I’ll have him build it.”

Preliminary problems

The engineer looking for a special project turned out to be a pleasant fellow named Mark Sexton. In about a week he had collected all the parts needed for the circuit. We checked them over and discovered that he had purchased a steel chassis. “Couldn’t you get an aluminum one?” we asked. “This is bound to induce hum if we try to mount the power transformers on the same chassis as the amplifier.”

Mark answered that he had tried to get an aluminum chassis, but the wholesale house was unfortunately out of them at the moment and he was anxious to get started on the project. We chewed our fingernails and said all right, the hum could probably be licked by orienting the transformers. (Mistake number three!)

Tom was anxious to have the unit built too. Did we think that Mark would have any trouble wiring it? “If he just follows the schematic and avoids ground loops, he won’t have a bit of trouble,” I assured Tom. (Mistake number four!)

Another week went by and Mark had finished the job. We plugged in a pair of headphones and turned it on. Loud hum! We rotated the input transformer. Still loud hum. We adjusted the filament balancing pot. Still loud hum.

“I wired it just like you said,” said Mark hopefully.

An hour later we discovered that Mark had wired it just the way we had drawn the schematic, but due to certain things we had forgotten, such as

The low-cost remote line amplifier with power transformer.

Fig. 1—Schematic of the final revision of the budget remote line preamplifier.
transformer case grounds, he had managed to wire in three ground loops. Once these were removed, the hum was down about 10 decibels, but it was still too high. Another hour's experiment showed that the power transformer was inducing hum both into the chassis and into the electrolytic capacitors sitting next to it. If we tried to put the power supply on a separate chassis there would still be the capacitor induction problem.

We finally solved the difficulty by attaching a 24-inch cable directly to the transformer itself. The case was removed and connections were made inside the shell. With a plug on the other end of the cord this gave us an auxiliary unit much smaller and easier to handle than the conventional separate power supply as well as completely isolating the transformer from all possible hum pickup. The transformer hooks on to the rear of the cabinet when it is being carried about.

Mark took the amplifier down to the electronics lab to run some tests. He came back with a neat set of charts that showed 15% distortion at 6 milliwatts output and a noise level only 30 db below the zero db output! "We'll have to put in a little feedback," he muttered.

About two days and several testing sessions later we had the hum and noise down about 35 db and had compromised on a 1 volt output at 4% distortion. Tom tried it out the next evening and reported that with all the controls full open it still didn't have enough output. "You must have used a defective microphone," we suggested. Of course, we were wrong again—the microphone was perfectly all right. The fact was simply that the amplifier didn't have enough gain.

This time we had sense enough to take the diagram home and work on it a little more carefully before we made any suggestions. We finally calculated that by adding one more tube, it would be possible to incorporate plenty of feedback and still have gain to spare.

Mark took our revised diagram and within the space of two days had not only added the extra stage but had replaced a noisy volume control and rearranged all the wiring so that it was neat and orderly.

This time it only took us about an hour to find two more concealed ground loops and discover that the power transformer case was not grounded; then we took the little monster down to the lab and made some last adjustments. The final circuit is shown in Fig. 2. It meets our original specifications of being flat within 3 db from 50 to 15,000 cycles at less than 3% distortion at zero db output. Tom tried it again and was pleased this time with its performance, so we wisely kept our mouth shut and just smiled and staggered away. However, for the benefit of the reader, it might be a good idea to discuss the amplifier a little further from the standpoint of criticism and evaluation.

Mixing systems

Since high-quality transformers are the most expensive components in such an amplifier, it was decided to try low-impedance mixing with both microphones feeding into a common input transformer. This system, while the most economical possible, has two serious drawbacks. It has an insertion loss of 6 db between the microphone and the first amplifier stage, and it places the mixer controls ahead of all stages of amplification. Hum and noise is automatically higher than it would be with electronic mixing. In this particular...
HIGH-FIDELITY STANDARDS

In a letter to Edward F. H Sexy, chairman of the Federal Trade Commission, John S. Meck, president of Scott Radio Laboratories has asked the FTC to "provide a standard for high-fidelity performance and take the necessary steps to protect the public from pseudo products." He continued:

"As the chairman of an organization that has done such an excellent job of protecting the buying public, you should be interested to know that the term 'high-fidelity' is being employed in the promotion of many instruments that in no way provide the components or performance of minimum high-fidelity standards."

The Scott president says he considers the following points as minimum high-fidelity essentials:

1. A pickup on the tone arm that preserves the true waveform at all frequencies, with particular reference to high notes and overtones.

2. A large and ample amplifier of the push-pull type with 6L6 or equivalent tubes, having a maximum output of 25 watts or more, of which 5 to 6 watts will be utilized under optimum range.

3. A wide-frequency-range coaxial speaker, with a separate cone for the low notes having a resonance point near 50 cycles per second; a second coaxially mounted speaker unit that faithfully reproduces the high notes to well above 15,000 cycles per second; and a crossover network to remove the highs from the low-frequency speaker unit and the lows from the high-frequency speaker unit.

At a meeting of RETMA's high-fidelity equipment section, a draft of standards was agreed upon. These proposed high-fidelity standards are: Wide-range loudspeakers, minimum range of 60-10,000 cycles per second; tuners, sensitivity on FM, minimum standard of 30 db of signal, with 25 microvolts into antenna amplifiers, minimum frequency response, plus or minus 3 db from 30-15,000 cycles at no less than 10 watts, with maximum of 5% inter-modulation distortion.

END

Table I—Audio harmonic distortion.

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necessity.

As can be seen, the microphone input is to Centralab delta-T pads. This was not done because of convenience of plugging in for a very special reason. The ear does not hear electronics well at all volume levels. As volume increases or decreases from about the center of the hearing range, the ear hears less and less of the very low or very high notes in relation to the medium notes. This is especially true and more noticeable at the low frequencies. This effect is usually called the Fletcher-Munson effect.

The delta pad is a volume control and special printed electronic circuit network designed to better reproduce the bass and treble response of the amplifier when the volume is at a low level. The pad is thus a true "low loss" control that will not induce a noticeable signal loss into a piece of equipment.

Since the budget remote line amplifier is essentially a low current device, the power supply is entirely adequate. The power supply filter may seem unnecessarily elaborate, but the RC filtering assures a minimum of ripple frequency finding its way into the various circuits.

Modifications

After reviewing the performance of the unit, it seems reasonable that the only two changes we might make if a second one were built would be to lower the value of the plate and screen resistors in the first stage and try to select components to give a slightly extended bass range.

With the exception of the possible two modifications just mentioned, the circuit seems to be a most satisfactory device according to the original goals established. The total cost of parts was almost exactly $50. For this amount of money and a little careful work, a unit can be constructed which will provide flat response at low distortion from 50 to 15,000 cycles. As a compact, lightweight, easy-to-operate remote line preamplifier, it fills a definite need for a low-budget semiprofessional unit.
HIGH-QUALITY AUDIO

By RICHARD H. DORF*

Part IV—The phonograph pickup is the decoder of recorded music; the beginning of the sound reproduction process

Thus we have two basic characteristics of sound: pitch or frequency (which we will use interchangeably for the moment), determined by the number of pressure variations per second; and volume, loudness, or amplitude (same comment), determined by the extent of the pressure variations.

We can draw a graph of a sound wave, which tells the entire story. Fig. 1-a is such a graph or picture of the sound wave produced by a tuning fork. This fork was tuned to A (440 cycles), and the graph shows a short section of time during which the air pressure started at its normal value, was compressed, returned to normal, became rarified then returned again to normal. This pattern—normal, maximum, normal, minimum—is repeated again and again. It is a complete cycle. Since the fork was tuned to 440 cycles per second, this one cycle must have taken place in 1/440 of a second.

Fig. 1-b shows what happens when we take two tuning forks, one at 440 cycles and a second at twice that frequency, 880 cycles. We strike both equally hard and they have equal effects on air pressure. The sound pressure now varies in a different pattern, since it contains two frequencies. But, there are not two separate waves. The pressure variations caused by the two forks combine and produce a single pattern of compression, which is a composite picture of the two. This is to be expected, since the same air particles could hardly be in two places at the same instant.

This is important in audio, so let us illustrate it. Fig. 2 shows Jack and Hal, each pulling on a rope wound around a rock. Jack is pulling with a force of 10 pounds, Hal with a force of 8 pounds. Obviously the rock cannot move simultaneously toward Hal and Jack. So, it must combine both forces and undergo a single movement which is a composite of the two. And since Jack is pulling 2 pounds harder than Hal, the rock will move toward Jack.

It is easy to see what would happen if there were four men—or seven, or any number—all pulling on the rock from different directions with different forces. Since the rock can move in only one direction at a time, it would have to make a calculation that takes into account all the forces and directions and take the one path that is the resultant.

Air is just as clever as rocks. When many different frequencies, each at a different amplitude, exist in a source of sound, the air makes the right calculation at every instant and compresses or rarifies to an extent and at a

*Audio Consultant, New York

DECEMBER, 1953
rate which takes into account all the acoustic forces. That is what has happened with the two frequencies in Fig. 1-b. Fig. 3 is a picture of a sound wave with a great many frequency components, more typical of what the usual musical instrument or orchestra really produces. All the frequencies are contained in a single pattern of air movement (two cycles of it are shown); but when all this reaches the ear, the brain will automatically break down the pattern to its original components, each of which will be heard as separately as transmitted.

![Diagram of sound wave]

**Preserving sound**

We have already recorded sound in Figs. 1 and 3. They are records of sound just as surely as "antidissipationantimentarianism" is a record of a word. However, they are records of only a very short period of sound—a small fraction of a second. To record even a few minutes would require many thousand inches of drawing, and it would be an almost impossible job for the draftsman if the sound were constantly changing, as it would in a musical composition. We need a device which will automatically translate air pressure variations into a permanent record. The record may be a drawn line on paper, variations in density of a film, variations in the magnetism of a strip of tape, or variations in the path of a spiral groove in a disc. The latter is what we are interested in at the moment.

The writer's book *Practical Disc Recording* (Gernsback Library) gives a good grounding in the how of making records, which we will not attempt to reproduce here. All we have to know is that the pattern of air pressure variations is translated by a microphone and amplifier into an exactly similar pattern (we hope) of variations in electric power. By a recording machine the electric power variations are engraved into a rotating disc as variations in the path of a spiral groove. Then, many exact (again, we hope) duplicates are made of this master record by various factory processes known as pressing.

![Diagram of phonograph record]

**How pickups pick up**

A phonograph pickup consists of two main parts. The first is the stylus, which fits into the record groove, and the second is the element, which translates stylus movements into an electrical voltage which can then be fed into an audio amplifier.

Obviously, therefore, the stylus must move with relation to the element. It would do no good if both stylus and element moved together in response to the wiggles of the record groove, for the stylus must move some part of the element in order to create a voltage. A good analogy is winding up the spring motor of a toy automobile. You must turn the winding key with relation to the car—and you do it by holding the car steady in one hand and turning the key with the other.

The reason this point is brought up is that some people are puzzled (with good reason) about the pickup. If the wiggles in the cause groove the stylus to wiggle back and forth, they also cause the whole pickup to wiggle, since it is mounted in a pivoted arm. Now, how can the stylus move with relation to the element?

It's simple. The element (combined with the case of the cartridge and the arm) has much greater mass or weight than the little stylus. The stylus is mounted to the cartridge in such a way that it is very free to move. It is compliant. The groove wiggles are very small and very fast. Therefore, while they can vibrate a small lightweight thing like the stylus, they simply haven't the power to vibrate a relatively big heavy assembly like the rest of the pickup, at so high a rate of speed. You can prove this. Hold your hand and see how fast you can vibrate it back and forth. Now hold a heavy bar of steel and see how fast you can vibrate that! It is easy to see that if you pivoted the bar of steel at one end like a phonograph arm and attached the pencil to the other end with a light spring, you could do a lot of pencil wiggling without getting a move out of the bar.

If you slow down the rate of wiggling, you will find some low speed at which moving the pencil will also move the bar. At this and lower speeds, the relative movement between pencil and bar will become less and less until, at some very slow speed, there will be none.

The same is true of the stylus and element. At some frequency of groove wiggles, the movement rate will be slow enough to allow the pickup and arm to move right along with the stylus—and there will be no electrical output from the pickup. The frequency at which this begins to take effect depends on the mass of pickup and arm, the stiffness of the arm, and the compliance (relative freedom of movement) of the stylus.

Ideally, the normal kind of arm would not be used. Instead, the pickup would be firmly clamped to a stationary mount, with only the stylus free to move. This would cause much mechanical difficulty, however, especially with the necessity for the whole assembly to move inward slowly with the groove spiral, therefore it is never done. Instead, high-quality audio systems use pickups and arms which provide just the characteristics to move the critical frequency down so low it is out of the audio range.

Resonance is another important arm factor. Any piece of metal (or any other substance) has a natural resonant frequency. The prime example is the metal tube which is struck by a hammer for carillon or chime effects. A pickup arm also has resonance, the frequency depending on its mass, length, and stiffness. The arm is very easy to move at its resonant frequency. If some groove wiggles make the stylus move at this frequency, the arm starts swinging all over the place (don't try to see it—it's still too a movement for that). This creates a great deal of relative movement between stylus and pickup element, and tones at the resonant frequency are greatly accentuated in volume. The listener hears a "boom-boom" which is the high-quality sound we are after.

The arm designer has many problems. The arm must be light enough to avoid excess stylus pressure on delicate grooves, but heavy enough to give low resonant frequency. It must be very stiff, yet the weight of bracing cannot be added. Fig. 6 shows a well-

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**Fig. 4—Path of stylus-spiral groove.**

**Fig. 5—Groove with signal recorded.**

**RADIO-ELECTRONICS**
made arm which, in addition to having low basic resonance, is actually damped with a viscous liquid like a hydraulic shock absorber. This positively prevents audio-frequency arm movements and also prevents the arm from popping on the record with enough force to damage stylus or disc.

Because we are talking about high-quality audio and not department-store or public address machines, this question of the mechanics of grooves and vibrating stylus and arms is an important one. Nothing is more true in high-quality audio than the old saw about the weakest link in the chain. A poor arm and a noncompliant stylus mounting in a pickup definitely mean poor quality. When you buy pickups and arms, remember what we have said in this article and make sure you consult salesmen and manufacturers' ratings to get the best you can afford—the arm with the lowest resonant frequency and a pickup with high stylus compliance. Unfortunately you have not a wide choice of arms when it comes to record changers, but even here changer makers are now paying more attention to arm resonance. If you fail to heed, not only will you have jube-box bass—but every bass note sounding like the same pitch (the resonant pitch of the arm)—but your records, especially the plastic LP's, will die an early death.

The war of the speeds

Until 1948 all records sold to the public were supposed to rotate at 78.26 r.p.m. and the spiral was pitched at between 86 and 110 lines per radial inch of disc.

In 1948 Columbia brought out the 33 1/3-r.p.m. microgroove LP, which extended the amount of music on a single disc, a laudable accomplishment which has given new life to the record industry.

For a complete symphony only one record need be manufactured, handled, and sold, instead of as many as six.

This saving is passed to the user. And—last—there is almost no surface noise, or "needle scratch." The plastic vinylite is expensive compared to the old shellac compound with its gritty filler, but LP makers can afford to use it. No longer does the stylus move at random several thousand times per second due to irregularities in record material surface. Vinylite is glassy-smooth by comparison and the stylus moves only in response to purposeful groove wiggles—or dust particles.

There are two main differences between slow-speed records and the older fast (78-r.p.m.) types. The size of the groove is made smaller because the spiral is tighter—250 to 350 grooves per radial inch—though occupying the same size disc.

Each cycle of the groove wiggles which hold the music is shorter in length for a given frequency. The frequency of a reproduced tone depends on how long it takes for each cycle of groove wiggles to pass under the stylus.

When the groove moves more slowly the length of a cycle in inches must be shorter to take the same time. That means its sides are steeper, its path from left to right and back again is more abrupt. Remembering that the stylus is pulled side to side by variations in the groove moving under it, we can see that the stylus would run into real trouble if the groove wiggles were square waves like those in Fig. 7. It would tend to tear through the groove instead of following it. The compressed cycles of ordinary audio on a slow-speed disc approach the condition of Fig. 7 more closely with their steeper sides than on fast records. Consequently, stylus must be more compliant (must move more easily) to avoid damaging the records by tearing off the steep corners and gouging the sides of the wiggle patterns. Lightness of weight is also necessary. Pickups without the right features will not track—they will simply be thrown out of the groove. In making slow-speed discs it is a very tetchy compromise between emphasizing high frequencies to make them come through despite tracking trouble and keeping them from too much emphasis which will allow them to be easily damaged because of steep slopes.

Records made at 45 r.p.m. were introduced by RCA. At this speed, the problems are less acute, but the available time is less. The groove dimensions are the same as for LP's and the same smooth plastic is used.

There is a great deal more to know about the mechanics of records than we can say here, but the information this month comprises the essentials that every home music system enthusiast and service technician ought to know. Having laid the foundation, we will begin next month to talk about how various kinds of pickups work and what to look for in buying, installing, and caring for them. (TO BE CONTINUED)

INEXPENSIVE SOLUTION TO REMOTE AUDIO PICKUP PROBLEM

In high-quality music installations, the tuner, record player, or other signal source may be a considerable distance from the control amplifier or the main amplifier. Since most components in a custom installation are designed to operate from and into high impedances, it is often difficult to make a satisfactory installation with the major components widely separated. Hum and feedback may occur if the audio signal leads are not shielded. If they are shielded, the highs may be attenuated by the capacitance between the conductor and its grounded shield. Wide-band line-matching transformers may be used but they are susceptible to inductive hum pickup and are also likely to introduce distortion into the system. A simple, inexpensive solution to the problem is described in an article in Radio Constructor (London, England). The a.f. signal source feeds into a cathode follower (V1 on the diagram) at the remote point. V1 feeds into a grounded-grid amplifier at the input to the control unit or main amplifier.

The cathodes of V1 and V2 are tied together through a conductor in the cable and are returned to ground through a common cathode resistor (R1). R1 is half the value required for a single tube of the same type used for V1 and V2. The impedance of the line between the cathode follower and grounded-grid amplifier is 500 ohms.

V1 may get its heater voltage from the control unit or main amplifier through an extra conductor in the cable or it may be powered by a separate filament transformer.
ATTENUATOR DESIGN

By NORMAN H. CROWHURST

The design of attenuators is not complicated. Each shape has its own characteristics and can be easily computed.

Calibrated attenuators, giving any desired degree of attenuation in definite steps can be bought ready-made, or assembled from kits supplied complete with the necessary close-tolerance resistors. But often, in both audio and radio work, we need an attenuator pad between the output of one piece of equipment and the input to another, to avoid overloading the latter and so we can operate the gain controls in a normal way, instead of at the "bottom end." Attenuators are occasionally needed for television, to prevent the overloading of certain stages in the receiver, which causes the well-known "soot-and-whitewash" picture.

An attenuator can be designed with comparatively simple formulas. But even those of us who are mathematically inclined may doubt our own accuracy, feeling safer if we get the answer from a ready-made chart.

The basic types of attenuator networks in common use are known—from their configurations—as T, π, lattice, bridged-T, and the two types of L (according to whether the shunt arm of the L is at the input or output end). These are illustrated at a to j in Fig. 1.

Fig. 1—Most frequently used attenuator configurations. All resistors are coded.

Only one of these—the lattice—is for balanced circuits. The others are all single-ended in their basic forms. However, each of these can be rearranged in balanced form by splitting the series resistor components, giving the corresponding types shown at g to k in Fig. 1. If the balanced attenuators are to have a grounded center point, the shunt resistor elements will also require center-tapping.

Such a variety of circuits can be confusing. Which one should we choose for a particular job? The balanced and single-ended variations need little explaining: if a circuit has one side grounded, then single-ended attenuators are necessary; if both lines of a circuit are above ground (have signal voltages on them), a balanced type must be used. After this selection, the choice depends upon a number of factors, chief of which are the working impedance (high or low) and the amount of attenuation required; also whether constant impedance is needed, while the advantage of constant impedance both ways is that it can be inserted in any circuit of the correct impedance without interfering with the existing circuit either before or after the point of insertion. This is particularly advantageous where an attenuator is patched in with equalizers and other components, as between a preamplifier and the main amplifier.

For this purpose, the T, π, lattice, and bridged-T types, with their balanced counterparts, are suited. Among these, the T is best suited for medium-impedance circuits (500 or 600 ohms), because it uses the most reasonable values in resistors, while the networks are better for low-impedance circuits, for the same reason. Along with convenience in resistor values, possible stray pickup also dictates a similar choice. The lattice variety is good for small values of attenuation (balanced circuits only), which can be achieved with good accuracy, but is poor for large attenuations, because the resistor values become very critical. The bridged-T is more complicated as a straightforward attenuator, but is better suited for a variable attenuator of the constant-resistance type, because it requires only two variable elements as against at least three for the others.

Where it is important for constant resistance to be held only one way, the L types will serve. As shown, both are designed to maintain constant resistance at the input end, which is usual. If for any reason the opposite is required, the network may be reversed. The choice of which end the shunt element goes at will be seen better from the examples. As with the choice between T and π, it is a matter of getting convenient resistor values.

The formulas for the various resistors, using the coding given in Fig. 1, are as follows:

\[ \text{db attenuation} = 20 \log_{10} K \]

\[ E_{in} = K \cdot E_{out} \]

R1 \quad K = 1 \quad R5 = K - 1

Z1 = K + 1 \quad Z6 = K - 1

Z2 = K - 1 \quad Z7 = K - 1

Z3 = 2K \quad Z8 = K

Z4 = 2K \quad Z9 = K

A number of different ways of presenting this simple design information have been derived. Probably the first stage was a simple graph giving resistance values against attenuation for some fixed working impedances. This results in curves of the form shown in Fig. 2. Here all the values are given as R divided by the operating impedance. This means the factor obtained from the graph must be multiplied by the working impedance to find the correct resistor values. The popularity of the abac (alignment chart or nomogram) led to applying the same information by means of contact curves, producing the arrangement shown in Fig. 3.

This uses the same information as in Fig. 2, but the reading is obtained by laying a straightedge from the required decibel attenuation scale at the left top point just touching the desired curve. This will give a reading on the right-hand scale that is identical to that given by the graph of Fig. 2. These charts give factors. A more common practice is to give actual resistor values for just one particular impedance, say 10 ohms.

Each of these presentations requires eight curves to cover all the possible attenuator configurations. The resistor values are given either for one working impedance only or in a form relative to the working impedance (as shown in Figs. 2 and 3). So we have to do some arithmetic—or use a slide-rule—to get...
the resistor values for the actual working impedance.

The decibel scale used has been linear. By adjusting the db scale spacing appropriately, any one of the curves can be converted into a straight line. Further, by plotting working impedance horizontally and resistor values vertically, a chart (Fig. 4) using irregularly spaced decibel rulings can give one of the resistor values in an attenuator for the actual working impedance required. Here the chart has been drawn to cover a decade of working impedances from 100 to 1,000 ohms, and the values are read off directly for any impedance in this range. Outside this range the value does not call for a slide-rule, but merely the addition or removal of some ciphers.

Fig. 4 is the chart for values of R3. The disadvantage of this presentation is that, to cover all the configurations of attenuators, eight charts are required, each with spacing between the db rulings to correspond with the individual formula. This is cumbersome. By applying the same method to the nomogram construction, the number can be reduced to two, because each reference line can be used to carry two different scales, one on each side. Notice that, in the eight formulas for resistor values, four are reciprocals of the other four. This means that the same set of decibel rulings can be used for a pair of resistors using reciprocal formulas by inverting the R and Z scales on the appropriate reference lines. This was used in the presentation of Fig. 3 to reduce the number of contact curves necessary to four. The decibel reference lines can also have a scale on each side, enabling two pairs of reciprocal formulas to be accommodated on one chart. This turns out to be quite convenient, because any one configuration uses only two resistor values, selected from one group of four in the list of formulas. By using a separate chart for each group of four, only one chart is necessary for the design of any particular attenuator.

Chart 1 (page 39) deals with T, \( \pi \), and lattice attenuators and can be used of course for the balanced equivalents of \( T \) (H) and \( \pi \) (O) types, while Chart 2 (page 39) deals with bridged-T and L types and their balanced counterparts.

You may wonder why so many types of attenuator networks are used—why not just stick to one? Several factors contribute to the answer to this question. It is largely a matter of relative values, and depends partly on the amount of attenuation required and partly on the working impedance. This will be made clearer by some examples:

**Example 1.**
To design a T type attenuator to give 20 db attenuation at an impedance of 600 ohms:

As shown in the top key for Chart 1, the scales for R and Z are both on the left-hand side of the R and Z reference lines; the db scale for R1 is on the left-hand side and that for R4 is on the right-hand side of the db reference line.

**Example 2.**
To design a \( \pi \) type attenuator for the same job as Example 1:

The middle key on Chart 1 shows that the right-hand scales for resistance and impedance are used, with one db scale on either side of the reference line as for the T pad. Using these positions, R2 is 750 ohms and R3 is 3,000 ohms.

Using the chart in this way, R1 is 480 ohms and R4 is 120 ohms. For an H pad, the series arms each would be half of 480 ohms, or 240 ohms.

**Example 3.**
An attenuator required to give 10 db attenuation at an impedance of 100 ohms: using the \( \pi \) configuration R2 is

Notice here that R1 and R2, for values of 20 db attenuation and upward, approach the same value as the working impedance. For the T pad R4 goes much lower and for the \( \pi \) pad R3 goes much higher. For smaller degrees of attenuation, the distribution of relative resistance values is bound to be somewhat different.
190 ohms and R3 140 ohms. For the T configuration, the opposite sides of the resistor and impedance scales are used again (for 100 ohms this is the same point on the impedance scale), giving R1 52 ohms and R4 70 ohms.

Notice here that the resistor values are all somewhere near the working impedance.

**Example 4.**

A lattice attenuator is required for 6 db at a working impedance of 250 ohms.

For lattice type attenuators, as shown in the bottom key on Chart 1, the left-hand db scale is used for both values, the left-hand resistance and impedance scales being used for one resistor and the right-hand scales for the other. Using these positions for a working impedance of 250 ohms, the required resistances are R1 85 ohms and R2 760 ohms.

**Example 5.**

A lattice attenuator is required for 20 db attenuation at 500 ohms. This gives R1 as 410 ohms and R2 as 610 ohms.

The point to notice with lattice attenuators is that as attenuation rises, both resistors approach the working impedance closely, so that resistance tolerances have a much greater effect on the amount of attenuation. It is obvious from Example 5 that a comparatively small change in any resistor would result in a relatively large change in attenuation. On the other hand, for low degrees of attenuation, the lattice attenuator gives greater precision without necessity for strict tolerance on resistor values.

**Example 6.**

To design a bridged-T attenuator for an attenuation of 26 db at 1,000 ohms:

In the bridged-T type attenuators, two of the resistors have the same value as the working impedance; in the balanced counterpart there are four resistors having half the value of the working impedance. The remaining values, R5 and R6, are found by using Chart 2, as Chart 1 is used for lattice attenuators. For this example R5 is 19,000 and R6 is 52.5 ohms.

Whatever attenuation is required, the working impedance is a geometric mean between the values of R5 and R6. For small degrees of attenuation R5 is very low and R6 is very high. As attenuation increases, the values of R5 and R6 change over, so R5 is high and R6 is low. The widespread decibel scale for R5 and R6 indicates that a strict tolerance on resistor values is not so vital with bridged-T and bridged-H type attenuators as it is with the other types.

**Example 7.**

To design an L type attenuator, with the shunt arm at the output end, for an attenuation of 14 db and an impedance of 60 ohms:

As shown in the middle key on Chart 2, the working impedance and resistor values both are on left-hand scales, while the db scales are on opposite sides of the db reference line, for R5 and R8. For the example specified R5 is 200 ohms and R8 is 62.5 ohms.

**Example 8.**

For comparison with the previous example we will design an attenuator for the same purpose with the shunt arm at the input end.

As shown in the key at the bottom of Chart 2, the references for R and Zc are on the right-hand side of their respective scales in this case. R6 is 12.5 ohms and R7 is 40 ohms.

Notice the difference in values for the same operating impedance and attenuation, as compared with Example 7.

The foregoing indicate why different attenuator configurations suit different cases.

The L types are much simpler than any of the others. They save one or more resistors but do not have constant resistance in both directions, as indicated in the configuration diagrams on Chart 2. When terminated at the right-hand, or output, end with Zc, the resistance measured at the input end is also Zc, but this is not true in the opposite direction. For many purposes an attenuator of this simple type is quite adequate. Often the source impedance preceding an attenuator is not the same as the output impedance into which it is working, so two-way matching is unnecessary anyway.

In the other types of attenuators, if the source impedance is Zc, the source impedance measured at the output end of the attenuator will also be Zc, giving two-way matching. An attenuator of this type is always desirable for really high-quality work, but to get the benefit of it, the impedances between which it is connected must be true values, and do not themselves deviate from the nominal working impedance.

I have often heard the opinion expressed about attenuators, similar to that about filters, that when resistances obtained from the required formulas are put into a circuit, the circuit possesses "magical" properties. An impedance of 500 or 600 ohms has been shown to be an ideal line impedance. This has been interpreted to mean that attenuators designed to work at this impedance will smooth out any discrepancies. That, for example, a 20-db 600-ohm attenuator will give an attenuation of 20 db and present terminal impedances of 600 ohms, regardless of what is connected to the other end of it. This is definitely not true.

Attenuators do not that are designed to do only when the correct impedances are connected to them. Sometimes, however, an output of one impedance requires that it be connected, via an attenuator, to an input of a different impedance. Then comes the puzzle of how to correct for this change of impedance. This will be dealt with in a succeeding article.
Miniature Transistor Hearing Aid

The trend in hearing aids which has been toward compactness has been given a boost with the introduction of the transistor.

By DAVID T. ARMSTRONG

Transistorized hearing aids are appearing on the market in quantity. The high efficiency of the transistor and its low power consumption give it a decided edge over vacuum tubes. Battery power is still required, but the drain is cut to such a tiny figure that the life of a battery is extended many times. The entire absence of an A battery in any all-transistor type hearing aid makes possible a unit small enough to be worn on the wrist or hidden in a woman's hair. These are real applications, not just theoretical possibilities. There has been a great deal of controversy over the merits of transistors in hearing aids. Like anything else that is new, certain obstacles must be overcome before final success is reached. One company actually stopped their production of transistor hearing aids, but with technical improvements, they have resumed.

Miniaturization has been achieved by using subminiature components for resistors, capacitors, and transformers, and by redesigning the microphone and receiver into magnetic types. By using miniature components and lightweight metals, Maico has produced the Transist-Ear using three Raytheon CK718 transistors. The instrument weighs a little over 2 ounces and its over-all dimensions are 2⅛ x 1⅛ x ⅛ inches.

The engineers responsible for this all-transistor hearing aid did not attempt to convert vacuum tube circuits to transistor applications by what is becoming known in the art as the "duality" technique. Rather, they started from scratch and designed circuits on the basis of which the associated components were specifically selected, for use in an all-transistor hearing aid. In this way they were able to balance the gain for the three stages and attain the greatest gain where it would produce the minimum accompanying noise. Hence this device is not any more noisy than a comparable type vacuum-tube hearing aid.

The circuit diagram of the Transist-Ear is shown in Fig. 1. Transformer coupling is used for the three grounded-emitter transistor amplifier stages. The bias resistor in each stage was selected to provide a predetermined collector current. In the present state of transistor manufacture there is wide variation in the characteristics of the individual CK718 Raytheon transistors used with this instrument; thus it is important to match the bias resistor with the individual transistor used in a particular stage.

The resistors R1 and R2 were selected to give 0.35 to 0.5 ma collector current; R3 was selected to give 1.7 to 2.1 ma collector current. These individual transistors vary considerably in gain and noise as well as in impedance. As part of the quality-control program established for the manufacture of these hearing aids, each transistor is checked in the laboratory and marked as a first-stage, second-stage, or output-stage transistor. The grounded-emitter circuit has been found to be superior for this type of transistor application, partly because the input resistance is completely independent of transistor parameters. Current design practice uses the grounded emitter almost exclusively for all but the output stage of amplifiers. In the output stage, a grounded-base circuit is found to be better for some applications. It provides a wider swing of collector voltage with linear operation, and hence greater efficiency. In this circuit, however, the output stage is a grounded-emitter type to control the gain and attenuate the noise.

The audio-frequency field is ideal for transistor applications because of the high gain, low noise, and high efficiency obtainable. The limitation is on how weak a signal can be handled before noise. Noise is much lower for junction-type transistors than for point-contact types. A transistor with a noise figure of 15 db at 1,000 cycles for a 1-cycle bandwidth has an equivalent noise input power of approximately 10⁻¹⁵ watts. A signal

Fig. 1—Schematic of the Transist-Ear.
The estimated life of transistors is about 100,000 hours, which would be equivalent to 20 years of use; compare this with the 5,000-hour life of a vacuum tube. (The switching of a transistor on and off may have some effect on its useful life.)

The magnetic microphone is much sturdier than the crystal microphone formerly used, and is far less likely to be affected by high humidity. The microphone is mounted on a soft floating rubber cushion to reduce to a minimum the noise created by friction of the case and the clothing. Compartmentalization design techniques were utilized to place the components in special snug-fitting niches in a nylon chassis. This design feature was adopted because it is expected to contribute to long life by reducing the possibility of damage through shock or vibration.

The interstage audio transformers are triumphs of miniaturization. They measure a 1⁄4-inch cube, and were specifically designed for such applications by Chicago Standard Transformer Corp., as their ultraminiature transistor transformers. They are the tiniest iron-core audio transformers currently available. They weigh less than 1⁄20 ounce and are no longer than the transistors they power. They are constructed of extremely fine wire, wound on molded nylon bobbins, with special nickel alloy steel transformer core laminations. They have a useful range below the 1-milliwatt level.

For comparison purposes the Stancor suggested circuit is given in Fig. 2, with the recommended values of the associated components. The available transistor ultraminiature transformers and their design characteristics are given in Table 1.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Application</th>
<th>Primary impedance (ohms)</th>
<th>Secondary impedance (ohms)</th>
<th>Primary d.c. resistance (ohms)</th>
<th>Secondary d.c. resistance (ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UM-110</td>
<td>Interstage</td>
<td>20,000</td>
<td>1,000</td>
<td>1,675</td>
<td>285</td>
</tr>
<tr>
<td>UM-111</td>
<td>Output or matching</td>
<td>1,000</td>
<td>50/60</td>
<td>120</td>
<td>9.0</td>
</tr>
<tr>
<td>UM-112</td>
<td>High impedance microphone input</td>
<td>200,000</td>
<td>1,000</td>
<td>4,000</td>
<td>195</td>
</tr>
<tr>
<td>UM-113</td>
<td>Interstage</td>
<td>20,000</td>
<td>1,000</td>
<td>1,350</td>
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<td>Output or matching</td>
<td>500</td>
<td>50/60</td>
<td>70</td>
<td>9.0</td>
</tr>
</tbody>
</table>

There is no a.v.c. in this circuit. Further, the distortion in the output is related to the output power level. Special circuits involving response-shaping networks and volume compression circuits are desirable in a hearing aid, but these are usually available only for custom built units.

A desirable accessory for a hearing aid is a telephone pickup coil which will enable the user to hear telephone conversations without the distortion introduced by transducing the signals from the telephone ear-piece to the hearing-aid magnetic microphone.

Practically no heat is generated by a transistor hearing aid; hence there is no problem of heat dissipation.
A circuit has been developed to measure intermodulation distortion in a circuit. The circuit is designed to measure intermodulation distortion and is described in detail in the document.

**Construction**

The wiring and layout are not critical except for the location of the coils, particularly L2. It is important that coupling between these components and the power transformer be kept to a minimum. L1, L2, and L4 must be mounted with their cores at 90° to the axis of the primary transformer windings and close to a plane passing through the center of the power transformer at 90° to its winding axis (see photo). An exact location can be found by connecting a high-gain scope, or other sensitive indicating device, across the coil. With the power transformer in operation, move the coil around until a spot is found where there is a null in the induced voltage. L1 is followed by the resonant plate circuit of the 6A8, so is not as susceptible to 60-cycle pickup, but there is a tendency for this coil to pick up 7-kc radiation from the oscillator coil. For this reason, L1 should be mounted as far as possible from the oscillator as spiral, with its axis at 90° to the axis of the oscillator coil.

L1 and L2 each consist of 1,600 turns of No. 30 enamelled wire, layerdown, on a 1/8-inch diameter slugwound, wound from a winding length of 1 inch. L4 is the same, except for a tap at 500 turns. A layer of Scotch tape between each winding layer prevents the possibility of shorts. The inductor used for L3 is a 5-henry unit.

The entire instrument is built on the panel of a standard 12 x 7 x 6-inch metal utility box. The double-deck construction provides good separation of critical components and makes a compact assembly, which takes up a minimum of bench space. The two shelves are made of 16-gauge aluminum and are held to the panel by the bushings of the potentiometers and switches.

**Adjustment**

After the wiring is completed and checked, the v.t.v.m. section should be calibrated by applying a known a.c. voltage to the input, as measured with an accurate meter. The IM output and input controls should be turned down to prevent any possible 7-kc radiation from affecting the v.t.v.m. The 50-ohm calibrating potentiometer is adjusted for agreement between the meters. Calibration is necessary on only one range. The use of precision resistors in the range decade will make the others take care of themselves.

To calibrate the IM section, a scope is necessary. Connect the circuit of Fig. 2. A vacuum-tube diode may be substituted for the crystal. Set the ratio on 4:1, S1 to V, turn output and input controls up about half-way, and adjust the slugs of L1 and L2 to resonance as indicated by maximum vertical deflection. The oscillator should be set for output in the vicinity of 7 kA. As you approach, back the input control down and make the final adjustments with it as low as possible. With the scope sweep on 120 c.p.s., it should be possible to get a pattern similar to that of Fig. 3. This looks very much like the standard textbook picture of a modulated carrier, which is exactly what it is. The diode introduces nonlinearity, which causes the 7-kc signal to become modulated by the 60-cycle signal in the same manner it would occur in a nonlinear amplifier. The percentage of modulation can be varied with the series resistor from near 0 to about 80%. Fig. 3 represents 50% modulation. The percentage for any pattern on the screen can be calculated by the formula: 

\[
\text{m} = \frac{a-b}{a} \times 100
\]

where a and b are the dimensions shown in Fig. 3. Measurements on the screen are best made by using the ruled grid supplied with most scopes. Set up a 50% pattern as closely as possible. Set the range switch to 0-10 volts and S1 to the IM 2 position. Adjust the input gain until the meter reads exactly half scale. Change S1 to the IM 1 position and adjust the IM calibrate control until exactly half scale is again indicated. When the switch is again placed in the IM 2 position, the meter will read 7-5 or 50% modulation. 20% and lower modulation values can now be set up and the meter should indicate them quite closely. For each measurement, the switch should be placed in the IM 3 position and the input gain set for a half-scale reading. Full-scale, or any other reference point, could be used and the calibrate control set accordingly, but half-scale is most convenient. To read values below 10%, move the range switch to the 1-volt position. This will give an IM range of 0-10%. To read very low values, use the 0.1 v position. This will read full-scale on 1% IM. On this low range, circuit noise causes a meter deflection.
Fig. 1—Diagram of intermodulation analyzer. 60 cycles and 7 kc are used.

of about .08% of this figure from the meter reading.

To measure the intermodulation in an amplifier, connect the IM output to the amplifier input and set the ratio on 4:1. Terminate the amplifier in a high-wattage resistor with a value equal to the output impedance of the amplifier. Connect the amplifier output to the input terminals of the analyzer. Set S1 to V IN and advance the output control until the desired amplified power output at which the measurement is to be made is indicated. To do this, a correction must be applied to the meter reading. The voltage is a mixture of two frequencies and has a higher peak to r.m.s. ratio than a sine wave. The meter reading would correctly indicate the average power dissipated in the load.

Materials for IM analyzer.

Resistors: 1-1.5, 1-2.2, 1-3.5, 1-150, 1-100, 1-2,000, 1-4,000, 1-10,000, 1-47,000 ohms; 1-1 megohm, 1-5, 1-10 megohms, all 0.5 watts; 1-10,000 ohms, 1 watt; 1-22,000 ohms, 2 watts; 1-90,000, 1-50,000, 1-9,000, 1-1,000, 1-50,000, 1-10,000, 1-100,000, 1-1 megohm, all precision resistors, available at TAB, 11 Liberty St., N. Y. E.

Potentiometers: 1-20,000 ohms, audio taper; 1-50,000, 1-100,000, 1-200,000, 1-1 megohm, dial tapers.

Capacitors: (Paper) 1-100 uf, 400 volts; 1-10 uf, 450 volts; 1-0.1 uf, 630 volts. (Ceramic) 1-1000, 500 volts; 1-100,000, 200 volts; 1-0.1 uf, 1000 volts. (Electrolytic) 1-25 uf, 25 volts, 2-10-10 uf, 450 volts; 1-10-10 uf, 675 volts.

Miscellaneous: 1-power transformer, 650 volts c.t., at 40 ma, 5 volts at 2 amp, 4.3 volts at 2 amp (Stancor PC426A); 1-5.6 filter choke (primary of small speaker output transformer can be used); 1-5.6 choke, parallel (5 ma or less); 3/4-inch diameter slug-tuned coil forms; 1-AXX, 1-6AF, 1-6AJ, 1-6C; 1-10-10 uf, 1-1 Muf, 1-10 uf, 1-1.5 uf, 1-7.5 inch metal utility box; 1-1/2-in. x 4-in. x 6-inch metal utility box; 1-1/2-in. x 4-in. x 6-inch metal utility box; 1-1/2-in. x 4-in. x 6-inch metal utility box.

Side view. L1 and L4 widely separated.

Top view. Analyzer contains v.t.v.m.

is why the 4:1 ratio is usually used for amplifier measurement. Occasionally an amplifier will have more distortion at high frequencies. In this case, the 1:1 ratio will indicate the fact by showing a higher IM value.

The minimum input signal required is

Fig. 2—Circuit used for calibration.

Fig. 3—50% modulation—7 kc by 60 c.p.s.

by the instrument for IM measurements is .08 volt at the 4:1 ratio and .2 volt at 1:1. This is enough sensitivity to easily permit measurements over a single stage, or on low-level amplifiers, such as phonograph preamplifiers.
FEDERAL Communications Commission has not yet taken official jurisdiction over community TV systems. However, it has been compelled to take an active interest in the radiation problems created by them.

Many community installations have been made in fringe areas where TV set owners have invested substantial sums in individual antenna towers, antenna arrays, rotors, and boosters. A home owner who has spent up to $500 for his antenna installation may be reluctant to connect to the cable of a community system, even though the latter will provide better pictures. If there is radiation from the amplifiers, a.c. power lines, connectors, tap-off units or cable of the community TV system, the radiated signals may be strong enough to cause annoying interference with direct pickup by individual antennas.

Interference caused by radiation from a community system is of two principal types. One is the ghosting which results from co-channel time-delay interference. The community system distributes certain channels by means of amplifiers, cable and other equipment. If set owners in the same community are able to receive these channels directly, and if these signals are weak, while the wired community TV system is radiating strongly, ghost images are inevitable. This is because the set owner with an antenna on his roof receives a picture from channel 2, for instance, first by direct pickup from the transmitter and then—a second, delayed picture—resulting from a closely adjoining section of the community system. The few microseconds delay in receiving the re-radiated signal is caused by the electronic equipment and cable through which this signal must travel before radiating to the set owner's antenna.

A second type of interference caused by radiation occurs when the community TV system is distributing channels adjacent to those received directly in a fringe area. For example, the community system may distribute channels 2, 4, and 6. Set owners within the same community, who have their own antennas, receive a weak signal from channel 3 transmitted 80 miles away. If there is strong radiation of channels 2 and 4 from the community system, adjacent-channel interference will annoy set owners tuned to channel 3.

Radiation is a double-edged problem. If a community TV installation radiates a strong enough signal to cause interference, it will certainly lose money. In many community systems, set owners have achieved good reception without either the formality or expense of a legitimate connection to the cable. I have seen simple dipole antennas placed close to a radiating cable—and the set owners happy with fair pictures obtained without paying $150 (or whatever the cable connection charge might be) to the community system. The system operators refer bitterly to this practice as "bootlegging" and generally take prompt steps to try to eliminate this harmful distribution of free signals.

Thus radiation is a serious problem for operators of a community TV system. With radiation, the wired system causes interference and complaints from the owners of individual antenna installations. These complaints, as their volume mounts, result in a visit from a polite but firm representative of the FCC, who says the radiation problem must be solved. Even more annoying is the fact that a radiating wired system invites "bootleggers" and endangers the substantial investment of the community system's owners.

Solving the problem

The more modern community TV installations have solved their radiation problems by recognizing that each signal-carrying element must be correctly designed. Any part of the system may be troublesome if it is not engineered so that radiation is reduced to a safe level, say 20 microvolts per meter at a distance of 20 feet.

This approach requires the design of each piece of electronic equipment and each type of cable with radiation in mind.

The antenna site is the first logical step. Often radiation is of no consequence here, if the site is on an isolated hilltop as in many community installations. Occasionally—as in the case of a new system now under way to serve sections of Burbank and Glendale, California—the best site for the antenna installation is in a heavily populated area. In such a location, it is obviously important that the head-end amplifiers, power supplies, and power lines are properly radiation-proofed. One easy way is to mount the amplifiers and other equipment in a sheet metal shack which acts as a shield against radiation. If this is impractical, place all electronic equipment including connectors in metal cabinets. The a.c. power line should be brought in through a low-pass filter, which should be in the shack or one of the cabinets. Such a filter, available commercially, prevents r.f. leakage back into the power lead and consequent radiation.

After taking these precautions, it is desirable to make tests with a simple dipole antenna and TV receiver placed a few feet away from the head-end equipment installed at the antenna site, to see whether objectionable radiation is still present. If so, more careful shielding of the amplifiers, power supplies, and connectors will be necessary. It also may be necessary to reduce the output level of the amplifiers. Some of the early amplifiers designed for community TV boasted an output of as high as 10 watts, and behaved like miniature transmitters. Modern design calls for an output level generally not exceeding 0.5 volt from the individual-channel strip amplifiers with associated a.g.c. used at community antenna sites.

In the distribution system of a community installation, where the electronic equipment and cables are installed in populated areas, radiation must be eliminated. The problem is most easily solved by designing each element of the system to reduce its potentialities as a radiator.

Line amplifiers—the term used to describe r.f. amplifiers utilized to boost TV signals along the main trunk cables and feeder lines—are an obvious source of radiation. As in the case of head-end equipment, the answer is good shielding and correct output level.
Mount the amplifier in a metal cabinet. This box should be large enough to contain the amplifier, its power supply, and such associated equipment as a power-line filter (to prevent r.f. leakage to the a.c. line, as noted above); the equalizer, used with broad-band amplifiers to compensate for variations in attenuation of the signal by the cable when distributing several TV channels and at very high radio frequencies; fine splitter, directional coupler, or distribution amplifier, for branching feeder lines from the main cable; any short lengths of cable used as matching sections to balance impedances; and connections to the distribution cables, whether made with connectors or soldered splices.

This list of equipment at a line-amplifier station may seem impressive. However, except for the amplifier and associated power supply, most of it is small. The metal cabinet shielding all this equipment may easily be mounted on a double crossarm installed on a telephone or power pole, or may be attached directly to the pole. Utility companies prefer crossarm mounting, since a metal cabinet on a pole reduces the climbing space available to their linemen and thus presents a possible hazard as well as an inconvenience.

Another important antiradiation precaution is to keep the line amplifier’s output level fairly low. Modern practice is not to exceed 0.2 volts per channel. Then, at the antenna site, test for radiation with a dipole and TV receiver placed about 30 feet from a typical line-amplifier installation.

A troublesome source of radiation has been connectors or splices in community TV cables. While working as an engineer on the Palm Springs community TV installation of International Telemeter Corporation, I found a simple and inexpensive way to make such connections radiation-proof. Merely wrap aluminum foil around the connector or splice, and then apply an outer weatherproofing of plastic tape and paint.

Isolation units, or tap-off devices, inserted in feeder cables to transfer TV signals from the cable to the drop feeding one or more TV sets in a subscriber’s home, are another possible source of radiation. A tap-off unit should be
adequately shielded. It usually contains either a resistor or capacitor connecting the outer conductor and of the feeder cable and the individual drop line. Such a tap-off device should be treated like a cable connector, and weatherproofed with plastic tape and paint. A wet tap-off has been known to act like a detector and radiate unrestrainedly. Here again, a little aluminum foil wrapped around the unit before tapping and painting is a good precaution if the device is not well shielded.

Selecting coaxial cable

A major cause of radiation in community TV systems has been the coaxial cables used for distributing signals to subscribers. Variation has been wide in the quality of the copper-braid outer conductor or shield used in even such a popular cable type as RG-11/U. Some manufacturers produce a finely woven braid that makes a satisfactory shield. Others, however, are inferior, as you can easily see if you strip off an inch or so of the outer vinyl jacket and observe the braid.

Since cable requires the most trouble and expense to install of all the elements of a community system, and cause the worst grief by radiating, it is well worthwhile to specify and select cable types carefully. From experience, it is best to use such low-loss cable as K-14 (Federal) or 21-125 (Amphenol) or the new aluminum-sheathed Styroflex (Phelps-Dodge) for long cable runs. Such long runs may include the line from the antenna site to the community and the main trunk lines in town. Radiation from K-14 or 21-125 cable is not of the same order as the amplifier output level is kept at or below 0.2 volt per channel. Styroflex, with its solid aluminum sheath, obviously will not radiate signal.

The coaxial cable most widely used for signal distribution in community TV systems is RG-11/U. Where line-amplifier output is maintained at 0.2 volt per channel or higher—to permit economical spacing of amplifier stations—there has frequently been trouble from radiation from this line, usually near an amplifier station because there the signal level in the cable is by far, the highest.

To solve this problem, cable manufacturers have developed a coaxial cable identical in attenuation characteristics with RG-11/U but providing two copper-braid shields instead of one. This double-shielded cable is designated as RG-75 by Federal and as "tri-axial" 21-529 by Amphenol, and is definitely superior to RG-11/U where radiation is a problem. Tests conducted by California Electronic Services Company, Los Angeles, a firm specializing in measuring radiation and electrical noise, indicate the following:

1. At 200 mc, the double-shielded cable has a radiation level 50 db below that of RG-11/U.
2. At 60 mc, the radiation level of SF-75 or 21-529 double-shielded coaxial is 37 db below that of RG-11/U.

Thus, although the double-shielded cable is approximately 50% higher in cost than RG-11/U, its use is now being recommended by engineers designing modern community TV installations as a safeguard against radiation from transmission lines.

Drops from this double-shielded feeder cable to the homes of individual subscribers are generally made with RG-59/U cable, where the run is not longer than 150 feet, or where the tap-off is reasonably near the line amplifier. Where the signal level is relatively low, the drop to the home should be made with RG-11/U because its attenuation is about half that of RG-59/U at v.h.f. television frequencies. For the same reason, RG-11/U is used for drops where the distance from tap-off unit to subscriber's TV set is longer than 150 feet.

Radiation is usually not a serious problem so far as such drops are concerned because of the reduction in signal level by the tap-off unit. However, should a drop cable be found to be radiating, it is preferable to use a double-shielded cable of either the SP-75 type or SP-76, a twin-shielded version of RG-59/U.

Grounding the system

One of the most important requirements of a community TV system is satisfactory grounding throughout the system. This is necessary not only as a safety measure (most of the utility companies whose poles are used) but also as an effective aid in reducing radiation. The antenna masts or towers are usually of steel and are set deep enough into the earth for adequate grounding. At certain sites, however, large wooden poles are used to support antennas, and occasionally preamplifier equipment. Here a heavy cable should be run from the antenna clamps and preamplifier cabinet down to a ground rod.

At each line-amplifier station, all chassis and cable shields within the metal weather-resistant cabinet should be securely grounded to the inside of the cabinet where it enters the building. The cabinet should be grounded to the steel messenger line to which the community TV coaxial cable is lashed. Telephone company standards call for keeping the outer conductor of TV cables and the messenger strand electrically continuous throughout the system. The messenger strand supporting community coaxial should also be bonded to the light strand used for supporting drops to subscribers' homes where such drops are supported. Also, the TV cable and the messenger should be bonded to telephone company strand at every 10th pole, or at every 8th pole on thoroughfares having trolley feeders or contact wires. The outer conductor of a drop to the home should be grounded, preferably to a water-pipe system, close to the point of entry into the building. Such grounding, like shielding, helps to prevent harmful and annoying radiation.

To summarize, radiation from a community TV system can annoy non-subscribers who have their own antennas, by causing interference, and may permit other non-subscribers to obtain signals without paying for them. To eliminate such undesirable radiation requires proper shielding of all parts of the system where the signal level is high, and makes it desirable to operate amplifiers at an output level below 0.5 volt per channel. A little shielding in the right places goes a long way in curing radiation problems.
Servicing TV with a WATTMETER

By JOHN B. LEDBETTER *

UNLESS you have actually used a wattmeter, you may have no idea of the time, trouble, and money it can save you in helping to check a TV receiver. (The wattmeter is not limited to the television set—it is equally helpful on AM receivers, PA equipment, or any electronic device which operates from a.c., including auto receivers.)

Suppose the set you are checking has weak picture and weak sound. From past experience you may judge the trouble to be a weak low-voltage rectifier, or, if the brightness seems to be normal, a weak tube in the video i.f. or front end. Checking these points takes time, and you may end up finding that the trouble comes from another source. Suppose the trouble is due to a leaky filter capacitor or an internal short (however slight) in the power transformer. This could take several minutes (or longer) to locate. Here is how the same thing can be done with the wattmeter:

First, plug the wattmeter into the a.c. socket and plug the receiver line cord into the wattmeter receptacle. From the moment the receiver is turned on, the wattmeter gives a constant indication of current drain. As the current continues to increase, past experience or the manufacturer’s rating will tell you if the current drain is normal. If the current indicated on the wattmeter is within tolerance for that particular receiver, you will know (without having made any check at all) that the power transformer is O.K. The trouble then may be found to lie in a weak rectifier tube, weak filter capacitor, or some point beyond.

Suppose, however, that the current drain indicated on the wattmeter is excessive. The next step is to remove the low-voltage rectifier tube (see Fig. 1) and observe the current reading. If it has fallen to approximately normal, the trouble is a defective filter or bypass capacitor at the output of the power supply, a gassy rectifier, or possibly a short in the focus coil bleeder resistor or filter choke.

A quick check of the filter capacitor is then made. The filter is disconnected from the circuit and the difference in current drain is noted on the meter. If noticeable drain is indicated, replace the capacitor. This method of checking often will disclose capacitor trouble which would not be indicated on a capacitor checker.

In making the first test, suppose the current drain had remained abnormally high with the rectifier tube out of its socket. This would have indicated an internal short in the power transformer and would have eliminated the need for further checking.

In a similar manner, the cause of low current drain can be quickly established. In Fig. 2, the B plus circuit (at the filter-capacitor output) is being shorted to ground. An excessively high drain under these conditions would be normal, while a low value would indicate a weak or gassy rectifier tube or a possible defect in the power transformer.

The wattmeter can be used in similar setups to check leakage factor of new filter capacitors, power factor of transformers, etc. Once you have become accustomed to having this instrument around the shop, you will find yourself creating other new and time-saving uses for it.

* Engineering Writer, Convair

DECEMBER, 1953
TELEVISION... it's a cinch!

By E. Aisberg

Seventh conversation, second half:
Sawtooth waves with multivibrators.

WILL—Isn't it possible to develop other pulse circuits than the one we've just been looking at? There are so many sine-wave generator circuits: Hartley, Reinartz, Colpitts...

KEN—Sure, you could use such circuits, but they would only bring in unnecessary complications. But, you can abandon coils altogether and get the feedback you need for oscillations by using a second tube whose voltages will be opposite in phase from the first, then reinjecting these voltages back into the input to maintain the oscillations.

WILL—That explanation doesn't seem very clear.

KEN—Let's try it another way. Imagine a two-tube, resistance-capacitance coupled amplifier. Connect the output back to the input. What do you get?

WILL—Something like two snakes eating each other up tail first!

KEN—We haven't done too well with examples from the zoo so far—let's cut them out! Now, how about analyzing just what does happen in such a circuit?

WILL—Well, suppose I try to reason it out the way you'd do. Let the plate current of V1 be increasing. Then the voltage drop across plate resistance r1 increases, reducing the plate voltage Ep1 on the first tube. This—acting through coupling capacitor C1—reduces the voltage Eg2 on the grid of V2. As it becomes more negative, the plate current of V2 drops. Therefore, there is less voltage drop across r2, and the plate voltage Ep2 increases, increasing Eg1 through coupling capacitor C2. That, of course, makes V1 draw more current—

KEN—Of course, you understand that all these things are happening at the same time. What is important is to note that the voltage at the output is in such a direction that it helps out the things that are happening at the input. The output and input voltages are in phase. And we should expect it. You've learned long ago that a stage of amplification reverses the phase; when the grid becomes more positive, the plate becomes less positive, and vice versa. So, with two stages, we get back into phase again.

WILL—Then you could use four tubes? Or six? Or eight?

KEN—You could. But are you a tube manufacturer's agent?

WILL—It seems to me our explanation didn't finish. Can the current in V1 keep on increasing indefinitely?

KEN—Certainly not—the house fuses would blow sooner or later! The rapid increase of current in V1, by making the grid of V2 more negative, reduces its plate current to zero (instant a in the curves Ep1, Eg1, Ep2, Eg2). With no further increase in Ep2, there will be no increase in the voltage Eg1. So the plate current of V1 remains high and its plate voltage low. Now C1, which is charged negatively, begins to discharge through R2 (instant a-b on the curve Eg2).

WILL—I'm having trouble following so many things at the same time!

KEN—These curves should give you some help.

WILL—As capacitor C2 discharges, plate current flows in V2 and starts to increase.

RADIO-ELECTRONICS
KEN—That’s right. And (at instant b on the curves) V2 finds itself in the same condition as V1 at instant a.

WILL—In other words, the voltage Ep2 drops; C2 passes that drop in voltage to the grid of V1, reducing its plate current and increasing its voltage. And that makes the grid of V2 still more positive.

KEN—O.K., you can stop now, Will, because the multivibrator will keep right on going. This oscillator with the long name produces regular voltages with an irregular shape. The two tubes repeat—every half-cycle—everything it has taken us so long to trace out with the curves’ help.

WILL—But this multivibrator won’t give us sawtooth waves?

KEN—Well, no. Their plate circuits produce something more like square waves. These have plenty of applications in television—and in the whole field of electronics. The duration of their positive and negative alternations is identical if all the equivalent components in the two stages have the same values. But if they differ, we destroy the symmetry. By changing them intentionally we can get short impulses separated by relatively long periods. So we get our sync pulses.

Return of the Sawteeth

WILL—Couldn’t we replace our two tubes with a double triode?

KEN—We can and we do. And further, if we have a single-cathode tube, or tie the two cathodes together, we can use the coupling through the common resistance R to replace one of our coupling capacitors.

WILL—I don’t see just how you can make a resistor replace a capacitor.

KEN—It’s not hard to figure out. Remember that each increase of plate current through one of the triodes increases the current through R, which makes the grid of the other tube more negative, since the voltage drop across R makes the end to which the grids are tied negative as compared to the cathode end. The capacitor on the other multivibrator produced the same effect.

WILL—I see. And you apply your sync pulses through a capacitor to the grid of V1, in the usual style.

KEN—Yes, and I find it simple to synchronize the circuit because the multivibrator is a very easy circuit to pull into step with a synchronizing frequency.

WILL—The multivibrator seems to have a lot of virtues. But since we are supposed to be talking about sawtooth generators, what good are they if it won’t make a sawtooth wave?

KEN—If you must have sawteeth, we’ll give you sawteeth! Just put the capacitor C1 (look at the dotted lines) between one of the plates and B minus. Then make the plate resistor (r2) of that tube considerably larger than that (r1) of the other tube, and you have sawtooth voltages across r2.

WILL—Is this our old charging circuit, with r2 playing the part of R1?

KEN—Exactly. Because of the high resistance of r2, we start with no current in V2. The voltage across C has to rise to a fairly high value before the capacitor starts to discharge across the anode-cathode space of the tube. But then we have an avalanche! For, as current starts in V2, the voltage across the cathode resistor rises, making the grid of V1 relatively more negative with regard to the cathode. Its current drops, and its plate voltage rises, charging V2’s grid more positive through C1, accelerating the discharge. This quick discharge, followed by a slower charge limited by the constants of C and r1—when the current through V2 is cut off—gives us a typical sawtooth wave.

WILL—So now I know all the ways of making sawtooth waves!

KEN—Sorry to disillusion you, Will; there are plenty of others! But with the thyratron, the blocking oscillator and the multivibrator, you know the principal types. The others are all based on ideas we already know. So you won’t have any trouble analyzing any new ones you may run into. And—next time we get together—we can forget about time-bases and talk about more cheerful subjects.

(TO BE CONTINUED)
URING our vacation we spent a postman's holiday for a few days, inspecting several u.h.f. antenna installations. We were quite surprised to find that many of them had no lightning protection. Many used a lightning arrester but failed to install it to give proper protection against lightning. (I must hasten to add that the greatest percentage of poor installations were found where the set owner himself had added a u.h.f. antenna to his existing v.h.f. installation.) The smaller dimensions of the u.h.f. antennas, plus the presence of the v.h.f. mast, tempts the set owner into trying the job himself. The unprotected u.h.f. installation can suffer costly damage if lightning should strike. Also, a poor installation by the television technician can lead to lawsuits, particularly if it can be proved that the resultant damage was caused by the technician's negligence to provide adequate lightning protection.

Several methods can be used for installing the u.h.f. antenna. One consists of installing a separate mast and u.h.f. antenna with the new lead-in connecting to the u.h.f. converter; or a doubler switch where a v.h.f. antenna is also used and the converter has no v.h.f. antenna terminals. For the new u.h.f. antenna and mast, the best lightning protection consists of grounding the mast and also using a lightning arrester for the transmission line. Some technicians prefer to mount the lightning arrester directly to the mast below the antenna. This method is not practical unless the mast is grounded. The grounding wire should be large (No. 6 or larger). The ground wire should be bolted to the bottom of the mast and run to a ground rod (available at most jobbers) (Fig. 1-a). If no ground rod is available, a 1/2- or 1/4-inch pipe can be driven into the ground. A 6-foot length will usually be long enough. Drive about four feet into the ground, leaving two feet above for attaching the ground wire.

A direct ground wire is run as shown in Fig. 1 is preferred, though this is not possible unless the antenna is mounted at the side of the house. Where the antenna is mounted near the center of the roof, the ground wire would have to run along the roof to the edge before it can be run down to the ground rod. Lightning seeks the most direct path to earth, so the straight run from the mast directly down to the roof is best. With such an installation, particularly where the antenna is some 10 feet or more above the roof, the home is actually protected better against lightning than if no antenna were present.

The lightning arrester can be placed down on the lead-in to the point where it enters the house as shown at Fig. 1-a and connected to the ground rod. It can also be used indoors by fastening it to a water pipe (never a gas pipe). A second choice would be as shown in Fig. 1-b, where the arrester is placed at the lower section of the mast. Here, the lead-in below the arrester is not protected against a direct hit, but when the ground wire is used, it is unlikely that the lightning would take the higher-resistance path afforded by the lead-in when it has the direct path available with the straight run of low resistance ground wire.

When the u.h.f. antenna is fastened to the same mast as the v.h.f. antenna, use an additional lightning arrester if the u.h.f. antenna uses a separate transmission line. Even with a grounded mast, a separate arrester always should be used for each lead-in employed. The exception, of course, is where a u.h.f.-v.h.f. crossover coupling unit is used. Since this device permits using the u.h.f. and v.h.f. antenna on a single transmission line, a single arrester will do.

Do not use the radio type of lightning arrester. They have considerable losses at v.h.f. and u.h.f. The television types have low loss gaps and some also use resistors for discharge of static. Some lightning arresters originally designed for v.h.f. may introduce losses at u.h.f. because of excessive shunt capacitance. Check the reception without the lightning arrester and note the difference if any on the weaker stations when it is connected. If losses are introduced try an arrester by a different manufacturer. Always make your installation and test it before installing the arrester, then note any difference in reception.

A good lightning arrester will dissipate static charges and afford a fair measure of protection against lightning. But there is no use deluding ourselves with the idea that it is the perfect answer to a direct heavy strike. When the mast is grounded, however, using heavy wire and good solid connections, neither the customer nor you have much to worry about.

**Interlace loss**

I am servicing a Raytheon model C-172-TA receiver which developed a blurring of the picture that cannot be corrected with the focus-control magnet. The scanning lines seem to appear in sets of two instead of one and they are not stable. When the vertical hold control is moved to a point just before the picture rolls, the scanning lines seem to try to come back to normal and the picture clears up, but this point is not stable. Please advise what defective part to look for. F.M., New York, N.Y.

In normal operation, interlace is upset only when the hold control is adjusted near the point where sync is about to be lost. Line structure is upset and interlace is lost. As shown in photo, the horizontal wedge pattern has a lacy moiré effect. Interlace is lost also when the picture rolls. In the receiver you mentioned, a defective component has upset this condition to the point where the setting for interlace is too critical to maintain good sync stability.

Try a new vertical oscillator tube. If this does not help, check the resistor-capacitor network which feeds the oscillator grid and check other resistors and capacitors in the oscillator circuit. Since this model has had some cases of vertical oscillator transformer leakage, replace the transformer if the foregoing suggestions do not help, this should stabilize the picture.

**Vertical troubles**

I have been unable to locate the cause of what appears to be foldover across the top of the picture in a Motorola 17T5D receiver. I also get a double picture from top to bottom. The horizon
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Horizontal sync is slightly unstable and at times drifts from right to left, showing the vertical blanking bar with the picture signal. How can I correct these troubles? V. H., Kansas City, Mo.

The double vertical image indicates improper or wide frequency change in the oscillator, while the crowding at the top is foldover as you suspected. Both are caused by a defective part in the R-C network associated with the vertical hold control. But first try a new 12BH7 video oscillator tube as well as a new 6SN7-GT sync clipper.

As shown in Fig. 2, the second sync clipper feeds sync pulses to both the vertical and horizontal circuits. A defective part in the vertical system will change the load on the horizontal a.f.c. input and produce the tendency toward instability in the horizontal sweep.

**Intermittent cut-off**

I have for repair a Philco 51-PT1297 with an intermittent condition. Sometimes it will go for hours and work well, then it will cut off completely. During cutoff, the a.g.c. bus goes highly negative. I have changed all tubes in the tuner and i.f. strip, as well as the detector, the a.g.c. rectifier, and others. I've also checked capacitors and resistors. I suspect the second i.f. amplifier, since this seems to be the critical stage. During cutoff, the picture can be restored by touching any lead in the second video i.f. transformer.

I have checked this unit but found nothing wrong. What would cause the a.g.c. to develop an excessive voltage? E. N., Skokie, N. J.

Several conditions could cause this, the most common being a stage which develops oscillations. When the latter occurs the grid draws current and charges the grid capacitor to form a high negative bias. Since this grid is tied to the a.g.c. line, the a.g.c. voltage is increased to a higher negative value than normal.

The fact that the defective part is sufficiently critical to become normal when the circuit is touched would seem to indicate a defective capacitor. Capacitors often act in this fashion when intermittent. Such an intermittent component is difficult to localize since the application of any test probes would restore the circuit to normal before the defective part was found.

Technicians often place the receiver on an unused portion of the bench and wait until the condition is more permanent. You can hasten the process by enclosing the receiver in a cardboard carton so that lack of ventilation will overheat parts.

We suggest you use a capacitor checker and test each capacitor in the second video i.f. amplifier stage by disconnecting it from the circuit. The full voltage rating of the capacitor can then be applied to cause an immediate breakdown of the weak one.

**Low high voltage**

I'm working on a Tech-Master model 5016 which at present has only 7,200 volts output.

I have substituted all tubes and capacitors from the video amplifiers and sync separator up to and including the damper section. I have also changed the flyback transformer. I still get the same results. Since this receiver uses a 14-inch picture tube there should be at least 10,500 to 11,000 volts. Can you suggest additional tests? R. F., Tulsa, Okla.

Insufficient high voltage can be caused by a low signal output from the oscillator or horizontal output stage. A decline in waveform amplitude can be caused by defective tubes, capacitors, or resistors, or by insufficient plate and screen voltages.

Try a new 470,000-ohm high-voltage resistor in the high-voltage lead from the 1X2 tube. If this doesn't help, check the low-voltage rectifier as well as the filter capacitors. In particular, check the resistors in the horizontal output system and replace any that are off by more than 10%. You should also recheck the coupling capacitor to the horizontal output tube grid, and also the screen bypass capacitor.

It is unfortunate that the peak-to-peak voltages of the waveforms in the horizontal system are not given in the service notes. This would help localize the trouble by use of an oscilloscope. The only method for making this check would be on another similar model which is in working order. The waveform amplitudes can then be ascertained and compared with those of the defective receiver.

**16AP4 to 16AP4A**

Recently I found it necessary to replace the picture tube in a Magnavox model CT-232 receiver. The original tube was a 16AP4, but I could not get this when needed, so I used a 16AP4A, assuming they were interchangeable. However, the new tube gives a dark picture even with the brightness control full on.

I have checked the voltages concerned with the brightness control and found nothing wrong, so I assume the dark-face tube is the root of the trouble. Are alterations of the brightness-control circuit necessary when using the 16AP4A? If not, what else can I check? T. H., Springdale, Conn.

The 16AP4 has a clear face while the 16AP4A has a gray face plate. Except for this, these tubes are identical in all electrical characteristics. Evidently the brightness was low initially in the receiver and the difference is now noticeable with the gray-face tube.

Either tube requires a double-magnet ion trap, and you should check the adjustments of the trap to make sure it is set for maximum brilliancy. Do not use the trap to eliminate corner shadows. The focus assembly is the one to use for this purpose. If trap settings do not help, try a new horizontal output tube and a new horizontal oscillator tube. Also check the B voltages in the horizontal system, and try a new damper and high-voltage rectifier.

If this does not increase brightness, check all parts associated with the horizontal oscillator and output stages. No alterations of the brightness circuit are necessary for the 16AP4A tube, and the latter should work satisfactorily in place of the 16AP4.

END

Note: When writing, give full details and be sure to include the model and chassis number of the receiver. Send a self-addressed, stamped envelope. We prefer the 4" x 9½" size envelope, because we often send data sheets with our answers.


A few months ago, we described a few of the circuits which manufacturers are using to delay the application of a.g.c. voltage and to set the minimum operating bias for cascade-type television tuners. While discussing some of these circuits with friends and TV service technicians, I found that most of them were a bit uncertain as to actually how keyed a.g.c. circuits work and that they were unable to follow the description of the tuner delay circuits. For this reason, we are reviewing the operation of the basic keyed a.g.c. circuit and the delay network as used in the Du Mont RA-171 chassis. The simplified circuit is shown in Fig. 1. The complete circuit was shown in Fig. 1 in this column in the July, 1953, issue, page 35.

The 6AU6 is the a.g.c. amplifier or a.g.c. keyer tube. R1 and R2 form the a.g.c. load resistor across which the full a.g.c. voltage is developed. The 6AU6 control grid is direct-coupled to the output of the video amplifier. A composite video signal is applied to the 6AU6 grid circuit from the video circuit. The cathode of the keyer tube is returned to a B plus line which is high enough to bias the tube to cutoff, so that only the sync pulses are strong enough to drive the tube to conduction. Now, unlike most amplifiers, which operate with a fixed d.c. plate voltage, the a.g.c. keyer plate voltage takes the form of high-amplitude pulses which are fed to the plate from a tap or winding on the horizontal output transformer. (In some sets, the flyback pulse is obtained from a second winding on the width coil.) The pulses on the 6AU6 plate occur at the same time the positive sync pulses reach the control grid, so the tube conducts and causes plate current to flow to ground through R2 and R1 as indicated by the dashed arrows.

In the Du Mont Service News the following example is used to explain the operation of the delay circuit. Assume that when the 6AU6 conducts, a current of 225 µa flows through R1 and R2. This makes the plate 55 volts (.000225 amp x 247,000 ohms) negative with respect to ground. However, this calculation is made without regard to the bleeder current which flows from ground through R1, R2, R3, and R4 to the plus 270-volt line.

Note that the bleeder current, shown by the solid arrows, flows in a direction opposite to that produced by the a.g.c. keyer tube. R1, R2, R3, and R4 total 2,667,000 ohms, so the current produced by the 270-volt line would be 270/2,667,000, or approximately 100 µa (.0001 amp).

With the 100-µa bucking current, produced by the 270-volt line, the current through R1 and R2 drops to 125 µa (225-100) and the voltage at the plate of the 6AU6 is only 31 volts instead of 55, as it was before we considered the effects of the bucking current. The a.g.c. voltage for the i.f. amplifier strip is tapped off at the junction of R1 and R2, which is approximately 5.9 volts negative. Since the left-hand end of R3 is 31 volts negative and the right-hand end of R4 is 270 volts positive, there is a total drop of 301 volts (31-270) across R3 and R4. There is a drop of approximately 27 volts across R3, which makes the junction of R3 and R4 27 volts positive with respect to the 6AU6 plate and 4 volts negative with respect to ground.

Looking into the voltage divider from the 270-volt line, there is a drop of 274 volts across R4 which makes the junction of R3 and R4 274 volts negative with respect to the 270-volt line, or 4 volts negative with respect to ground.

When the strength of the incoming signal drops, the 6AU6 conducts less heavily and its plate becomes less negative. When the voltage drops to minus 27, the junction of R3 and R4 (the tuner a.g.c. take-off point) becomes zero. The current through R1 and R2 drops to 109 µa and the i.f. a.g.c. take-off point drops to approximately 5.2 volts. Thus, when the total a.g.c. voltage drops 4 volts (from 31 to 27) the tuner a.g.c. voltage also drops 4 volts (from minus 4 to zero) while the drop on the i.f. a.g.c. line is about 0.7 volt.

A minimum bias of about minus 0.5 volt must be maintained on the cascode r.f. amplifier to prevent it from drawing excessive plate current. This voltage is obtained in a number of ways. In the RA-171 it is obtained by using the con-
tact bias potential developed by a diode connected between the tuner a.g.c. line and ground.

If the total a.g.c. voltage across R1 and R2 drops below 27, the tuner a.g.c. line would tend to go positive. This is prevented by connecting the plate of a diode clamp tube to the junction of R3 and R4 and connecting the cathode to ground. When the diode plate goes positive, the tube conducts and reduces the left-hand end of R4 to the contact bias potential of -0.5 volts.

The bucking voltage from a B plus source is used in almost all cases where a making a.g.c. circuit is used in sets which use cascode tuners.

**Hoffman a.g.c. circuit**

The keyed a.g.c. circuit and delay network in the Hoffman 190B and 191B TV chassis is shown in Fig. 2. In these sets, the 6AU6 develops its full a.g.c. voltage across two parallel-connected voltage dividers. One is composed of R1, R2, and R3 and the other consists of R4, R5, and R6. The bucking current for the delay voltage is obtained from the 265-volt B plus line and is applied to the junction of R4 and R5 through the 1.8-megohm resistor.

When the signal level is low, a minimum bias of approximately 0.5 volt is applied to the tuner a.g.c. line. This voltage is obtained from a tap on the 6BQ6-5T grid resistor (which consists of the 100-ohm resistor and R6 in series). The diodes of the 6SS7 a.f. amplifier are strapped together and are used as the a.g.c. clamp, which prevents the positive voltage on the 265-volt line from being applied to the tuner a.g.c. line and the 6BQ6-5T grid when the r.f. signal is low.

**G-E 6U8 a.g.c. keyer**

Most TV design engineers seem to have settled on the 6AU6 as the tube most suitable for use as an a.g.c. keyer, so the 6U8 keyer attracts especial attention in the G-E 21C35 receivers. The diagram is shown in Fig. 3.

The keying tube cathode is biased highly positive by its connection to a tap on the 260-volt B plus voltage divider. The high bias holds the keyer at cutoff until its grid and plate are driven positive simultaneously by the positive-going sync pulses and the pulse which occurs at the end of each horizontal sweep cycle. The tube conducts and develops a voltage drop across the 350,000- to 180,000-ohm and 47,000-ohm resistors connected between plate and ground. As in the other keyed a.g.c. circuits which we have discussed in this column, the voltage is most negative at the plate end of the resistor string. A.g.c. bias for the first three waves of r.f. amplifiers is tapped off at the top of the 47,000-ohm resistor.

The a.g.c. line for the r.f. amplifier in the tuner is tapped off at a higher point on the a.g.c. load resistor string. Delay bias for the first three waves of r.f. amplifiers is obtained by making the 180,000- and 47,000-ohm resistors a part of a B plus voltage divider across the 260-volt line.

**A BROADBAND V.H.F. ANTENNA**

The Channel Master 2-Bay Champion Antenna

![Antenna current distribution](image)

**Fig. 1—Antenna current distribution.**

**Fig. 2—Complete dipole assembly.**

**Fig. 3—Result of current addition.**

E are in-phase. The resulting current distribution is shown in Fig. 3.

The impedance of each of the two small phase-reversing dipoles was below 300 ohms, due to mutual impedance and coupling. Special one-fourth-wave transformer lines had to be designed to transform these low impedances to sufficiently high values, so that the total impedance of the three dipoles in parallel was in the vicinity of 300 ohms (see photo).

A screen-type reflector, rather than a straight bar parasitic reflector, was selected for the system. The maximum potential gain of a straight bar reflector is approximately 3 db and can be achieved only at one frequency. A straight bar parasitic reflector could not function effectively on both the high and low bands. However, a screen type reflector has an optimum gain of approximately 7 db and is non-resonant.

A further advantage of the antenna is its versatility. It may be used in one-band, two-band, or four-band arrays, providing optimum reception in any kind of television area. A high degree of stacking efficiency is maintained by the specially designed stacking harnesses. It is the first v.h.f. antenna ever developed which uses two-stage stacking transformers. The two-band version provides gain of over 11 db across the entire high band.
To plot the frequency response of an amplifier, a crossover network, or a filter circuit, the usual technique is to apply sine-wave signals of various frequencies to the input of the circuit to be checked, keeping the input amplitude constant, and checking the output signal amplitude at each frequency used. Since few audio oscil-lators or sine-wave generators have a flat output (except for the more expensive laboratory instruments), it is necessary to keep a constant check both on the output of the signal source (input to circuit) and the output of the circuit being tested.

One solution is to use an a.c. voltmeter to check both the input and output signal amplitudes at each test frequency, switching the instrument connections back and forth as necessary. This has several disadvantages: It is time-consuming, and is likely to introduce errors due to the changes in loading as the voltmeter leads are connected and removed, as well as to the general confusion invariably involved in such a process.

A better technique is to use two a.c. voltmeters or one voltmeter and an oscilloscope. One instrument is connected to the input of the circuit being checked, while the other is connected to the output. In this way, a running check on the input signal amplitude is possible, permitting it to be kept constant. This technique introduces its own disadvantages, however.

In many instances, two a.c. voltmeters may not be readily available to the technician. Even if available, this solution means that two fairly expensive instruments will be tied up while a series of measurements are carried out, preventing their use in other tests or measurements that may be necessary at the same time.

If an oscilloscope and an a.c. voltmeter are used, two valuable instruments are again tied up at the same time. In addition, the use of a scope may mean unnecessary bulkiness and excessive space requirements for an otherwise compact and simple equipment layout.

To overcome these difficulties, the instrument shown was designed and built. Although quite compact (case size is only 4 x 5 x 6 inches), this instrument is basically an uncalibrated a.c. v.t.v.m. It serves to indicate the relative level of signals applied to its input allowing any changes in signal level, whether an increase or decrease in amplitude, to be readily observed, thus permitting a readjustment back to a predetermined amplitude. The frequency response is essentially flat well past 100 kc, permitting tests on hi-fi as well as conventional amplifiers. Both a frequency-compensated step attenuator and a continuously variable sensitivity control are incorporated in the circuit design, thus allowing the user to make tests with signal amplitudes ranging from a fraction of a volt to well over 100 volts.

A further advantage of the instrument is its light weight and small physical size. This permits its use in an equipment layout without increasing the bench space requirements. It may be easily placed on top of the case of an audio oscillator or sine-wave generator which is used for making the measurements of frequency response.

Circuit description

The complete schematic diagram is given in Fig.1. The circuit is quite straightforward and conventional. No complicated "trick" circuits are used.

Any signal applied to the SIGNAL (input) terminals is coupled through capacitor C1 to the step attenuator or MULTIPLIER circuit, consisting of R1, R2, R3, R4, C2, C3, C4, C5, and S1. C1 serves primarily as a blocking capacitor, permitting a.c. to pass, but blocking the flow of d.c. to the circuit. This permits the instrument to be used to indicate relative signal levels in circuits where both a.c. and d.c. may be present, as in the plate circuit of an amplifier tube.

Using both resistors and capacitors in the MULTIPLIER circuit provides frequency-compensation, so that the input signal level may be reduced without affecting the over-all frequency response of the instrument. This switch permits a straight-through feed to the grid of the amplifier tube, or reductions of 10:1 or 100:1 in signal strength, corresponding to the 100X, 10X, and 1X positions in the photograph.

The signal is applied to the grid of V1 (1/2 of a 12AT7) and amplified, with the amplified signal appearing across plate-load resistor R5. This resistor is kept fairly low in value to permit a wide frequency response. Bias for V1 is obtained by a conventional cathode resistor R2, together with its bypass capacitor C6.

The amplified signal appearing across
R6 is applied through blocking capacitor C7 to the cathode of a diode-connected triode V2 (second half of the 12AT7), where rectification occurs, with a d.c. voltage proportional to the a.c. signal amplitude appearing across R8.

Since the d.c. voltage across R8 contains an a.c. component, a simple R-C filter circuit is used to serve as a ripple filter, permitting essentially d.c. to be applied to the sensitivity control R10. The filter circuit consists of R9 and C8.

A portion of the d.c. voltage across R10 is applied to the grid of V3 a sensitive tuning-eye tube. The amount of eye closure obtained depends on the amount of d.c. voltage applied to the grid of this tube, and thus serves as an indication of the relative signal level applied to the input terminals. R11 is the plate-load resistor for V3.

D.c. operating voltages for the circuit are obtained from a conventional half-wave rectifier circuit using a selenium rectifier and a half-wave power transformer which also supplies filament voltage for the tubes. An R-C pi-type filter consisting of C9, R12, and C10, is used in the power supply circuit. R13 prevents damage to the rectifier during the charging of C9.

Since the power requirements for the instrument are small, it was not thought necessary to provide an on-off switch in the primary circuit. The instrument may be left connected while measurements are being carried out, and turned off simply by removing the plug from the power receptacle.

**Construction hints**

The layout of major parts is apparent from the exterior and interior photographs of the instrument. The circuit is not critical and a different layout may be used without difficulty if desired by the builder. Two precautions should be followed: A.c. signal leads should be kept as short and direct as possible. The input terminals and multiplier circuit should be well separated from other circuits to minimize distributed capacitances to ground.

Construction is simplified by using a small subchassis on which is mounted the amplifier tube, the power transformer, and other parts; and by using an Amphenol tuning-eye assembly. The Amphenol assembly provides the mounting bracket for the 6E5 tube, the front escutcheon, and a wired socket (including R11).

The MULTIPLIER and SENSITIVITY controls are mounted on the front panel of the Bud Minibox used as a cabinet. The carrying handle is optional and may be purchased from a dime store or hardware store.

Bud Miniboxes may be obtained in either etched aluminum or gray Ham-
merloid finish (like the model shown). If the builder plans to use some other type of finish, such as gloss enamel or wrinkle varnish, he should obtain a box with a plain wall by a finish, applying the point after drilling and punching, but before mounting parts.

Controls and terminals may be identified—using standard name-plates or decals. If a light finish is used, the new black decals have an attractive appearance (see photo).

The trimmer capacitors C2 and C3 in the multiplexer assembly should be rigidly mounted in such a position that adjustment is easy after the wiring is completed.

**Adjustment**

Once the wiring is completed and checked, the tubes should be placed in their respective sockets and the unit plugged in. After a warmup period, the tuning eye should glow normally. The eye should then be rotated until the opening faces downward.

The operation of the instrument may next be checked by applying a signal of from 1 to 6 volts to the input terminal and adjusting the MULTIPLEXER and SENSITIVITY controls. The eye should close or overlap (depending on the input signal).

If the eye does not glow green after a reasonable warmup period, first check and make sure the 6E5 is in good condition and that its filament is lit. If the tube filament lights, but a glow is still not obtained, check the wiring for errors and make sure B plus is available from the power supply.

Should the eye tube glow properly, but not close when a reasonable level a.c. signal is applied to the input and the controls adjusted, check for opens or shorts in the signal circuits. Also make sure that R11 is not open.

Once the unit is operating normally, the trimmers in the multiplexer circuit should be adjusted to obtain proper frequency compensation. To do this, connect the vertical input terminals of an oscilloscope to the output of the amplifier stage (between the plate of V1 and ground). Connect a square-wave generator to the input terminals of the instrument.

Using a 10-kc square-wave signal, turn the MULTIPLEXER to the 10X posi-

tion and adjust C2 until the square-wave signal observed on the screen of the scope is flat with square corners, as shown in Fig. 2-b. A slant like that shown in Fig. 2-a indicates that the trimmer capacitance is too high, while a slant in the opposite direction or a "rounding" of the leading edge (Fig. 2-c) indicates that it is too low.

After properly adjusting C2 in this fashion, switch to the next position of the multiplexer switch and adjust C3 similarly. It may be found that adjustment of the scope gain controls or the output of the square-wave generator may be necessary to obtain a reasonable signal level.

**Applications**

The output indicator may be used in place of an a.c. voltmeter wherever the actual voltage is not important and where a relative signal level may be indicated. Such applications include the use of the instrument as an output indicator when aligning radio receivers, as a null indicator when working with impedance bridge circuits, and as a level indicator when plotting frequency response curves. As can be seen, the instrument is quite versatile and may be used in a number of different applications, the only limit being the ingenuity of the user.

A basic setup for using the instrument output indicator when obtaining the frequency-response curve of an audio amplifier is illustrated in Fig. 3.

Next connect the a.c. voltmeter and the output indicator in parallel with the output of the audio generator. Adjust the output control of the generator to give the desired voltage, as indicated on the a.c. voltmeter. Set the MULTIPLEXER and SENSITIVITY controls of the instrument output indicator so that the tuning eye just closes, as shown in Fig. 4-b.

In this case it is used in conjunction with an audio generator and an a.c. voltmeter.

First, connect the a.c. voltmeter and the output indicator in parallel with the output of the audio generator. Adjust the output control of the generator to give the desired voltage, as indicated on the a.c. voltmeter. Set the MULTIPLEXER and SENSITIVITY controls of the instrument output indicator so that the tuning eye just closes, as shown in Fig. 4-b.

Then adjust the audio generator to supply signals of different frequencies to the audio amplifier, and the output reading obtained on the a.c. voltmeter is noted.

If the signal from the audio generator decreases in amplitude as different frequencies are used, the tuning eye will tend to open (Fig. 4-a). If the signal increases in amplitude, the eye will overlap, as shown in Fig. 4-c.

In either case, readjust the output control of the audio generator until the eye is again just closed, as in Fig. 4-b. This insures maintaining a constant input signal to the audio amplifier.

Do not readjust the MULTIPLEXER or SENSITIVITY controls of the output indicator during the tests after the initial adjustment.

A slightly different technique is to connect the instrument output indicator to the output of the circuit under test, connecting the a.c. voltmeter in parallel with the output of the audio generator. In this case, the output signal level is kept constant (as indicated by the closed tuning eye) and the input signal voltage required to just close the tuning eye at each of the different frequencies is noted.

**Output indicator parts list.**

- Resistors: 1-220 ohms, 1-33,000 ohms (5%); 1-47,000 ohms, 2-100,000 ohms, 1-1,000,000 ohms (5%);
- 2-3.3 megohms (5%), 1/2 watt, carbon; 1-2200 ohms, 1-10,000 ohms, 1 watt, carbon;
- 1-3 megohms, potentiometer, carbon, linear taper; 1-megohm, 1/2 watt, carbon (in MSA-4 assembly).
- Capacitors: 1-0.1, µf, 600 volts, paper; 2-2.5 µf, 200 volts, metallized paper; 1-0.001 pf, 100 volts; 1-1.0 µf, ceramic; 2-5-50 µf, ceramic trimmers;
- 1-1 pf, 25 volts, electrolytic; 2-50 pf, 190 volts, electrolytic (may be dual capacitors).
- Miscellaneous: 1-1pole, 3-position switch (Mallory 1223J — one section); 1-25-mg selenium rectifier; 1-12AT7 tube; 1-655 tube; 1-power transformer, 150 volts, 1.5 ma; 1-Mc (Marconi); 1-Bud Miniator, 6x6x6 inches; 1-Amphenol MSA-4 transformer assembly; 1-small chassis (Bud No. 1617; 1-line cord; 1-9 pin miniature socket; 2-Banana plug type binding posts; 2-pointer knobs; 1-handle; wire, solder, and hardware.

The average technician should have no difficulty in wiring the unit in from six to eight hours. Once it is completed and adjusted, only a few minutes experimenting will familiarize the user with its operation and application. END

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**Fig. 2—Patterns for adjusting indicator.**

**Fig. 3—Obtaining amplifier response.**

**Fig. 4—Eye indicates signal amplitude.**

In cases where a low-level signal must be supplied to the circuit under test, so that it is not possible to completely close the eye, the setup shown in Fig. 5 may be employed. The instrument output indicator is connected to the output of the audio generator, and a frequency-compensated attenuator is used between the audio generator and the circuit be-

**Fig. 5—Low-level signal arrangement.**

The average technician should have no difficulty in wiring the unit in from six to eight hours. Once it is completed and adjusted, only a few minutes experimenting will familiarize the user with its operation and application. END
Intermittent Recorder

Here it is—the answer to the technician's prayer—a device that will locate and record those intermittent circuits

By JOSEPH RACKER

Intermittents, which represent one of the most time-consuming troubles that the average service technician encounters, can now be automatically located. The instrument which does the locating sounds a buzzer and lights a lamp indicating where trouble has occurred, simplifies servicing of intermittents, and results in fewer recalls than conventional shop repair jobs. Since the lamp remains on even after the trouble has disappeared, intermittents can be located while the service technician is out of the shop or devoting all of his attention to other sets.

The instrument, called the Magne-Pulse type 202 intermittent recorder, consists, in effect, of three vacuum-tube voltmeters which monitor as many as three separate voltages in a chassis. With the set operating normally, each of the three voltages being monitored are zero-set by a potentiometer so that the meter pointer is at 0 for all three circuits. If any of the three voltages deviate beyond preset limits, the voltage change is detected by the associated v.t.v.m., and a relay is actuated, causing the appropriate lamp to light and the buzzer to sound.

As soon as any lamp is lit, its associated circuit automatically locks out the other two circuits so that only the earliest failure is recorded. The probe for each monitor is color-coded for easy identification. One circuit, identified as red, can monitor a voltage from 0.5 volt to over 500 volts. The second circuit (green) operates from 3 to 500 volts, while the third circuit (white) operates from 15 to 500 volts. The input impedance to these circuits is 2 megohms, with negligible capacitance, so that they will not load the circuit that is being monitored.

Fig. 1 is the diagram of the circuit used for tests where voltages range between 0.5 and 500. It duplicates the 3- and 15-volt circuits except for minor changes. The unit is essentially a monitoring circuit used to check a.c. or d.c. signals, positive or negative. A.c. signals are rectified by one-half of a 6AL5.

Fig. 1—Schematic of "v.t.v.m." circuit contained in Intermittent Recorder.
twin diode, providing a d.c. voltage across the 2-megohm potentiometer. For d.c. signals the 6AL6 is removed from the circuit. The 2-megohm zero-set potentiometer is adjusted for a zero reading on the meter. With the circuit zeroed, both halves of the 12AX7 draw equal currents and no voltage difference exists between the two plates.

When a voltage change of sufficient amplitude occurs, the 12AX7 becomes unbalanced and a voltage difference exists between the two plates. This causes one of the two halves of the 6AL5 coupled diode (to the 2D21) to conduct. The half that conducts depends upon the polarity of the voltage change. With the 6AL6 conducting, a positive voltage is placed at the grid of the 2D21, causing this thyratron to fire. In the plate circuit of the 2D21 is the actuating relay which lights the appropriate lamp and sounds the buzzer. Even if the voltage change disappears, the thyratron continues to conduct, since once such a tube is fired it cannot be cut off until the plate voltage is removed. Plate voltage is cut off only when the reset button is pressed.

The method of balancing the circuit for zero reading on the meter is unusual for a v.t.v.m. circuit of this type. One grid (pin 7) of the 12AX7 is grounded, so the other grid (pin 2) would also have to be at ground potential (zero volts) for the circuit to balance. Since the alarm is operated by that grid, it produces a portion of the potential in the input circuit, a 1.5-volt cell is placed in series with the grid to buck the voltage developed at the arm of the potentiometer. The circuit balances when the voltage on the arm of the potentiometer equals the voltage supplied to the grid by the battery. The input selector switch reverses battery polarity so it buck the voltage applied to the input.

The circuit in Fig. 1 must operate on voltages as low as 0.5, so the cell voltage is reduced by the 3-1 divider consisting of the 100,000- and 47,000-ohm resistors in series with the cell. The bucking voltage for the grid is tapped off the smaller of the two resistors. In the 3- and 15-volt circuits the cell connects across a 150,000-ohm resistor in series with the grid.

The inputs to the 3- and 15-volt circuits have controls as parts of fixed voltage dividers. The 3-volt input has a 2-1 divider consisting of a 1-megohm resistor in series with a 1-megohm potentiometer. The 15-volt circuit has a 10-1 divider consisting of a 2-megohm resistor in series with a 200,000-ohm potentiometer.

The recorder can be operated by d.c. or a.c. voltages at any convenient point in an electronic circuit. When the input probe is connected directly to the plate of an amplifier, it operates with changes in the average voltage when the applied voltage consists of d.c. with superimposed a.c. By using a blocking capacitor in series with the probe, the circuit operates from changes in the a.c. signal alone.

### PRACTICAL IMPEDANCE CHECKER

**By ALBERT L. SOHL**

**COMPACTNESS and simplicity**

Keynote this unit which takes up no more space than a pack of cigarettes. The checker is based upon a substitution method (Fig. 1) using easily obtainable components.

I used a plastic thread and thimble box measuring 1\(\frac{1}{4}\) x 2 inches obtained in a 5-and-10-cent store. A four-in-line insulating panel material with approximately the same dimensions will serve as a mount for the few items involved. A phone plug with the bakelite shell removed has one terminal screwed directly on the panel. This plug is connected directly into the output jack of the test audio oscillator.

The switch back and forth by varying the potentiometer until the meter readings are the same at both switch positions. When both readings are identical remove unit from oscillator and check resistance of R with an ohmmeter. Ohmmeter check can be made by moving switch to position 2 and adjusting v.t.v.m. to read resistance. The value of the resistance will be the impedance of the unknown L, C, or R.

**Determining L, C, R**

If the unknown impedance is a resistor, its value will be equal to R. If the unknown impedance is an inductance or a capacitance, some simple formula substitution must be used. If it is an inductance, the value of R is approximately equal to its inductive reactance \(X_L\). The formula \(L = \frac{X_L}{\pi f}\) can then be used to find L. If the unknown impedance is a capacitance, the value of R is equal to \(X_C\). The formula \(C = \frac{1}{\omega^2 R^2 X_C}\) can then be used to find C. For those allergic to formulas, nomographs or reactance tables can be used.

**Materials for checker:**

- Resistors: 1-1 megohm potentiometer, midget.
- Miscellaneous: 4-Farnestock clips; 1-single-circuit jack, 1-phone plug with bakelite shell removed; 1-single-pole double-throw toggle switch; 1-insulating plastic panel; 1-box, 1\(\frac{1}{4}\) x 2 inches.

**Fig. 1—Schematic of impedance checker.**

The known resistance R (a 1 megohm midget potentiometer, in this case), is connected between Farnestock clips A and B. If other or more critical values of the known resistance are required, the mounted potentiometer can be eliminated and the new resistance substituted.

To operate, set the test oscillator at 1,000 cycles and plug the a.c. v.t.v.m. into the output jack of the impedance checker. Place the unknown impedance between Farnestock clips C and D, and plug the checker into the oscillator output. When the toggle switch is at position 2, the v.t.v.m. will measure the voltage across R; on position 1, it will measure the voltage across the unknown impedance. Now move toggle switch back and forth by varying the potentiometer until the meter readings are the same at both switch positions. When both readings are identical remove unit from oscillator and check resistance of R with an ohmmeter. Ohmmeter check can be made by moving switch to position 2 and adjusting v.t.v.m. to read resistance. The value of the resistance will be the impedance of the unknown L, C, or R.
Machines instead of men can now do the biggest part in producing desperately needed electronic equipment for the armed forces during manpower scarcities. The Navy Bureau of Aeronautics and the National Bureau of Standards jointly announced that they had pushed automatic mass production of electronic devices so far that the most refined skill and something that closely resembles intelligence has been transferred to machines. This revolutionary system is code-named “Project Tinkertoy.” At the present moment, the Navy is especially interested in such electronic devices as guided missiles, radar sets, proximity fuses, electronic fire control and communication methods. Project Tinkertoy was developed primarily to make the parts and circuits required for such military equipment.

Starting with raw or semi-processed materials, machines automatically manufacture ceramic materials and adhesive carbon resistors, print conducting circuits, and mount resistors, capacitors, and other miniaturized component parts on standard uniform steatite wafers. The wafers are stacked very much like building blocks to form a module (building block) that performs all the functions of one or more electronic stages. Automatic inspection machines check physical and electrical characteristics of the parts mounted on the wafers at numerous stations along the production line. The completed module is a standardized, interchangeable subassembly combining all of the requirements of an electronic circuit with ruggedness, reliability, and extreme compactness.

MDE design system

The key to the automatic, mechanized production of electronic equipment in Project Tinkertoy is the design system developed by the National Bureau of Standards, called MDE—for Modular Design of Electronics. The system establishes a series of mechanically standardized and uniform modules producible with a wide range of electrical characteristics.

Each module consists usually of four to six thin ceramic wafers, bearing various circuits associated with an electronic stage. A number of individual modules are combined to form a larger subassembly.

Since electronic assemblies consist largely of electronic tubes and groups of simple parts (like resistors and capacitors) which account for the mass of the individual parts and are also responsible for most of the manual labor in conventional production, they have been the chief target for redesign in the MDE system.

The MDE system does away with the conventional circuit diagram of the tested electronic model and places all necessary production programming information on an MDE work sheet. Each work sheet contains the front and back outlines of six wafers with numbering to identify each notch in the wafer, each riser wire, and the electronic piece that is to be placed on the wafer. The engineer translates his conventional wiring diagram to an MDE diagram. He indicates the position of the piece and its proper value and tolerances. Lines are drawn to indicate how the circuits between wafers are to be connected.

MPE production system

Modules and assemblies, designed in the MDE system, are produced and inspected mechanically in Project Tinkertoy. The production system is called MPE—Mechanized Production of Electronics. MPE uses non-critical raw materials. The ceramic wafers— 3/8-inch square by 4-inch thick—are produced directly in quantity from the raw materials. Ceramic capacitors are made the same way. Another part of the line produces adhesive tape resistors. These and other basic parts are fed into the production line. The proper circuits are printed by automatic
machines. Interconnection between any number of modular units is simple.

**Modular design**

In a series of metallizing operations, sections of the wafer or capacitor body are silver-painted. During these stages, circuits are printed on the wafers, the notches are coated, the conducting surfaces and leads are applied to capacitors, the bodies are cured in a furnace, and the circuits are inspected.

Once the wafers and components have been made and metallized, the next step is joining them. Machines are used to apply up to two capacitors to each side of a wafer. Other machines apply either one or two resistors to each side of a wafer. Rolls of resistor tape are mounted on a machine that automatically cuts the tape into one-half-inch strips, presses it between printed electrodes on a wafer, applies pressure, and ejects the completed piece. Tube sockets are also mounted on their appropriate wafers so that the pins will connect with suitable notches.

After many of the steps in the components assembly process, parts or circuit lines must be soldered or tinned. This is done automatically by induction heating and dip tinning.

Uniform wafer-mounted component parts, including wafer-mounted coils, toroids, potentiometers, and crystals are now ready for assembly. The module is completely assembled in a single machine. Six feeders issue the wafers to a loading device that holds them upright between specially designed jaws. A chain drive carries the jig to a soldering position at which six riser wires are guided into appropriate notches, three on a side. The mechanism then solders the wires to the notches. Another mechanism next turns the unit 90°, and the chain drive carries it to another soldering position where six more wires are bonded to the module. The final operations on an assembled module consist of clipping the riser wires automatically at specified positions and testing the completed units.

**Inspection and assembly**

During each stage in the mechanized production of electronics, provision is made for 100% automatic inspection. This is both a physical gauging and an electrical comparison. Printed circuits, resistors, and capacitors are compared with their electronic equivalents both before and after assembly. This is done with electronic computers, bridge circuits, and other comparison devices. The inspection “code” is contained on the punched cards which were prepared by the design engineer and have accompanied the wafers all through the production process. After the final assembly of the module the whole circuit is again tested to see that it meets specifications.

The final assembly operation need not necessarily be considered a part of the Mechanized Production of Electronics. Normally, a set of modules (as many as ten) are mounted on or between copper-clad base plates. Circuits have been etched into the copper surface and connect the riser wires of the several modules to form a complete electronic circuit. Several such plate assemblies may form a single piece of equipment. One base plate with six modules, for instance, contains all the necessary circuits to make a six-tube radio receiver function properly.

Project Tinkertoys makes possible a rapid conversion from civilian to military products (and back again) on short notice and, concurrently, allows a greatly expanded production capacity. Tinkertoys speed up the output beyond anything that could be done through pep talks or incentives to workers. A small pilot shop now in operation is rated to produce 1,000 modular subassemblies every hour. Depending on human hands, you'd need a huge factory to equal that pace.
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Men already in Radio who seek a short intensive 100% TELEVISION Training with FULL EQUIPMENT INCLUDED are invited to check and mail the coupon at the right.

DECEMBER, 1953
Another new, outstanding instrument design so typically characteristic of Heathkit operation in producing high quality instrument kits at the lowest possible prices. A new, improved model Impedance Bridge Kit featuring modern cabinet styling, with slanted panel for convenience of operation and interpretation of scales at a $10.00 price reduction over the preceding model. Built-in adjustable phase shift oscillator and amplifier with all tubes of the battery operated type completely eliminates warm-up time. The instrument is entirely AC line operated. No 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 capacitance measurements, Maxwell Bridge for low Q, and Hay Bridge for high Q inductance measurements. Read Q, D, DQ all on one dial thereby eliminating possible confusion due to the incorrect dial reference or adjustment. Only one set of instrument terminals necessary for any measurement function. Panel provisions provided for external generator use.

A newly designed two section CRL dial provides ten separate units switch sections with an accuracy of ±5%. Frictions 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 condensers in all measurement circuits.

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

HEATH COMPANY • Benton Harbor 20, Mich.

RADIO-ELECTRONICS
NEW 5" Heathkit
OSCILLOSCOPE
KIT
MODEL O-9
$59.50
SHIPPING WT. 28 LBS.


DECEMBER, 1953
The beautiful Heathkit Model V-6 VTVM, the world's largest selling kit instrument, now offers many outstanding new features in addition to retaining all of the refinements developed and proven in the production of over 100,000 VTVM's. This is the basic measuring instrument for every branch of electronics. Easily meets all requirements for accuracy, sensitivity, convenience of ranges, meter readability, and modern styling. It will accurately measure DC voltages, AC voltages, offers tremendous ohmmeter range coverage, and a complete dB scale for a total of 35 meter ranges.

New 1½ volt full scale low range provides well over 2½" of scale length per volt. Upper DC scale limit 1,500 volts. DC ranges 0-1.5, 5, 15, 50, 150, 500, 1,500 volts full scale. AC ranges 0-1.5, 5, 15, 50, 150, 500, 1,500 volts (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 Heathkit AC Vacuum Tube Voltmeter Kit is designed for TV service work or any similar application where the measurement of high DC voltage is required. The Heathkit Model 556 High Voltage Probe Kit will prove invaluable. A precision multiplier resistor mounted inside the two-color, steel, plastic probe body provides a multiplication factor of 100 on the DC ranges of the Heathkit 11 megohm VTVM. The entire kit includes precision resistor, two-color plastic probe, tip connector spring, test lead, phone plug, panel connector, and complete assembly instructions.

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

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

Heathkit AC Vacuum Tube Voltmeter Kit

**Model AV-2**

$29.50

**Shipping WT.** 5 lbs.

No. 336

$4.50

**Ship Wt.** 2 lbs.

Heathkit PEAK-TO-PEAK PROBE KIT

No. 338-B

$5.50

**Ship Wt.** 2 lbs.

Heathkit RF PROBE KIT

No. 309-B

$3.50

**Ship Wt.** 2 lbs.

Heathkit 30,000 Volt DC PROBE KIT

For TV service work or any similar application where the measurement of high DC voltage is required, the Heathkit Model 556 High Voltage Probe Kit will prove invaluable. A precision multiplier resistor mounted inside the two-color, steel, plastic probe body provides a multiplication factor of 100 on the DC ranges of the Heathkit 11 megohm VTVM. The entire kit includes precision resistor, two-color plastic probe, tip connector spring, test lead, phone plug, panel connector, and complete assembly instructions.

**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
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 safety type banana jacks — standard universally available batteries — rugged practical sized cabinet with plastic carrying handle, and a total of 35 calibrated meter ranges.

RANGES
Voltage ranges selected entirely for service convenience. For example 1½ volt full scale low range for measuring portable radio filament voltages, bias voltages, etc., 150 volt full scale range for AC-DC service work, 500 volt full scale range for conventional transformer operated power supply systems. Complete voltage ranges AC and DC, 0-1-5-10-15-20-25-30-50-100-200-500-1,000-2,000-5,000 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 10,000 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
$85.00
SHI P. WT. 2 LBS.

Heathkit HANDITESTER KIT
The Heathkit Model M-1 Handitester readily fulfills major requirements for a compact, portable voltmeter and milliammeter. Despite its compact size, the Handitester is packed with every desirable feature required in an instrument of this type. AC or DC voltage ranges full scale, 0-10—30—300—1,000—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 milliamperes load on both AC and DC ranges. Special type, easily accessible, battery mounting bracket — 1½% 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 copper sulfide unit used either as a full wave rectifier or voltage doubler according to the position of the panel range switch.

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

### Heathkit VIBRATOR TESTER KIT
Your repair time is valuable, and service use of the Heathkit Vibration 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 Bally-Good scale. The Heathkit VT-1 checks both interpersed and self-rectifier types of vibrators. Five different sockets for checking hundreds of vibrator types.

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

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

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

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

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

**NEW Heathkit**

**SIGNAL GENERATOR KIT**

**MODEL SG-8**

$19.50

**SHIPPING WEIGHT**

8 POUNDS

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

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

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

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

**NEW Heathkit**

**BAR GENERATOR KIT**

**MODEL BG-1**

$14.50

**SHIPPING WEIGHT**

6 POUNDS

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

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

Instrument operation is extremely simple, and merely requires connection to the TV receiver antenna terminal. The unit is transformer operated for safety when used in conjunction with universal or transformerless type TV circuits.
NEW Heathkit
TUBE CHECKER
KIT
MODEL TC-2
$29.50

The new Model TC-2 Heathkit Tube Checker features many circuit improvements, simplified wiring, and chart drive and illumination of 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 local, 7 and 9 pin miniatures, 5 pin Hytron and a blank socket for new tubes. Built-in neon short indicator, individual three-position lever switch for each tube element, spring return test switch, 14 filament voltage ranges, and line set control to compensate for supply voltage variations, all represent important design features of the TC-2. Results of tube tests are read directly from a large 4½" Simpson three-color meter, calibrated in terms of Bad—Good. Information that your customer can readily understand. Checks emission, shortened 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 multicore, color coded wires, providing a harness type installation between tube sockets and lever switches. This procedure insures standard assembly and imparts that "factory built" appearance to instrument construction. Completely detailed information is furnished in the new step-by-step construction manual, regarding the set-up procedure for testing of new or unlisted tube types. No delay necessary for release of factory data.

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

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

New
HEATHKIT
PORTABLE TUBE CHECKER
KIT
MODEL TC-2P
$34.50

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

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

Heathkit TV PICTURE TUBE
TEST ADAPTER
No. 355
Ship. Wt. 1 Lb.

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

Heathkit POWER SUPPLY KIT

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

LABORATORY AND SERVICE SHOP
BOOKLETS

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

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DECEMBER, 1953

CHECK THESE Features

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

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

This new signal tracer features a special high gain RF input channel, used in conjunction with a newly-designed wide frequency range demodulator probe. High RF sensitivity permits signal tracing at the receiver antenna input. A separate low gain channel and probe available for audio circuit exploration. Both input channels are constantly monitored by an electron ray beam indicator, so that visual as well 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 wasteage 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, photo crystals, etc.

Don't overlook the interesting service possibilities provided through the use of this new instrument and let it work for you by saving time and money. The kit is supplied complete with all tubes, circuit components, demodulator probe, audio probe, and additional test leads.
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 price. Panel mounted crystal socket, standby switch, key, clicker, AC line filer, good shielding, etc. VFO or crystal excitation — up to 55 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 input, plug in chassis provisions for VFO or modulator and rugged clean construction. Frequency range 80, 40, 20, 15, 11, and 10 meters.

The AT-1 Transmitter Kit is a very low cost way to add the fun of communicating to your station. A short kit which might be used to make a receiver or a transmitter. This kit is powered by a 6AG7 oscillator-multiplier, 6L6 amplifier-doubler, 5U4G rectifier. Physical dimensions 8¼" high x 13½" wide x 7" deep.

This amazingly low kit price includes all circuit components, tubes, cabinet, punched chassis, and detailed construction manual. The ideal kit for the novice just breaking into ham radio. It can be used later on as a stand-by rig or an all band exciter for higher powered transmitter.
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, wide 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-section 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, microphones, phonograph pick-ups, and loud-speakers. High and low frequency inter-modulation, inter-modulation unit, power supply, and AC vacuum tube volt meter all in one complete instrument. Per cent inter-modulation is directly read on the calibrated scales. 50%, 10%, and 5% 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 inter-modulation analysis for accurate audio interpretation.

Heathkit AUDIO GENERATOR KIT

A Heathkit Audio Generator with frequency coverage from 20 cycles to 1 mc. Response flat ±3 db from 20 cycles to 400 kc, down 3 db at 600 kc, and down 8 db at 1 mc. Calibrated, continuously variable, and step attenuator output controls provide convenient reference output level. Distortion is less than .5% 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, 1% precision resistors in multiplier circuits, high level output across entire frequency range, etc., readily qualify this instrument for audio experimentation and development work. Special circuit design consideration features thermometer 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 Simple.

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. Most every high fidelity audio requirement and make listening to recorded music a thrilling new experience.

This outstanding amplifier is offered with optional power transformer operation, providing either the conventional triode output circuitry or the new extended power circuitry in which the screen supply voltage is obtained from separate transformer primary taps. Frequency response within ±1 dB from 10 cycles to 100 kc. Tube complement — 6SN7 cascade amplifier and phase splitter, 6SN7 push pull drivers, two 5681 push pull power amplifiers, one 5V4G cathode type rectifier.

Matching preamplifier available providing three switch selected inputs, correct compensation, and individual bass and treble tone controls. Uses 12AY7 (or 12AX7) preamplifier — 12AU7 tone control amplifier. Particularly designed for the novice kit builder and requires no specialized knowledge or equipment for successful assembly and operation.

NEW Heathkit 20 WATT High Fidelity AMPLIFIER KIT

MODEL A-9A

A new 20 watt high fidelity amplifier, designed especially for custom audio installations demanding clean reproduction, adequate power, and flexibility to meet individual requirements. Separate treble and bass tone controls provide up to ±5 dB boost or cut. Four switch selected inputs, each with the necessary compensation for the service desired. Output transformer impedances of 4, 8, and 16 ohms.

Preamplifier, tone control, and phase splitter circuits utilize 5 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: 6BQ5 preamplifier, 12AU7 voltage amplifier and tone control, 12AU7 voltage amplifier and phase splitter, two 6L6 push pull pentode power output, 5U4G rectifier. Truly outstanding amplifier performance coupled with low cost.

NEW Heathkit FM TUNER KIT

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

FREE CATALOG

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

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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 an ingenious turn-under twin sapphire stylus for LP or 78 records without turning the cartridge. Simplified, 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.

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DECEMBER, 1953
Simple Tubeless Photo Timer

With no critical parts involved, this timer is both durable and accurate

By KAI M. KLEMM

Above schematic shows electrical layout of simple tubeless photo timer at right.

A TIMER of one sort or another has always been a useful piece of equipment in the darkroom, on the experimenter's workbench, or even in the XYL's kitchen. Mechanical timers have always had the disadvantage of having to be wound up for each new timing period. Most electronic timers use 117-volt dual-purpose tubes with some kind of capacitor charging system in the grid circuit, and a plate relay in the plate circuit. The disadvantage of these timers is that the tubes are expensive and operate rather hot. So, if used in a small case, the life of the tubes and components is very much shortened.

With these points in mind I wondered if it would be possible to build a timer using as the heart of the unit a 1-watt neon bulb. A neon bulb is an open circuit until its ionizing voltage is reached. Then it conducts. After many trials and errors the circuit above was developed. The operation of the circuit is:

Switch S1 and S2 is a double-pole double-throw switch wired so that S1 is closed and S2 is open when the switch is thrown in one direction and S1 is open and S2 is closed when thrown the other way. When S1 is closed, 117 volts a.c. is applied to the selenium rectifier. C1 is an 8-µf, 200-volt, electrolytic capacitor which filters the half-wave d.c. C2 is a 150-µf, 150-volt electrolytic capacitor. (I used a 3-section 50-50-50-µf capacitor, tying its three sections together) which is charged through a ¼-watt neon bulb and variable resistor R1. When C2 is charged to about 80-85 volts the neon bulbs across which it is connected will conduct. The 5,000-ohm relay in series with the 1-watt neon bulb will close for a brief instant due to the current flowing through the neon bulb, and will automatically connect the neon bulb and itself across the full output of the power supply. To repeat the timing cycle the switch is merely thrown the other way for a second, opening S1 and closing S2. This discharges C2 through the 220-ohm resistor. The longest time period is determined by R1. Originally, a 2.5-megohm volume control was used which gave a maximum of about ¼ hour. To get a longer period, the resistance of the control may be decreased. Since the ¼-watt neon bulb glows very faintly when such high resistance is used, it is advisable to connect a capacitor of about 0.1-µf across it. The ¼-watt neon bulb is mounted on the panel to show when the timer is in operation. The capacitor will make the bulb flash brightly every few seconds, showing that the instrument is on. The minimum interval is about 15 seconds. By removing the ¼-watt neon bulb this can be decreased to a minimum of about 1 second. However, the upward range cannot then be made so high. The whole apparatus can be built into a utility box 4 x 5 x 3 inches, and the 1-watt neon bulb should be mounted in a conspicuous place. The on-off reset switch should be mounted in an easily accessible place.

Materials for photo timer
Resistors: 2—100; 1—220, ½-watt; 1—2½ megohms, potentiometer (linear).
Capacitors: ½-0.1 µf, 200 volts, paper; ½-8 µf, 200 volts, electrolytic; ½—150 µf 150 volts, electrolytic.
Miscellaneous: ½—50-ma selenium rectifier; ½—3,000-ohm relay (Kurman-2221/90Y); ¼—p.d.t. switch; ½—1-watt neon bulb, NE 49; 1—1-watt neon bulb, NE 30; cabinet; sockets; hardware; solder; and hookup wire.

The timer should not be very expensive to build, especially if you have any of the parts in the junk box. The relay, the major item in cost, is a Kurman 2221/-90Y which can be had on the war surplus market for around 75 cents or ordered from Kurman Electric Co., 85-18 37th St., Long Island City, N.Y., at list price.

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Ward flashes again with the handsome Dymon-vane, the second model in its new series of Tele-vane TV antennas. Reflecting the modern trend and decor the beautiful new Dymon-vane enhances any home and becomes a valuable prized addition. Clean cut in design, a flawless performer, the Dymon-vane stands out as a glittering solitaire among all other TV antennas. A conical antenna with aluminum elements and black permataube cross arm with wrought adornments, the Dymon-vane is designed for complete coverage of VHF Channels 2—13 in metropolitan, suburban and fringe areas. The New Dymon-vane comes in single bay or two bay stacked models...folded and pre-assembled ready for easy installation.

The Ward Products Corp.
Division of the Gabriel Company

1148 Euclid Avenue, Cleveland 15, Ohio

In Canada: Atlas Radio Co., Ltd., Toronto, Ont.
A patent* was issued August 19, 1952, on a new form of gas-tube oscillator which contains no resistive, capacitive, or inductive time-constants, and needs no external or internal resonant circuits or cavities. This new ionic oscillator can deliver high output at audio or radio frequencies and has good stability over long periods of time. This is the simplest electronic oscillator known, and operates on as little as 2 milliamperes from a plate supply of 22½ volts or less. Fig. 1 shows the ionic oscillator’s simple circuit.

![GAS-FILLED TUBE](image)

**Fig. 1**—The utter simplicity of the ionic-oscillator circuit. The battery voltage is made equal to the normal ionization drop across the gas tube.

The U.S. Naval Research Laboratory in Washington found that when a certain critical voltage is applied between the plate and cathode in an inert-gas or vapor-discharge tube, the ionized gas generates oscillations in the audio-or radio-frequency range. This is something like the oscillations in a resonating crystal—but with the added advantage of much higher output.

A very simple experiment convinced the Navy and patent men that the oscillations were generated in the ionized gas of the tube and not in any external circuits. Fig. 2 shows the basic circuit used in original ionic-oscillator experiments. The full 22½ volts is applied first to fire the 884; then the voltage is reduced to the optimum value for stable sine-wave oscillations.

![Circuit used in original ionic-oscillator experiments. The full 22 Chung volts is applied first to fire the 884; then the voltage is reduced to the optimum value for stable sine-wave oscillations.](image)

**Fig. 2**—Circuit used in original ionic-oscillator experiments. The full 22½ volts is applied first to fire the 884; then the voltage is reduced to the optimum value for stable sine-wave oscillations.

The physical setup is shown in the photograph. If you check the settings of the scope controls you can see that the frequency of oscillation of the 884 is about 500 kc.

This experiment showed that any gas-filled tube (except certain neon bulbs) will oscillate when you apply a d.c. voltage across its plate and cathode equal to the voltage drop of the tube when ionized, and it will generate an almost perfect sine wave (not a sawtooth as in other gas-tube oscillators). Many gas tubes besides the 884 were tested in the same circuit and they all oscillated in the same way, except that each tube had its own fundamental frequency of oscillation just as crystals have.

The ionic oscillator in this experiment put out enough r.f. to be picked up on a home receiver at distances of 10 feet or more—*without an antenna*.

The ionic oscillator can be tuned over a limited range by changing the plate-cathode voltage in diode types, or by inserting a variable resistor between plate and grid in triodes and adjusting it for the desired output frequency.

Some of the gas tubes tested and their fundamental single-frequency outputs are as follows: 884—500 kc, tunable from 400 to 1,000 kc; 6Q5—1,000 kc tunable from 500 kc to 1,500 kc; 2050–15,000 cycles tunable from about 1 cycle to 20,000 cycles; 6C5/VR105—1,400 kc tunable from 900 to 1,900 kc. The Navy SN7 strobecope tube has an output of about 1,000 cycles tunable over the entire audio range. Neon bulbs have no frequency of oscillation as yet discovered. Fluorescent lights oscillate over a very broad frequency band and can be detected almost anywhere on the dial, but have definite peaks at certain frequencies. Some large thyratrons used in high-current circuits were found to have outputs as low as ½ cycle per minute, with current changes of up to 1 ampere. Many other types of gas tubes were tested and frequencies as high as 9 megacycles were noted.

**Modulation**

Either frequency modulation or amplitude modulation may be applied, depending upon whether the modulating voltage is inserted in series with the plate or in parallel with the grid and cathode. A .01-volt a.c. signal applied between the grid and cathode of a triode-type gas tube as shown in Fig. 3 will modulate the output of the ionic oscillator from zero to well over 100 percent. (With over 100 percent modulation you get a pulse-modulated carrier.) A ±0.01 volt input to the grid will produce as much as 1.5 volts change in the output carrier. This represents an a.c. amplification factor of 150, and also shows that grid control is possible with gas oscillators.

When a sound-powered or crystal microphone was connected between grid and cathode of the thyratron (Fig. 3) the voice-modulated output could be heard clearly on a radio receiver tuned to the fundamental frequency of the ionic oscillator.

When two ionic oscillators with different fundamental frequencies were connected in series as shown in Fig. 4 the result was a frequency-modulated carrier with an output of at least 1¼ volts r.f. The percentage modulation of this series circuit could be varied with the 50,000-ohm control of the upper triode.

**Advantages**

Now let’s look at the differences between this ionic oscillator and other more familiar oscillators. First we’ll compare the ionic oscillator with the relaxation oscillator which also uses a thyratron (or a gas diode) and may confuse a person who is not up on his electronics. The relaxation oscillator gives out a sawtooth waveform, whereas the ionic oscillator gives out a sine wave. The relaxation oscillator has a top frequency limit of about 50 kc because of the electron transit time between the plate and cathode elements and the ionization and deionization time of the gas. The ionic oscillator has an upper limit of over 1,500 kc. In the relaxation oscillator an external R-C time-constant network sets the frequency of oscillation; but an ionic oscillator using the same tube type has nothing but a battery in the external circuit.

In the gas-tube relaxation oscillator the grid loses control over the output waveform oscillation starts, but in the ionic oscillator the grid maintains control at all times. This is proved by the voice-modulation circuit shown in Fig. 3. In addition, the ionic oscillator works at a voltage equal to the plate-cathode voltage drop of the ionic oscillator.
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It's causing excitement everywhere, this display that is an eye
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Here's another selling tool that may be mailed directly to your
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They let everybody going into and by your store know that you
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ionized gas tube used, but the relaxation oscillator must have a much higher B supply due to the voltage drop in the external L-C network.

In comparing the ionic oscillator with the inductance-capacitance tuned-tank oscillator or the crystal oscillator, the ionic oscillator can be loaded very heavily; it needs no coupling circuit, and will transfer almost as much of its output to a low-impedance load as to a high-impedance load. In the L-C oscillator the resonant-tank circuit determines the frequency of oscillation, whereas in the ionic oscillator the ionized gas itself determines the resonant frequency regardless of the external circuit.

One further advantage: An L-C oscillator can be detuned or killed by hand capacitance. The ionic oscillator is not affected at all.

In tuning an ionic oscillator the plate-cathode voltage is adjusted so that a small plate current flows. This current is fairly critical over a limited region for single-frequency operation. (With larger plate currents, the ionized gas oscillates erratically at random frequencies.)

A circuit for general experimental work is given in Fig. 5. Either an 884 or 6Q5 thyatron can be used. R1 is a variable voltage-dropping resistor, and R2 is a variable grid resistor for tuning. The battery is 140 volts, and the 6.3-volt filament supply may be either a.c. or d.c. A current of about 10 ma should produce a good sine wave of about 1,000 kc with a 6Q5, and at about 550 kc with an 884. This oscillator can be modulated with a crystal phono pickup or microphone connected between grid and cathode, and the modulation should be heard clearly in a nearby radio.

**Other applications**

What uses can this oscillator be put to? Well, the ionic oscillator will drive an 807 r.f. power amplifier directly. No elaborate modulator circuit is needed for phone operation, as modulation can be applied to the oscillator itself.

The circuit of this transmitter is shown in Fig. 6. Here the ionic oscillator is used as the master oscillator for the 807. (Remember—this is an experiment only and keep F.C.C. regulations in mind!) At 600 kc the power output of the 807 is enough to light a 40-watt fluorescent tube. The bandwidth is no more than 10 kc on any conventional receiver.

The 807 is set up as a conventional class-A amplifier except for the fact that there is no grid tank circuit. The plate tank circuit was designed only to prove a point and not to stand up on any breakdown test. The tank coil was a four-pie 1-mh r.f. choke and the tank capacitor was a midget 144-µf variable. A 450- to 500-volt d.c. power source supplied the plate and screen voltages, and a dropping resistor supplied the ionic oscillator plate voltage. The ionic oscillator and the r.f. amplifier were coupled through a 0.05-µf 200-volt capacitor. (This may be varied for optimum drive to the 807; the cut-and-try method will give the best results.)

The ionic oscillator is adjusted till it oscillates best. Then the amplifier is turned on and the plate tank is tuned till the fluorescent tube lights with maximum brilliance when touched to the plate of the 807. Those who know tank circuit design and are licensed to operate on 160 meters or higher frequencies can operate the 807 as a doubler. Those who do not have a license are advised not to try this experiment, as this simple transmitter will radiate quite a distance.

The physical setup of the circuit shown in Fig. 2. Sweep-control settings show the sine-wave oscillations have a frequency of approximately 500 kc.

**Fig. 5—A circuit for general experimental work with the ionic oscillator.**

The ionic oscillator has been used also in audio signal generators, photo-cell amplifiers, radio receivers, pulse generators, special waveform generators, frequency- and amplitude-modulated oscillators, control circuits, and other special devices.

**Other Characteristics**

For those who are more interested in the experimental value of the ionic oscillator the following data were recorded during actual experiments:

**Fig. 6—A 40-watt 500-ke transmitter with an ionic master oscillator.**

It was found that an OC5/VR105 voltage-regulator tube will oscillate at as many as five different modes. These modes can be produced by opening and shutting the plate-current circuit. Each mode will follow the other in sequence as the plate circuit is interrupted. At the same time a spot of blue light can be seen switching up and down the cathode as each mode is reached. These modes or frequencies will always be the same for the same position of the
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This great series once again reaffirms Finco leadership! Model 502 is a 2-bay unit of the colateral* type with a "snap-out" screen for instantaneous installation. Model 504 is the 4-bay version, highly effective in super fringe areas where ultra high gain is consistently required. Both models feature high front to back ratio and excellent impedance match to 300 OHM line for low signal fringe areas. Completely preassembled — corrosion proof aluminum throughout (including screen) — one antenna, one transmission line!

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- 502B — channels 29-55
- 502C — channels 53-83

- 504A — channels 14-32
- 504B — channels 29-55
- 504C — channels 53-83

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blue cathode spot. This same shifting of frequency can be accomplished by beating one variable-frequency ionic oscillator against another.

It was also noted that if a d.c. or a.c. arc is made on a hard metal surface any ionic oscillator in the vicinity will shift frequency. Arcs on soft metal will not produce this effect. When a Navy type SN7 stroroscope gas tube is hooked up as an ionic oscillator and placed in the beam of another stroscopic light source, alternate light and dark bands can be seen moving clearly toward the plate from the cathode. If one pole of a magnet is brought near the column of ionized gas in the SN7 the frequency of this ionic oscillation will decrease as the bands move farther apart.

When an SN7 stroroscope tube is working as an ionic oscillator at about 5,000 cycles, the high-pitched audio note can be heard clearly coming from the tube elements.

If a variable resistor is connected between cathode and grid of a 4 tube oscillator, the oscillator will continue to work, even after the filament voltage has been removed, when a certain resistance has been reached.

If the grid of a triode-type ionic oscillator is driven very hard by an audio signal generator, the output carrier frequency will increase from about 1,000 kc to 9 mc. There will also be many different waveforms and pulsed radio- or audio-frequency combinations.

A tetrode gas tube such as the 2650 used as an ionic oscillator can have two separate control signals—one applied to the control grid and the other to the screen grid. These two signals can gate the tube to work only when both are present or when one or the other is present. In some tubes fixed a.c. modulating waveforms may be used for switching the ionic oscillations on and off.

In summary, the ionic oscillator is unique in that it is a high-frequency gaseous tube oscillator. In addition, it is a stable oscillator whose frequency and voltage output is constant for wide variations in load impedance. All this is done with extreme simplicity of construction.

Prior to the ionic oscillator, all oscillators using gaseous discharge tubes had the frequency determined by a tuned tank circuit connected to the output of the tube or by the charging time of an external capacitor as in a relaxation oscillator. The upper limit of most gaseous tube oscillators is generally no more than 50 kc because of the off-on process which has a definite minimum time limit. However, the ionized gas in a discharge tube normally oscillates within the tube at a frequency between 500 and 1,500 kc at low orders of ionization, the frequency being dependent on certain of the external circuit constants.

It should be clear to the reader that this is truly a new and unusual electronic invention that has many possibilities. Data will have to be compiled and checked before practical applications can be made.
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THE industrial uses of high-intensity sound waves far above audible frequencies are finding new practical applications. The 50-year-old field of ultrasonics has produced a great deal of theory, but, to date, very few commercially useful devices. Sonar is the outstanding military application, and much know-how has been locked up in Government laboratories.

This article describes three ultrasonic devices of known commercial utility. These devices will do jobs which are either impossible or impractical to do with conventional equipment. The 10-ke magnetostrictive oscillator can clean small complicated mechanical parts such as precision ball bearings more thoroughly, and faster, than ever before. An ultrasonic machine tool provides a device for machining complicated forms in the super metals and ceramics without using the critically short-supply and expensive diamond dust. For a new chemical catalyst, and medical therapy, the 1-mc electrostrictive equipment closes the gap a little further between the theoretical and the practical application of ultrasonics.

A **magnetostrictive oscillator**

The Raytheon 200-watt 10-ke magnetostrictive oscillator, model DF-101, was designed as a research tool primarily for the science laboratory and may be used to vibrate a sample of liquid at a frequency of approximately 10 kilocycles. However, it is finding application in industry for cleaning small parts.

The magnetostrictive oscillator consists of a driver unit and a treatment unit, Fig. 1. The treatment unit consists of a covered cup for holding samples. A vibrating diaphragm serves as the bottom of the cup. A laminated nickel rod is attached to the bottom of the diaphragm, and the field coil for magnetizing the rod is encased in a stand which is also used to hold the rod and cup.

The driver unit generates the ultrasonic electrical power which is fed to the field coil in the stand. A special push-pull electron-coupled oscillator is used to eliminate oscillator detuning due to changes in the load. The a.c. oscillations developed in the grid circuits of the oscillator tubes are coupled to the low-impedance load in the plate circuit with a step-down transformer. Because of the push-pull arrangement, core losses and second harmonic distortion are considerably decreased over single-tube operation. Maximum trans-
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fer of power to the field coil is effected by means of a filter circuit which balances out the reactive component of the load. The a.c. signal from an electrical oscillator is then superimposed upon a d.c. polarizing current supplied from a rectifier and together they are passed through the energizing coil in the stand.

A magnetostrictive motion

When a d.c. magnetic field is set up in a bar of magnetostrictive material, it expands or contracts parallel to the axis of the magnetic field. The permalloys expand while pure nickel contracts. With flux densities of a few thousand gausses, this contraction or strain in the material is about $10^6$, or 1 part in 100,000. When, in addition, an a.c. signal is passed through the same coil of wire, the resulting alternating magnetic field causes the bar to periodically shorten and expand about the contracted length whose value is determined by the polarizing current. If the frequency of the alternating current is equal to the resonant frequency of the bar, its resultant motion is also a resonance phenomenon, and the d.c. strain of $10^6$ may be multiplied 10 or 100 times depending on the effective Q of the material. Laminations are used to cut down the eddy-current losses which are proportional to the square of the frequency, flux density, and the thickness of the individual core laminations. Besides a magnetic hysteresis loss which is common to all magnetic materials, there is also an elastic hysteresis loss. In other words, a material which is subjected to alternate expansion and contraction exhibits a stress-strain loop similar to the familiar hysteresis loop.

The nickel laminations are used in producing the oscillations, for the following reasons: (1) A-type nickel, properly heat treated, has as high an electromechanical coupling factor (a figure of merit which relates the amount of electrical energy converted into mechanical energy) as any known magnetostrictive material. (2) Nickel is as rugged as the other materials and a lot easier to work with than annealing as well as machining point. The motion or amplitude developed at the end of the laminated nickel rod is coupled to a specially designed dia-

Fig. 2—A simplified schematic diagram of electronic driver and control equipment. spraying inside the enclosed can. Since the magnetic acoustic pressure of nickel deteriorates with increasing temperature, this water spray is necessary for best operation. A cap prevents the escape of any liquid when subjected to violent agitation and decreases the intensity of the sound radiated to the air.

The generation of cavitation

From a physical point of view, a major use of the 10-kc oscillator is its ability to cavitate liquids. The phenomenon of cavitation, which has long been one of the unknown quantities in engineering, is being attacked theoretically as well as experimentally by a number of laboratories. Present results indicate that at a fixed-pressure sound waves are transmitted to a fluid, the mechanical strain in the liquid becomes so great that the liquid is torn apart. Under steady-state conditions, liquid filled with air cavitate when the negative acoustic pressure reaches the atmospheric pressure. In terms of power density transmitted by the diaphragm to the fluid, the power required to cavitate liquid at atmospheric pressure is only 1% of a watt per square centimeter. Power densities of the order of 25–50 watts per square centimeter are available from the 10-kc unit. Cavitation point depends on frequency. For a fixed amplitude of sound, it is easier to cavitate at low frequencies. Major uses of the 10-kc equipment to date have been in the cleaning of small metal parts, bacteria disintegration, and the emulsification of immiscible liquids. The vibrating diaphragm may be coupled to a tank or container of any
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size or shape instead of the cup, thus facilitating the treatment of larger parts or the installation of continuous-flow apparatus. The standard cup supplied will hold about 150 cc.

An ultrasonic machine tool

Another magnetostriuctive device is the Raytheon ultrasonic machine tool which utilizes electronics and ultrasonics in a combination providing a unique machine tool capable of many operations which have in the past been impractical. The essential parts of the apparatus are the electronic driver and control unit, the transducer which converts electrical into mechanical energy, and the work-holding and positioning mechanism. Even though carbides and ceramics may be machined, the cutting tools may be made from cold-rolled steel or brass and are attached to the transducer so that they vibrate normal to the work surface. An abrasive suspended in water flows between the vibrating tool and the work piece. The

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### DC Resistance
- 19000 ohms per volt
- 1900 ohms per volt
- 190 ohms per volt
- 1.9 ohms per volt
- 0.19 ohms per volt
- 0.19 ohms per volt

### AC Voltage
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- 1900 ohms per volt
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- 0.19 ohms per volt
- 0.19 ohms per volt
- 0.19 ohms per volt

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### Notes:
- Complete with operating manual and pair of test leads with removable mini-clip leads. 4000 volt used in place of vacuum tube meter for many voltage and resistance measurements. May be obtained in 7 inch case. Read 3 ranges direct on the dial. The biggest dial in the smallest case before available commercially. Volt-Ohm-Microammeter with this sensitivity. 7 inch dial in 7 inch case. Read 3 ranges direct on the dial. The biggest dial in the smallest case before available commercially. Volt-Ohm-Microammeter with this sensitivity. 7 inch dial in 7 inch case. Read 3 ranges direct on the dial. The biggest dial in the smallest case before available commercially. Volt-Ohm-Microammeter with this sensitivity. 7 inch dial in 7 inch case. Read 3 ranges direct on the dial. The biggest dial in the smallest case before available commercially. Volt-Ohm-Microammeter with this sensitivity. 7 inch dial in 7 inch case. Read 3 ranges direct on the dial. 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**Electronic equipment**

A simplified schematic diagram of the electronic driver and control equipment is shown in Fig. 2. It consists essentially of a master-oscillator-power-amplifier utilizing two 6L6 tubes (V1 and V2) as a push-pull electron-coupled oscillator. The capacitance of C1 is varied to tune the driver to the transducer operating frequency. An untuned transformer T1 couples the m.o.p.a to the class-B power amplifier, utilizing push-pull 810's (V3 and V4) with approximately 500 watts output. A special output transformer T2 matches the 810's to the transducer load. An isolating network composed of C2 and L1 (CONTINUED ON PAGE 91)

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Indianapolis 26, Indiana
Telephone: Cherry 2461

$19.95
Color television is fast becoming a reality! Sets are expected to be available the first part of next year and stations are purchasing the necessary transmitting equipment. Initial costs, unfortunately, will be high but as improvements in design and production are achieved the price of color television will become within everyone’s reach.

The consumer is concerned with the problems presented by television in color. He has read reports on prices and availability; all have been conflicting. He knows, however, that his set will have to be replaced or converted. What he does not know is that if he has an AMPHENOL INLINE*, there will be no extra expense in antenna or installation! AMPHENOL engineers provided for color in the original design of the INLINE*.

Every dealer, distributor and installer will want to acquaint their customers with this reassuring information. The color television market is potentially tremendous. It certainly will prove of benefit if the consumer can be reassured on one part of the cost of conversion to color.

The fact that AMPHENOL INLINEs are able to receive color television so well reflects favorably upon the engineering ability of AMPHENOL. For in ordinary black and white television the same level-gain design has proved valuable. Set owners know, now, that their AMPHENOL INLINE* is providing them with the best black and white picture their sets can deliver.

Antenna Electrical Requirements for COLOR TELEVISION

Information now available on color television has made it clear that the receiving antenna must have these characteristics:

1. Antenna gain must be flat, no gain or loss greater than one db, within 1.5 mc below and 0.6 mc above the color sub-carrier* (a width of 2.1 mc).

2. Antenna gain must be held down across the FM frequencies. Rejection of FM signals is much more important in color than in black and white television.

*Channel frequency widths are at present divided between the monochrome amplitude modulation picture carrier and the frequency modulation sound carrier. The addition of the color sub-carrier is made at 3.58 mc above the monochrome carrier.

The AMPHENOL INLINE* fully meets the two conditions listed above. Besides being engineered to reject FM signals, from 88 mc to 108 mc, the INLINE provides very level gain across all channels, particularly over the color sub-carrier. Typical of the INLINE's performance on all channels is the gain chart illustrated above for channel 3. [Measured in accordance with proposed RETMA standards.]

AMERICAN PHENOLIC CORPORATION
chicago 50, illinois
permits application of a variable polarizing current to the transducer. Variation of this current enables the operator to control the ultrasonic power. The polarizing current is a direct current applied to the transducer to permit operation on the most efficient part of the magnetization curve. It is applied through L1 which offers a high impedance to 26 kc and thus isolates the polarizing current power supply from the 500 watts of 26 kc power applied to the transducer. The capacitor C2 has a low impedance at 26 kc, allowing passage of the 500 watts, but prevents the d.c. polarizing current from flowing in the secondary of T2.

The transducer

The heart of this machine tool is the ultrasonic transducer which converts electrical energy into mechanical energy of vibration or motion. A cross-section sketch of the transducer used on the first model of this equipment is shown in Fig. 3. In addition to the direct polarizing current, 26-kc electrical energy at approximately 80 volts and 6 amperes is fed into the coil wound around a stack of nickel laminations. For each ampere of current increase, the magnetic flux setup in the 4-inch nickel stack causes it to mechanically contract about one hundred thousandth of an inch. A decrease in current causes it to expand an equal amount in the manner previously described for the 10-kc oscillator. A sinusoidal change of current in the transducer coils will cause a sinusoidal variation in mechan-

Fig. 4—Sample of complicated machining on tungsten carbide, and tool used.

ical length of the nickel stack. At the mechanical resonant frequency of 26 kc, the length changes about .001 inch.

Attached to the lower end of the nickel stack is a metal cone designed to transmit the vibrational energy to the tool. The cone is designed to increase the amplitude of vibration and provide a closer match or more efficient energy coupling between the tool and work piece. A good analogy is the tapered electrical transmission line in which the capacitance and inductance per unit length are varied to change its characteristic impedance. The mass and stiffness per unit length are changed so that the nickel stack is matched at one end of the cone, and the tool at the other end more closely matches the load.

When you stock these five models of Featheride Replacement Cartridges, you can handle virtually all replacement needs—regardless of make of record player or changer—quickly, easily, profitably, and with a minimum inventory investment.

Mail the coupon for free copy of our handy new Replacement Chart YF-2, showing how you can most profitably fill your replacement needs.

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Model WS • A versatile unit capable of replacing the majority of 78 RPM Cartridges in the field.
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Model BX • Designed primarily for RCA Automatic record changers and Columbia players. Unusually high fidelity.
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Model FX • A two-needle twist cartridge, delivering high or low output.

THE NEW DISPENSER WILL INCREASE YOUR SALES

This attractive Featheride Replacement Cartridge Dispenser on your counter or wall will boost your sales and profits. It comes with a basic stock of 10 each of the 5 models shown above—each cartridge packaged with all needed fittings, instructions and data, in individual transparent plastic box. Replacement chart included in back of dispenser.

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Little Devil® COMPOSITION RESISTORS

Tiny, yes... but what dependability, ruggedness, and stability! And they provide an extra margin of safety—being rated at 70°C rather than 40°C. Completely sealed and insulated by molded plastic, they meet all JAN-R-11 requirements... are available in 1/2, 1, and 2-watt sizes in all RTMA values.

TYPE AB Noise-Free POTENTIOMETERS

Because the resistance material in these units is solid-molded—not sprayed or painted on—continued use has practically no effect on the resistance. Often, the noise-level decreases with use... and they provide exceptionally long, trouble-free service. Rated at 2 watts, with a good safety factor.

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ELECTRONICS

placed on it by the cutting action.

Tool cutting action

Although the maximum movement of the tool is only 0.004 inch, the acceleration is about 1.5 x 10^9 g (g = 32 ft./sec^2). This means that an object, the size and weight of a penny, when mounted on the end of the transmitting cone would exert a force of about one-half ton on the cone end. With the tremendous forces in play at the tip of the tool, it is not surprising that the abrasive and tool will eat their way into the work piece. The high acceleration given the abrasive particles is probably responsible for the cutting. Their extreme small motion gives a good surface finish and high accuracies.

Fig. 5—Ceramic transducer for propagation of ultrasonic energy into liquids.

Even though the tool material is cold-rolled steel or brass, the machine readily cuts tungsten carbide, glass, quartz, and many other hard and brittle materials. The operations it can perform are unique in the machine-tool field. It can be mounted to drill holes of complicated cross-section as illustrated in Fig. 4. The ultrasonic machine tool is finding application in die-making, and other fields where the use of expensive diamond dust has before been the only method of machining.

High-frequency ultrasonics

The practical physical dimensions of magnetostrictive materials limits the high frequencies at which a transducer made of this material can operate. It is therefore necessary to use either crystals or ceramics to obtain higher frequencies. In the study of propagation and absorption phenomena, frequencies in the order of 15 mC are commonly used. One megacycle is very good, since most liquids absorb large amounts of energy at that frequency. A 1-mega-cycle liquid treatment unit is now being developed which has as the transducer, an electrostrictive barium titanate ceramic. The equipment consists of a treatment cup, a barium titanate transducer, and an electronic driver.

The barium titanate transducer

Barium titanate is a polycrystalline ceramic which exhibits ferroelectric properties below its Curie temperature analogous in the electrical case to magnetic properties which are known to exist in magnetostrictive materials. In its original state the ceramic is not...
THINGS ARE NOT AS THEY SEEM...

The long lines are strictly parallel—that they appear otherwise is an optical illusion.

This fuse merely has the metal caps cemented to the glass.

The difference between these two fuses is no illusion...

This Littelfuse has the caps locked to glass like this.

The ends of the glass are formed. The solder which is bonded in a separate operation to the cap reflows through the small aperture and spreads out to form a permanent collar-button lock between cap and glass—impervious to moisture and vibration. The exclusive Littelfuse feature eliminates fuse failure due to loose caps.

Littelfuse leads all other fuse manufacturers in design patents on fuses. Lock-cap assembly patent no. 1922642

LITTELFUSE
DES PLAINES, ILLINOIS
piezoelectric. The piezoelectric behavior is introduced by applying a d.c. bias of 30,000 volts per centimeter with the directions of the electrical and mechanical axes depending on the direction of the polarizing field. When the d.c. field is removed there remains a residue polarization which may be as high as 90% of the saturation polarization. Therefore, there is no need for maintaining a fixed electric biasing field on the ceramic during operation.

Even though the ceramic can withstand high temperatures without changing its physical properties, the piezoelectric polarization is reduced at temperatures around 90°C, and becomes completely depolarized above the Curie temperature which is about 120°C. It is therefore necessary when using barium titanate as a transducer to have some form of cooling system that will keep the ceramic below 90°C.

Applying a small alternating voltage to the barium titanate will cause the ceramic to mechanically vibrate. If the frequency of the applied alternating voltage approximates a frequency at which mechanical resonance can exist in the ceramic, the amplitude of vibration is considerably larger. Since the ultrasonic intensity of a sound wave is directly proportional to the square of the amplitude, vibrating the ceramic at resonance will give a large ultrasonic intensity output.

The electromechanical coupling factor of barium titanate is much greater than that of quartz. The electromechanical coupling factor is the same as described for the magnetostrictive transducer. It represents the percentage of the total electrical energy applied to the crystal or ceramic which is stored in mechanical form. For quartz the electromechanical coupling factor is about 1%, whereas in barium titanate it may run as high as 30%.

One advantage barium titanate has over quartz is the low impedance of the ceramic which allows it to operate at low driving voltages. Another advantage that barium titanate has over quartz when being used as a transducer is that the transducer can be made to any desired size or shape. The ceramic can be molded in the shape of a focusing radiator which will concentrate ultrasonic energy in a given region.

A one-megacycle treatment unit

Fig. 5 shows the liquid treatment unit with the ceramic transducer mounted against an aluminum diaphragm. The ceramic is 2 inches in diameter and has a thickness of 0.100 inch. The diaphragm is designed to couple a maximum of ultrasonic energy to the liquid. This is accomplished by making the diaphragm an integral number of half waves thick. For aluminum at 1 mc a half wavelength is 0.32 cm or 0.126 inch. The diaphragm in the present liquid treatment unit is two wavelengths thick or 0.504 inches. This thickness gives the diaphragm sufficient cooling surface to keep the ceramic from overheating while in operation. A special grease is used to bond the ceramic to the diaphragm, with enough pressure being applied by a spring to keep the ceramic in contact with the diaphragm. A metal contact which supplies the alternating voltage to the transducer is made so that the gap is constrained as little as possible while vibrating, and at the same time prevents the ceramic from slipping.

The water cooling system serves to keep the diaphragm, which is in contact with the ceramic, at a temperature low enough to prevent the ceramic from becoming depolarized. The liquid treatment unit is at ground potential with the high potential lead connected to the ceramic as shown in Fig. 5.

As was mentioned before, the low impedance of the ceramic permits 60 ultrasonic watts output with only 100 to 180 volts drive. Intensities of 3 watts per square centimeter are easily obtained. The unit shown in Fig. 5 can easily be adapted to continuous flow treatment or larger tank by bolting the transducer on the side or bottom of any large container. In this manner the transducer may be adapted to any liquid in almost any container. A large deal of information has been published on successful ultrasonic treatment of many liquids. In the field of chemistry, success has been obtained in the degassing of various types of liquids, vaporization of liquids, and the transformation of chemical compounds. A few biological effects are the destruction of protozoa and bacteria, loss of reproduction power to yeast cells, and loss of luminosity to luminous bacteria.

Since sound is such an integral part of sonar and similar underwater detection, it is highly probable that magnetostrictive oscillators will become increasingly important in depth sounding devices such as fathometers, and for military applications.

Many surprising and interesting effects are produced by high-intensity ultrasonic waves, but there yet remains a vast field of observed phenomena of intrinsic value to society. It will pay to keep an eye on this field for new developments which are sure to come.
The KAY-TOWNES "BIG JACK" IS not A NEW ANTENNA

The "BIG JACK", recognized even by competitive manufacturers as the best performing VHF antenna design ever developed HAS BEEN ON THE MARKET FOR MORE THAN 1½ YEARS!

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Kay-Townes technical experience and engineering details plus careful manufacture, all combine to make "BIG JACK" the most advanced antenna on the market today. As a matter of fact, certain other manufacturers who have failed to come up with matching performance in antennas of their own design, have attempted to copy the "BIG JACK" design, with questionable results.

HUNDREDS OF STATEMENTS LIKE THE ONE REPRODUCED HERE, PROVE "BIG JACK'S" SUPERIORITY!

Dear Sirs:

I have one of your BJ-2 "Big Jack" Antennas, which was installed approximately 2 months ago. It has consistently proved vastly superior to any other antenna in this locality. I have nothing but praise for this well made, expertly designed antenna. We receive WSB-TV, Atlanta, channel 2, 165 miles away better than everyone else around here. WAGA-TV, Atlanta, channel 5, and WBTV, Charlotte, channel 3, also come in clear and sharp.

James R. Rule
Oak Ridge, Tennessee
ADFOJET

Mark II

Electronic equipment has a relatively short life under the best of conditions. Juniors' interest could hasten electronic oblivion

By ED BUKSTEIN

T O A TWO-YEAR-OLD boy, the radioman's home or shop is a paradise of fascinating gadgets. Standard toys like blocks, rubber balls, and miniature automobiles lose their appeal and become unattractive in the presence of such attention-catchers as a signal generator and oscilloscope. The two-year-old is an indefatigable knob-twister and switch thrower, and an instrument panel provides an ideal outlet for his natural and insatiable curiosity. The complexity of the problem is further increased by the fact that the pages of a Rider's Manual are ideal in size and weight for making paper airplanes, and that a slide rule equipped with a rubber band can be used as a cross-bow type of weapon.

Fathers who subscribe to the old adage, "Spare the rod and spoil the child", probably have well-behaved children; but these are dull, unimaginative children deprived of curiosity and self-confidence. Equally unfortunate is the child whose father follows the newer philosophy of letting the child express himself even if this self-expression takes the form of drilling holes in the floor. The ideal solution to the problem lies in diverting the child's attentions into nondestructive channels while still providing him with ample opportunity to exercise his imagination and curiosity.

It was after the discovery that several reference books had taken on a coating of jam, and that an assortment of broom straws, match sticks and pencil leads had been pushed into the pin-jacks of the audio generator, that I seriously directed my attention to this problem. This led to the development of ADFOJET (Attention Diverter For Junior Electronic Technicians).

The first ADFOJET unit consisted of a masonite panel with six pilot-light assemblies mounted in a horizontal row. Each assembly had a different color jewel (white, yellow, blue, orange, green, and red). It took several trips to the buzzer ring, it is necessary to depress the push-button of the same color. To preserve the peace and tranquility of the household, spacers were placed under each push-button. This permits the button to be pushed far enough to make contact, but not far enough to lock. The unit was mounted in a bookshelf where it has been serving its purpose admirably ever since. It has proved to be an excellent teacher of logical thinking, cause and effect reasoning, etc.

Should the novelty of Mark II wear off, several modifications are being held in reserve. For example, the unit could be used to teach a child to identify objects by their names. This would involve pasting pictures of the objects over the lights, and printing the names alongside the corresponding push-buttons.

Also, by marking the lights 1 times 9, 2 times 9, 3 times 9, 4 times 9, etc., and marking the pushbuttons 9, 18, 27, 36, etc., the unit could be used to teach the multiplication tables. In each case, the sound of the buzzer indicates a correct answer.

The tension has gone now, and everyone has relaxed. The vacuum tube voltmeter looks out defiantly from its shelf, and the reference books stand brave and unmolested. Peace has returned to our household.

END
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Superior's new Model 670-A

SUPER METER

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

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/30 Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/10,000 Ohms to 10.1 to 100.1 Ohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Quality test for electrolytic)
REACTANCE: 50 to 2,500 Ohms 2,500 Ohms to 2.5 Megohms
INDUCTANCE: 15 to 7 Henries 7 to 7,000 Henries
DECIBELS: +6 to +18 +14 to +38 -34 to -58

ADDED FEATURE:

The Model 670-A includes a special GOOD-BAD scale for checking the quality of electrolytic condensers at a test potential of 150 Volts. The Model 670-A comes housed in a rugged crinkle-finish steel cabinet complete with test leads and operating instructions.

$28 40 NET

Superior's new Model TV-11

TUBE TESTER

SPECIFICATIONS:

Tests all tubes including 4, 5, 6, 7, Octal Lock-in, Peanut, Bantam, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Norals, Sub-minors, Proximity fuse types, etc.

Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin placement in the RCA box numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are instantly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary.

The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

Free-moving built-in roll chart provides complete data for all tubes.

Newly designed Line Voltage Control compensates for different voltage line voltages between 105 Volts and 130 Volts. Noise Test Plug on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

$47 50 NET

Superior's New Model 660-A An AC Operated

SIGNAL GENERATOR

PROVIDES COMPLETE COVERAGE for AM-FM & TV Alignment

SPECIFICATIONS:

Generates Radio Frequencies from 100 Kilocycles to 70 Megacycles on fundamentals and from 50 Megacycles to 220 Megacycles on powerful harmonics. Accuracy and Stabilities are assured by the use of permanently trimmed High-G coils, R.F. available separately or modulated by the Internal audio oscillator. Built in 400 cycle sine wave audio oscillator used to modulate the R.F. signal available separately for audio testing of receivers, amplifiers, hard of hearing aids, etc. R.F. Oscillator Circuit: A high transconductance hexode is used as an R.F. oscillator, mixer and amplifier. Modulation is effected by electron coupling in the mixer section thus isolating the oscillator from load changes and allowing high stability. A.F. Oscillator Circuit: A high transconductance pentode is used in an audio oscillator circuit. A high stability is achieved by modulating the oscillator signal to R.F. and mixing it. The output (over 1 Volt) is nearly pure sine wave. A attenuator: A 5 step ladder type of attenuator is used.

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Please send me the units checked. I am enrolling the down payment with order and agree to pay the monthly balance as shown. It is understood there will be no monthly balance or other charges, provided I send one monthly payment due when due. It is further understood that if I fail to make any monthly payment when due, the full unpaid balance shall become immediately due and payable.

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City......State

DECEMBER, 1953
RATING POWER TRANSFORMERS

By DARWIN H. HARRIS

USUALLY, the most important rating of a power transformer is the maximum B plus current it can supply. Here is a simple yet reliable method for measuring that current. It is especially useful for checking self-regulating transformers, which are often rated optimistically, to say the least; or for checking those beautiful hermetically sealed military surplus jobs which most of us find irresistible, and then wonder what to do with, because no one seems to know their specifications.

The first step is to measure the resistance of the high-voltage secondary winding. (One side of a center-tapped winding is enough, but it's a good idea to check both sides to make sure you don't have an open winding.) Then, with all secondaries unloaded, connect the primary across the power line and measure the voltage (be careful!) across the half-secondary. If the transformer is already installed and wired into a piece of equipment, remove all the tubes, and take resistance and voltage readings at one of the plate pins of the rectifier tube.

Divide the open-circuit voltage by the measured resistance. This gives a figure (called here the V/O ratio) which is the formula for our current; however as used in this case, it is meaningless. (If we were to apply Ohm's law, we would use V/Z.) To get the figure we want, multiply the V/O ratio by the factor 25 for a capacitor-input filter, or by the factor 35 for a choke-input filter. The answer is the current capacity, in milliamperes.

The principle is simple: The resistance of the secondary is a function of the size and length of the wire in its winding, while the voltage is a function of the length of the wire alone. The V/O ratio is then a function of the size of wire only, and this is a measure of the allowable current. Of course, a number of other factors contribute to the development of heat, which is the basic limitation to the current drawn; all such characteristics that are a part of the transformer are assumed to be of average value, that is, their net effect is considered constant.

This would not be true over a wide range of transformer sizes. The factors given are known to apply to small and medium sizes, up to about 200-ma ratings. The author has had little experience with larger units, and the application of this method in that range is uncertain.

It is important to take account of the difference in load resulting from the type of filter input used, by employing the appropriate factor.

Here are three examples showing how to use this rating method:
YOUR ELECTRONIC EQUIPMENT Demands Highly Specialized WIRE

THE MANUFACTURERS AND SERVICE MEN WHO SERVE BEST

Specify Belden WIREMAKER FOR INDUSTRY

DECEMBER, 1953
Follow this path to faster, more profitable repair service

If you're like thousands of other busy Service Engineers, you can't afford to sacrifice profit time—hunting for repair parts. That's why it pays to have your Centralab controls on hand when you need 'em—in one of these 3 handy Blue Shaft Control kits. Assortments contain every replacement value you use every day, in plain or switch types, for popular radio and TV sets!

contains 23 controls (8 types) in ½ and 1 megohm. All units C4 audio taper. Standard full-length fluted mill and split-knurl shafts.

For your own satisfaction as well as for the customer's benefit, you should check the alignment of every TV set that you repair. Do this after you have fixed the other troubles and the set is in operating condition.

Most technicians think of a careful TV-i.f. alignment as a long-drawn-out operation that involves the following procedure:

1. Set up the TV receiver for picture-i.f. over-all response check, with sweep generator, marker generator, dummy antenna, and oscilloscope connected according to set manufacturer's instructions (See Fig. 1).

2. If the response is too far out to be corrected by minor adjustments, disconnect the oscilloscope and replace with a v.t.v.m.; disconnect the sweep generator and hook up the marker generator alone.

3. Set the marker generator to each trap frequency in turn, and adjust the corresponding traps for minimum output on the v.t.v.m.

4. Set the marker generator to each i.f. alignment frequency in turn and adjust the corresponding i.f. windings for maximum output on the v.t.v.m.

5. Disconnect v.t.v.m. and replace with oscilloscope; disconnect marker generator from receiver and replace with original sweep-generator-marker-generator hookup.

6. Check over-all response and make any adjustments needed to get the correct curve.

I get the same results in much less time with the following method:

1. Hook up the sweep generator, marker generator, dummy antenna, and oscilloscope, and check the i.f. response as before. If realignment is necessary turn the sweep-width or deviation control on the sweep generator to zero; throw the sweep center-frequency dial or band-selector switch out of the i.f. band and cover the bright aluminum interior with flat black paint, resulting in a markedly cooler ambient temperature. This system may not be foolproof, but it's a step in the right direction.

IMPROVED TV AND FM ALIGNMENT PROCEDURE

By JOHN VAN DORMOLEN

1. A small replacement type transformer is rated "700 volts c.t. at 50 ma." The secondary measured 650 ohms and 840 volts open-circuit. The V/O ratio is 1:3; 25 times 1.3 equals 33 ma for capacitor input, and 35 times 1.3 equals 46 ma for choke input. It appears that the advertised rating applies only to choke input, and the high secondary voltage confirms this. The extrapolated regulation line would intersect zero current at roughly 500 volts d.c. (half secondary unloaded r.m.s. voltage times 1.33) and assuming purposely poor regulation of 2,000 ohms, voltage at the filter output with a 50-ma load would be 400 volts (560×2,000 × .05) approximately. With choke input, assuming 1,000 ohms regulation and a 50-ma load, the corresponding voltages would be about 380 and 330 respectively.

2. A husky-looking good-quality surplus transformer was rated by the seller at 125 ma. This was wired into a circuit without checking the current rating (before this method of checking was adopted), and the transformer ran very hot when operated at the supposedly conservative load of 50 ma. Later measurements of the secondary gave 550 ohms and 500 volts. The V/O ratio is 1:0, and ratings become 25 ma and 35 ma for the respective inputs. This is an extreme example of misrating; usually surplus transformers turn out close to the listed current figure.

3. The power transformer in my oscilloscope was running hot and I was interested in comparing the actual current with the V/O rating. The secondary readings were 1,300 ohms and 850 volts. This gave a V/O ratio of 0.65. The filter output with a 50 ma load is the rating is 17 ma. The measured current also showed exactly 17 ma—a rather surprising agreement. The overheating was due to inadequate ventilation. This was remedied by punching ventilating holes in the frame and covering the bright aluminum interior with flat black paint, resulting in a markedly cooler ambient temperature. This system may not be foolproof, but it's a step in the right direction.
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with U.H.F. —Licensed under RCA patents

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both with U.H.F.

TECH-MASTER Model 630 TV CHASSIS. This Model has retained the outstanding characteristics of the RCA-630 circuitry, namely the four-stage, full band with picture 1F strip and the three-stage FM sound section + In addition, the latest innovations in synchronization and sweep circuits have been incorporated to produce a custom-quality receiver assuring outstanding performance • 30 tubes, 12 speakers
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RADIO-ELECTRONICS
THE CBS-Colortron, an aluminized, direct-view, tricolor picture tube designed for use in color-television receivers, has been announced by CBS-Hytron. Electromagnetically deflected and electrostatically focused, the Colortron (HD-187) has a deflection angle of 45°, and an over-all length of 28.75 inches. It provides a choice of full-color or black-and-white pictures on a screen area of approximately 104 square inches.

It is an all-glass tube with a 15-inch envelope and uses a unique mask-and-screen assembly (see photo in Radio Magazine). It is interchangeable with the RCA 15-inch glass color tube. The electron-gun assembly contains three matched, electrostatic-focus electron guns, each similar to the gun used in the 5TP4 projection-type black-and-white tube. The phosphor screen of the Colortron contains some 250,000 phosphor dots of each primary color, a total of 750,000. These dots are arranged in 250,000 triangular groups, or triads. Each triad contains one red, one blue, and one green phosphor dot.

Typical operating voltages for the HD-187 are: Anode 20,000; grid 4 (convergence) 9,300; grid 3 (focus) 3,100; with grid 2 of each gun at 200 volts; grid 1 of each gun 45 to 100; and grid 2 of each gun 240 volts.

Base diagram of CBS-Colortron HD-187. Pin (1) heater; (2, 3) grids 1 and 2 of red gun; (4, 5) cathodes of red-and-green gun; (6, 7) grids 1 and 2 of green gun; (8) no connection; (9, 10) grids 4 and 5; (11) back grid 2 and 1 of blue gun; (13) cathode of blue gun; (14) heater; metal flange—anode.

CBS-Hytron also plans to mass-produce a 21-inch rectangular color tube late next year.

RCA has announced production of three new tube types, the 12X4, 601, and 6293.

The 12X4 is a full-wave 7-pin miniature vacuum type rectifier tube intended especially for use in vibrator type power supplies of automobile radio receivers operating from a 12-volt storage battery.

Rated to withstand a maximum peak inverse plate voltage of 1,250, the 12X4 can supply a maximum peak plate current of 0.06 ampere per tube. When operated in a full-wave circuit with capacitor input to filter, and an a.c. plate-to-plate supply voltage of 650, the 12AX4 can deliver about 300 volts d.c. to the filter at a load current of 70 milliamperes. With choke-input filter and an a.c. plate-to-supply voltage of 900, it can deliver approximately 370 volts d.c. to the filter at a load current of 70 milliamperes.

The 6101 is a "premium" medium-mu twin triode of the 7-pin miniature type. It was designed for use as a class A amplifier and control tube in mobile and aircraft equipment, where dependable performance under shock and vibration is a fundamental consideration. It is constructed and processed to meet military requirements.

Developed from the type 610, the 6101 has many unique structural features. These features include additional mica insulators to keep the mount rigid and to lock the tube parts firmly in place, and an embossed cathode which is stitched to the top mica insulator and securely anchored to minimize cathode shift.

The 6293 is a small, sturdy beam-
What the well-dressed window is wearing
power-amplifier tube intended for pulse modulator service in both fixed and mobile equipment.

Rated for service with duty factors up to 1.0 together with a maximum averaging time of 10,000 microseconds in any interval, the 6293 offers the equipment designer a wide choice of operating conditions involving different combinations of pulse lengths and repetition rates. For example, the 6293 can deliver a peak plate current of 3 amperes during a pulse length of 30 microseconds under conditions with duty factor of 0.003 and plate-supply voltage at high line conditions, and increased ruggedness to withstand momentary overloads.

Amperex Electronic Corporation announces the addition of a new type, type 6282, to its line of twin tetrodes. It is a lower-power version of Amperex type 5884/AX9903. Its maximum plate dissipation rating is 20 watts under ICAS conditions and it works efficiently with a power output of 12 watts at 600 mc. It has been successfully operated as a frequency multiplier over the entire u.h.f. television band. The tube is particularly suitable for low-drain mobile transmitters and multiplier chains.

Rounding out a wide selection of new tubes this month, RCA announces production of the 5ABP1, 5ABP7, and the 5ABP11, a new series of 5-inch, flat-face, C-R tubes utilizing electrostatic focus, electrostatic deflection, and post-deflection acceleration. They differ from each other only in the spectral-energy emission and persistence characteristics of their respective phosphors, P1, P7, and P11.

The 5AB type has exceptionally high sensitivity and low capacitance electrodes provided for vertical deflection. These electrodes are especially suited for operation from wide-band amplifiers, the high sensitivity making up for the low signal output of such amplifiers, and the low capacitance providing the type of load into which such amplifiers work best. The horizontal deflecting electrodes have higher sensitivity than previous similar electrostatic types while retaining full screen deflection.

Another feature of these new types is the small size and high brilliance of the fluorescent spot, characteristics which make it possible to "see" more, even with high-speed phenomena. The 5AB types can generally be substituted for the corresponding older 5C types to give improved performance.
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WITH THE TECHNICIAN

NATESA HOLDS CONVENTION

Nearly 700 service dealers and technicians from 35 areas from Texas to Ontario convened in Chicago October 9, 10, and 11 at the Fourth Annual Convention of the National Alliance of Television and Electronic Service Associations. The records indicate 659 registrations during the three days of the convention. In addition, some 30 companies rented booth space for exhibits of new items of interest to the service profession.

The October 9 sessions were devoted to the subject of business promotion. Highlight of the day was the talk by Professor J. H. Hazlehurst of North- west University, "Are You Training Your Competition?" Professor Hazle- hurst pointed out that most TV tech- nicians are trained on the job, and that it costs time and money to train them. He suggested means for making the greatest use of this training and retaining the employee, instead of handing over the job, along with the employee, to a competitive organization.

The second day witnessed possibly the most brilliant collection of papers ever read before a service convention. Opening with a talk on u.h.f. and u.h.f. antennas by John Spack of Amphenol, the program continued with the now famous talk "How To Interpret What You See" by Bill Ashley, Raytheon field engineer. Dan Cretato, vice-president of RCA Service Co., spoke briefly on training for color TV, and introduced E. R. Klingman, who unveiled RCA's new Color TV Trainer. This is a complete color receiver, mounted on a somewhat larger board than the older and now well-known black-and-white Dynamic Demonstrator. Constructed under the supervision of Merrill Gander, chief engineer of RCA Service Co., it operates as well as a more conventionally wired color receiver. With all its 540 parts and soldered connections out in sight, it offers an ideal tool to demon- strate the correct adjustment of a color set as well as adjustment of many forms of possible malfunctioning.

A Sunday crowd of visitors inspected the exhibits which included the "hire day" of the convention. An informal demonstration and discussion on color television occupied the earlier part of the afternoon. Later there was an excellent funda- mental talk on training by C. E. Walters of RCA Service Co., following which Howard Sams and Bill Rennier of the Sams Photofact Service discussed u.h.f. problems.

The whole slate of NATESA officers was re-elected for the next year. They are Frank Moch, Chicago, president; J. B. McDowell, Kansas City, secretary general; John Hemak, Minneapolis, treasurer; Bertram Lewis, Rochester, New York; Eastern vice-president Harold (Dusty) Rhodes, Paterson, N. J., East- ern secretary; Fred Colton, Columbus, Ohio, East-Central vice-president; Francis Fingado, Denver, Colo., West- ern vice-president; Homer Mauer, Chey- enne, Wyo., Western secretary; and Vincent Lutz, St. Louis, Mo., West- Central vice-president.
BETTER BUSINESS

The Better Business Bureau of Columbus, Ohio, recently paid a telling tribute to organized service enterprises. Speaking through its publication "For the Home Folks," the Bureau stated: "The Columbias B.B. is happy to report that it has never had an one complaint against any member of the Associated Radio and Television Service Dealers" (the local service association), and goes on to point out that ARTSD is living up to its insinuation: "Certified Radio and TV Service." ARTSD has also solved a very important topical problem in modern servicing, namely, the correct definition of a high-fidelity enthusiast. According to ARTSD Service News, "A true high-fidelity fellow is one who, when he hears a girl singing in the bath, puts his ear to the keyhole!"

RETMA SPONSORS COURSE

The Radio-Electronics-Television Manufacturers Association September 21 opened a pilot course for training radio-TV service technicians in New York City. The course is open to practicing technicians with three or more years experience. Both classroom and laboratory instruction in advanced servicing techniques are included in the program. RETMA member companies donated 15 benches of test equipment as well as TV antennas, components, antennas and printed instructional material. The photo shows one of the test benches, with students at work.

NOW IT'S FTRSAP

The Pennsylvania State Federation, at a meeting held in the Sheraton Hotel, Pittsburgh, decided to take final action to change the present charted title of the organization to The Federation of Television-Radio Service Associations of Pennsylvania. Action was to be effective with the October meeting.

A panel discussion was held on the effect of Pennsylvania's newly enacted Consumers' Sales Tax Law and its application to the service industry in the State. A number of delegates felt that tax registration would more clearly define the margin between a wholesaler and retailer, since the latter also requires a State registration number.

NEW GROUPS JOIN NATESA

Three new radio-TV associations have joined NATESA, Frank Moh reported at that organization's annual meeting in Chicago. The new groups are: Association of Television Service Companies, Cincinnati, Ohio; Association of Western New York, Buffalo; and Rhode Island Radio and Businessmen's Association, Providence.

DECEMBER, 1953

“Save with confidence!”

The Lowest Priced Kits on the Market

Lowest Priced Signal Generator, Broadcast Band

A new simplified two-tube oscillator is being marketed by Station Engineering for $7.95. It is made to operate with the 455 K.C. shortwave broadcast band. It is "completely wired, will operate for hours as a test oscillator for broadcast equipment."

6-Tube Radio Kit

Kit #2 - A low-priced 6 tube kit designed for high sensitivity, excellent selectivity and good tone quality. Uses 25L4, 25G7, 6AT7, 6EG1, 6SK7 in an easily constructed circuit. The 6 tubes are housed in a plastic cabinet. Complete kit for $6.95.

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Kit #3 - No kit! Wireless phonograph oscillator transmits recording for crystal pickups or voice from carbon microphone through radio. Also used for intercomm by using F.M. speaker-tubes! Two tubes, $2.95. Kit of Complete Set of Tubes, $3.95.

5 Tube AC-DC Superhet Kit

Kit #1 - A five tube superheterodyne kit, A.C. or D.C. contains all components required to build this latest design of high sensitivity superhet receiver. Price is for black box and solder: Only $7.95. Kit of 5 tubes (D804, 12AT6, 35U4, 50C5, 50C6). Only $3.25.

D 1273 INSULATED RESISTOR KIT

Contains 100 resistors 1/2, 1/8, 1/4, 1/2 and 1 watt 5% tolerance in a plastic box. Price complete $1.65.

D 1278 PAPER TUBULAR BY-PASS CONDENSER KIT

Contains 50 by-pass condensers ranging in capacity from 0.005 to 0.025 Mfd, to 20 Mfd, and at voltages from 200 to 1600, housed in a plastic transparent cabinet. Size 7 x 3/4 x 1/2. Price $2.95 per kit.

D 1279 DISC CONDENSER KIT

Contains an assortment of 50 Eric type disc ceramics, includes the following capacities: 0.01, 0.02, 0.05, 0.1, 0.15, 0.2, 0.3, 0.4, 0.5, 0.6, 0.8, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0, 10.5, 11.0, 11.5, 12.0, 12.5, 13.0, 13.5, 14.0, 14.5, 15.0, 15.5, 16.0, 16.5, 17.0, 17.5, 18.0, 18.5, 19.0, 19.5, 20.0. Price $2.95 per kit.

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* VOLTAGE REGULATION (A Precise First)

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300K-Kit form $129.50

300K-factory wired $199.50

NEW PATENTS

CONTRAST CONTROL
Patent No. 2,641,649
Robert H. Pierce, Palatine, Ill.
(Assigned to Radio Corp. of America)
TV circuits, like radio, suffer from limited dynamic or contrast range. The original TV signals must be compressed for transmission through video channels. For best contrast, it may be desirable to compress voltages representing light areas and to expand those representing dark ones, while reducing the over-all range. This control network is instantly adjustable and maintains constant impedance. It uses four rectifiers (1N34) and two 1,000-ohm ganged potentiometers. The output impedance is about 350 ohms.

Assume that the movable arms are at the left of each potentiometer (see Fig. 1). If the video input is negative, its path is through D1, D2, and the potentiometers. R7 is minimum and R8 is maximum. The network becomes a voltage divider that passes most of the signal to the load. The greater the negative voltage, the better the conduction through D1, and the higher the percentage of signal transmitted to the other. In these records, negative signals are expanded. See curve A in Fig. 2.

Positive signals pass through D3, D4, and the potentiometers. In this case, R7 is maximum and R8 is minimum. Less than half the input is transmitted. The greater the positive signal, the greater the conduction through D4, and the smaller the percentage of voltage passed on to the load. Thus, positive signals are compressed as shown by curve A.

When the potentiometer arms are both moved to the right, conditions are reversed. The positive signals are expanded, the negative signals are compressed. This is shown by curve B.

With the potentiometer arms set to mid-point, there is practically no compression or expansion, and the contrast remains unchanged (curve B).

SPACE CHARGE CONTROL TUBE
Patent No. 2,607,861
Herbert M. Wagner, Auburndale, Mass.
(Assigned to the United States of America as represented by the Secretary of the Army)
Billions of grid-controlled tubes are used for communication, computation, and control. Their performance is best at low and medium frequencies. At very high frequencies, efficiency drops off. This is due primarily to inductive and capacitive effects. This inventor suggests the use of a grid electrode to form a capacitor. In this way the frequency range can be greatly extended.

The space-charge tube is shown in diagram. The electron gun appears at the left of the tube. Cathode K1 emits electrons which pass through grid G toward the plate P1. They must travel over a relatively long path, so they remain within the tube for a considerable time. Thus a space charge is built up. The main tube discharge occurs between cathode K2 and plate P2, and is aided by accelerating grids A1, A2. Output cur-
rent flows through the load and high-voltage supply.

When G goes more positive, it passes more electrons and the space charge grows. The charge is negative so it opposes emission from K2. For example, if G is driven beyond cutoff, there is no space charge at all. Output current would then be maximum. Thus, input signal modulates tube output at all times.

Absence of a metallic grid reduces the input capacitance and means a far greater input impedance. A space-charge tube of this type has possibilities for both control and amplification. For high gain K2 should be a much larger element than K1.

DIRECTIONAL TV ANTENNA WITHOUT MOTORS

Patent No. 2,585,670
Marvin P. Middlemark, Woodside, N. Y.

This is a directivity control for TV antennas. The antenna may be a crossed-dipole affair as shown. Leads from its four conductors end at a 9-position switch located near the receiver. The viewer turns the switch as required for maximum signal and minimum ghost.

The switch has two sections, X and Y. Each has seven fixed contacts, one of them a common terminal. Also, each section has two movable contacts (shown shaded). The smaller contacts (one on each section) are strapped together. The antenna conductors, 1 to 4, connect to certain switch contacts as marked. For example, XK indicates an X terminal to which S is tied. Note there are two of them.

In the position shown, conductors 2 and 3 feed the TV receiver through the common terminals. Also, 1 and 4 are shorted through the small movable contacts. Response is maximum from a direction midway between the effective conductors, that is from the east. As the switch is rotated from one position to another, the directional pattern changes. The table lists various positions (counting clockwise) and results obtained.

PUSH-PULL TRANSISTOR AMPLIFIER

Patent No. 2,844,859
Loy E. Barton, Princeton, N. J.

This is a push-pull amplifier that may be connected either with grounded base or grounded emitter. The first is more stable, the second permits more gain. This circuit feeds the transistor in push-pull. Neither base nor emitter is grounded. A ground tap is placed on the input coil between the emitter and base terminals.

The turns ratio between windings A, B, are determined as follows. The ratio between base and emitter impedances must be known. The base input resistance will be negative. If, for example, the base resistance is 10,000 ohms and the emitter has a positive resistance of 500 ohms, this is a ratio of 20 to 1. An impedance ratio of 20 means a turns ratio of 20/20 or 0.5 to 1. Thus A should have 4.5 times as many turns as B. A turns ratio of 4.5 to 1 is typical. Since the turns ratio varies as the square root of the impedance ratio, it will not vary greatly. R and C form a bias network for the emitter.

END

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FRINGE ANTENNA

JFD Manufacturing Co., 4101 Sixteenth Ave., Brooklyn 4, N. Y., has announced a v.h.f. antenna for fringe-area reception, the Jet123. It has a flat gain curve for channels 2-6, due to the dual reflector action. The high-channel section consists of two driven elements and two directors spaced to present a reasonably flat response on channels 7-13.

Among outstanding advantages of the Jet123 is its excellent directivity and the absence of side lobes.

Model 102

(1000 ohms per volt meter) + 3°
SQUARE METER • 3 AC CURRENT RANGES (0-30/150/600 ma) • Some zero adjustment for both resistance ranges (0-1000 ohms, 0.1 megohms) • Some ranges on Model 102 + Also 5 DB Ranges $18.75
Model 102-3 with plastic carrying strap $19.25

Model 103

(1000 ohms per volt meter) + 3°
SQUARE METER • 3 AC CURRENT RANGES (0-30/150/600 ma) • Some zero adjustment for both resistance ranges (0-1000 ohms, 0.1 megohms) • Some ranges on Model 102 + Also 5 DB Ranges $31.25
Model 103-3 with plastic carrying strap $33.75

Model 104

(5000 ohms per volt meter)
4 1/2" SQUARE METER (50 micro-ampere-Alnico magnet) • Includes carrying strap • 5 DC Voltage Ranges 0-10000 volts only to 3000 V, 5 AC Voltage Ranges to 3000 V, 3 Resistance Ranges to 20 mgs, Also 3 AC & DC Current Ranges $26.95
HVT 30,000 Volt Probe for Model 104 $7.95

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NEW DEVICES

Perma-Tube, a plastic-coated electric-welded steel tubing which resists the corrosive effects of salt water, has been introduced by A-8222, replaces a v.h.f. antenna for fringe-area reception. The Jet123, Subjeed to a standard ASTM weatherometer test, which reproduces weather conditions such as exposure to the sun's rays, heat, humidity and rain, the Perma-Tube does not deteriorate. After a period of 9000 hours, the plastic-coated tubing shows no signs of corrosion. A test simulating cold-climate conditions produces no bad effects on the coated test pieces. Perma-Tube is available in 5- and 10-foot lengths and in wall thicknesses of 16 and 18 gauge.

HI-FI SPEAKERS

Permoflux Corp., 4600 W. Grand Ave., Chicago 39, III., has announced the Super Royal line of high-fidelity speakers. The line includes 9, 12, and 15-inch models, all of which feature a slotted, treated cone for low resonance and superior low-frequency response. Model 15 is 81. Illustrated here, has a frequency response of 30 to 11,000 c.p.s.; power rating of 25 watts. 8 ohms voice coil impedance, and magnet weight of 14.5 oz.

REPLACEMENT PARTS

Chicago Standard Transformer Corp., Standard Division, Addison St. and E1st Ave., Chicago 18, Ill., has added four new replacement flyback transformers to its line. A-8230 replaces Philip model No. 32-8565, used in 14 models and chassis; A-8211 replaces 32-8555 in 29 models and chassis; A-8227 replaces 32-8533 and 32-8534 in 38 sets; and A-8273 replaces 32-8572 in 15 sets. All models involved are from 1952 and 1953 production. These units are exact duplicates of the original Philip parts they are designed to replace. They include the choke coils, resistors, and capacitors.
NEW DEVICES

ANTENNAS
Best Electronics Corp., 1386 W. Olympic Blvd., Los Angeles 6, Calif., has announced a v.h.f. and three u.h.f. antennas in their Double-Diamond line.

PIN STRAIGHTENER
CBS-Hytron, Danvers, Mass., has developed a twin pin-straightener for 7- and 9-pin miniature tubes. The tool is vest-pocket size and is made of steel.

REPLACEMENT PARTS
International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif., has announced a series of miniaturized selenium rectifiers for use in the production of TV boosters and u.h.f. converters. These units are also ideal for replacement purposes in servicing boosters, converters, and other electronica.

RADIO INVERTERS
American Television & Radio Co., 300 E. Fourth St., St. Paul, Minn., has announced new inverter models for operation from 6- or 12-volt storage batteries in automobiles, buses, and trucks.

LEAD-IN WEATHERHEAD

The v.h.f. model 213 averages 10 db over the low band and from 12 to 15 db over dipole cut for channels 2 to 13. Horizontal lead is 3 db points at 30°, and corresponding vertical lead is 20°. Average impedance is 450 ohms. The model 213 measures 7 feet high, 6 feet 6 inches wide, and 17 inches deep. The v.h.f. antennas are similar in shape to the model 213 but smaller and need no cross-arms. Model 214 covers channels 14-40, model 3570, channels 35-10, and model 6083, channels 60-83.

ANTENSA ROTATOR
Leader Electronics, Inc., 2925 E. 55th St., Cleveland 27, Ohio, has announced a new antenna rotator, the Superpro. Among the unit's features are a detachable drive unit, a double lock-stop, built-in chimney-mount design, steel-reinforced construction, and various precision tensioning:

The rotator's speed is 1 r.p.m. and it can be operated at more than 330 feet from the control box. Over-all size is 1½ x 7 x 4½ inches. It is rated at 60-75 watts input, 117 volts, 60 cycles a.c.

The C series selenium rectifiers consist of a number of cells assembled within a cylindrical aluminum tubing and provided with integral copper leads for easy sealing into crowded spaces. The smallest unit, type C-8, is 0.5 inch in diameter and 2.2-inch long, while the largest unit has a diameter of 2.75-inch and a 6.4-inch long. These miniature selenium rectifiers are rated for maximum r.m.s. input voltages of 130 and 160 for operation into a capacitive load.

NEW DEVICES

Javes, Inc., Redlands, Calif., has announced a TV lead-in wrench ahead of molded acrylic resin, the Jena Shingle. This fits under shingles on a roof or under siding, and covers the small hole required for the lead-in. It is transparent and accommodates standard 300-ohm line.

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SPECIAL BULLETIN

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NEW DEVICES

UHF-VHF ANTENNA

All Channel Antenna Corp., 79-37 Queens Blvd., Woodside 77, N. Y., has developed an all-direction, all-channel antenna, the Super 10. This antenna features the same relative high gain as the AD 20, with only 10-inch spacing between bays to improve the ultra-high frequencies, low-loss phenolic insulators, and a redesigned low-loss switch.

5 NEW PRODUCTS

United Technical Laboratories, Morrisville, N. C., has five new products for radio and TV: 1) a TV crossover network which permits the use of U.H.F. and V.H.F. antennas with a single lead-in and elimination of antenna controls for all-channel reception; an interference filter for use between the transmission line and a TV receiver; a tuner for operating two TV receivers from a single antenna; a variable inductance shunt consisting of eight permeability-tuned coils; and Klipsion paints for panel mounting.

UHF ANTENNAS

Television Hardware Co., a division of General Cement Manufacturing Co., 919 Taylor Ave., Rockford, Ill., has announced their new Wishbone antenna line for U.H.F. The Butterfly, No. 8765, has one stacking bar and weighs 2½ pounds. The Corner-Tenna, No. 8984, is a reflector type that weighs 5 pounds.

These antennas feature the Wishbone insulator, which provides a free air space to prevent shorting out.

UHF ANTENNAS

Finley Co., 4612 St. Clair Ave., Cleve-

End

8-inch woofer, a multichannel tweeter, and has impedances of 4 and 8 ohms with a 20 watt power rating. It is 11 x 10 x 2¾ inches. All specifications given on these pages are from manufacturers' data.

RADIO-ELECTRONICS
DU MONT RA-160, RA-162
Loss of horizontal size with all horizontal sweep components checking O.K. may be noted in the Du Mont RA-160, -162, and -162B TV chassis.

The trouble is probably caused by an increase in the series resistance of the 4-pf cathode bypass capacitor (C314) in the horizontal output circuit. (See partial schematic.) The increase in resistance causes degeneration.

This reduces the amplitude of the horizontal sweep voltage and causes shrinking.

To remedy the situation, replace C314 with a Du Mont part 03 013 670 or 03 122 480.—Du Mont Service News

CROSLEY TV CIRCUIT CHANGE
A circuit change was made early in the production of 1954 Crosley TV receivers to improve picture contrast and shading. All 1953 21-inch sets and 1954 sets which do not incorporate the change may be modified in the field. Fig. 1 shows the circuit before modification and Fig. 2 shows it after modification.

The change lowers the voltage on grid 2 (pin 10) of the picture tube. Grid 2 is disconnected from the top of the focus control and is connected to a point on a voltage divider (R193 and R194) which is added to the circuit.

Focus control R171 is not used in 1954 21-inch sets because they use magnetically focused tubes.—Crosley Service Department

6BJ7'S IN CASCODE TUNERS
A number of sets using 6BJ7's in cascode tuners have come in with complete loss of sound and video. Performance has been restored to normal although the old tube checks good in a tube tester. To minimize callbacks because of a recurrence of the same

DECEMBER, 1953

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Both feature the patented JFD strain-relief lips which prevent contact washers from ripping the lead-in wires apart!

1. for UHF or VHF tubular twin lead
2. for VHF flat twin lead
3. for VHF or UHF open wire

JFD MANUFACTURING COMPANY, INC.
World’s largest manufacturer of co-axial cables and accessories, Brooklyn 4, New York.
HANDBY TEST ADAPTER

It is easy to measure voltages at the pins of miniature tubes without removing the set from the cabinet when you use this simple adapter. Similarly, when aligning a set using miniature tubes, the adapter makes it easy to connect the output meter to the plate of the output tube.

The drawing shows the construction of the adapter. A wafer-type miniature socket provides the connector for the tube pin. Pry one of the lugs loose from the wafer socket and flatten it with pliers. Solder the lug to a length of flexible test lead and then cement a piece of tight-fitting spaghetti over it so only the tiny socket is exposed. Place a phone tip or banana plug on the other end of the lead and you have an adapter which saves time and increases your efficiency when checking and aligning sets using miniature tubes.—Jack Lipner

TUNING EYE FOR TV SETS

With the a.g.c. systems included in present TV sets, the picture contrast changes very little for large changes in input signal. Therefore, it is hard to adjust indoor antennas, rotators, or boosters, for best results, and it is also hard for dx fans to estimate the relative strength of signals. An electron-ray tuning indicator, easily added to any set, can change this situation.

The method of connecting the indicator depends on whether the set is of the intercarrier or separate-sound type.

For the intercarrier type, connect the grid lead of the indicator tube directly to the a.g.c. line. In such a case the indicator should not be used for tuning, as it will give misleading results when so used.

However, for split-sound sets the situation is different, as the indicator is connected in the sound channel. If the set uses a ratio detector, connect the grid of the indicator to the negative end of the electrolytic capacitor in the ratio-detector circuit. If the set uses a limiter-discriminator circuit, the grid of the indicator should go to the grid of the first limiter through a filter network as shown in the diagram. Here the indicator serves well for tuning, as minimum shadow will indicate that the sound is properly tuned in. However, if there are two positions of minimum shadow close together, this means that the sound i.f. is overcoupled, and then the correct tuning position is in between the two minima. In any case, if the glow of the eye tube is objectionable during normal viewing, a switch can be placed in the B plus lead to shut it off when it is not being used.—Charles Erwin Cohn
TRY THIS ONE

TURN COUNTING AID

If you wind your own coils or transformers, don't throw away broken or discarded plastic dial covers. Take any fair-sized piece and cut it to the general shape of a guitar pick as shown in the drawing. Then sand the pointed end down to a sharp thin edge to make a useful aid for counting the turns on your coil.

Just pull the thin edge of the device slowly over the winding and you will hear a single sharp click for each turn in the coil. It is perfect for coils wound with bare or enameled wire. To use it on plastic- or cloth-insulated wire, use less pressure and count the slight ups and downs you feel in your fingers as the tip passes over each turn.—Thomas Oda Miller.

HIGH-VOLTAGE TESTER

The neon tube contained in a discarded fluorescent starter can be used as a simple, quick, and safe means of determining whether or not the high-voltage circuit in a TV set is operating. The neon bulb is attached to the inside of the bakelite base or terminal board. Remove the terminal board and invert it so the neon lamp is on the outside and then reinstall it on the metal container. If there is a capacitor shunting the lamp, remove it.

This simple voltage indicator may be used also to check r.f.-type power supplies in oscilloscopes, TV sets, and other devices requiring high voltage at low current.

To use the indicator, hold it about an inch and a half from the plate of the horizontal output tube, high-voltage rectifier, or the high-voltage contacts on the flyback transformer. The bulb glows when voltage is present. The strength of the voltage can be estimated by the brightness of the glow and the distance from the test point. A few minutes experimenting with sets which are developing normal high voltage will enable you to quickly determine whether sufficient voltage is being developed in the set under test.—Abraham Jacobowitz

CHECKING TV LEAD-INS

To quickly check continuity of a lead-in connected to a folded dipole radiator, disconnect the lead from the set and unscrew the bottom from a flashlight. Touch one side of the lead to the bottom of the exposed battery and the other to the metal shell of the flashlight. The bulb will light if the lead is not broken. It will flicker or will not light at all if the lead and antenna are not continuous.—Arthur Hellman

END
PHOTO SLIDE TRIPPER

In many instances, teachers, lecturers, field service engineers, and sales personnel use photographic slides to illustrate their talks. If the same speech must be delivered a number of times, it is often convenient and advantageous to record the talk on magnetic tape. Since a projector operator is not always available or if available may not be familiar with the material, I have developed a method of cueing the tape so that slides are changed automatically at the correct instant. The setup is shown in Figs. 1 and 2.

A standard tape recorder is fitted with a miniature phototube and a 6.3-volt light source as shown in Fig. 1. The tape is cued by perforating it so that light passes through it and causes the projector to release the next slide.

Fig. 2 shows the diagram of the phototube relay which operates the slide-trip mechanism on the projector. This circuit operates with an increase in light. It was taken from the RCA manual on phototubes.

The current limiting resistor in series with the relay and the plate of the 2050 depends on the resistance of the relay coil. The total resistance in the plate circuit should be at least 1,200 ohms to limit the plate current. This resistor may be omitted if the relay coil resistance is 1,500 ohms or higher. The relay should operate on 25 ma or less.—Robert P. Kraig

DRIVER FOR COAX CABLE

Cathode followers are widely used to drive low-impedance lines carrying low-level high-frequency signals from one remote point to another. When the signals must be reproduced faithfully, the cable must be terminated in a resistive load equal to its nominal impedance. In the article "A Coaxial Cable
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**RADIO-ELECTRONICS**

Driver with Gain" in The Review of Scientific Instruments, Kurt Enslein, of the University of Rochester (New York), describes a grounded-cathode circuit with a gain of about 2.4 over a cathode follower designed to work into the same 93-ohm line. The circuit is shown.

A negative power supply is used to keep the coaxial conductors at ground potential without using prohibitively large blocking capacitors. The 1,000-ohm resistor between the grids prevents the amplifier from oscillating. The linearity of the circuit is not as good as that of a cathode follower but it is better than 1% with r.m.s. signal inputs between .01 and .01 volt.

**WIDE-BAND VIDEO AMPLIFIER**

Wide-band amplifiers are often required for TV, pulse, radar, and oscillographic applications. An interesting video amplifier having a gain of 100 and response substantially flat from 15 cycles to 5 mc is described here through the courtesy of Electronic Engineering (London, England). The amplifier was designed to boost the output of a signal generator from 50 mv to 5 volts and has also been used as a preamplifier for a v.t.v.m. and a number of other applications. Its input-output curve is linear for signal input voltages up to 0.5 volt r.m.s. Distortion sets in above this level.

The amplifier uses a pair of EF91's connected as a feedback pair working into an EF56 cathode follower. The output impedance is 10 ohms or less for signals between 50 cycles and 500 kc and rises to 1/gm at the extreme ends of the pass-band.

The frequency response of the amplifier is adjusted with the compensating trimmer capacitor across the 3,300-ohm, 5-watt resistor (three 10,000-ohm, 2-watt resistors in parallel) in the cathode circuit of the EF56. The trimmer should be set to about 21 µf for best results in a typical amplifier constructed according to good video engineering techniques. The coupling capacitors between the EF91's should be suspended away from the chassis to reduce stray capacitance. Leads on the 33-ohm resistor should be as short as practical to reduce the inductance in the cathode circuit of the input stage.

The EF91 and EF56 are European types. The former is directly replaceable by a 6A6G. The EF56 is similar to a 6AC7, but the two types are not directly interchangeable. These and most other European types can be obtained through North American Philips, 100 E. 42nd St., New York, N. Y.
LOW-COST MAGNETIZER

This simple, low-cost magnetizer for permanent magnets was constructed at the National Bureau of Standards and described in the Bureau's Technical News Bulletin. The magnetizer operates by discharging a very large capacitor through the magnetizing coil. The simplicity of the unit is evident from the diagram.

The 6,500-mf capacitor is charged to about 125 volts d.c. available from the 400-ma selenium rectifier. The 1-1 transformer isolates the unit from the power line. Pressing the push-button switch operates the heavy-duty 24-volt d.c., 70-amp motor-starting relay which connects the magnetizing coil across the capacitor bank. The relay coil is excited by the voltage across the capacitor so the contacts open shortly before the capacitor fully discharges. Since the contacts open at a time when the current is low, they need not be designed for interrupting high currents.

The storage capacitor was made from 10 surplus 650-mf, 80-volt d.c. capacitors which were found to operate satisfactorily at 125 volts after being formed. The power consumed by the magnetizer varies from 1 to 150 watts with the capacitor discharged, to about 10 watts when it is fully charged. At normal rate of magnetizing—one pulse each 15 seconds—the average power drain is not more than 30 watts.

The size and shape of the magnetizing coil depends on the object to be magnetized. Usually, the coils have 150 to 200 turns, an inside diameter no larger than necessary to accommodate the piece to be magnetized, and d.c. resistance of 0.2 to 1.0 ohm. In a typical operation, the peak current of about 150 amps has a duration of 2 milliseconds.

In some cases, it will be necessary to slowly draw the object to be magnetized, from the coil. Keeping it there may leave it only slightly magnetized by the final pulsation.

END

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DECEMBER, 1953

RADIO-ELECTRONIC CIRCUITS

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QUESTION BOX

SCREEN-MODULATING THE SCR-274-N

? I have a set of SCR-274-N command transmitters complete with control box, BC-456 modulator, and DM-36 dynamotor. Reports indicate that when operating this equipment on the amateur phone bands, the percentage of modulation is low. I tried doubling the screen voltage on the final amplifier without any improvement. Is there any way that I can raise the modulation percentage while using the BC-456?

J. F. O., Klamath Falls, Ore.

A. For 100% modulation when using screen-grid modulation, the plate current should drop to zero when the screen voltage is driven to zero. With most pentodes, the screen must be driven negative to cut off plate current and output. About 80% modulation is the maximum that can be obtained without producing intolerable distortion.

The peak a.c. signal delivered to the screen by the modulator must be about 15% greater than the d.c. screen voltage—which, for screen modulation, should be about one-half of the value used for c.w. Use a scope or modulation meter to check the modulation. If it is low, check the operating voltages on the final and then check tubes and components and make corrections necessary to bring the operating voltages up to normal for screen modulation.

It may be that the BC-456 modulator was designed for close talking in a loud voice. In this case, for ordinary ham-station use you will need more gain between the mike and modulator to bring the audio up to the required level for full modulation.

Fig. 1 shows a simplified partial schematic of the modulator. Since m.c.w. (tone modulation) is not used in the amateur bands covered by this equipment, you can remove the 12J5 tone oscillator (not shown) and rewire its circuit as a speech amplifier. Disconnect all leads from pins 5, 3, and 8 of the 12J5 and from pin 4 of the 1625 modulator and rewire the circuit as shown in Fig. 2.

END

ADDITIONAL POWER AMPLIFIER TO 80-METER TRANSMITTER

? I am enclosing the circuit of my 2-tube 80-meter c.w. transmitter. If practical, I would like to have a diagram for adding an 807 power amplifier and power supply to it. I want to use a x network in the plate of the final.

J. T., Chicago, Ill.

A. There is almost no need to add an 807 after the 6L6 unless you plan to use the latter as a buffer or multiplier when the rig is used on higher frequencies. If you limit your activities to 80 meters, all you need do is substitute an 807 in place of the 6L6. The circuit remains the same. Change the grid resistor R2 to 98,000 ohms and substitute
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* Learn how to evaluate instrument readings and put this to practical use

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10-DAY FREE TRIAL

Henry C. Roemer, former president of Federal Telephone and Telegraph Corp. Raymond S. Perry, vice-president and general sales manager of Federal, succeeds Mr. Roemer as president.

Charles B. Denton was appointed marketing manager of Weston Electrical Instrument Corp., Newark, N. J. In this newly created post, he retains direction of the Advertising Department and also assumes responsibility for the sale of all retail and distributor products.

William J. Slavson joined Pyramid Electric Co., North Bergen, N. J., capacitor manufacturer, as assistant sales manager, Jobber Division. He was formerly with Federal Telephone and Radio Corp. and John F. Rider Publisher, Inc.

Harry E. Moon was appointed executive vice-president for both the Mechanical and Plastic Divisions of General Industries Co., Elyria, Ohio. He was formerly vice-president in charge of sales of the Mechanical Division. Mr. Moon has spent his entire 30-year business career with General Industries.

Obituaries

Walter M. Skillman, manager of marketing administration of the Radio and Television Division of the General Electric Electronics Division, died after a brief illness.

Joseph Webber, pioneer in radio engineering, and at one time chief engineer of Warwick Manufacturing Co., Chicago, died from a heart attack at his home in Santa Monica, Calif.

Personnel Notes

... Elwood W. Schafer joined CBS-Hytron, Danvers, Mass., as assistant to Charles F. Stromeyer, vice-president in charge of manufacturing and engineering. He was formerly a vice-president of National Union Radio Corp.

... Robert A. Elliot was appointed manager of the Distributor Sales Division of Erie Resistor Corp., Erie, Pa. He was previously with Pioneer Electric and Research Corp., Standard Coil Products, and RCA.

... K. L. Bishop was named to the new position of general sales manager of the V-M Corp., Benton Harbor, Mich. He had been industrial and export sales manager for the company.

... Max F. Balcom, Sylvania Electric Products, was elected chairman of the new Radio-Television Industry Committee of the RETMA, and F. R. Lack, Western Electric, was elected Chairman of the Electrons Industry Committee.

... C. L. Orcutt, joined P. R. Mallory & Co., Indianapolis, as assistant to the president. He was formerly with Sylvania Electric Products.

... Louis W. Selsor is now handling distributor sales for Jensen Manufacturing Co., Chicago. He has been with the company for over a year. Philip B. Williams, an 11-year veteran with Jensen, has been named chief engineer.

David Gnesin was appointed educational director of Transvision, Inc., New Rochelle, N. Y. He is the editor of Television Notes, the company's house organ.
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NEW 7" Oscilloscope Kit ............... $ 94.95
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MANNFRED PROUDLY PRESENTS

December, 1953

... Douglas J. Sullivan was appointed to the newly created post of manager of personnel development for the Marketing Section of the General Electric Tube Department, Schenectady, N. Y. He had been manager of employee and plant community relations for the department.

... Edward Schulz joined the RCA Laboratories Division, Princeton, N. J., as director of personnel. He was a former associate professor of management and industrial relations at New York University School of Business.

... Ashley A. Farrar was promoted to assistant vice president of Raytheon Manufacturing Co., Waltham, Mass. He was previously manager of Government Contracts for the Equipment Division of Raytheon.

... Merton W. Whitney joined the sales staff of Simpson Electric, Chicago. He was formerly with Cook Electric.

... Robert D. Hallack joined American Microphone Co., Pasadena, Calif., as plant manager. He has had wide experience in the electronics field.

... P. N. Cook, Chicago-Standard Transformer Co. was named chairman of the Social Committee of the Association of Electronic Parts and Equipment Manufacturers. Other committee chairman include: E. Van Dever, Jensen Manufacturing, Credit; O. D. Jester, Standard Coil, Publicity; Roy S. Laird, Ohmite, Educational; Theodore Rosman, Pentron, Industry Relation; Wilfred Larson, Switchcraft, Membership and Attendance; and Ben Boltz, Amphenol, Merchandising Problem Analysis.

... Hank Gropper is now with Techno-Master Products, New York City, as assistant to Paul Witte, sales manager. He had been with United Transformer Co.

... Major William J. Schoenberger, recently released from active duty with the Air Force, joined Insuline Corp. of America, Long Island City, N. Y., as assistant to Samuel H. Spector, president of the firm. He will be in charge of the Contracts Division.

... Isadore Weber joined C-B-C Electronics, Philadelphia, as vice-president in charge of sales. He was formerly with Radio Electric Service Co.

... Ray Murphy was named manager of the Electronics Division of Industrial Engineering Corp., Tampa, Fla.

... Marshall T. McGuiness was appointed advertising manager of The Hallcrafters Co. branches in Chicago, Kansas City, and Milwaukee.

... Jerry B. Minter, vice-president of Measurements Corp., Boonton, N. J., and president of Components Corp., Denville, N. J., was elected president of the Audio Engineering Society.

... Albert E. Hylas and Walter V. Tyminski joined the engineering staff of Industrial Television, Inc., Clifton, N. J. Both were formerly with the Research Division of Allen B. Du Mont Laboratories.

... Miriam Simpson, of Mark Simpson Manufacturing Co., Long Island City, N. Y., was awarded an associate membership to the American Institute of Management.

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**EDISON RADIO AWARD**

A nation-wide search for the amateur radio operator who performed the outstanding public service of 1953 has been announced by the General Electric Company Tube Department. The winner will receive the Edison Radio Award. His name will be announced on February 11, 1954, Thomas A. Edison's 107th birthday anniversary. The 1953 eligibility rules are as follows:

Nominations may be made by any individual or group familiar with the service performed.

The service must have been performed during 1953 while the candidate was pursuing his hobby as an amateur within the continental limits of the United States.

Candidates must hold an amateur radio license issued by the Federal Communications Commission.

Decisions of the judges will be based upon (1) the good service rendered to an individual or group and (2) the amount of ingenuity and sacrifice displayed in performing the service.

No employee of the General Electric Company is eligible to receive the award.

Nominations should be addressed to the Edison Award Committee, Tube Department, General Electric Company, Schenectady 5, N. Y.

Last year, the Edison Award went to 20-year-old Don L. Mulliean, Searcy, Ark. He stuck to his shortwave set for more than five days—almost without relief—to bring emergency aid to tornado victims in two nearby towns.

**PAPER THAT TALKS**

A dictating-transcribing machine, the Pentron Dictorex, recently placed on the market by Pentron Industries, uses magnetic coated paper called Talkform, which can be used and reused over 2,000 times without loss of fidelity. The machine electronically erases the paper so completely, while re-recording, that not even a whisper of previous recordings remains, even at full volume.

The paper can be written upon, folded, and filed. It feeds into the Pentron Dictorex like a typewriter, rotating around a drum to form a cylinder. As the drum rotates, the record-erase carriage moves slowly along its length so that the recording track is helical.

**No Choice**

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I settled in my chair tonight
And puffed my set to watch a flight.
It ended, and I puffed again
To twist the knob to Channel Ten.
A cooking show—I puffed once more
To try the fare on Channel Four.
I puffed and puffed, but didn’t see
A single show that suited me . . .
For me, TV has met its death,
For I’m completely out of breath.
RCP VTVM

Model 655

READS PEAK-TO-PEAK VOLTAGES DIRECTLY

ACCURATE MEASUREMENT OF COMPLEX WAVESHAPES

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RMS or Peak-to-Peak.
Useful and necessary—faced directly with Model 655.

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Video Amplifiers—Peak-to-Peak Measurements. A Peak-to-Peak Directly With The Model 655.

Quickly... Accurately
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...gives a true reading measurement of complex and sinusoidal voltages with necessary peak-to-peak or RMS value read directly, for the analysis of waveforms in video, sync and deflection circuits.

Versatility of measurement, built into each Model 655, serves a variety of industrial applications in the service of oscillator power supplies, AC generators and all equipment utilizing any wave form or DC.

Match the Model 655 with any peak-to-peak VTVM—You will find that comparable performance can only be found in much higher priced instruments.

Comes complete with new "RCP SOLD FINDER LEADS" for operation on 105 to 125 V AC.

FOR TELEVISION SERVICE AND INDUSTRIAL MAINTENANCE
- PEAK-TO-PEAK AC measurements of from 2 V to 4000 V on 7 ranges.
- AC RMS measurements of 1 V to 1000 V on 7 ranges.
- DC measurements of from 0 V to 1500 V on 7 ranges.
- RESISTANCE measurement of from 2 ohms to 1000 Megohms on 7 ranges.

See Your Local Parts Distributor or Write For RCP Catalog RE 12.
The TACO UHF GRID YAGI

The first all-welded, all-aluminum UHF yagi — designed to meet your installation needs better.

Welded construction of the TACO Grid Yagi assures perfect mechanical and electrical union between all elements. Exclusive grid reflector for improved directivity and highest front-to-back ratio. Packed two to a carton, with stacking lines — may be used as a single antenna or two-stack array.

Four Bay Stacking Kit provides added gain and directivity.

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1954 EDITION

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Sensational Xmas Gift Value!

Sethel Carlson de Luxe Table Radio
Made to Sell for 899.50!

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- Powerful & True
- 19" FM Speaker
- Three Bands

Offers all the advantages of a large size console set in minimum space and at very moderate cost. Features include: 3 bands, 540-1600 kc, 244.6 Mc, 617.6 Mc. Well-designed five tube plus rectifier circuit. Tubes: 212/5A6, 12AT6, 6V6, 6X4. Power output is 3 watts undistorted to 17 kHz high PM speaker. Has provisions for external antenna, phone pickup, and power to phone. AC or DC. Extra plug for use on 220 volts AC. Automatic. Nonskid cabinet-maker's hand finished genuine mahogany veneer cabinet. 231/4 x 14 x 6 1/2". Available in Blonde or Mahogany finish. Weight: 14 lbs. Stock No. F-51301 Mahogany Net $29.50

Stock No. F-51308 Blonde Net $32.50

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arization of the tube characteristic without loss of sensitivity and without the disadvantages of extra transformer windings.

Both Williamson and Frieborn incorrectly refer to the Ultra-Linear circuit as a feedback arrangement. This is not correct, and it is simple to show why. In a feedback circuit the reduction in distortion and the reduction in internal impedance can never be greater than the reduction in gain. However, in the Ultra-Linear circuit there is practically no reduction of gain, but there is a significant reduction in distortion and internal impedance. Thus, there is a definite advantage to the Ultra-Linear circuit since, as Williamson puts it, “you get something for nothing,” and distortion can be made lower than for either triode or tetrode operation of the output tubes.

David Hafler

POWER LINE TROUBLES
Dear Editor:

While looking over the August issue of Radio-Electronics, I noticed the article entitled “Power Line Troubles” (Page 108).

Having worked for power companies and consumers alike, I have seen the voltage-regulation problem handled from both ends. Mr. C. L. L. may have a solution, but 90% of the time poor regulation is the trouble. I have seen voltage fluctuation like Mr. J. T. K. writes about. Correcting these troubles is an expense to the power company. Therefore, occasionally nothing is done even though repeated complaints are received.

The solution to this problem is to make one complaint to the power company and then make a recording of the voltage. Have the chart signed by one or two witnesses and present it to the Public Service Commission having jurisdiction over the company in question. The chart should cover a seven-day period with time of day and date indications at the margin. I have never seen this method fail to bring about voltage stability. In making your readings, be certain that you are using a reliable instrument; if possible, checked by the local power company.

Thomas L. Bartholomew
Clarksburg, W. Va.

CORRECTION

The italicized statement beginning with the tenth line on the second page of “Stubs” in the June issue is erroneous.

Open quarter-wavelength stubs attenuate all odd harmonics (the 1st, 3rd, 5th, and so on) when they are connected across the signal source or transmission line. Even harmonics are not attenuated. A shorted half-wave stub will attenuate the fundamental and all harmonics.

Our thanks to Robert A. Sadilek of Anchorage, Alaska, for spotting this error and reporting it to us.

END

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**Index to Diagrams**

The 1958 Edition of Master Index to Supreme Picture Guide Most-Needed Radio and Television Servicing Information has just been released. It presents complete information for quickly finding diagrams and servicing data in the 13 Most-Needed Radio Diagrams manuals covering radio receivers from 1926 to the present day, the seven manuals of TV service data, and the u.h.f. manual. Names of set manufacturers are listed alphabetically with models and chassis listed numerically under each. Opposite each model is an entry indicating volume and page number where the service data will be found.

A copy can be obtained from The Supreme Publications, 727 W. 118th St., Chicago 23, Ill., by mentioning Radio-Electronics and enclosing $4 for postage.

**UHF Tubes**

Sylvania has issued a 15-page report on their u.h.f. tubes 6A4 and 6T4. Ratings and characteristics are given in great detail. The booklet contains circuits showing the use of these tubes. Gratis from Sylvania Electric Products, Inc., 1710 Broadway, New York, N. Y.

**TV-AM-FM Coils**

Stamway's 22-page coil catalog is a well-illustrated, indexed booklet covering almost every conceivable coil for TV, AM, and FM use. Five pages of wiring diagrams and charts are included.

Obtainable free from Stamway Windng Co., Newburgh, N. Y.

**Deflection Yokes**

Syntronics' newest catalog page describes three new deflection yokes for military and oscilloscope applications. Technical information given includes dimensional drawings, electrical and mechanical data, and complete tables of push-pull and single-ended deflection coil data.

Free on request to Syntronic Instruments, Inc., 100 Industrial Road, Addison, Ill.

**TV Antenna Folio**

Anmphol has issued an attractive booklet: TV Antenna Folio. Looseleaf sheets illustrating and giving specifications on three v.h.f., four u.h.f. and one all-channel antenna, and a sheet on TV accessories, are contained in a folder. The folder describes basic factors of antenna performance and basic antenna types. Colorful shots from an Anmphol film point up the descriptions.

Gratis from the American Phenolic Corp., 1840 South 24th Ave., Chicago 50, Ill.
NEEDLE MINTS
Jensen's new 2-color pocket-sized booklet on the care of records, needles, pick-ups, and cartridges is a consumer publication available for dealer distribution. It illustrates needle wear and contains information on phonograph care. A chart shows the exact Jensen diamond needle replacement for specific record players.


ACCESSORY CATALOG
Electronic accessories for TV, PA systems, radio, amateur radio and audio are listed in Javel's Catalog No. 252. Among items listed in the 8-page booklet are wall plates, high voltage probes, plugs, sockets, and connectors.

Free from Javel, Redlands, Calif.

WHEELCO CATALOG
Wheelco's new 42-page data book and catalog, Bulletin TC-10, lists a complete line of thermocouples, radiation detectors, and resistance bulbs. Information on several protection tubes, lead wire and other accessories for use with indicating, controlling, and recording instruments is also included.

Available on request to Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.

OSCILLOGRAPHS
Du Mont has issued bulletins on their Type 302-A dual-beam and Type 301-A miniaturized wide-band, cathode-ray oscillographs.

Gratis from Technical Sales Dept., Allen B. Du Mont Laboratories, Inc., 780 Bloomfield Ave., Clifton, N. J.

TRANSFORMER BULLETIN
Stancor's bulletin No. 409, TV Replacement Transformer Popularity Tables lists the number of TV models that use each transformer replacement part. About 55 major set manufacturers are listed.

Copies free on request to Chicago Standard Transformer Corp., Standard Division, Addison and Elston, Chicago 18, Ill.

HIGH FIDELITY
Templeos of Tone is a 16-page illustrated brochure issued by Electro-Voice, and describing components needed for high-quality reproduction. Brief discussions of how the human ear hears, the limits of ordinary reproducing equipment, distortion, and choosing components for an audio system make it interesting to all music lovers and service technicians.

Write to Electro-Voice, Buchanan, Mich., for this one, gratis.

SOUND CATALOG
Shure's 12-page general catalog gives technical data and replacement information on components used for sound reproduction. Included are microphones, microphone parts and accessories, photo cartridges and pickups, and recording heads.

Request Catalog No. 44A from Shure Brothers, Inc., 225 West Huron St., Chicago 10, Ill.

DECEMBER, 1953

The main purpose of this text is to present methods for analyzing servomechanisms, there is very little reference to design. The authors first present the reader with a thorough discussion on the direct and inverse Laplace transformations. They treat means of setting up the differential equations which define the motion of elementary systems—with some applications to more complex systems—in a general manner.

Having established the necessary mathematical background, they undertake the transient analysis of servomechanisms. Only simple cases are considered, since it is felt that the principles involved without unnecessary mathematical complications, but most of the important variations are treated in detail.

The remainder of the text is devoted to the intensive development of the transfer-function approach, including mechanical procedures in manipulation, mathematical theory, and graphical aids to analysis and design.

While written very clearly, it is on a very high level. For the reader encountering difficulty, the appendix is rich in clear explanations of error detectors, controllers, servomotors, and compensating devices.

This text is written for the senior or graduate engineering student. It is well-organized and fundamentally theoretical in intent.—JK


Oddly enough, books on studio operating techniques are rare. This important subject has been treated in the off-hand manner with which one disposes of an unwanted relative. It is refreshing to find that at least one author has the courage to believe that the multimillion dollar TV broadcasting industry is worthy of a book all its own.

This work is authoritative from two viewpoints. The author knows what to say and makes every effort to have the reader understand—a technique often overlooked by writers of engineering texts.

Intended for those making telecasting their vocation, the book covers every phase of television broadcasting. Essentially what you need to know about the description of the camera lens and the studio control room. This includes the TV camera, lens system, picture tubes, viewfinders, switcher and mixer units, picture and waveform monitors, slide projectors, stabilizing amplifiers, the monoscope, and other equipment.

We hope the author will include a chapter on color telecasting when a new edition is printed. Until then, this is an excellent book if telecasting is your career.—MC

RADIO-ELECTRONICS

A systematic and reasonably complete treatment of the many factors which affect the behavior of vacuum tube oscillators is presented in a thorough, well-connected discussion of the design and operation of these devices. The author treats the subject from the viewpoint of design rather than analysis.

The level of discussion is directed toward a junior or senior undergraduate course in electrical engineering, and for practicing engineers. The text is heavy with mathematics, and the reader should have a good working knowledge of the calculus.

The book is generally divided into two main classes—harmonic, and relaxation oscillators. Chapters on general characteristics of transient behaviors of linear systems, negative resistance, nonlinear, and negative resistance systems and stability criteria, and resonators, form the preparatory material prior to dealing with specific oscillators.

In his chapter on resonators, the author does a remarkably good job on the proper design of components. For the mathematically inclined, this textbook is an excellent comprehensive treatment on oscillator design.—JK


This book is written for college students by a college professor. As its name suggests, it emphasizes circuit theory, especially in terms of equivalent networks. It is clearly written and easy to understand, but the reader must know physics and mathematics through calculus.

The major topics—amplifiers, oscillators, modulators, power supplies—are covered in much detail. Tubes and transistors are treated from the standpoint of equivalent 4-terminal networks. Diagrams and graphs appear often, to illustrate the material. Each chapter ends with numbered problems.—IQ

UHF TELEVISION and VHF TUNERS, by Edward M. Noll. (Also called Notebook No. 7, TTB Series) Published by the Paul H. Wendel Publishing Co., Inc., Indianapolis, Ind., 8 1/2 x 11 inches, 72 pages. Price $1.00.

This publication is divided into two parts of almost equal length. The first discusses v.h.f. tuners, the second u.h.f. television. It is written in concise, lecture style with numerous schematics, mostly of commercial TV equipment. Part 1 is about commercial tuners and characteristics, with brief manufacturers' alignment and data. Response curves and sweep calibration are also covered briefly. Part 2 is more detailed and describes topics that are relatively new to technicians. Beginning with u.h.f. characteristics, it goes on to various alignment techniques and converters. Also included is a chart listing u.h.f. channels.—IQ

A systematic and reasonably complete treatment of the many factors which affect the behavior of vacuum tube oscillators is presented in a thorough, well-connected discussion on the design and operation of these devices. The author treats the subject from the viewpoint of design rather than analysis.

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In his chapter on resonators, the author does a remarkably good job on the properties of resonator components. For the mathematically inclined, this textbook is an excellent comprehensive treatment on oscillator design.—JK


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Part 1 is about commercial tuners and characteristics, with brief manufacturers' alignment data. Traps, response curves and sweep calibration are also covered briefly. Part 2 is more detailed and describes topics that are relatively new to technicians. Beginning with u.h.f. characteristics, it goes on to various antennas, plug-in strips and converters. Also included is a chart listing u.h.f. channels.—IQ

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