IT'S DONE WITH MIRRORS!

Protected by a wall of lead bricks and using a mirror to guide his instruments, this Bell Laboratories scientist is preparing a solution of a radioactive isotope, for use as a tracer to study materials for your telephone system.

Bombardment by neutrons turns some atoms of many chemical elements into their "radioactive isotopes"; these are unstable and give off radiation which can be detected by a Geiger counter. Chemically a "radioactive isotope" behaves exactly like the original element. Mix the two in a solution or an alloy and they will stay together; when the Geiger counter shows up an isotope, its inactive brother will be there too. Minute amounts beyond the reach of ordinary chemical methods can be detected—often as little as one part in a billion.

The method is used to study the effect of composition on the performance of newly developed germanium transistors—tiny amplifiers which may one day perform many functions which now require vacuum tubes.

It enables Bell scientists to observe the behavior of microscopic impurities which affect the emission of electrons from vacuum tube cathodes. It is of great help in observing wear on relay contacts. And it may develop into a useful tool for measuring the distribution and penetration of preservatives in wood.

Thus, one of science's newest techniques is adopted by Bell Laboratories to make your telephone serve you better today and better still tomorrow.

BELL TELEPHONE LABORATORIES
EXPLORING AND INVENTING, DEVISING AND PERFECTING. FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.
BE A SUCCESS AS A
RADIO-TELEVISION
TECHNICIAN

America's Fast Growing Industry Offers You All Three

1. EXTRA MONEY IN SPARE TIME

As part of my servicing course, I send you SPECIAL BOOKLETS starting the day you enroll that show how you can make $5, $10 or more a week EXTRA fixing neighbors’ Radios in spare time while learning. Test you build with parts I send helps.

2. GOOD PAY JOB

Your next step is a good job installing and servicing Radio-Television sets, or becoming boss of your own Radio-Television Sales and Service Shop, or getting a good job in a Broadcasting Station. In 1945, there were 943 Radio Stations. Today, about 2,700 are on the air! Result—thousands of qualified men stepped into good jobs. Then add developments in FM, Two-Way Radio, Police, Aviation, Marine, Micro-wave Relay Radio. Think what this means! New jobs, more jobs, good pay for qualified men.

3. BRIGHT FUTURE

And think of the opportunities in Television. Only 19 Stations were on the air in 1947. Today, more than fifty. And the experts say there will be over 1,000 within three years. Manufacturers are producing over 100,000 Television sets a month. Be a successful Radio-Television Operator or Technician ... get in line for success and a bright future in America’s fastest-growing industry!

I Will Train You at Home
You Practice Servicing or Communications with MANY KITS

I've trained hundreds of men with no previous experience to be successful TECHNICIANS. I will train you, too. Or you can enroll for my NEW practical course in Radio-Television Communications. Told for your FCC operator's or technician's license. You learn Radio-Television theory from clear, illustrated lessons in my tested home study courses.

As part of both my Servicing and Communications course, I send you MANY KITS of modern equipment that "bring to life" theory you learn.

You Build This MODERN RADIO

As part of my Servicing course, I send you speaker, tubes, chassis, loop antennas, transformer, EVERYTHING you need to build this modern Radio. Use it to conduct many valuable tests and practice servicing. It's yours to keep.

You Build This TRANSMITTER

As part of my New Communications course, I send you parts to build this low-power broadcasting Transmitter that shows how to put a station "on the air." Perform procedures demanded of Broadcast Station operators, conduct many tests, experiments. It's yours to keep.

MAIL COUPON NOW.

VETERANS
GET THIS TRAINING WITHOUT COST UNDER G. I. BILL.

Mail Coupon for Books FREE

Coupon entitles you to ACTUAL LESSON on Radio-Servicing with many pictures and diagrams plus my 64-page book, HOW TO BE A SUCCESS IN RADIO-TELEVISION" both FREE. See what my graduates are doing and earning. Send coupon today. J. E. SMITH, President, Dept. G. X. National Radio Institute, Pioneer Home Study Radio School, Washington 9, D. C.

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MARCH, 1950

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Get Into RADIO, TELEVISION and ELECTRONICS
Master ALL Phases


GOOD PAY and Unlimited Opportunities in JOBS LIKE THESE:

- Business of Your Own
- Radio Manufacturing, Sales, Service
- Broadcasting, Televasting
- Television Manufacturing, Sales, Service
- Laboratories: Installation, Maintenance of Electronic Equipment
- Electrolysis, Call Systems
- Garages: Auto Radio Sales, Service
- Sound Systems and Telephone Companies
- Oil Well and Drilling Companies
- Engineering Firms
- Theatre Sound Systems, Police Radio
- And scores of other good jobs in many related fields

YOU CONDUCT MANY EXPERIMENTS LIKE THESE!

- Checking action of condensers
- Experiments with AF and RF amplifiers
- Experiments with resonance
- Producing beat frequencies
- Calibrating oscillators
- Experiments with diode, grid-bias, grid-leak and infinite impedance detectors
- Practical experience in receiver trouble shooting
- Application of visual tester in checking parts and circuits
- Experiments with audio oscillators
- Advanced trouble shooting
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T. R. F.
RECEIVER
You build several T. R. F. Receivers, one of which, a 4-tube set, is shown here. You learn construction, alignment, make receiver tests, and do trouble shooting.

MARCH, 1950

Get This Superheterodyne

You receive complete standard equipment, including latest type High-Mu Tubes, for building various experimental and test units. You progress step by step until you build a complete Superheterodyne Receiver. It is yours to use and keep.

YOU RECEIVE THIS PROFESSIONAL MULTITESTER!

You will use this professional instrument to locate trouble or make delicate adjustments - at home or on service calls. You will be proud to own this valuable equipment. Complete with test leads.

SIGNAL GENERATOR

You construct the Transitron Signal Generator shown here, demonstrating Transitron principles in both R.F. and A.F. stages. You study negative type oscillators at firsthand.

AUDIO OSCILLATOR: An electronic device, which produces audio-frequency signals for modulating R.F. (radio frequency) carrier waves, testing A.F. (audio frequency) amplifiers, speakers, etc.

T. R. F.
RECEIVER

You build several T. R. F. Receivers, one of which, a 4-tube set, is shown here. You learn construction, alignment, make receiver tests, and do trouble shooting.
Only RCA Makes the VoltOhmyst*

The Master VoltOhmyst . . . the most versatile instrument of its kind. The instrument that "has everything"—the RCA WV-95A Master VoltOhmyst has no equal for fast and accurate servicing of AM, FM, and TV receivers. It's a profitable investment because this one instrument measures capacitance, current, voltage, and resistance.

With the WV-95A you can measure ac and dc voltages to 1000 volts, dc current from 1 microampere to 10 amperes, resistance from 0.1 ohm to 1000 megohms, and capacitance from 4 mmf to 1000 mf—all with the usual efficiency and absence of circuit loading characteristic of all RCA VoltOhmysts.

When used with the RCA WG-275 accessory diode probe, the WV-95A can be used to measure rf voltages at frequencies up to 250 Mc.

For full details, ask your RCA Test Equipment Distributor for Bulletin 2F721—or write RCA, Commercial Engineering, Section C49X, Harrison, N. J.

The Standard VoltOhmyst . . . work horse of the servicing field. The RCA Type 195A measures ac and dc voltages to 1000 volts, resistance to 1000 megohms, in six ranges. Reads db at all audio frequencies. Has zero-center scale for discriminator alignment. Its 10-megohm dc input resistance insures accuracy of readings in high-impedance circuits. WG-263 accessory crystal probe permits rf voltage measurements to 100 Mc.

The Battery VoltOhmyst . . . the meter you can use anywhere. The RCA WV-65A is completely portable. Batteries last up to 10 months. Measures ac and dc voltages to 1000 volts, resistance to 1000 megohms, and direct current to 10 amperes. WG-263 accessory crystal probe permits rf voltage measurements to 100 Mc. Best buy of the year at the new low price of $39.50.

Available from your RCA Test Equipment Distributor

RADIO CORPORATION OF AMERICA
TEST EQUIPMENT
HARRISON, N. J.

RADIO-ELECTRONICS for

www.americanradiohistory.com
To a $60 a week man interested in earning $100 a week and more in TELEVISION and FM SERVICING

QUALIFIED TV REPAIRMEN are in demand. The ads shown (taken from a single issue of the Washington Sunday Star) prove it. Every area with TV stations has openings for servicemen. Every area with TV stations planned (750 stations by 1955 is a conservative estimate) will have more openings.

Anyone in the field—if he is to get ahead—needs to know how to use test equipment, how a TV set works, why it works, and how to make it work better. You can’t repair “by ear” anymore. You need knowledge. CREI’s practical course in TV-FM servicing provides it. Designed by teaching specialists, taught by practical TV instructors, reviewed and checked by qualified service experts, KEPT UP-TO-DATE through daily contact with CREI’s affiliated retail sales-and-servicing stores (one of Washington’s largest retailers of TV sets), the CREI course equips you to qualify for the $100-a-week jobs.

TV is developing fast. Now’s the time to get on the bandwagon! CREI offers you—in one practical course at a popular price—greater earnings and a secure future. Don’t delay. Start your training now—and start applying your new-found knowledge in your daily work. The facts are yours for the asking. Mail the coupon now for complete data.

Veterans: CREI training is available under the G.I. Bill. For most veterans, July 25, 1951 is the deadline, ACT NOW!

FREE SAMPLE LESSON

MAIL COUPON FOR FREE BOOKLET

CAPITOL RADIO ENGINEERING INSTITUTE
Dept. 1438, 16th & Park Rd., N. W., Washington 10, D. C.

Gentlemen: Send me FREE SAMPLE LESSON and complete details of the TV and FM Servicing home study course. Also send brochure that explains the CREI self-improvement program and gives complete details and outline of course. I am attaching a brief resume of my experience, education and present position.

Check the Field of Greatest Interest:  □ TV, FM & Advanced AM Servicing  □ Aeronautical Radio Engineering
□ Practical Television Engineering (FM, TV)  □ Practical Radio Engineering
□ Broadcast Radio Engineering  □ Radio-Electronics in Industry
□ I AM ENTITLED TO TRAINING UNDER G.I. BILL.

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CITY                        ZONE STATE
□ SEND DETAILS ON RESIDENCE SCHOOL.

MARCH, 1950

[Image of CREI brochure with details about courses and qualifications]
RADAR AND LORAN, when put into more general use on ships, will reduce insurance costs enough to amortize the costs of installation, according to Rear Admiral Telfair Knight, chief of the Maritime Commission's bureau of services. In a speech last month at a luncheon celebrating the third birthday of the service's radar-loran school in New York, Admiral Knight cited reductions already in effect for radar-equipped vessels making the hazardous winter run to Alaska. More than 1,600 merchant marine deck officers have graduated from the school since its inception. It is open to all licensed deck officers; each course lasts one week.

SERVICE CONTRACTS for television receivers were purchased by less than 26% of those who purchased television receivers during the first month. WSAZ-TV, Huntington, W. Va., was on the air. The station is the area's first. Other interesting facts shown by a survey last month are a strong preference for sets with built-in antennas and largest sales (75%) to low- and middle-income groups.

COLOR TELEVISER improvised last month by Forest W. Killy, a Roselle, N. J., electrician, to pick up experimental color broadcasts from New York's CBS station, cost only 50 cents, plus about $4 worth of material from the junk box. After modifying the sweep circuits of a standard TV receiver to conform with the frequencies of the CBS color system, Killy made a 12-inch color wheel (see photo) out of cardboard and cellophane. Attached to a phonograph motor mounted on a wood base, the wheel spins at high speed in front of the C-R-tube screen, reproducing the scenes in color.

Publication of the report in the daily press brought to light a number of similar devices made by New York and Washington radio technicians and experimenters.

MOVING MOUNTAINS is still not very practical but a report from Westinghouse last month says that the next best thing was done recently in Pennsylvania power-station installation. A generating plant and a substation of the Pennsylvania Electric Co. at Johnstown are 12 miles apart and separated by a mountain. The expense of running telephone lines between generator and substation was too high, but microwave communication was blocked by the mountain. The solution was to bend the waves around the mountain. This was done with a 20-foot-square sheet of aluminum placed on a 50-foot tower 2 miles from the substation. It is within sight of both locations. Microwaves hitting it are reflected to bypass the mountain and reach their destination in either direction.

TRAFFIC SURVEYS in Los Angeles are now being made by a set of special detectors in conjunction with an electronic digital computer. Science Service revealed last month. Detectors, which close a circuit when a car passes over them, are sealed to the pavement with cement. They are connected to a digital computer in the University of California at Los Angeles engineering laboratory a mile away. The setup records the speed of passing vehicles, tells what lane they are in, totals the number of vehicles in each lane in a given period and records speed distribution in a selected lane during any hour of the day.

1950 IRE CONVENTION will be held from March 6 through 9 with headquarters at the Hotel Commodore in New York City. Technical papers by outstanding technical workers will, as usual, cover all the important fields of electronic endeavor. The engineering show will again be at Grand Central Palace. RADIO-ELECTRONICS will be present in Booth K.

Experimenter Killy and his color wheel. Wheel diameter allows for 6-inch picture.
MEDAL OF HONOR of the Institute of Radio Engineers will be awarded to Prof. Frederick Emmons Terman, dean of the School of Engineering of Stanford University, at the annual IRE convention, to be held March 6-9 in New York City. The medal, the Institute's highest award, will be given Prof. Terman for his many contributions to radio as teacher, author, scientist, and administrator. He is best known to radio engineers throughout the world for his two books, Radio Engineering and Radio Engineers Handbook, which are standard reference works.

Prof. Terman is a native of English, Ind. He earned his B.A. and E.E. degrees at Stanford and a D.Sc. at MIT. He has been a member of the Stanford faculty since 1925 except for a break from 1942 to 1945, when he headed the Harvard University Radio Research Laboratory. He has been dean of the engineering school since his return from Harvard in 1940. He is a past president of the IRE.

SYNTHETIC MICA with essentially the same properties as natural mica, but able to withstand much higher temperatures, has been crystallized successfully by Dr. Herbert Insley, Alvin Van Valkenburg, and Robert Pike, the National Bureau of Standards announced last month. To allow the mica to form at atmospheric pressure instead of under high pressure as it does in nature, fluorine in the form of fluorosilicates is used as a crystallizing agent. The other components are like those often used to make glass—quartz, mica, and bauxite. The raw mixture is melted in a platinum-lined crucible in an electric furnace at almost 1,400 degrees C. As the furnace cools, mica crystals grow from a tiny seed at the bottom of the crucible. The largest crystals so far grown at the Bureau have a surface area of 4 square inches, and have a dielectric constant of about 6.5.

The Radio Month

X-RAY MICROSCOPE which makes visible the internal parts of materials opaque to light was announced last month by General Electric. Future refinements of the instrument, which is still purely experimental, may result in sharper images and more magnification than possible with visible light. It may be able to compete with electron microscopes, with the additional advantage that specimens need not be enclosed in a vacuum. At present, magnifications of 100 diameters have been obtained.

The unit operates on the principle that X-rays can be reflected from polished surfaces if they strike at very small angles. The apparatus consists of an X-ray tube and a pair of curved mirrors. The rays strike the mirrors at an angle of less than one-half degree after passing through the sample. Like a convex lens acting on a light beam, the mirrors bend the X-rays so as to form a magnified image on photographic film. The mirrors in the experimental setup are platinum-coated slabs of fused quartz which can be curved by hand-controlled mechanical pressure to obtain best focus.

ELECTROSTATIC CHARGES on sheets of paper running off a printing press are detected with a new powder announced last month by R. R. Donnelly & Sons Co., Chicago last month. Developed by Harry H. Hull, the powder is a mixture of red and blue powders. When sheets are dusted with it, red remains where there is a positive charge and blue where there is a negative one. The blue powder is dyed lycopodium and the red, carmine mixed with sulphur. Many drugstores carry both.

CANADIAN TELEVISION plans announced last month by the CBC call for two stations in Montreal, one French and the other English, plus a station in Toronto. The first test programs may be on the air next fall and regular service is expected by September, 1951.

WWV AND WWVH, U.S. Bureau of Standards radio stations in Beltsville, Md., and Maui, T. H., inaugurated a revised schedule of services on January 1. WWV broadcasts on 2.5, 5, 10, 15, 20, 25, 30, and 35 mc. Time announcements are given at 5-minute intervals by voice in Eastern Standard Time and by code in the Universal Time 24-hour system. The standard 440-cycle audio transmissions alternate with a 600-cycle tone, which is broadcast for 4 minutes beginning on the hour and every 10 minutes thereafter. Other services, such as the tick every second and the propagation disturbance warnings, continue.

WWVH, recently established in Hawaii, broadcasts experimentally on 5, 10, and 15 mc with substantially the same program as WWV. The National Bureau of Standards, Washington 25, D.C., welcomes reports on reception of the two stations, especially WWVH, whose purpose is to cover many areas not served by WWV.

Flakes of new mica are examined by microscope for possible structural defects.
Radio Business

Channel Master Corp., Ellenville, N. Y., announces that Judge Edward R. Koch, of the Supreme Court, New York County, has decided that Channel Master Corp., as assignee of Joseph Y. Resnick, is the owner of U.S. patent 2,405,331 for a foldable television antenna, and that Video Television, Inc., is not entitled to it. Video Television brought the action against Channel Master and Mr. Resnick, claiming the invention.

Sylvania Electric Products, Inc., has announced that the new 1N34A and 1N58A germanium diodes will be marketed to Sylvania distributors in a new carton and counter merchandiser. The improved individual crystal carton was adopted after considerable study of effective color combinations and methods of cartoning for individual crystals, and ties in with Sylvania's new counter merchandiser carton for 25 units.

The new individual packing measures approximately 4 1/2 x 1 1/4 x 3 1/8 inches with an oval window in the top permitting visual inspection of the improved "glass" product against a bright red carton insert. Type number and Sylvania trade mark are printed in black on white, and over-all design is white on bright green. The new 25-pack counter merchandiser was adopted to promote retail sales to experimenters who now represent an appreciable market for the product.

RCA Service Co. has introduced a special, low-cost television service contract under the terms of which the customer pays a base fee (smaller than the usual one) and after the first 90 days pays for each service call. The new contract plan will be available as an alternative choice for purchasers of RCA Victor television receivers who desire protection at a smaller initial cost than that required for the complete coverage contract. The present complete contract plan, which will be maintained, covers installation, one year's parts and tube protection, and unlimited service for annual fees beginning at $45 with a built-in antenna and $65 with a standard outdoor antenna for 10-inch sets.

The new alternative contract, available starting January 1, provides for complete installation, instruction of the customer, parts and tube protection, including the kinescope, for a year, unlimited service for 90 days, and, after that, a preferred flat rate of $5.75 per call for service-as-needed, with contract prices starting at $22.95 with a built-in antenna and $39.95 with an outdoor antenna for 10-inch sets.

Comparable charges for sets with larger tubes will be $24.95 and $44.95 for 12%-inch models, $29.95 and $54.95 for 16-inch models, and $33.95 and $59.95 for projection models. Prices will be slightly higher for combination instruments and in outlying areas, but the preferred flat rate charge for service calls after the 90-day period will be $5.75 for all models.

The RCA Service Co. now makes available a library copy of service notes and service information, at no charge, to all service associations and service trade publications. This is in line with the widespread distribution of individual copies of these notes through RCA Victor distributors to dealers, independent servicemen, and service technicians.

Admiral Corp., Chicago, has purchased the 64,000-square-foot General Mills plant in Bloomington, Ill., John H. Hilaris, Admiral's executive vice-president, has announced.

The factory, which is located just outside the Bloomington city limits opposite the Lakeside Country Club, was originally the property of Colonial Radio Corp. and was taken over by General Mills in January, 1948.

RCA Victor will now release some of its Red Seal records in 33 1/3 r.p.m., long-playing versions. It will continue to issue releases on standard 78 r.p.m. and the newer 45 r.p.m. discs. With this move, all major record manufacturers are now making 33 1/3-r.p.m. LP records.

New industry committee, to be composed of both RCA members and non-member companies to develop further plans for educational Town Meetings of television dealers, was arranged by a score of television manufacturers at a preconference in the hotel, Chicago. The conference was called by Chairman R. C. Sprague of the RCA Town Meetings Committee and included several non-RCA members.

Original plans for the television dealers' meetings proposed TV distributor-dealer conferences in 60 principal cities for presentation of four 20-minute films on major subjects to assist dealers. The new industry committee will further study these plans toward development of a more definite program underwritten by set manufacturers in cooperation with distributors. A meeting of the new planning committee within the next few weeks is planned.

Yardney International Corp., New York, has announced that initial commercial use has proved that the first industrially effective silver-cell battery, now being manufactured on a pilot basis, is successful.

For many years, it has been known that such a storage battery would be possible if it could be charged and discharged repeatedly over a number of cycles comparable with or in excess of that achieved from the better known lead-acid types now in use.

The Silvercell is only 1/3 to 1/5 the weight and its volume only 1/2 to 1/3 of common batteries now in use. The ampere-hour efficiency of the Silvercell approaches 100% and the energy efficiency 85%, which is almost 20% higher than that of lead and nickel batteries.

The unique construction of the entire battery completely eliminates the hazards of leakage and spilling. The Yardney unit withstands heavy discharges without any damage, in common with most alkaline batteries. Noticeably absent during the charging cycles or discharging cycles are corrosive and poisonous fumes characteristic of other types of storage batteries.


Ultra-modern, the new plant is designed for mass production of television picture tubes. With it, Hytron will expand its production of these tubes begun nearly a year ago. Three thousand television picture tubes will roll off the new production lines daily. Ranging in size up to 20 inches, they will be both round and of the new rectangular design.

Howard W. Sams & Co. Inc., Indianapolis, publisher of radio and television service data, is now located in its new plant at 2201 E. 46 Street.

The new building, comprising 30,000 square feet of daylight, air-conditioned floor space, houses the entire business. New high-speed photo-offset presses and other modern equipment have been installed in the new plant, where the complete line of Photofact publications is being produced.
Only D.T.I. offers you the "BIG 5" TELEVISION RADIO-ELECTRONICS Laboratory Type HOME TRAINING

Build and Keep 10, 12½ or 16 inch Picture Tube Quality TELEVISION RECEIVER as you prepare for a Profitable Future

Here is everything you need to prepare you at home for FASCINATING WORK, GOOD MONEY and a THRILLING FUTURE in one of America's most promising fields.

This includes the opportunity to build and keep the top quality Television Receiver shown above—with choice of a 10, 12½ or 16 inch picture tube that gives big, bright, sharp, steady pictures. Get the complete facts. This is an optional feature—available when you complete your training described below. See how D.T.I.'s wonderfully practical "BIG 5" method meets industry's needs. No previous experience needed. Mail coupon today!

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Work over 300 electronic experiments and projects from 16 big shipments of parts. This includes building and keeping all test equipment and radio set shown at left side of page. Modern easy-to-read lessons with handy fold-out diagrams simplifies your entire training.

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D.T.I., alone, includes the modern, visual training aid...MOVIES to help you learn faster, easier at home. See electrons on the march and other fascinating "hidden action"—a remarkable home training advantage that speeds your progress.

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If you prefer, you can get ALL your preparation in our new, Chicago training laboratories...one of the finest of its kind. Ample instructors...modern equipment. Write for details!

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Without obligation, give me complete facts showing how I may make my start in Television-Radio-Electronics.

Name__________________________Age________
Street__________________________Apt.________
City__________________________Zone______State________
We're still in the radio business

Seems as though everything nowadays is TV... TV... TV. We've had so much TV news for you! Hytron's new 16RP4 rectangular picture tube. Hytron's new low-cost deflection-circuit tubes: 1x2, 6BQ6GT, 6U4GT, 6W4GT, 25BQ6GT, and 25W4GT. And many more Hytron designed-for-TV tubes coming.

But we're still in the radio business — both of us. Radio still is king. We realize that. Also that most service problems are still radio — not TV. You can depend on Hytron radio tubes. Whether it is the original Hytron GT... miniature... G... metal... or loctal. For a-c/d-c, portable, f-m, phono, or auto radio. Hytron will strive to give you the most dependable radio (as well as TV) replacement tubes.

Oldest manufacturer of receiving tubes

Hytron

Radio and Electronics Corp.

Main Office: Salem, Massachusetts

I want to know how the Hytron tools can help me make more money. Please send me the free Hytron Tool Catalogue at once.

(please print)

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Street.............................................................................

City.............................................................................

State.............................................................................

R.F..............................................................................

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1. **MODERN STYLING**
Heathkits have brought a new conception of beauty to laboratories and service benches. Many organizations have standardized on Heathkits to make their shops appear attractive and uniform. The panels are produced in grey and maroon and the modern streamlined aluminum handles give the instruments a pleasant, professional appearance. There is no waste space or false effort to appear large in Heathkits — space on service benches is at a premium and the size of Heathkit instruments is kept as small as is consistent with good engineering design.

2. **BEST OF PARTS**
You will find many famous names on the parts in your Heathkit. Mallory switches and filter condensers, Chicago Transformer Corporation and Electrical Assembly Transformers, Centralab Potentiometers. Belden Cable, IRC and Allen Bradley resistors, G.E. tubes, Cinch and Amphenol sockets with silver plated contacts, Defiance variable condensers. Eby binding post and many other quality parts. The finest of parts are used to assure long trouble-free service from Heathkits.

3. **LARGE EASILY READ CALIBRATIONS**
No charts or calculations are necessary to use any Heathkit properly. All scales are simply and plainly marked. The operator instantly knows the proper use of the instrument and can proceed confidently. No multiplication is required as each scale is calibrated independently of the others.

4. **KITS THAT FIT**
Heathkit chassis are precision punched to fit the quality parts supplied. The grey crockle aluminum cabinet and the two-color panels are die punched to assure proper fitting. Many Builders have written marvelous of the ease with which assembly can be accomplished. The chassis are specially engineered for easy assembly and wiring — there are no small, tight corners which cannot be reached — the ends of the chassis are left open in order that installation of parts and soldering can be done with both hands.

5. **COMPLETE KITS**
When you receive your Heathkit, you are assured of every necessary part for the proper operation of the instrument. Beautiful cabinets, handles, two-color panels, all tubes, test leads where they are a necessary part of the instrument, quality rubber line cords and plugs, rubber feet for each instrument, all scales and dials ready printed and calibrated. Every Heathkit is 110V 60 cy. power transformer operated by a husky transformer especially designed for the job.

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Wherever required, the finest quality 1% ceramic resistors are supplied. These require no aging and do not shift. No matching of common resistors is required. You find in Heathkit the same precision voltage divider resistors as in the most expensive equipment. The transformers are designed especially for the Heathkit unit. The scope transformer has two electrostatic shields to prevent interaction of AC fields. These transformers are built by several of the finest transformer companies in the United States.

7. **COMPLETE INSTRUCTION MANUALS**
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8. **IDEAL FOR SCHOOLS**
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The NEW V-4 Heathkit Vacuum Tube Voltmeter Kit

**Features**
- Motor scale 17½% longer than average 4½" meter.
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- 34 Complete ranges.
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- New television type multivibrator sweep generator.
- New magnetic alloy shield included.
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March, 1950
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New 1950 VERNIER TUNING RF
Heathkit SIGNAL GENERATOR KIT

- New 5-to-1 ratio vernier tuning for ease and accuracy.
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- Most modern type R.F. oscillator.
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The most popular signal generator kit has been vastly improved — the experience of thousands combined to give you the best. Check the features in this fine generator and consider the low price $19.50. A best buy for any shop, yet inexpensive enough for hobbyists. Everyone can have an accurate controlled source of R.F. signal voltage.

The new features double the value — think of being able to make fidelity checks on receivers by inserting a variable audio signal. Internal 400 cycle saw-tooth audio oscillator modulates R.F. signal and is available externally for audio testing. The new 5-to-1 ratio vernier drive gives hairline tuning for maximum accuracy in scale settings. The coils are already precision wound and calibrated. Uses turrent type coil and switch assembly for ease of construction. The generator is 110V. 60 cycle transformer operated and comes complete in every detail — cabinet, tubes, beautiful two color calibrated panel and all small parts — new step-by-step pictorial diagrams and complete instruction manual make assembly a cinch even for novices. Why try to get along without a signal generator when you can have the best for less than a twenty-dollar bill. Better order it now. Shipping weight, 7 lbs. Model G-5.

**$19.50**

$34.50

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Experimenter and servicemen working with a square wave for the first time invariably wonder why it was not introduced before. The characteristics of an amplifier can be determined in seconds compared to several hours of tedious plotting using older methods. Stage by stage, amplifier testing is as easy as signal tracing. The low distortion (less than 1% ) and linear output (+ one db ) make this Heathkit equal or superior to factory built equipment selling for three or four times its price. The circuit is the popular RC tuning circuit using a four gang variable condenser. Three ranges 20-200, 200-2,000, 2,000-20,000 cycles are provided by selector switch. Either sine or square waves instantly available at slide switch. All components are of highest quality, tested 110V. 60 cycle power transformer. Mallory F.P. filter condensers, 5 tubes, calibrated two-color panel, grey crackle aluminum cabinet. The detailed instructions make assembly an interesting and instructive few hours. Shipping weight, 12 lbs. Model G-2.

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3. Has lever switching for speed.
4. Complete range of filament voltages.
5. Uses latest type lever switches.
6. Uses beautiful shatterproof full view meter.
7. Large size 11" x 14" x 4" complete.
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Everything you want in a television alignment generator. A wide band sweep generator covering all TV frequencies 0 to 46 — 54 to 100 — 174 to 220 megacycles, a marker indicator covering 19 to 42 megacycles — mechanical driven inductive sweep. Husky 110V. 60 cycle power transformer operated — step type output attenuator with 10,000 to 1 range — high output on all ranges — band switching for each range — vernier driven calibrated indicator marker tuning. Large grey crackle cabinet 164" x 105/8" x 7.3/16". Phase control for single trace adjustment. Uses three high frequency triodes plus 5Y3 rectifier — split screen tuning condensers for greater efficiency and accuracy at high frequencies — this Heathkit is complete and adequate for every alignment need and is supplied with every part — cabinet, calibrated panel, all coils and condensers wound, calibrated and adjusted, tubes, transformer, test leads — every part with instruction manual for assembly and use. Actually three instruments in one — TV sweep generator — TV AM generator and TV marker indicator.

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A LABORATORY INSTRUMENT NOW WITHIN THE PRICE RANGE OF ALL

Measures inductance from 10 microhenries to 100 henries capacitance from 0.0001 MFD. to 100 MFD. Resistance from 0.01 ohms to 10 megohms. Dissipation factor from .001 to 1. Q from 1 to 1000.

Ideal for schools, laboratories, service shops, serious experimenters.

An impedance bridge for everyone — the most useful instrument of all, which heretofore has been out of the price range of serious experimenters and service shops. Now at the lowest price possible. All highest quality parts. General Radio main calibrated control. General Radio 1000 cycle hummer. Mallory ceramic switches with 60 degree indexing — 200 microamp zero center galvanometer — 1/2 of 1% ceramic non-inductive decade resistors. Professional type binding posts with standard 3A" centers. Beautiful birch cabinet. Directly calibrated Q and dissipation factor scales. Ready calibrated capacity and inductance standards of Silver Mica, accurate to 1/2 of 1% and with dissipation factors of less than 50 parts in one million. Provisions on panel for external generator and detector. Measure all your unknowns the way laboratories do — with a bridge for accuracy and speed.

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- Measures leakage
- Checks paper-mica-electrolytics
- Bridge type circuit
- Magic eye indicator
- 110V. transformer operated
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MARCH, 1950

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550 Kc. to 20 Mc.

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Experts in tube-testing have built this new instrument... but you don't have to be an expert to operate it. Counter clerks, uninitiated in radio technicalities, can use it after a few minutes' instruction. For the benefit of the customer, the illuminated meter reads "GOOD" or "REPLACE" for all tubes, including diodes. Gas tests can be made easily. It is the first tester with both circular and linear subminiature sockets. The new fast, smooth-running roll-chart is easily removable from the front panel.

Modern styling of both models tells even the layman that your up-to-the-minute service is one jump ahead of tomorrow!

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In Tube Testers 219 (Counter) and 220 (Portable)

- Novel voltage controls prevent tube damage
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Home Radio-Electronics

... A neglected, but lucrative field for technicians and experimenters ...

By HUGO GERNSBACK

A S POINTED out elsewhere in this issue, the home is the one place from which radio-electronics has been practically excluded for reasons difficult to fathom. If there is one place where such applications are definitely needed, it is in the home. There are literally hundreds of radio-electronic devices which can improve existing archaic conditions and make homes more secure and more healthful. In this short article we give only a few suggestions as to what can be accomplished in this direction.

It is well to note that most of the required apparatus and components are already in existence. By combining them, any clever constructor handy with tools can often achieve spectacular results.

PHONE RECORDER: There are a number of commercially made phone recorders on the market. Unfortunately, these are expensive. Yet home-made phone recorders are not difficult to build. One of the simplest and best methods is to devise a new cradle for the hand set to rest on. When the phone bell rings either a mechanical contact of the bell energizes a circuit or a microphone intercepts the sound and a small amplifier energizes a magnetic trip which raises the hand set. This starts a phonograph record revolving. The sound of the record is picked up by the microphone of the hand set, and the distant speaker is invited to leave his message, which is then recorded. After a few minutes the mechanism stops automatically and is ready for the next call.

All this sounds complicated, but is not. Such a system can be built for not too great a cost by anyone acquainted with radio-electronics and possessing a reasonable knowledge of mechanics. The device will soon pay for itself. It can be enclosed in a small box less than 1 foot square.

RADIO ALARM: The ordinary clock alarm is satisfactory only in that, if you set it once a day, it will faithfully wake you up at the prescribed hour. This is true of most existing mechanical or electrical alarm clocks. If, however, you forget to set them, you will not be called at the expected hour.

Clearly what is needed is a 24-hour alarm, there being no very low priced models on the market today. Anyone can take two cheap clocks, either mechanical or electric, mount them side by side and arrange a number of contacts so that the hour hand will sweep over them. These contacts can be 15 minutes apart around the clock. One contact—usually the 12 o'clock one—is electrically wired so that when the hour contact reaches 12 the circuit is automatically switched to the next clock. Thus we have a 24-hour alarm. Simple contact trips are arranged to sound the alarm at any hour of the day or night. It is, therefore, possible not only to be awakened by radio, but one can also select any radio or television program during the day or evening which then turns on the radio or television set for any program desired.

INTRUDER ALARM: Burglaries in this country still run into the millions of dollars every year. Most of us are careless when we leave our homes unprotected. Expensive caretakers or watchmen are required for unoccupied country houses occupied only a few months during the year. The usual burglar alarms are not of much use.

Here is a suggestion for service technicians who can cash in on this situation, if they specialize in home protection. The main doors should be protected with infrared beams; breaking the beam will put into the circuit the alarm system explained further on. All windows should be protected with a thread, criss-crossing the window four to six times. The best material is a shoemaker's waxed thread, which is very strong, does not absorb humidity, and, therefore, does not stretch or shrink. These threads are thin and almost invisible when stretched across windows; any intruder touching them will close a contact. Normally the entire thread is under tension. Pushing against the thread increases the tension and closes one contact. Cutting the thread, closes another contact. Once a contact has been made by an intruder, either through the door or through the window, a series of bells ring outside the house simultaneously. At the same time the telephone hand-piece is lifted from its cradle and a small motor either rotates the phone dial to "Operator" or (on non-dial phones) energizes a phonograph which notifies the operator that the house has been broken into and that the police be notified. Such a system is practically foolproof. Even if the intruder cuts the telephone wire, the racket of the ringing bells is sufficient to frighten off even the most stout-hearted burglar. In addition to setting off the bells, a number of house lights can be switched on automatically, making any intruder most uncomfortable.

There is a secret switch, its location known only to the rightful owner. This master switch is turned off when the owner wishes to enter the premises and therefore no alarm is set off.

These are only a few simple radio-electronic home suggestions. There are, of course, hundreds of other worth-while applications, many of which can be readily worked out by any of our enterprising readers.
A DeLuxe Televi...
Fig. 17—A complete schematic of the telever.
enamelled wire will be required for winding the inductor on either of these forms. The coil is random-wound to occupy approximately ¾ inch directly over the powdered-iron core when it is screwed all the way in. Hold the coil in place with household cement.

Most of the smaller components are mounted on terminal boards as shown in Fig. 20. These boards (see Fig. 18) are constructed in much the same manner as those used in the video i.f. amplifier described in the January issue. Note that some of the boards have soldering lugs under the nuts which hold the space bolts. Solder the lugs to the nuts to insure a good ground at these points.

The high-resistance bleeder in the high-voltage supply consists of 15 20-megohm resistors mounted on a Plexiglas or Lucite sheet and connected in series as shown in Fig. 19. The resistors are soldered to eyelet-type soldering lugs. To fasten these lugs to the plastic board, drill ¼-inch holes for the lugs and countersink one side of each hole ¾ inch with a ¼-inch drill. Place the lugs on the smooth side of the plastic and ream them over in the depressions made by the countersink. Remove all pins except Nos. 2, 4, and 7 from the rectifier tube socket and mount it with its pins on the terminal side of the board as shown in Fig. 21.

The two independent, low-voltage power supplies are on a separate chassis. One delivers 250 and 225 volts and the other 400 volts. The transformer shown in Fig. 17 is a surplus unit having a multiple high-voltage secondary; two 5-volt, 3-amp. windings for rectifiers; a 6.3-volt, 0.6-amp. winding for the C-R tube; and a 6.3-volt, 10-amp. heater winding for the other tubes in the set. Almost any combination of transformers can be used if they deliver 250 volts at 175 ma or more and 400 volts at 60 ma or more. If the output of your supply is not more than 20 volts high, it can be reduced by using a smaller input filter capacitor and by using a filter choke having a higher resistance. Increase the voltage by using a larger input filter capacitor.

The heaters require 10 or 12 amperes. Two or more low-current filament transformers can be paralleled to supply this current. Connect an a.c. voltmeter across the paralleled secondaries and connect the primaries in parallel across an a.c. line. The meter should deflect as soon as the power is turned on. If it does not, immediately turn off the power and reverse one of the windings. This insures that the transformers are correctly phased.

All leads to and from the low-voltage chassis are in a 12-conductor cable which is terminated with a Jones type F-312-CCT male connector which plugs into a type S-312-AB socket on the receiver chassis. The cable is made from 4-foot lengths of No. 14 or 16 flexible wire. Two of these are connected in parallel for each side of the 6.3-volt, 10-ampere filament line. Each pair of the pairs is connected to the same terminal on the transformer and to separate terminals on the plug and socket.

The chassis, 18 x 19 x 4 inches, was bent from soft aluminum sheet, .064 inch thick, and the high-voltage power supply is in a two-piece metal box 9¾ inches under the chassis free from a maze of wires.
inches deep, 3 1/2 inches wide, and 7 inches high. It can be made from solid metal sheet or from perforated metal screening.

When the chassis and the various metal brackets and fittings have been made and all components installed on their mounting boards, begin wiring the chassis. Connect the heaters as shown in Fig. 17. The wire sizes given are selected for minimum voltage drop in the heater circuit. Use two twisted wires and ground only at the points indicated. Continue with the rest of the wiring, using almost any procedure desired. One method is to start in the corner near the TV-OFF-RADIO switch and work down this side of the chassis, installing mounting boards, filter capacitors, potentiometers, and other components as they are needed. Leave out heavy or bulky components until the major part of the wiring is completed. Use a good grade of flexible insulated wire for the connections. The mounting boards are designed so bare copper wire can be used in most cases. We suggest that the wires from the boards be wrapped around the tube socket terminals rather than placed in the holes. This facilitates removal of the boards if it ever becomes necessary.

Before installing the tuner on the chassis, put four soft rubber grommets in the four large mounting holes. Place lockwashers on two 3/16 x 6-32 screws and fasten these permanently in the two mounting holes in the top section of the chassis with 6-32 nuts. Slide the tuner into position by placing the shafts at the front into the two large holes in the front of the chassis and pushing the unit down on the two mounting screws. Place a washer on each of these screws to cover the grommet, then a nut pulled only tight enough to allow the front end to float. Place the solder terminals at the end of the braid on the screw; put another nut on top of these and pull it up tightly. Repeat for the two mounting holes on the front of the chassis with the exceptions that a nut is not used against the chassis and the screw on the right side does not have a grounding braid.

Editor's Note

Inquiries from readers have indicated that a number of points needed clarification in the first installment of the article "De Luxe Television" in the January issue.

The mixer plate decoupling capacitor is shown as .003 µf in Fig. 1 and as .0047 µf on board No. 1 in Fig. 6. Both values will work; however, the larger value is preferred.

The dimensions for the terminal boards shown in Fig. 1 (January issue) are: No. 1, 2 3/4 x 2 3/4 inches; Nos. 2, 3, 4, 1 1/4 x 2 1/4 inches; No. 5, 2 x 2 inches.

The notch in the lower left corner of the video i.f. chassis (Fig. 5) is 1/2 inch deep and its left edge is 1/2 inch from the left side of the drawing.

On the 6A6T i.f. strip, Fig. 5-a, add grounds from the No. 1 pin to the socket ground between pins 1 and 2 on the first three stages only. The ground leads between pins 3 and 4 remain as they are.

Formex and Formvar insulated wire is used in small motors and generators. This wire can be obtained from most electric motor and armature repair shops. A number of surplus stores sell unmounted field coils wound with wire suitable for winding some of the coils.

A number of the mica and ceramic capacitors used in this set have JAN values such as .003 µf, and 51 and 75 µf. Such values are widely available on the surplus market but are seldom available from regular manufacturer's stock. If the required values are not available, get the nearest commercial value or parallel standard values to get the required value.

The double-eject terminals were obtained from World-Wide Radio, 88 Cortlandt St. and the bakelite tubing from Highbridge Electronics, 485 Canal St. and Eddie Electronics Inc. 154 Greenwich St., both in New York.

Reports From Television DX-ers

TELEVISION viewers in many parts of the country are receiving programs over long distances. Here are some of their reports.

George E. Marshall, Wichita, Kans., received WPTZ, Philadelphia, Pa., and WMMR-TV, Baltimore, Md., at 8 pm on November 1. Sound and picture were excellent for 45 minutes. A Motorola 10-inch receiver and Regency booster were used with a Hy-Lite Yagi antenna 3 feet above the chimney of a two-story house.

Mrs. Renee Pannell, Allendale, Ill., reports several instances of dx reception. The most interesting are WBAF, Fort Worth, Tex., and WATV, Newark, N. J., each of which were received several times. The receiver was a G-E 606 and the antenna a Telrex. Mrs. Pannell, incidentally, is a ham and a radio service "man."

Edwin Cox, Garden City, Kans., reports reception of WMBR-TV, Jacksonville, Fla., at 8:10 pm on November 16, 1949. Sound was good but the picture was a little spotty. A Sentinel 1U-400TV receiver was used with a Jerrold booster and a Workshop 2A-4 antenna.

R. H. Hall, San Diego, Calif., received KRLD-TV, Dallas, Tex., on channel 4—with the Los Angeles channel 4 station on the air at the same time. There was no interference when the antenna was rotated correctly for each. The antenna is a stack of four folded dipoles and the receiver has an RCA 650TS front end. KRLD-TV was received on December 6 from 5:10 to 9:45 pm.

Don Ossege, Toledo, Ohio, received KNBH, Los Angeles, Calif., on September 11, with a Magnavox CT-220 receiver and high- and low-band folded dipoles with reflectors.

Floyd Murphy, Thompson, Ohio, received a test pattern from KLEE-TV in Houston, Tex., last July 5. On one occasion he viewed a program relayed through a Stratovision aircraft with the call WIXW. A Du Mont Chatham receiver was employed with an RMS booster.

Nelson B. Teal, Burlington, N. C., reports receiving three dx stations on a July afternoon last year. First WRAP, Fort Worth, Tex., came in for several hours. Then KLEE-TV in Houston was seen with a signal strong enough to wash out all local ignition noise. After that, channel 4 yielded excellent reception for the rest of the day from WKY-TV, Oklahoma City.

Fig. 21—Side view of the receiver. Note layout of parts in high-voltage supply.
Television Dictionary

(Continued from page 33 of the February issue)

Dissector
A type of pickup tube used in the television camera, more properly referred to as an image dissector. The scene to be televised is focused through a system of lenses upon a photocathode surface. The electron emission from every point on this surface is directly proportional to the intensity of the light falling upon that point. Since emission takes place simultaneously from all points on the surface, an electron image corresponding to the optical image is formed. This electron image is deflected in such a manner that a small portion of it at a time passes through a window or aperture, on the other side of which is an electron-multiplier tube. The output contains signal currents corresponding to the optical image.

Diverging lens
A lens which causes the light passing through it to diverge or spread out. Such a lens is thinnest at its center and becomes thicker toward the edges.

Dynode
An intermediate electrode between the cathode and plate of an electron-multiplier tube. The dynode  emits secondary electrons for each incident electron striking it. (See Electron multiplier tube.)

Electromagnetic deflection
The process of bending or altering the path of an electron stream by means of a magnetic field. The magnetic field is normally created by the passage of current through deflection coils.

Electron lens
An arrangement of electrodes for focusing or otherwise influencing the electron stream in a manner comparable to the way a beam of light is influenced by optical lenses.

Electron multiplier tube
A tube in which many electrons eventually arrive at the plate for every electron leaving the cathode. Electrons emitted from the cathode are attracted by a positive charge on an adjacent electrode called a dynode. For every electron striking it, the dynode produces several secondary electrons. The secondary electrons are attracted to a second dynode where secondary emission again produces additional electrons. A number of such dynodes may be used, the number of electrons being increased considerably before they eventually reach the plate.

Electronic scanning
Scanning of a television image by means of an electron beam, as distinguished from mechanical scanning.

Electrostatic deflection
The process of bending or deflecting the electron stream in a cathode-ray tube by the use of an electrostatic field, as distinct from electromagnetic deflection which employs a magnetic field for the same purpose.

Focal length
In an optical system, the distance between the center of the lens or mirror and the point at which the ray of light converges. The focal length is also called the focal distance.

Field
The picture information produced by scanning the image from top to bottom in the standard interlaced scanning system. The odd and even lines are scanned separately; thus two fields are necessary to produce the complete picture.

Field frequency
The number of fields scanned per second. Under present television standards, this frequency is 60 fields per second.

Field of view
The area included in a televised image as "seen" by the camera.

Field period
The length of time required to scan one field. The field period is equal to 1 divided by the field frequency.

Field repetition rate
Same as field frequency.

Flicker
The visual sensation resulting from presenting a series of images at a slow rate. This rate must be at least 16 per second to enable the persistence of vision of the eye to fill in the time interval between successive images. In standard television practice, the fields are presented at a rate of 60 per second.

Fluorescent screen
The face of a cathode-ray tube when the inside of the glass is coated with phosphor.

Flyback
In cathode-ray tubes, the return of the spot between successive sweeps. Flyback is also known as retrace. In some oscilloscopes and in all television receivers, the cathode-ray tube is biased beyond cutoff during this period.

Flying spot
A system of televising in which a phototube is used instead of an incoherent or other conventional pickup tube. The image to be televised is scanned by a small spot of light. This light, reflected or directed into the phototube, produces the signal currents.

Focus
The point at which the rays of light converge after passing through a lens or after being reflected from a mirror. The distance between this point and the center of the lens or mirror is the focal length.

Focus control
The adjustment which varies the potential of the first anode in a cathode-ray tube. When it is properly adjusted, the stream of electrons converges to a sharp point at the exact instant it strikes the fluorescent screen.

Foot-candle
A unit of measurement for indicating intensity of illumination upon a surface. One foot-candle is the intensity of illumination on a surface located at a distance of 1 foot from a 1-candellepower source.

Frame
The total picture information contained in a scanned image. In the standard interlaced scanning system, one frame consists of two fields. The frame frequency is therefore equal to one-half of the field frequency, or 30 frames per second.

Frequency divider
A circuit which produces an output frequency equal to a submultiple of the input frequency. The input signal is applied to the plate of a diode which has a capacitor in its cathode lead. On the positive alternations of the input signal, the diode conducts and charges the capacitor. On each successive positive

tive alternation the capacitor receives an additional charge. The voltage across the capacitor therefore builds up in the form of stair-steps.

The voltage of the capacitor is applied to the grid of a modified blocking oscillator, which is biased beyond cutoff by the application of positive voltage to the cathode. When the charge on the capacitor has built up sufficiently to overcome the cutoff bias, the triode conducts current. The flow of triode plate current through the primary of the transformer induces a voltage in the secondary. This induced voltage is of such polarity that it drives the triode grid positive. The resultant flow of grid current discharges the capacitor, and the cycle repeats itself. Since the blocking oscillator is pulsed once for a number of input steps, its output frequency is equal to a submultiple of the input frequency. Frequency dividers are also known as counters.

Grounded-grid amplifier
A circuit in which the incoming signal is applied to the cathode rather than to the grid of the tube. A stage of this type, also called a cathode-input amplifier, has a low input impedance. It is sometimes used as the input stage in television receivers to match the low impedance of the antenna.

Halation
An area of glow surrounding the spot on a fluorescent screen. Halation causes blurriness of the television image.

Halo
A ring of light surrounding the spot on a fluorescent screen.

Height
The vertical dimension of a television image.

Hold controls
The adjustments which control the free-running frequency of the horizontal and vertical sweep oscillators in a television receiver.

Horizontal blanking
The application of cutoff bias to the cathode-ray tube during the horizontal retrace.

Horizontal centering control
The adjustment which permits the television image to be shifted in the horizontal direction so that it may be centered on the screen.

By ED BUKSTEN

Radio-Electronics for
Television Service Clinic

National model NC-TV 7

To insure proper operation of this receiver with low line voltage, the manufacturer recommends adding an autotransformer to give the required voltage either at 105 or 115 volts a.c. Fig. 1-a shows the circuit. Putting the fuse in a second fuse holder (labeled 105-115) compensates for low line voltage.

Fig. 1—Autotransformer raises voltage.

In Fig. 1-b the autotransformer is connected to raise only the B-plus voltage. A switch permits the set owner to compensate for low line voltage at certain times.

Du Mont metal tube

The new 19-inch metal-envelope Du Mont picture tube has some unique features which require special attention with the tube is substituted for any other.

The horizontal deflection angle is 70 to 75 degrees while the standard 10-, 12-, 15-, and 16-inch picture tubes have a 55-degree angle. (The new 16GP4 has a 76-degree deflection angle). This means that standard deflection yokes will not provide a wide enough picture. Three possible modifications can be made to sweep the 19-inch tube. Adding an 82,150-µuf mica capacitor from the plate of the damper tube to ground and shunting the width-control coil with a .003-.05-µf capacitor often gives enough additional width.

Another method is to use a second horizontal output amplifier tube in parallel with the existing one, or else modify the circuit for use with a new ceramic-core-type horizontal output transformer (the 77J1). This transformer, developed by General Electric Co., will be produced by several manufacturers.

The third method is the use of a special 75-degree deflection yoke. Samples of this yoke are now being tested by the industry.

The 19-inch tube, and the 16GP4, as well as the new all-glass 16-inch tube, employ a bent-gun type of ion trap requiring only a single magnet. This means that the double-magnet ion traps used on such tubes as the 10BP4, 12LP4, and 16AP4 will not produce a raster on the new tubes. A special ion trap using a small, single, permanent magnet is currently being produced for the 16- and 19-inch Du Mont tubes.

WALTER N. BUCHSBAUM*

In past issues we have run a series of answers to television servicing queries. This article presents more information along the same lines, though in slightly different form.

Future publication of additional solutions for specific groups of problems depends on whether or not this type of information is valuable to you. If it is, your queries mailed to RADIO-ELECTRONICS. For answering in future issues will prove the matter.

Admiral model 20A1, 20B1

Television Custom Built, Brooklyn, N. Y., reports that the picture is very good on all channels and because of the a.g.c. system the contrast control needs no adjustment, except on channel 4. This channel comes in very strong and appears to be over-modulated. When it is tuned in, a horizontal jitter appears which can be cured by resetting the horizontal hold control. In some cases the rear adjustment must be used. If channel 4 is synchronized properly, all other stations are out of sync. Two Admiral models 20A1 behaved that way, but a third one brought in for re-alignment did not show this defect.

The solution lies in the sync separator circuit. On channel 4 the strong signal apparently overdrives the 6AU6 used as a sync separator tube. To avoid this, the manufacturer has made a change in later production runs which completely eliminates the jitter. A 47,000-ohm resistor goes from the screen (pin 5) of the 6AU6 to ground and an 82,000-ohm resistor to B-plus, as in Fig. 2. If the 47,000-ohm resistor is removed and the 82,000-ohm one connected to the centertap of the contrast control, the screen voltage will be decreased as the contrast is decreased. This prevents overdriving the sync separator even at the strongest signals and eliminates the horizontal jitter.

1948 Teletone

Joe's Radio Service, Ridgewood, N. Y., reports complaints of insufficient vertical sweep or no vertical sweep at all on 10-inch Teletone receivers. This set uses the circuit shown in Fig. 3. A 6SN7 is used as blocking oscillator and output amplifier. The plate load of the blocking-oscillator section is made up of R65 (1.5 megohms) and the height control R66 (2.5 megohms).

It was found in most cases that R65 was either shorted or open. Replacing this with a resistor of the same value, but with a 1-watt rating permanently cures the defect.

Fig. 3—Teletone vertical sweep circuit.

In this same model another defect, common to many other magnetic deflection TV sets, was found. The picture showed "wrinkles" on the left side, an indication of insufficient damping in the horizontal flyback circuit. Changing the 5V4 damper tube did not rectify the trouble. The faulty component turned out to be the 56-µuf capacitor connected across one of the two horizontal deflection coils. The capacitor is inside the deflection yoke, on the neck of the picture tube.

Fada models

Garcia Radio & Television Service of Flushing, N. Y., reports the following experience with several 10- and 16-inch Fada sets. Customers have complained of horizontal jitter which may be steady or intermittent. The defect seems to be cured by substituting some new tubes, especially a new 6K6 horizontal oscillator tube. After about 2 hours the jitter returns and can now be cured by changing the 6A37 horizontal sync reactance tube. Two hours later the same condition prevails again. Each time one of these tubes is exchanged it seems to remedy the defect, but the remedy is always only temporary.

The true source of the trouble writes Mr. Garcia, is a .065-µuf capacitor connected across the synchronlock transformer. This capacitor becomes leaky to the extent that it distorts the pulse passing through it and thus creates an unbalance which affects the rest of the sync circuit. Putting in new tubes changes the capacitance temporarily. After a thorough warm-up the old troubles shows up again. Only replacement of the leaky capacitor is a permanent remedy.

* Chief Engineer, Tech-Master Products Co.

March, 1950

www.americanradiohistory.com
A Ten-Tube FM Receiver

In these days of high-priced radio parts, it seems impossible to build anything at moderate cost. Yet through careful design and the use of a piece of readily available surplus equipment, a high-quality FM set can be built. The tuner has a stage of r.f., two i.f. stages, limiter, and discriminator. The detector circuit used is similar to the one employed in the better FM receivers. The total cost is less than $10.

The before-and-after photographs of the chassis deck. Below, the R89/ARN-5-A receiver in new condition; above, appearance after conversion for FM.

The tuner

The first step is to remove everything from the chassis of the glide-path receiver except the following: the i.f. strip, consisting of four i.f. cans and three 6AJ5 tubes; three resistor strips—one near the chokes and two on the rear chassis wall; the two chokes marked 59 and 60; the sockets for the 12SK7 and the 12SN7 near the front of the chassis. (Refer to the photographs.) In removing the wiring, be careful to leave intact the bundle of wires running next to the i.f. strip, as it contains the wires carrying the plate, screen, and heater supplies. Put aside the parts that have been removed for future use.

The next step is to mount the three miniature tube sockets, tuning capacitor, two coil forms, phone jack, antenna input socket, filter capacitor, pilot light, and power switch. If the amplifier described below is used, its parts should be mounted also. This will necessitate a moderate amount of drilling and filing, but most of the holes are small and the only tools necessary are a hand drill, a keyhole-type metal saw, and rattle and flat files.

This set is built around the R89/ARN-5-A glide-path receiver, which operates at several hundred megacycles to guide aircraft in landing. The unit costs between $4 and $5 at most surplus dealers and can be obtained for even less without the side covers. The i.f. strip is broad-banded and already tuned to 21.5 mc. Thus very few changes have to be made to the original i.f. section.

The FM set will be described in three sections, tuner, power supply, and amplifier, as some experimenters may have amplifiers or power supply which could be used instead of building a new one.

Referring to the schematic of Fig. 1, coils L1, L2, L3, L4, and L5 can now be wound. L2 consists of four turns of No. 14 enameled wire spaced the wire diameter on one of the ceramic coil forms. L1 is two turns of No. 14.
cotton-covered wire wound between the turns of L2. Solder a 4-inch piece of wire to each end of L2, and cut L1 so that its ends will just reach the antenna-input receptacle. L5 consists of three and one-quarter turns of No. 14 enamelled. It is tapped one-quarter turn from ground. The ground end should be at the open end of the coil form—away from the slug. L4 has three and three-quarter turns of No. 14 enamelled wire wound on one of the ceramic coil forms and then slipped off the end to be mounted without a form. L3 is a 47,000-ohm resistor on which 25 turns of No. 24 enamelled wire are wound and soldered at each end. The forms containing the L1-L2 combination and L5 may now be mounted, L1 and L2 projecting above the chassis and L5 below. The leads from L2 should be pushed through a hole to the bottom of the chassis.

The front end (r.f., oscillator, and mixer) can now be wired. It is very necessary in these stages to have all the leads as short as possible. All the ground leads should go to a common point on the tuning capacitor. L4 is mounted directly from pin 1 of the 6AJ5 mixer tube to the common ground point.

Fig. 2 shows the i.f. strip before it is changed. Comparison with Fig. 1 shows that very few modifications have to be made. In fact, the second i.f. can need not be opened. In working on the i.f. strip do not move the slugs as the coils are already tuned to 21.5 mc. This will save considerable trouble in alignment later. It is necessary to install a secondary coil in the last i.f. can. To do this, carefully drill or ream out the hole in the top Bakelite plate and mount the ceramic coil form having a shiny slug. Care should be taken when drilling the Bakelite as it has a tendency to crack easily. Fourteen turns of No. 24 enamelled wire are to be wound on this form. The two 40-µf capacitors across this coil should be chosen as nearly alike as possible, as they are to provide an electrical centertap for the coil.

The only remaining wiring to be done in the tuner is that of the discriminator tube. The tube used is a 6H6 if the a.f. amplifier given below is to be used or a 12H6 if the tuner is to work into an external amplifier. The resistors and capacitors between the cathodes of the discriminator should match fairly well. They are to be mounted on the resistor strip near the last i.f. can.

Power supply

Figs. 4-a and 4-b give the details of two alternate power supplies. The

Completed FM tuner looks businesslike and sounds good. Controls are at side.
Fig. 2—The original i.f.-strip hookup. Comparing this diagram with Fig. 1 shows that little modification is necessary.

heaters are connected in series; but if only 6.3-volt tubes are used, a small filament transformer may be substituted. The series connection has the advantage of economy, but slightly better performance may be obtained by using a filament transformer. If the amplifier recommended below is used, the filaments should be connected as in Fig. 3. If an external amplifier is used, the filaments should be connected as in Fig. 9 b. Note that the line cord has only one conductor. The chassis must be firmly connected to a good external ground.

The filter chokes (L1 and L2) are parts 59 and 60, respectively, in the glide-path receiver. L1 consists of two coils connected in series. For best results only the side of this choke having the higher d.c. resistance should be used.

Audio amplifier

The audio system may be mounted on the same chassis, or the tuner may work into an external amplifier and speaker. One way in which the construction of an amplifier and a power supply could be avoided would be to connect the tuner into the audio section of an ordinary AM receiver and to take the B+ from the radio's power supply. Be sure that the maximum ratings of the power supply are not exceeded.

AM alignment and the procedure given below for FM.

1. Check the amplifier with an external signal source and make any necessary adjustments. Connect the amplifier to the tuner and allow the set to warm up for at least 10 or 15 minutes.

2. As the i.f. is already in alignment or nearly so, some signal should be fed judging by ear by a v.t.v.m. connected across the 6H6 cathodes, adjust the primary of the discriminator i.f. coil for maximum output. Then adjust the secondary slug for a minimum of distortion, or, using the v.t.v.m. across the cathodes of the discriminator, until the meter reads zero. Repeat this step if the adjustments turn out to be large.

3. The i.f. strip can now be touched up. Start with the secondary of the next-to-the-last i.f. coil (the last one has been adjusted in step 2) and work backwards. The tuning should be rather broad, and for maximum fidelity the coils should be tuned exactly to the center of the pass band.

4. Tune to several stations to determine if the frequency range of the receiver (88 to 108 mc) is correct. If not, adjust the oscillator trimmer until the correct range is obtained. It may be necessary to adjust the transformer on the oscillator coil. Finally, adjust the r.f. and mixer trimmers.

Checking NBFM Transmitters

Narrow-band FM—commonly called NBFM—is permitted in portions of amateur phone bands so long as the frequency modulated signal does not occupy any more space than a 100% modulated AM signal having the same modulation frequencies. The bandwidth of an AM signal is twice the modulating frequency.

When a carrier is frequency modulated a number of sidebands are generated. These sidebands are separated by the modulation frequency and their number is determined by the modulation index which is the carrier deviation divided by the modulation frequency producing it. With NBFM, the modulation index is approximately 0.6 when the amplitude of the second pair of sidebands is 20 db below the amplitude of the unmodulated carrier. At this point, the spacing between the second pair of sidebands may be regarded as the effective bandwidth.

One method of checking deviation is to use a calibrated a.f. oscillator and a communications receiver. Allow the receiver to warm up thoroughly, then zero-beat the unmodulated signal from the exciter or oscillator. Connect a six- or eight-volt variable voltage to the grid of the reactance tube and increase the voltage until carrier deviation is indicated by a beat note in the receiver output. Measure the beat note by comparing it with the signal from the a.f. generator. Record the beat frequency and the d.c. voltage producing it. Reverse the battery and repeat the procedure, using several voltages up to the maximum. Transfer the measurements to graph paper. The resulting plot should be linear at the desired bandwidth. If it is not, the deviation capabilities of the oscillator are exceeded at the point where the line curves. The peak a.f. signal on the reactance tube should not exceed the highest d.c. voltage which produces linear deviation.

If deviation is not linear at the desired bandwidth, the oscillator should be operated at a submultiple of its present frequency and bandwidth made up in the frequency multipliers which produce the output frequency.
Applause
Meter

by GUY S. CORNISH

Whenever a church, club, school or other organization gives an entertainment in which local talent competes for prizes, the winners usually are selected by popular applause. If the ones who judge the applause rely solely upon their ears, the job becomes very difficult. But if some means is at hand to register and record the intensity of the applause for each contestant, a comparison of the readings will be accepted without question.

Such a device, known as an applause meter, consists of a means of converting sound into electrical energy which is fed to a suitable indicating device. To eliminate any question of a misreading on the part of the judges, the indicating hand does not return to zero after each round of applause, but stays instead at the maximum position to which it was deflected until the judges have recorded the reading.

The applause meters available on the market are expensive. For the average service technician their limited use does not justify the expense of purchase. However, a simple, easily handled meter is a source of revenue for any radio technician. For those who have some spare time and are handy with tools and possess one of those famous junk-boxes found in all radio shops, here is a home-made applause meter.

The applause meter comprises three principal items. A high-impedance magnetic speaker (or a standard PM with a voice-coil-to-grid transformer) acts as a microphone to pick up the sound of the applause. A standard audio amplifier amplifies the sound and feeds it to a meter. The meter is the heart of the device and must be built especially for its purpose. Since it must be seen by the audience, it must be large; and to eliminate controversy, it must stay at maximum deflection rather than returning to zero after the peak.

The meter is of the simplest possible type and reminiscent of certain battery testers (and some cheap prewar radio meters). Fig. 1 and the photographic Fig. 2 practically explain it. References to letters and numbers in the following description are to the lettered and numbered pieces shown in those two figures.

The indicating mechanism is constructed on the well known solenoid principle, a soft iron armature being drawn into the field of a coil when current is flowing in it. As the current is alternating, the armature must be thin, light, and free from all traces of residual magnetism. Thin transformer laminations make excellent material for this purpose. When no current is flowing in the winding, the armature should rest just outside the coil. As the flow of current increases in the coil, the armature will be drawn in. The coil form is made from 1/8-inch formica sheet, cut in the form of an arc as shown in Fig. 1-a.

Two of these are required, and can be cut by hacksaw and finished by proper files. They are separated by four spacer washers and one segment spacer cut from 1/8-inch formica sheet or similar material. Screws and nuts hold the form together, with a little speaker cement to hold the segment in place. The winding consists of 180 turns of No. 28 cotton-covered enameled wire, bound with coil cement after winding. Starting from the left-hand side, the wire is wound over to the right, keeping the turns tight together along the smaller arc edge and then back again to the left in the same manner. This will take about 165 turns. The remaining 25 turns must be wound over the left end as shown in b. About 8 inches of wire should extend from each end of the winding for terminal connections.

The armature also is in the form of an arc and moves into the coil with a circular motion. This rocker armature consists of a thin piece of transformer laminating, cut to the dimensions shown in Fig. 1-c. The arc is riveted to a thin piece of magnesium alloy, also shown in c. The celluloid pointer is cemented to it. The magnesium sheet, salvaged...
from war surplus material, was chosen for its lightness. However, aluminum will give as good results. The rocker armature, normally just outside the coil, will move in as the current increases. This can be done by either spring action or gravity. In favor of simplicity, the writer chose the latter. To minimize friction in the bearings, pin center mounting is used. For a shaft we used a 1/16-inch stove bolt cut to a length of 3/4 inch. With our shop lathe, both ends were tapered down to a fine point as shown at d.

If the technician does not have access to a lathe, a drill press or a breast drill clamped in a bench vise can be used. The stove bolt can be clamped in the chuck and, while being rotated, a fine file can be used to taper both ends. After the stove bolt has been tapered, it is mounted in the rocker arm and held firmly by two nuts as shown at e.

The bearing plates f are made of brass, 1/8 inch thick and 1/2 inch wide. A center punch was used to make a deep indentation in these plates to receive the bearing points of the stove bolt shaft. Be sure the angle of the punch is greater than the angle of the pointed shaft, in order that the bearing is on the points and not the sides of the shaft. Care must be exercised in marking off this position: the shaft must be perpendicular to the plates when mounted, as shown at g. The plate spacers must be carefully made and the plates spaced so that, although there is no end-play in the shaft, the rocker will swing freely without binding.

To prevent rust, a drop of 3-in-1 oil was used on each bearing. The brass bearing plates are held in position by two 1/4-inch stove bolts, 2 inches long, which also hold the coil form on the formica base plate (4 in Fig. 2). On the outer bearing plate is mounted a circular brass disc (see h in Fig. 1 and 6 in Fig. 2) 1 3/8 inches in diameter, with a 1/8-inch boss in the center, 3/8 inch high. This is the bearing for the celluloid indicating hand or pointer. A 10-32 machine screw extends from the center of the boss to hold a brass cover plate. Washers cut from blotting paper are used to give the indicating hand just enough friction to hold it in any position on the scale when moved by the rocker arm. See j in Fig. 1. A knob on the end of the screw forms the “0 return” (see photographs).

The base plate holding the complete indicating mechanism is mounted between two brass supporting arms (2 and 3 in Fig. 2 and at k in Fig. 1). These arms also support the 0-100 scale, which was made with black India ink on white glazed drawing paper of the sort on which ink drawings are made. A 15-watt, 127-volt lamp will pass sufficient light through this paper to give a well-illuminated scale.

The divisions are not calibrated to any actual units, but are simply reference points which enable the judges to make their comparisons. The scale should be laid out lightly with a lead pencil and then retraced with black drawing ink.

The meter was built from scrap materials taken from our junk-box, and the sheet aluminum, wire, and wood for the cabinet, was salvaged from war surplus purchases. The indicator hand was made from white celluloid. The metallic sheet supporting the scale was cut from aluminum, 1/8 inch thick. The brass bars, 1/8 inch thick and 1 inch wide, used for the bearing plates and the supporting arms were purchased for this purpose. The formica was salvaged from old panel scrap material. The materials used and dimensions given are offered only as a guide to those who may desire to construct the meter. Because many readers may have ideas of their own on construction and design, we have not dwelt too much on details.

The amplifier used is very similar to one described in the September Tube Manual several years ago. It has a 6SJ7 and 6C5 as voltage amplifiers, a 6N7 phase inverter, and 6L6-G's in pushpull—a very standard circuit. While it has given excellent results, a technician may have a pet circuit of his own, which may be substituted if the gain and power are ample. The output transformer should be heavy enough to handle 15 or 20 watts and should have a 4- and 8-ohm tap. When the meter is completely assembled and housed, try first 4 and then 8 ohms. The one that gives the best results should then be permanently connected in circuit.

In Fig. 3 are shown the two functions of the feed lever. When it is in the left position, the amplifier output is kept out of the indicator mechanism, thus preventing needle swing on ordinary conversation. When the lever is moved slowly to the right while the

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**Fig. 1**—Sketches show how each individual part of the applause meter is made.

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**Fig. 2**—Exploded view of meter. 1—scale plate; 2 and 3—brass supporting arms; 4—base plate; 5—bearing plate; 6—bearing plate with indicator bearing; 7—the rocker armature and its shaft.
plause is on, the rocker arm will move the indicating hand up gradually to the maximum position, assuring a relatively correct comparison between each round of applause.

Care must be exercised in the placement of the pickup. No doubt the best position would be above the heads of the people, near the ceiling, in the center of the room. If a light fixture is available, the pickup may be attached to it. A satisfactory and far more convenient location would be in a corner of the room, hanging the pickup at such an angle that the sound received would be reflected from the ceiling.

Fig. 3—Feed lever works output control.

Several precautions must be taken in operating the applause meter if satisfactory results are to be expected. It should be turned on to warm up about 10 or 15 minutes before use. Just before the program starts, the master of ceremonies should request everyone to applaud vigorously while the gain is adjusted to a point where the indicating hand registers 100 on the scale. He now tightens the lock to hold the gain in this position and brings the indicator back to 0 by turning the 0 return knob to the left. This knob is normally held in the right position by spring action. As a check, asks the audience to applaud once more while he turns the feed lever to the right as far as it will go and then lets it return to the left or starting position. The indicating hand should now register approximately 100 on the scale.

If there is a possibility that a number of people may enter the room after the meter is set and locked, it will be advisable for the m.c. to adjust the gain to read 90 instead of 100 on the scale. This will permit the late-comers' applause to register.

For best results, the audience should be instructed to applaud their favorites by hand-clapping only and not by stamping and whistling. They should also be told that it is intensity of applause, not the length that registers.

The reading of each contestant is recorded by the judges and awards are made from these figures. In case of a close or tie decision, the judges can request that the applause be repeated.

Sponsors of this type of entertainment, after becoming familiar with the applause meter, will never go back to the old method of selecting by ear. To local radio technicians having such a meter, every such group is a potential permanent customer.

MARCH, 1950

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Announcing

$1,200.00 Prize Contest

Radio-Electronic in the Home

DESPITE the amazing and extraordinary progress made in radio-electronics during the past two decades, one phase seems to have been neglected completely. We refer to radio-electronic applications in the home.

Practically all present-day inventions and patents concern themselves with industrial applications. Even such obvious applications as automatic electronic door openers are used chiefly in railroad terminals, restaurants, and other public places.

The home is the place where radio-electronic devices are really needed today. There are potentially thousands of ingenious ideas that can be used in the modern home, not only to lighten our work, but to make life safer, to give us more leisure, to safeguard our health, and to give us conveniences which are often urgently needed.

These applications need not necessarily be new inventions. It is simply a matter of applying ourselves to adapt the innumerable radio-electronic devices and instruments available. Most of our readers can solve these various problems at not too great a cost in their spare time.

On page 40 we present a single example of applied electronics—in this instance to do away with an annoyance. While this particular application has its humorous features, there are other hundreds of serious applications that are critically needed in the home.

We are sure that readers of Radio-Electronics have many worth-while ideas for applying radio-electronics in the home.

We therefore invite you to contribute to this monthly Prize Contest, which will run for a total time of one year.

Monthly prizes totaling $100 will be given for the best ideas submitted during the month. These are cash prizes as follows:

- **FIRST PRIZE** $50
- **SECOND PRIZE** $25
- **THIRD PRIZE** $15
- **FOURTH PRIZE** $10

Please Note the Following Rules

1. This is a monthly cash Prize Contest for the best idea submitted during the month for a practical new radio-electronic application in the home.
2. The highest prizes will go to those contestants who have actually built the devices they describe and who submit photographs to prove it. Lesser prizes may be given for "ideas" not reduced to practice and for entries unaccompanied by photographs.
3. Entries of constructed devices must be accompanied by photographs, full description, and complete circuit diagrams.
4. Ideas for new devices which have not actually been built must be stated in complete detail and accompanied by complete diagrams, drawings, and all other possible descriptive material.
5. All such inventions and photographs of the prize-winning devices or ideas will become the property of Radio-Electronics, which will publish a descriptive article on each device or application. The prize winners will be paid regular rates for their articles, in addition to the prize money. Entries not winning prizes will be returned.
6. If two or more entries submitted during the same month are judged to be of equal worth, identical prize awards will be made for both entries.
7. All entries will be judged by the Board of Editors of Radio-Electronics. Prizes will be awarded in accordance with novelty, general importance of the application or device, smallness of cost involved in building it, and practicability. The decisions of the Board of Editors of Radio-Electronics will be final.
8. Excluded from this contest are radio-electronics employees and their relatives.
9. The first monthly contest closes April 3 at midnight, Eastern Standard Time. All entries postmarked not later than April 3 will be judged in the first month.
10. Announcement of the first monthly prize award will be made in the July issue of Radio-Electronics. The first month's prizes will be paid on the publication date of the July issue of Radio-Electronics.
Miniature-Tube A.F. Amplifier

Three miniature tubes give 4 watts output with good frequency response

By R. CAMERON BARRITT

The complete miniature amplifier. The chassis measures only 4 x 5 x 2 inches.

With the development of miniature tubes to meet almost every need, it has become possible to make electronic equipment extremely small. Described here is a miniature, high-fidelity, 4-watt, a.c.-d.c. amplifier that is flat ± 1½ db from 30 cycles to 10 kc, has less than 2% distortion, a gain of 60 db, and a noise level 70 db below 4-watt level. Tubes used are two 50B5's and a 12AU7. The amplifier is constructed on a 4 x 5 x 2-inch aluminum chassis, and over-all measurements are 5½ x 6 x 4 inches. It takes less than half the space of a conventional amplifier using 50L6's. The push-pull 50B5's are employed in a cathode-driven phase-inversion circuit (see schematic), and the two triodes of the 12AU7 are in cascade. This results in 10 times the gain that would be possible if the two triodes were used in the conventional type of inverter circuit.

Although the two triodes in the 12AU7 envelope are identical, the circuit constants are different, being designed for minimum distortion at the levels presented to each.

It is almost impossible to show the actual placement of chassis connections in the circuit schematic, but care in these is most important for low noise level. There are but three chassis connections and they all go to the wires on the 12AU7 socket. Buses run from here to the metal-can capacitors, the only other chassis connections. (An additional minor one is the 50-ohm bias control for the 50B5's.) The input jack is insulated with fiber washers. One ground point instead of several results in less inductive hum pickup because of elimination of closed low-impedance loops. We consider this feature of the amplifier a major contribution to its low noise level. The wiring is as compact as possible, and signal leads are close to the chassis and well shielded. Filament leads are twisted tight, the chassis-connected end of the string going to pin 4 of the 12AU7 voltage amplifier.

Many other points of mechanical construction in the amplifier help stability and keep noise down. For example, the lugs of the phono jack are moved close together. A shielded lead covered with spaghetti runs from this jack to the 12AU7 socket, and the inside lead is drawn out through an appropriate hole to make connections at the volume control. Center socket shields are grounded. Whenever possible, socket lugs are soldered together without utilizing wires. The a.c. plug and switch are kept close together and on the opposite side of the chassis from the input jack. Output jacks are mounted on the other end of the small chassis.

It is necessary to mount the filter choke directly underneath the output transformer, but no trouble has been experienced with hum. The cathode bypass capacitor in the first stage does not raise gain, as it would appear, but eliminates hum. Incidentally, a 450-volt capacitor is used instead of a 150-volt unit on the input of the B+ plus filter to minimum maintenance, as it is subject to surges. For the same reason a selenium rectifier instead of a vacuum tube is used. The filter capacitors are exposed to a considerable amount of heat, but the Mallory PP units used are designed for this and have proven that they can take it without going bad.

The cathode phase-inversion circuit of the 50B5's permits economical use of tubes. It is also probably the best for maintaining balance through wide frequency bands. It is not unstable, tricky, or difficult to adjust. The reason for the wideband performance is that no capacitors are involved. The phase-inverting cathode resistor is made equal to the reciprocal of the tubes' transconductance and is adjustable. (The transconductance of 6B5's is in the order of .0075 mho; thus the resistor is adjustable around 133 ohms.) A cathode-coupled phase-inverter has the gain of a single tube, the signal voltage being effectively split and half applied to each side of the push-pull circuit.

This is how it works. The signal from the 12AU7 is coupled to the grid of the upper 50B5 in the usual way. The cathode of the 50B5 is unby-passed. The signal plate current, passing through the cathode resistor to ground, creates a voltage drop between cathode and ground, which changes at an audio rate. The grid of the lower 50B5 is grounded and its cathode is connected to that of the upper tube. Any voltage appearing across the cathode resistor as the result of signal through the upper tube, also appears between cathode and grid of the lower tube.

There are several ways of adjusting the bias of the tubes for balanced inversion. Probably the best and easiest is to note with a pair of headphones

*S QAN, Scranton, Pa.
The polarity of the primary and secondary of the output transformer must be correct so that the feedback is negative, not positive. If it is not right on the first try, interchange the connections.

Frequency runs at various levels have been plotted, and there is much improvement in performance when the output transformer is run well under saturation. This is the reason for a 25-watt transformer in a 4-watt amplifier; the larger the transformer, the better the bass response and the lower the distortion.

(Note this warning carefully: the chassis and the capacitors can in this amplifier are directly connected to one side of the line—and it may be the hot side! To make the amplifier safe for use, several methods are possible, though none are entirely safe and precaution is still required.

The entire unit may be enclosed in a nonmetallic cabinet so that no metal part can be touched. If the input is "isolated" from the line with a .05-µf capacitor (not used originally by the author) a phonograph pickup connected to it may be touched with little danger.

The best procedure is probably to bring all points shown connected to chassis to a common negative point, from which the chassis can then be entirely isolated. Two-terminal filter capacitors with insulated cans would, of course, be necessary. This method is used in underwriter-approved receivers, most of which also use a .05-µf capacitor between chassis and negative B.

Getting components into small space is not easy but can be done with planning.

Another method would be to orient the power plug in the wall socket so that the chassis side of the line is the grounded side. The socket and plug can then be so marked that the orientation will be the same in the future. While electrically preferable, this method is psychologically unsound—even a brilliant radioamateur will forget some day and get burned. If, however, the amplifier is to be connected to a tuner or any other powered device, the polarized plug trick is the only way to be safe—and it may also be the only way to keep out hum.—Editor)

**Amplifier Has Unusual Circuits**

Rather unusual tone-control and phase-inverter circuits are used in this amplifier, described originally in *De Radio Revue* (Belgium). The 6SJ7 is a conventional microphone preamplifier. One section of a 6SN7 V1-a is the first voltage amplifier and mixer tube. This section is resistance-capacitance-coupled to V1-b, connected as a low-frequency amplifier. The highs are bypassed around R5 by the .05-µf capacitor. The amplitude of the lows appearing on the grid of V1-b is controlled by the setting of R5.

The output of V1-b is connected to the second 6SN7, which is a "long-tailed" amplifier (see "Phase-Inverter Circuits" in the July, 1946, issue of this magazine). In the original circuit, the grid of V2-b is grounded through a large capacitor C2. In this circuit, the designer has connected one end of C2 to an R-C network consisting of R1, R2, R3, R4, and C1. When the arm of R3 is close to the junction of R1 and R2, the grid of V2-b is effectively grounded. When the arm is at the opposite end of R3, the highs developed across R4 are applied to the grid of V2-b. In this way, the second 6SN7 works as a phase inverter and as a tone-control mixer tube.

**Materials for Amplifier**

- Resistors: 1-270, 2-1,000, 4-20,000, 1-20,000, 8-11,000 ohms; 1-220, 1-470, 1-1,500, 1-3,300, 5-220,000 ohms.
- Audio taper potentiometers.
- Transformers: 1-15-watt output, 11,000-ohm primary, multitap secondary; 1-power, 650 volts, c.f., at 60 ma, 6.3 volts at 2 amps, 5 volts at 2 amps.
- Miscellaneous: Chassis, sockets, tubes, switch, speaker, hookup wire, and shielding braid.
MUCH of the atomic energy one hears about is really nucleonic energy—not that it is any less worthy of respect for that reason. On our cover this month is an illustration of true atomic energy—energy due to the action of single whole atoms.

The equipment used to produce this energy is a magnetron u.h.f. heater designed by General Electric to operate at 1040 mc, and used chiefly for dielectric heating. It has a water-cooled magnetron with an output power of 5 kw, coupled by a co-axial line to a heating chamber in which the work is normally placed. An arc is made to form across the end of the output line. Nitrogen is passed through this arc, and it is the beam of nitrogen gas which forms the atomic blowtorch. Not that the gas is hot—it remains relatively cool till it reaches its work!

The answer to the paradox is simple. Atoms of many types of elements are sociable—they prefer to go around in pairs or groups and are disturbed if forced to separate. In fact, it takes a tremendous amount of energy to pull them apart.

Atoms of nitrogen gas travel in pairs. But the beating they get in passing through the 915-mc, 5-kw arc is more than enough to separate large numbers of them from their partners. They still feel the urge to get together again and do so as soon as they contact any solid object with which they can form molecules. Each time a pair meet again, they give up in the form of heat the energy required to separate them, and in doing so may raise the temperature in the area immediately surrounding them to a very high value. An exact measurement of the highest possible temperature obtainable from the new beam has not yet been made, but the cover picture shows it melting a rod of quartz, which requires 4,118 degrees F. Tungsten, which has a melting point of 6,092 degrees F, has been melted. In tests, it melted not only the metals, but...
also the firebrick which is used in furnaces.

The stream of gas is not in itself hot—it remains cool until it impinges on some solid substance with which it can form molecules. This is only when the atoms begin to recombine that heat is given out. This can be demonstrated with such absolutely inert gases as argon or neon, which never combine with anything. Passed through the arc, they become electrically ionized; electrons are displaced from their orbits, but remain so cool that a hand has been placed in a stream of gas from the arc without ill effects.

There is an important difference between this type of energy and that produced by nuclear action or atomic fission. The energy of fission—once a chain reaction has been started—is supplied by the atoms themselves. The power released in the atomic bomb is that supplied by the ultrahigh-frequency beam.

The generator that supplies the power is by no means complex. From the rear (see photo), it looks like mostly blower. The tube itself is water-cooled, and the blower simply cools the output seal. To the right of the blower are transformers for the filament supply. Filament temperature control equipment is in the upper left corner. Elaborate controls are necessary here, as the filament temperature depends not only on the current supplied by the filament transformer, but also upon the plate current and the match to the load. If a great deal of power is reflected back to the filament, temperature increases. Normal filament current is 53.5 amperes at 10.5 volts—over 500 watts for the heater alone.

The six-plate-supply rectifiers are seen along the shelf at the top. The Z-1492 magnetron uses 2 amperes at 5,000 volts. The tube itself is directly behind the blower, but the co-axial output line may be seen ascending in the upper left, behind the filament control equipment.

No circuit is given, as the fundamental circuit is simply that of a diode with a piece of co-ax running out of it. Two directional couplers (see RADIO-ELECTRONICS, December, 1948, page 26)—one to measure the power going down the co-ax from the tube and the other to measure any power reflected back from the load—are connected to the co-ax and show whether the equipment is working normally. While there is a considerable amount of auxiliary apparatus, it is associated either with the power supplies or with the control and safety circuits, and is therefore of much more interest to the technician maintaining the set than to anyone else.

The uses of the new equipment have not yet been thoroughly explored. As a new and convenient source for extremely high potentials, it will no doubt open up new fields for itself as well as facilitate present processes which require use of particularly high temperatures.
PERSONS working in any given field sometimes get so close to the details of their work that they fail to see opportunities or techniques that an outsider would have expected them to have seen at the first glance. To most radio men, electronic equipment means radio, sound, and television, with hearing aids and industrial control equipment hovering somewhere in the fringe area. The idea of applying electronics to solve everyday problems rarely occurs to them. Yet everyday life can be benefited by the application of electronics; witness such devices as the electronic rat trap (Radio-Craft, May, 1944) and the later electronic baby watcher used by a group of veteran college students to permit one sitter to "watch" all the babies in a G.I. student barracks.

As a more recent example, note the problem of W. J. McGoldrick, electronics engineer and vice president of the Minneapolis-Honeywell Co., manufacturer of electronic controls and regulators. Awakened at 4:30 every morning by the barking of his golden retriever, Major, he lost so much sleep that he began to worry about his health. Surely electronics, which could regulate so many processes, could be used to control the nocturnal barking of a dog.

After a little consultation, it was decided that a device already in production by the company could readily be adapted to silence the troublesome dog. The device was an electronic amplifier, designed originally to take information from a bridge of temperature-sensitive resistors and amplify it to actuate a relay, which controlled the power to a radiant-panel heating system. The relay amplifier of the Electronic Moduflow control system is a two-tube unit. The first tube, a 12SL7, acts as a two-stage voltage amplifier (see schematic). The final amplifier is half of the 12SN7, which receives the signal from the second 12SL7 stage and has the relay coil in its plate circuit. The other half of the tube acts as the rectifier for the 12SL7 plate supply. The 12SN7 amplifier section is connected directly across half the high-voltage winding of the power transformer, acting as its own rectifier.

It was a matter of only a few min-

Top—Major watches the adaption, little guessing the equipment is for him. Center—Result of short yelp, 4:30 a.m. Bottom—A now quiet Major inspects the gadget with considerable respect.
utes to disconnect a few parts and hook in a microphone, making the amplifier a sound-operated device. The load circuit was connected to a solenoid-operated valve which released a spray of water every time the relay operated. Major soon learned that silence was the price of a dry kennel.

The above is only one example of home electronic gadgetry. There are no doubt hundreds of other prosaic, simple, and useful opportunities in the average community. The radio technician who develops a few of these may discover in them a welcome addition to his income; and some device or application, properly protected and marketed, may possibly put him into an altogether new and higher income bracket!

The Moduflow relay amplifier. Mike is connected between R and T and load between 3 and 4. Parts inside dashed lines were not used in the application.

Everything Radiates

By BALDUR MEYER

ACCORDING to the law of Stefan-Boltzmann, any material whose temperature is above absolute zero (~273 degrees C) puts out infrared radiation. Since no way has yet been found to reduce temperature to absolute zero, every material radiates—including ice! The infrared radiation output of any material (in watts) is .5 * 10^-12 * T^4 * A * K (273 degrees C), and A is the area of the radiating surface in square centimeters. Using this formula, you will find that even small surfaces at room temperature emit astonishing amounts of infrared. The rays are often very penetrating, some radiating through more than 3 feet of water without losing all their energy.

Detector is simple neon-tube oscillator adjusted to work at very low frequency.

The little instrument described here is so sensitive an indicator of infrared that the radiation from such odd objects as magazines, copper cups, books, and a piece of ice can easily be detected (see photos). It was discovered by accident while the writer was trying to build a radiometer using an NE-51 neon lamp instead of a Geiger-Muller tube. While it detects radium, it is so sensitive on infrared that radium and infrared radiation cannot be told apart. It is also sensitive to radio waves and indicates strongly in the presence of an unshielded superheterodyne oscillator. It reveals the presence of alternating power-line current, too, when the probe is held near a power cord as well as detecting many other kinds of radiation. The NE-51 is truly a miraculous—and to most people, an unexpected—radiation detector.

The instrument is very easy to build. It is simply a neon-lamp relaxation oscillator adjusted to the point at which the frequency is in the order of one cycle every few seconds. The diagram gives the complete story. Mount the NE-51 on the end of a plastic probe and connect it to the circuit with a lampcord cable.

The batteries can be old ones as long as they still have some no-load voltage. If they are fairly new and their voltage is above 100, it may be necessary to insert a resistance at point X to reduce the voltage so the “background count” will be very slow. Experiment with values.

To use the instrument, set the 50,000-ohm potentiometer to approximately the middle of its range (both controls should have linear tapers). Now adjust the 1-megohm potentiometer until oscillations begin. Next, regulate the 50,000-ohm control until the rate of oscillation is very slow—a single discharge should take place only every few seconds.

Any small quantity of radiation will now increase the capacitor discharge rate and raise the frequency of the clicks in the headphones. Begin by holding the luminous dial of your watch near the lamp. Then take a black book, a colored paper, a white paper, a metal box, your hand, a piece of wood, a stone—even a piece of ice—and hear the click rate go up each time, indicating radiation.

To prove that this is no accident, put the cover of your fountain pen over the lamp. The results are nearly the same. But shield the lamp with a metal tube, and the detector goes out of business. (Presumably the pen cap was a hard rubber one. Rubber is often used to filter out visible light and pass infrared.—Editor)

The beam of a flashlight influences the NE-51, too; it acts like a photo-voltaic cell. Instrument was placed in small plastic container with batteries. Here it detects infrared radiation from a piece of ice. Pen cap was placed over lamp.

A check on the October, 1949, number of this magazine probably indicates how much “hot material” it contains. A check on the October, 1949, number of this magazine probably indicates how much “hot material” it contains. It is a good idea, incidentally, to conduct all experiments in dim light for that reason.

This inexpensive little “wonder counter” is an ideal way for anyone to prove to himself and his friends that we live in a radiating world!
How to Become a Ham

MANY newcomers to the radio game, especially those well supplied with folding money, start off with elaborate transmitters of relatively high power. A great many more, however, begin with the very simplest kind of gear. It is our opinion that the low-power angle is by far the best approach to ham radio. In angling, the highest honors go to the light-tackle boys simply because they demonstrate the greatest skill. So it is with ham radio: the fellows with simple, low-powered rigs must exercise great care in the operation of their stations. Many of them have established enviable records.

Although the newcomer is primarily interested in simplicity, there are a number of other considerations, of which mechanical stability, low harmonic output, good keying characteristics, safety of the operator, are a few though not necessarily in that order of importance. Compromises must be made. For example, the transmitter shown in the photos and diagrammed in Fig. 1 works on only one amateur band with any one crystal. Separate crystals are needed for operation on the 3.5- and 7-mc bands. If the design were changed slightly, we could operate the output amplifier as a doubler, thus covering an additional band. However, a good doubler is necessarily rich in harmonics, and that is just what we are trying to avoid.

The oscillator stage employs a 6AG7 in a Pierce circuit. This stage will operate on the 80- and 40-meter bands with suitable crystals. The Pierce circuit was chosen because of its simplicity. No tuned circuits are needed with normally active crystals, However, this circuit is not recommended for use with crystals ground for 14 mc or higher. Capacitive coupling is employed between the oscillator and amplifier stages, resulting in only one tuned circuit for the entire transmitter.

An 807 was the natural choice for the output tube; no other gives so much for so little. Admittedly the 807 is temperatureal; but, when handled properly, it behaves very well. Most difficulties encountered with 807's can be traced to overdriving, improper screen voltage, too little capacitance in the output circuit, and the like. Shielding, too, is very important! This 807 is operated with an input of 60 watts (600 volts at 100 ma), and the output, as close as we can determine, is 40 watts.

Two decisions must be made early in the design of a transmitter: first, whether or not the power supply is to be a separate unit; and second, whether the whole business is going to be built on metal chassis or a wood base. We vote for the metal-chassis type of construction because it provides a much better ground system. We like a separate power supply because that permits its use with other apparatus without the necessity for tearing into carefully wired circuits.

The r.f. portion of this transmitter is built on a 5½ x 9 x 3-inch welded-aluminum chassis. Nearly all the components are above deck. A 2¼-inch strip of aluminum is bent to form an L-shaped sub-base having one 2¼-inch side, on which the 807 is mounted, and another side ¾ inches long for accommodating the 6AG7 tube and the crystal. Three spade bolts are used to fasten the sub-base to the main chassis. All wiring is completed before the sub-base is mounted. This arrangement and procedure is of great convenience since it makes it unnecessary to handle the whole transmitter during the greater part of the wiring job.

When the sub-base has been wired, it is placed in position and the main base marked for the holes through which the heater, screen, and plate-voltage wires

Part VI—Building a 60-watt transmitter and a power supply for it

By GEORGE W. SHUART, W4AMN

This rear view of the transmitter shows how the components are wired to the tube sockets. The author used a Millen 807 shield but you can make your own.

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When the sub-base has been wired, it is placed in position and the main base marked for the holes through which the heater, screen, and plate-voltage wires
pass. Below deck will be found only the 6AG7 plate and screen chokes, the 6AG7 grid leak, the 807 screen dropping resistor, and the final plate choke. Small four-lug terminal boards (three are used) are connected underneath the plate.-The in an all-out effort to keep r.f. currents where they belong, all low-potential wiring employs braided shield covering. The heater circuit uses the shield as one leg of the circuit. The shield is grounded at the output and wherever it passes through the aluminum base. A shielded keying lead is also used. Here, the braid forms one leg of the circuit.

Since we are little concerned with minimum capacitance in the output circuit, except that it should be high, we have used parallel plate feed and the plate capacitor has been mounted directly on the metal chassis with its rotor grounded. This frees the plate capacitance and the rest of dangerous high voltage. The main thought here was for the operator's safety. To be sure, high-potential r.f. voltages are present, but they are less dangerous to life should the operator come in contact with the capacitor or the tube (though they can cause bad burns). The capacitor illustrated is war surplus and has excessive plate spacing and capacitance. The diagram shows the correct value. A receiving-type capacitor with a 750-volt breakdown rating will fit entirely satisfactorily. The coils may be home-wound or B&W JEL50 and JEL40 coils may be cut down to fit the specifications in Fig. 1.

Only one meter is needed to operate the transmitter because only one circuit requires metering. The final amplifier plate current readily indicates the operation of other circuits. The meter used in the original transmitter is a 0-100 milliammeter. A meter mounted on the front apron of the main chassis. Any meter will serve so long as it will indicate at least 100 ma.

The power-supply unit is really a dual supply; there are two separate units built on the same chassis, as Fig. 2 shows, thus allowing separate low voltage for the oscillator. In addition there is a voltage-regulated circuit which may be used to operate other small apparatus such as the converter previously described. The particular transformer employed in the low-voltage section has a rating of 350 volts each side of center at 165 milliamperes. Thus it may be used to supply a number of lower-power stages. To extend further the application of the low-power section, a separate 6.3-volt filament transformer is connected in series with the filament winding of the power transformer having the correct voltage for the tubes being used having 6.3-volt heaters may be used if desired.

High voltage is supplied by a transformer having a rating of 650 volts at 250 ma. While the current rating is about twice that required by the 807, such a voltage is a good investment for the simple reason that it allows the use of two tubes in the final amplifier should the builder so desire. Since transformers usually last a long time, give the subject considerable thought before making a selection. Choose transformers which will have wide application—they will pay dividends in the long run.

A power supply with good regulation is one whose output voltage does not vary widely when the load current is changed. Poor regulation may be due to overloading, use of improper rectifier tubes, a poorly designed filter, or just poor transformer design. Poor regulation should be avoided, especially in keyed transmitters and in class-B modulators.

The filter for the low-voltage supply is a brute-force type with capacitor input. Such a filter is satisfactory with a high-vacuum rectifier. Sufficient inductance and capacitance are used to assure smooth, ripple-free output. The high-voltage supply, however, presents quite a different problem because here we employed mercury-vapor rectifiers for improved regulation. Choke input is a unst with mercury-vapor tubes. Less filtering is required for c.w. transmitters than for phone transmitters. For c.w. we may use a single-section choke input filter is sufficient. The product of the inductance of the choke under load and the capacitor value (in mf) should be equal to 20 or better to reduce the output ripple to 0.5% or less. Thus a 20-millihenry swinging choke, and a 4-mf capacitor would do the trick with full-wave rectification on 60-cycle current. An additional section should be used with phone transmitters.

Output connections on the power supply are made through Jones plugs. This is a safety measure—there are no exposed hot terminals to be accidently touched. Separate toggle switches provide flexible control of the output voltages. A single toggle protects the entire unit. If the two supplies were separately fused, there might be danger of causing serious damage to the equipment were one section to go out and the other left running. By using a single fuse that danger is avoided: both will go out at the same time.

**Firing up the rig**

Before any attempt is made to operate this equipment, check the wiring thoroughly. The most likely place for mistakes is probably at the tube sockets.

Insert the oscillator power plug into the low-power receptacle on the power supply. Do not, at this point, connect up the amplifier high-voltage plate lead! Turn on the low-voltage supply—be certain that the other switches are off. Place a 12-volt incandescent lamp (1/4-watt size) against the plate terminal of the oscillator tube. The neon lamp should glow when the key is closed if the crystal is in place and the tube is oscillating.

Next, place the correct coil in the amplifier coil socket. A 40-meter coil is used with a 40-meter crystal. Connect the high-voltage plate lead of the amplifier to the low-voltage supply, not to the high voltage. Then, as the key is closed, swing the plate capacitor from full capacitance downward toward minimum. There should be a pronounced dip in plate current somewhere between maximum and half capacitance. This point of minimum current indicates that the amplifier is in resonance with its crystal frequency. Repeat the above procedure with a crystal for the other band.

The rig is now ready to receive the high voltage and be connected to the antenna system. When the antenna is connected, the plate current will rise, and the dip, or point of minimum current, will become less pronounced. As the antenna coupling is increased (if a variable link or an external antenna coupler is used), the plate current of the amplifier will continue to rise.

Always reset the plate capacitor to minimum value of plate current to maintain resonance. The amount of change needed to restore resonance will be negligible if there is a good match between the antenna feed system and the output circuit of the amplifier. In no case should the plate circuit of the 807 be loaded beyond 180 ma. Offset resonance plate current can run extremely high and seriously damage the 807. That is why it was recommended that tuning be done with the low voltage instead of the full 600 volts applied to the 807.
MRS. PEEBLE," the obituary notice concludes, "was apparently electrocuted while swirling suds in her washing machine with one hand and tuning her radio with the other."

Obituary columns make morbid reading, perhaps, but they annually chronicle the untimely demise of thousands of solid citizens and citizens who accidentally draw more current than their circuits can handle. The details differ, of course, but most home electrocutions involve simultaneous contact with a grounded object and a transformerless radio.

The underwriters' labs have tabooed the hot chassis for years, it is true, and as a consequence most reputable manufacturers have adopted the policy of isolating the chassis from the line return through a bypass capacitor. But still obtainable everywhere are "bargain radios" whose chassis are at line potential, and the innocent purchaser seldom suspects that the absence of a little paper sticker labeled "UL" may mean a future tragedy in his family. Nor does he suspect that even an approved radio can bring sudden death through the untimely failure of a paper capacitor.

It is unfortunate, indeed, that plastic cabinets and plastic knobs, good insulators in their own right, get cracked and broken through rough handling. It is even more unfortunate that such a beat-up radio is usually the one which is relegated to the basement where its exposed chassis and the dampness of the concrete floor combine to make an excellent instrument of execution. But most unfortunate of all is the deplorable fact that often a "repaired" radio comes home to roast minus its isolation capacitor, with its chassis tied directly to one side of the line. It is doubtful, of course, whether a bonafide radio serviceman would ever delete this safety device, but many an amateur repairman and screwdriver mechanic has traced a motorboating or intermittent condition to the line-isolation capacitor and gleefully effected an economical repair by shunting it with a piece of hook-up wire. Imagine his consternation if one of these tinkers should be indicted for premeditated murder after his "repair job" had turned into an electronic booby trap.

Electrocutions by transformerless radios are considered "accidental," of course, in every sense of the word. There must be a combination of conditions set up, a sort of circumstantial accessory-before-the-fact. The radio must have its chassis at line potential, either through cheap design, capacitor breakdown, or tinkering; the a.c. plug must be in the socket in such a way that the chassis is connected to the ungrounded side of the line; the victim must simultaneously contact a grounded object—bathtub, sink, radiator, water pipe, or concrete floor—and the chassis.

Since certain conditions must be met before a transformerless radio becomes a death-dealing booby trap, it follows that removing the conditions will remove the danger of accidental death by shock. It follows, too, that it lies within the power of the radio industry to save many lives by removing some of these circumstantial conditions.

Radio service technicians can help reduce the needless toll of radio-electrocutions by following a simple three-point program:

1. Refusing to stock, sell, or repair the "bargain radio" having no provision for isolating the line from the chassis.
2. Checking every transformerless radio that crosses the repair bench for shorted or "shunted" isolation capacitors, replacing them if necessary.
3. Educating customers on the importance of looking for the Underwriters' label on every electric appliance they buy, as well as avoiding contact with any electrical device while wet or otherwise grounded.

So much for existing radios in existing homes, but much more can be done to improve the safety factor of the future transformerless radio in the future home. If electrical wiring codes are amended and revised to require polarized sockets for all wall outlets (90% of existing outlets are already polarized; if you don't believe it, look for yourself!) and to standardize one particular pole for ground connection; and if radio manufacturers are required to utilize the corresponding pole of polarized a.c. plugs for the grounded side of the line in their transformerless radios, then the electronic booby trap will cease to exist. Until such conditions obtain, Mrs. Peeble and her unfortunate kin will continue to furnish material for the obituary columns of a thousand morning papers.

Poor Mrs. Peeble!
Review of Recently Issued Tubes

Two kine-copes are among the new tubes released during the month. Raytheon announced the 16LP4, a glass 18-inch which employs an external ion trap. RCA's contribution is the 16GP4, a short, metal-cone picture tube. The face is made of fiberglass for increased contrast in lighted rooms. The cone-to-neck section is newly designed for a longer, more efficient yoke. The design also facilitates centering the yoke on the neck; in combination with improved beam centering inside the neck, this contributes to better uniformity of focus. An ion trap is required.

General Electric has brought out 6- and 12-volt versions of the gated-beam discriminator, 6BN6 and 12BN6. The tubes are miniatures used as combination limiter, discriminator, and audio voltage amplifier in FM receivers designed for them.

Two more miniatures were introduced by G-E, the 6AB4 and the 12AY7. The former is an r.f. grounded-grid amplifier triode usable also as a frequency converter or oscillator up to about 300 mc. There is an internal shield.

The 12AY7 is a 9-pin, miniature, medium-mu twin triode with separate cathodes. Designed for input stages of high-gain audio amplifiers, it is a low-noise, low-microphonic tube. The heater is center-tapped to allow operation on either 12.6 volts at 150 ma or 6.3 volts at 300 ma.

Sylvania is responsible for three miniatures. The 6AB4 is similar to the G-E tube. A new pentode, the 6BA5, has a 3,300-mho transconductance; that of the 6AD4 is 2,700. Both have 6.3-volt, 150-ma heaters.

Three new industrial-type tubes have the Sylvania label. They are the 5691, 5692, and 5693. The first is a high-mu twin-triode voltage amplifier with series-unity heaters. The 5692 is a medium-mu twin triode suitable for balanced d.c. amplifiers, multivibrators, and blocking oscillators, as well as for voltage amplifiers. The 5693 is a sharp-cutoff pentode designed for high-gain resistance-coupled amplifiers. Life for all three is rated at 10,000 hours, and all can resist impact shocks of 100 G for long periods or up to 500 G for short durations.

RCA's 1V2 is a halfwave rectifier in a miniature, nine-pin envelope. It is designed for use in high-voltage power supplies of the pulse type. Peak inverse plate voltage is 7,500, peak plate current 10 ma, and average plate current 500 µa. Filament voltage is 0.625 at 300 ma.

Two new deflection amplifier tubes are announced by RCA especially for use with the new 16GP4.

The 6CD6-G is a high-perveance, beam-power amplifier featuring low mu, high plate current at low plate voltage, and a high operating ratio of plate current to screen current. Because of these features, the 6CD6-G makes possible the design of an efficient horizontal deflection circuit in which the plate voltage for the tube is supplied in part by the circuit and in part by the low-voltage d.c. power supply of the receiver.

The 6S4 is a high-perveance, medium-mu triode of the nine-pin miniature type. In suitable vertical deflecting circuits, the 6S4 will deflect fully a 16GP4 or any other similar kinescope having a deflection angle up to 70 degrees and operating at anode voltage up to 14 kv.

The world's smallest X-ray tube, for use in dental radiography, has been announced by Amperex.

The Mini-X O45A measures only 2¼ inches in length (including the pins), has a diameter of 1¼ inches and has an extremely small and critical focal spot of 0.8 square millimeter (conventional X-ray tube focal spots vary from 1.5 to 2.1 square millimeters).

The tube is designed for oil-immersed operation at 45 kv peak and 7 ma.
Repairing Radios from a Wheelchair

Author consults a service manual, then tells assistant how to make the repair.

Unable to use arms or legs, Wendell Ward makes a living repairing radio sets by directing assistants' work

By WENDELL WARD

Radio repair is undoubtedly one of the most intricate of vocations, demanding a high degree of hand and brain coordination and manual dexterity, and an ability to use fine tools with precision. I possess none of these characteristics: I am a spastic cripple, strapped to a wheelchair, without the use of either arms or legs. Yet I am a radio repairman, able to hold my own in a highly competitive business and to equal or better my rivals in quality and dependability of work.

How did I come to choose radio repair—above all things—as a career? How did I become interested in radio itself? How can I, almost completely helpless physically, test and repair radio equipment? And what are some of the special problems confronting the handicapped radio man? All of these questions I hope to be able to answer in this article. The answers may be of interest, not only to those in the field, but to the general public as well, particularly to the disabled.

My interest in radio dates back almost to its infancy, as well as to my own. In a manner of speaking, we were brought up together. In 1924, when I was six years old, I heard my first broadcast, an exciting and thrilling event that I shall always remember. Here at last was diversion, entertainment, and education all wrapped into one, and, best of all, easily available to a crippled child. Those primitive earphones of my first set opened wonderful vistas for me then, and even today radio remains my main source of pleasure and recreation besides being my bread and butter.

For 12 years my interest and delight in radio grew. Gradually from that interest came a desire to know the functioning of radio and the workings of the gadget that had brought so much pleasure into a fairly quiet, wheelchair existence. The opportunity presented itself, I watched radio repairmen at work; and a conviction began to grow within me that I too could learn the art.

In the early spring of 1940, the long-awaited chance arrived. A close friend of mine had become interested in radio and began a primary course in repair. I immediately began to learn with him. An old set acquired from a skeptical but friendly neighbor became our first experiment. After long hours of kitchen-table mechanics—much to the dismay of my mother and grandmother—we finally completed our job successfully. The set worked! From that start, it was a natural step to a real paying job ($3.00 for a simple part replacement in a set belonging to another neighbor, which I immediately invested in a pair of pliers, 29 cents worth of solder, and some parts. Now I was in business—part-time anyway.

At first, jobs were scarce; and since I could invest very little in advertising, I could easily handle all of the work I received. In eight months, however, the picture changed. Because of the war, customers became plentiful, and it was a question of going all-out or of quitting altogether. After deciding to make radio repair my full-time career, I ran head-on into the difficult business of getting scarce testing equipment. After a furious search, I acquired an ancient tube-tester and a venerable ohmmeter. In 1942 I put my first advertisement in the local paper; the response was overwhelming. I was launched in business on a full-time schedule and have been going ever since.

The obvious question arises as to how I can work on radio equipment without the use of my hands. True, I am physically handicapped to the extent that I have practically no control over or use of my body, but I do have two things that I can and do use: my brain and my voice. I have learned the theory and practice of radio repair through constant and exhaustive study of manuals, diagrams, and other learning aids. I know radio cold. I have even developed a photographic memory of sorts that enables me, to picture intricate wiring diagrams and complicated layout designs in my mind without recourse to the books containing them.

With wheelchair existence, this knowledge to assistants whom I have originally trained and who do the actual work. In a way my system can be compared to that of the surgeon who, under local anesthetic, directs an operation upon himself. In the beginning I supplied the know-how and my assistants are my hands. Eventually, through training, they become more and more inde-
pendent, but in tricky and difficult jobs, I continue to direct them with my voice. It is as simple as that. But with all its simplicity, radio repair involves many problems one never dreamed of by the radiomani without disability; and above all, it takes a dogged determination to succeed plus a stubbornness that amounts nearly to fanaticism. It is not expected to those who do not relish the thoughts of long—appallingly long—hours of concentrated, tedious work and study.

With the laborious acquisition of the system of repair described above, the business would still be useless without customers. Here I find my biggest problem. In a sense, this is the problem faced by every man in business: to sell oneself and one's ability to the skeptical public. How doubly difficult it is for one with a disability as severe as mine to convince a total stranger who has a valuable radio to be repaired that I am capable of doing the job efficiently, when I am totally unable to meet him at the door or assist him into the shop with his machine or shake his hand. This business of selling myself to the public is a problem that haunts me from day to day, and I have worked almost as hard on its solution as I have on mastering radio repair itself.

In my only answer to this problem is psychological. I must have implicit confidence in myself and I must transmit that confidence to the prospective customer. That takes doing as well as some analysis of the customer before it can even be attempted. The hesitant or skeptical prospect must be assured that I am highly competent and capable of repairing his particular set. I can convey this feeling of confidence through word-of-mouth. I must talk him into belief in my ability; I cannot show him.

One of the most perplexing problems in setting up my particular system of radio repair was the difficulty of transferring my thoughts to assistants, especially in the early stages of training. Such difficult concepts as circuit functions of radio receivers, r.f., oscillator, and amplifier circuits, and the functions of different tubes in these circuits are extremely difficult to explain through speech alone. I can't even use my hands enough to point at what I am referring to at the particular moment; they are strapped to my sides.

Training assistants to know each necessary point so that it will not be necessary to explain again and again as each new job comes in is just a sample of the complications that arise. Many people have difficulty transmitting things through their own fingers, but my trouble arises when I attempt, as I must, to transfer my thoughts to other people's fingers in a type of work that demands the utmost coordination and muscle.

Some of the other more common difficulties and problems are certainly not exclusive with me, but must also be shared by radio repairmen all over the country. The tremendous difficulty of obtaining parts and equipment during wartime must be mentioned here. It was an obstacle of no mean proportions during the first crucial five years of my business career.

Among the most common complaints of all radio men—and most certainly one of mine—is the lack of replacement parts standardization. Many parts could be used interchangeably if there were some standardized system of parts manufacture. As it is, many repairmen working on a limited budget—and I include myself in that category—must go to the expense of stockpiling all types of tubes and other replacement parts. Not only does this make radio repair more expensive, but it also causes delay and confusion, since we must deal directly with each manufacturer, rather than doing business with a jobber who could supply us quickly and directly if standardization were in effect.

In the technical area, my chief difficulty has been in tracing and troubleshooting new FM-AM radios. This especially occurs where the same oscillator is used for both. Most of the trouble is brought about by the intricate band-switching circuit and—again—by the failure of the manufacturers to standardize circuits.

The delay in receiving service diagrams is another cause of headache to all repairmen. Without service diagrams the repair of some modern radios is next to impossible and tedious, a process not unlike that of a blind man attempting to thread a fine needle. The diagrams are usually sent at least a year after the new set has been released for sale. By that time the capable technician has figured out repair procedures and doesn't need the diagram.

So much for my troubles. Most of them are no different from those of the ordinary repairmen except in degree. The career that I have made for myself in radio has amply repaid me in satisfaction for any headaches that it has brought in the process. Latest statistics show that there are eight or nine hundred thousand physically handicapped persons in this country today. Many of them are totally or partially dependent on the state or on some individual for support. That is not necessary! My own case and hundreds of similar ones prove it beyond a doubt. The important thing it to get some sort of work that you are capable of doing, and do it. The type of work is not important; the important thing is to get it. Once a feeling of satisfaction is aroused at being able to produce, nothing can stop you. The rest will take care of itself.

Recommend Price Displays

A RECENT study in 10 different cities, made by National Analysts, Inc., and reported by Sales Management magazine revealed that displaying price information in store windows and on sales counters is highly effective in increasing sales. RCA quoted the survey in connection with its recent campaign directed to service technicians.

According to the survey, 85% of customers want to see prices on each item in the window and the same number want prices in printed advertising. Price tags on counter merchandise are desired by 76% of those queried. A significant fact is that 50% will not ask prices, fearing they will be too high—and that means loss of sales! On the other hand, 80% make "impulse" purchases when the price is clearly shown.

More sales losses are found in these figures: 72% will not enter a store to ask the price, even of something they want or need; and 77% of those who didn't buy in a given instance would have bought if they had known the price.

The lesson here for the radio dealer and service technician who sells receivers or parts is plain. If it's for sale—put a price on it. If you're ashamed of the price, you shouldn't be selling it. If you don't display the price, you probably won't sell it!

That every item is plainly priced does not mean that your window or counter need look like a bargain basement. The arrangement of merchandise can be just as tasteful as before, but a small card, with lettering large enough to be readily legible, should be set on or next to each item. RCA is now furnishing pricing kits with movable numbers, through tube jobbers. Alternatively, you can have a local draftsman, artist, or sign painter make up price cards for a small charge. Another good suggestion is to invest in a couple of lettering templates, a bottle of India ink, and a lettering pen. If you purchase a little lettering set, such as a Wrico, at your local art or drafting supplies store, you can learn to do beautiful lettering in a very few minutes.

MARCH, 1950

Servicing | 47

"It may be some time before we can fix your loudspeaker."

Suggested by: Hugh Luhach

www.americanradiohistory.com
Shunting Potentiometers

Shunting a variable resistor alters its taper. Curves show what tapers and resistances result

by HUGH LINEBACK*

ALTHOUGH radio technicians have long been familiar with different tapers on volume controls and circuits requiring nonuniform resistance changes, the experimenter may sometimes wonder how he can obtain some special resistance variation. Or it may be that the variable resistors at hand are of high values, and the designer would like to know how the characteristic is affected by using a fixed resistor as a shunt.

In the accompanying charts two common rheostat connections are shown, with the variable element $R_v$ shunted by a fixed resistor $R_s$. The horizontal axis represents the amount of rotation of the movable arm from left to right in the diagrams. The vertical axis gives the percentage of maximum resistance available at the different settings for any curve.

In using the charts it must be remembered that the maximum resistance depends on the values in parallel when $R_v$ is set at its highest resistance. The tables indicate how the maximum resistance may be determined for a certain rheostat. For example, suppose it is desired to shunt a 1,000-ohm linear variable resistor to give it characteristic of curve A in Fig. 1. From the table, $R_s$ must be 0.1 $R_v$, or 100 ohms. The highest resistance obtainable with this combination would be 0.1% of 1,000, or 10 ohms. On the chart the 100% point of the curve would represent this maximum value, and the resistances for other settings may be calculated. Thus, at 10% of the rotation the resistance would be 9.1% of the maximum, or 90 ohms (91 x 0.1%).

In order to keep the maximum circuit resistance near the value of the original rheostat, it would be necessary to use a 1,000-ohm variable resistor with a 1,000-ohm shunt, giving a maximum resistance of 910 ohms.

Using the same 1,000-ohm resistor to obtain curve B, in which case $R_s$ would be 500 ohms, the maximum resistance would be 333 ohms.

Several interesting relationships will be noticed in the curves and the resistance ratios they represent. Curve A of Fig. 1 shows a rapid rate of resistance change at first; in fact, over half the total change occurs in the first 10% of rotation. Such a characteristic might be desired for providing fine adjustments over most of the range; beyond 30% rotation the change in resistance takes place very gradually. The same effect is shown with less emphasis by curves B and C. Curve D is practically linear, and ratios with $R_s$ greater than 5 times $R_v$ merely make the curve come closer to being a straight line.

A different effect appears in curves A and B of Fig. 2. Again assuming a 1,000-ohm variable resistor, with $R_s$ equal to zero the peak of curve A would represent 250 ohms. Study of the curves will show that the halves of curve A actually correspond to a more gradual rate of resistance change than curve D when they are applied to the same rheostat. This may not be evident at first from glancing at the entire figure, as the 100% reference will correspond to different values of actual resistance in each of the two cases.

The two circuits given are for rheostats. Another common situation occurs with potentiometers, when, for instance, the constructor shunts a volume control to obtain a lower-resistance unit. The grid finds a resistance equal to the net shunt value when the arm is at the top of the potentiometer and a higher value as the slider moves down, as in Fig. 2. That is frequently important because it may introduce or accentuate Miller effect, which is often highly undesirable.
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MARCH, 1950
Part XIII—The Power Supply

By JOHN T. FRYE

The crystal set and its modern lineal descendant, the transistor receiver, are the only radio receivers that do not use vacuum tubes. All the rest—AM, FM, and TV sets—lavishly employ these so-called “electronic wonder-workers.”

By itself, though, a vacuum tube is a cold and lifeless thing, about as full of magic as an empty pop bottle. Not until a filament current has warmed the cathode and given its electrons a stimulating hotfoot do they start swirling from the cathode surface; and only when the proper voltages have been applied to the tube’s electrodes can these darting electrons be pushed and pulled into precise behavior patterns that are able to delight our eyes with the sight of distant events and our ears with the sound of faraway music.

This power supply puts out 500 volts at 200 ma, with choke input. The meter measures the output current and the small lamp, in the centertap, is a fuse.

It follows, then, that all ordinary radio receivers must have some source of power that will light up the filaments of the tubes and provide proper voltages for their electrodes. Batteries, the first answer to this need, are still used in portable receivers. A low-voltage, high-current A-battery is used to heat the filaments, connected either in series or in parallel. A higher-voltage, lower-current B-battery furnishes the electrode potentials. Quite often both of these batteries are packaged in a single battery pack.

Battery power, while practical for sets providing limited volume and used only intermittently, is expensive if called upon to supply a powerful, multitube console that is tuned in on a wake-up program the first thing in the morning, kept in a lather by soap operas all day long, and not turned off until after the last newscast at night. Radio engineers looking around for a cheaper source of power focused on the house-current socket. If they could make the electricity that came out of that socket do the job that the electricity from their batteries had been doing, they would be sitting pretty. The only catch was that batteries furnished d.c. whereas a.c. came from the light sockets.

That did not daunt our heroes. First they set out to solve the problem of how to use a.c. to heat the filaments. They could not use this pulsing, reversing current to heat the slender filaments of their early 201A’s because those filaments heated and cooled too quickly—so quickly, in fact, that the temperature, and consequently the emission, of these tubes rose and fell right in step with the reversing 60-cycle current. The result was a bad hum.

Two separate solutions were quickly found. First, increasing the bulk and current-carrying capacity of the filament allowed it to store sufficient heat so it could stay hot and continue to emit during the brief periods when the a.c. was falling to zero and reversing its direction. Second, heating the emitting cathode indirectly from a separate filament made the emission independent of rapid filament-current variations.

B-supply rectifiers

That took care of the A-supply, but getting rid of the B-battery was not so easy. The voltages applied to the plates and screens of the tubes had to be steady direct current. The manner in which the neat trick of converting a.c. into smooth-flowing d.c. is performed is really a two-part drama. Act One is called Rectification, and Act Two is titled Filtering.

![Fig. 1—The basic half-wave rectifier.](image)

In Fig. 1, notice that the current flowing through resistor R is in the form of pulses resembling half of a sine wave. Note, too, that these pulses are separated by the time interval required for the supply voltage to go through the negative half of its cycle. Since the system uses only half of the 60-cycle wave, it is a half-wave rectifier.

The efficiency-loving engineers, though, couldn’t bear to see their rectifying system just sit there and twiddle its thumbs during half of every a.c. cycle; furthermore, smoothing out that pulse, wait-a-while, pulse, wait-a-while kind of d.c. took quite a bit of doing. Pressed by these annoyances, they worked out the full-wave rectifier shown in Fig. 3.

Again we have a transformer with a secondary winding to heat the filament of our rectifier tube, but now our rectifier has two plates. What is more, the high-voltage secondary has its ends connected to these two plates, while a lead

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but that's not all! In addition, this finely engineered instrument provides a degree of accuracy never before attained in a unit selling for even double this price. Furthermore—in designing this unit, we took advantage of every recent improvement in components. For example, by using slug-tuned coils, we are able to efficiently adjust each instrument for perfect accuracy. This feature will also enable you to recalibrate the model 200 periodically without having to return it to the factory. The use of a Noval tube (the 12AU7) with its extremely low inter-electrode capacity enabled us to reach a higher frequency range than was heretofore possible in a unit of this type.

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brought out from the center of the winding now goes to R. Now the a.c. voltage across the ends of the transformer winding is slightly more than twice the d.c. voltage required.

Let us say that the voltage appearing across this winding is 600 volts. Then, when the top end is 600 volts positive with respect to the bottom end, it is 300 volts positive with respect to the lead brought out from halfway down the winding, and when the bottom end is 600 volts positive with respect to the top end, that bottom end is 300 volts positive with respect to the centertap. That centertap is just like a man sitting in the middle of a seesaw: first one end of the board rises above him and then the other; there is always a downgrade to him from one of the two ends of the plank.

Recalling that the ends of the winding are connected to the plates of the tube and the centertap is connected through R to the filament, you can see that one plate or the other of the tube is always C volts with respect to the filament. We know that under these conditions electrons will go from it to whichever of the plates happens to be positive at the time, will flow down through one half of the winding to the centertap, and then will return through current through L, it runs head on into the choke's strong dislike for any change in the amount of current passing through it. We turned in our study of inductance that self-induction bucks any increase in current through a choke, while the collapsing field of the inductance will provide extra current in an attempt to prevent any faltering or reduction in the steady value. These efforts on the part of the choke to keep the current on an even keel result in lowering the peaks and filling in the valleys of the pulsing current delivered to the input of the filter from the rectifier.

Capacitor C stores up current during the small voltage peaks delivered to it from the choke and then returns this stored charge to the load when a dip in voltage starts to occur. This action still further smooths the voltage across the load resistance. If additional filter stages are used, the ripple will be further reduced. But the ripple is still present and can be measured.

**Fig. 3**—Duo-diode full-wave rectifier. The Dual diode is connected like a bridge rectifier from the output of the transformer.

**Fig. 4**—Tube plates conduct alternately. R to the filament. During the time a plate is negative, of course, it catches no electrons; thus each plate works only half of the time. But between the two of them, they keep current pulsing through R almost continuously. Fig. 4 shows this clearly.

**Smoothing filters**

The output of the full-wave rectifier is a decided improvement over that of the half-wave job, but it still looks too much like the bouncing path of a frog for use on the plates of our tubes. We have to smooth out those peaks and valleys, and that is where our filter comes in.

**Fig. 5**—A choke-input smoothing filter. An input filter is added in order to further smooth the output voltage. If additional filter stages are used, the ripple will be further reduced. But the ripple is still present and can be measured.

**Fig. 6**—This filter has capacitor input. The output, while the output of the capaci-
or, especially with light loads, approximates the peak voltage of this output (minus the drop across the choke resistance). However, the output of the system falls off much more slowly under an increasing current load than will that of the capacitor-input filter. In general, though, the higher voltage available from a transformer with a capacitor-input filter makes this type by far the most popular with radio manufacturers. Transformer output transformers are usually found of money into the pockets of radio technicians, and most of these troubles are quite easy to locate. For example, a rectifier tube that does not light because the filament is broken can usually be spotted at a glance; yet a rectifier containing such a tube will be as dead as a burnt match.

The eyes, too, are useful in deciding if there are any shorted filter capacitors. When a veteran technician first turns on a radio set, he watches closely the rectifier plates. If these plates show no color, he feels safe in leaving the set turned on while he makes other tests; but if the plates start to turn red, he quickly snaps off the receiver before damage is done to the rectifier tube or the transformer. In the latter case, he can feel fairly sure that one of the filter capacitors has shorted and provided a low-resistance return path for the electrons, allowing millions of the filament's electrons to bombard the plates and make them red hot from the impact very quickly.

On the other hand, if one of the capacitors opens up, the ears can easily detect the hum that appears in the speaker because of loss of the filtering action of the defective unit. The trained ear can even tell which of the two capacitors has opened because of the subtle difference in the type of hum produced.

Even the nose has its place in analyzing power supply troubles, for it can quickly detect the odor that clings to a transformer that has been overheated.

**Fig. 7**—Rectifier delivers heavy pulses. This foul, pungent odor, beside which that of a skunk is pleasant by comparison, is impossible to describe adequately, but, once smelled, it is impossible to forget it or to mistake it for anything else.

However, I am not trying to say that you should depend entirely on your senses to locate power supply troubles. The point is that they are not hard to find, and those that cannot be seen, heard, felt, tasted, or smelled can be readily ferreted out with a volt-ohmmeter.

We are not through with the subject of power supplies. What we have studied this far are the fundamental types. Now we are ready to go ahead and investigate the a.c.-d.c. or transformerless power supply, the output load type, the three-way portable power supply, the voltage-doubling rectifier, and so on. These and other interesting and practical variations will be taken up in the next chapter.
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SEVEN UNUSUAL POWER SUPPLIES

By LYMAN E. GREENLEE

THE power supplies described in this article all use standard, easily obtainable parts. That is important to the constructor who wishes to build an experimental unit without buying or making special equipment. Results will depend largely on the quality and insulation of the components, since some transformers and other units are operated at higher than normal voltages. However, the constructor need not worry too much. The tubes, capacitors, and transformers are all low-cost items; and if one unit breaks down and has to be discarded, a replacement probably will stand the gaff.

Bias supply

The circuit shown in Fig. 1 provides a practical way of obtaining an isolated source of bias voltage from any 6.3-volt heater winding without adding a heavy load to the amplifier power transformer. The isolating transformer T may be either a small 6.3-volt filament transformer or a midget output transformer. A universal output transformer is particularly desirable as the taps allow a variation of output voltage. The 47-ohm resistor in series with the selenium rectifier acts as a protective fuse in case the rectifier breaks down or the output is shorted. The maximum voltage under load should not run higher than the rated operating values for the rectifier and filter capacitors, usually 150 volts. A tube rectifier could be used, but this would add an extra heater load to the power transformer and there would be no advantage.

Supply for test equipment

The supply shown in Fig. 2 is ideal for supplying B-voltage to vacuum-tube voltmeters, small portable radios, oscillators, signal generators, or any equipment requiring not more than 150 volts at about 50 ma. T1 and T2 are two small filament transformers with their 6.3-volt windings connected together. They will have enough power-handling capacity to run one or two tubes and supply filament current, but the total wattage for filament and plate must be kept below the rating of the two transformers so they do not overheat. Since it is often difficult to determine the actual wattage these small transformers will handle, the circuit should be hooked up breadboard fashion and allowed to run for a considerable time under maximum load. Allowance must be made for mounting the parts in a cabinet in which heat dissipation may be less because of inadequate ventilation.

Vibrator-multiplier supply

The power supply shown in Fig. 4 is of particular interest to those looking for a portable source of high voltage for operating a Geiger tube or for any similar use such as with a small battery-powered scope. A standard auto radio transformer and vibrator may be used with a 6-volt battery, or one of the midget radio transformers and vibrator assembly may be used on 2 to 4 volts. Output from the low-voltage section should be in the 250-300-volt range, not higher, to avoid overloading the rectifiers and exceeding their voltage rating. The buffer should be carefully chosen to reduce surges to a minimum and prevent rectifier breakdown. In some instances it may be advisable to use three midget selenium rectifiers in series to avoid breakdown from excessive surge voltages.

(Continued on page 58)
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T-39/4PO-9 RADAR TRANSMITTER

This is the transmitter described in February "CQ" for conversion for the 420-150 Mc. Amateur band and is now being subjected to approval by the F.C.C. for the 465 Mc. Citizen's hand. Albert N. Gahimer, d/b/a Home Radio & Electric Co. 17, Indianapolis, Indiana, has been conducting exhaustive tests experimentally in the Citizen's hand frequency under experimental license KG2XAR. He states that the oscillator has excellent frequency stability and that two-way communications are possible for distances of 40 miles between his shop and auto. The above person is requesting approval for licensing this equipment on the 465 Mc.

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Fig. 4—Dual supply for Geiger counters.

Blocking-oscillator supply

Two simple high-voltage power supplies employing the principle of the blocking oscillator are shown in Figs. 5 and 6. These supplies are suitable for applications requiring a very small current. The supply shown in Fig. 5 is for a.c. operation and uses a 3-to-1 audio transformer with a 6K6 or 6V6 and a 2X2. The two transformers should be adequately insulated to withstand surges. It is a good idea to dip them in insulating varnish and bake in an oven as an added precaution. If a cold-cathode rectifier such as the Raytheon CK-1013 is available, it may be used in place of the 2X2 and will require no filament transformer.

Fig. 5—Circuit uses blocking oscillator.

The battery-operated circuit of Fig. 6 works on the same principle and is good primarily for driving a G-M tube at about 900 volts from a small 6H2, 90-volt, portable B-battery. The 1T4 tube will withstand voltages up to 1,500 without breaking down. The small 3-to-1 audio transformer is not critical. Some 1T4 tubes may be unsuitable and break down internally at the high operating voltage but the performance of most will be satisfactory. This makes a very compact, lightweight assembly that is simple to build. The most expensive part is the CK-1013 rectifier. For those who wish to try this circuit without using the CK-1013, a 1T4 may be used as in Fig. 7. The only disadvantage to using the 1T4 as a rectifier is the separate 1.5-volt filament bat-

Fig. 6—Cold-cathode rectifier used here.

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**NEON-TUBE SUPPLY**

Another circuit suitable for use with a Geiger counter or similar device is given in Fig. 7. A small neon lamp used as a relaxation oscillator drives the IT4 tube, and high-voltage surges appear across the plate choke. A "sounding" hearing-aid-type audio transformer or choke coil may be tried. It should have about 50,000 ohms impedance for best results. Output voltage may be adjusted by altering the B-voltage or varying the load. The load must be in the 50-100-megohm range to secure satisfactory voltage output. A Raytheon CK-1013 may be substituted for the IT4 rectifier with savings in switching and filament-circuit complications, but the voltage drop is greater and cost of the cold-cathode tube is a factor to consider. Adjusting the padder will change the neon oscillator frequency and permit tuning the circuit to resonance with the choke for maximum output. The padder shown is a standard mica-insulated unit with screwdriver adjustment. Some IT4 tubes may function satisfactorily in this circuit.

While the current output from the power supplies in Figs. 5, 6, and 7 is

IT4 (2)

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MULTIPURPOSE TESTER

By P. F. EGERTON, JR.

Included in this test instrument are a signal generator, a.f. oscillator, phono oscillator, a.f. preamplifier, a.f. and r.f. signal tracer, and radio tuner.

The r.f. signal generator is modulated by the signal from a neon-type a.f. oscillator when the modulation control is advanced. The tuning capacitor is from a small superhet with antenna and cut-plate oscillator sections connected in parallel. The r.f. coil is wound with No. 20 enamel wire on a 1½-inch form. There are 80 turns on the grid winding and 30 turns on the tickler. Both windings are close-wound and spaced approximately ½ inch apart. This coil covers from 450 to 1500 kc.

Plug-in coils can be used to cover other ranges.

The tester is several instruments in one.

The a.f. oscillator can be used as a code-practice set by replacing the jumper with a key across the key terminals. Pitch of the a.f. signal is varied with the 2- to 5-megohm con-

The in series with the neon lamp and B-plus.

Short shielded leads are used for a.f. and r.f. signal-tracing probes. The r.f. probe should be not longer than 2 feet.

To use the unit as a phono oscillator, connect a pickup to the a.f. input terminals and adjust the volume to a suitable level with the 1-megohm control. It may be necessary to connect a short piece of wire to the r.f. output terminal.

Connect a coil, capacitor, and antenna to the signal tracer terminal and you have a simple r.f. tuner. The signal can be taken off the a.f. output ter-

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RADIO-ELECTRONICS for
When is a dot not a dot?

Look carefully at the pictures on this page, to see how television creates an image.

No. 2 in a series outlining high points in television history.

Photos from the historical collection of RCA

As parlor magicians say: "The hand is quicker than the eye!" But modernize the statement so that it becomes: Television magic is quicker than the eye—and that's why you see a photographic image in motion...where actually there is only a series of moving dots!

To explain this to laymen, ask them to examine a newspaper picture through a magnifying glass.

Surprisingly, few people know that newspaper pictures are masses of tiny dots "mixed" by the eye to make an image. Even fewer know that the same principle creates a television picture...and, when picture after picture comes in rapid succession, the eye sees motion.

Devising a successful way to "scan" an image—to break it into dots which could be transmitted as electrical impulses—was one of television's first basic problems. Most of the methods dreamed up were mechanical, since electronics was then a baby science. You may remember some of the crude results transmitted mechanically.

Television as we now know it, brilliant images on home receivers, begins with the invention of the iconoscope tube by Dr. V. K. Zworykin of RCA Laboratories. First all-electronic "eye" of the television camera, this amazing tube scans an image—"sees" it even in very dim light—translates it into thousands of electrical impulses which are telecast, received, and re-created as sharp, clear pictures in black-and-white—on the phosphorescent screens of today's home television receivers.

And, just as the first flickering "30-line" pictures—produced mechanically—eventually became our own present sharp 525-line images, so the iconoscope itself was improved until it became today's supersensitive RCA image orthicon television camera. All-electronic, the image orthicon peers deep into shadows, needs only the light of a candle to see and transmit dramatic action.

But every single television development made by scientists at RCA Laboratories depends, in the end, on a basic physiological fact: When the human eye sees a series of swift-moving dots on a television screen, it automatically "mixes" them into a moving photographic image!
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minals and fed to phones or an a.f. amplifier.

The unit shown in the photo was constructed on a 6 x 10 x 2-inch chassis and mounted in a small metal cabinet. Its power can be obtained from almost any source which will deliver 90 to 150 volts d.c. and 6.3 volts a.c.

From left to right, the controls and terminals are: r.f. output, r.f. output control, r.f. tuner input, volume and modulation control, a.f. input, audio output, pitch control and power switch, and phone input jack. Key terminals and power are on rear.

Z-AXIS INPUT FOR SCOPE

By TED LADD

THE utility of an oscilloscope can be increased considerably by adding an intensity-modulation (Z-axis) input terminal to the instrument. A textbook on oscilloscopes in any form will reveal the many uses for this input. The terminal may be added easily.

The schematic shows the connections to be made. The 1-megohm isolating resistor R1 must be connected between the Z-axis grid of the oscilloscope (intensity electrode) and the intensity (brilliance) control, if R1 is not already in the regular circuit. The Z-axis input circuit consists of coupling capacitor C, resistor R2, and the insulated binding post ORP on jack J. The Z-axis lead must be covered with ground shield braid throughout its length. The binding post must be installed in the rear of the oscilloscope case as close as possible to the oscilloscope tube socket.

A signal applied to the Z-axis input while another signal is being observed on the scope screen will modulate the intensity of the pattern on the screen. If the Z-axis input consists of sharp positive pulses, bright dots will be spaced along the trace of the pattern.

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If the pulses are negative, blanked-out spots or spaces will be present instead of dots. If the frequency of the Z-axis input is known, these dots or blanks may be used for timing purposes. When a positive signal or square wave is applied to the Z-axis input, the pattern will be broken up into a series of bright lines along the trace, their number and length depending upon the frequency of the Z-axis signal. All negative Z-axis signals blank out portions of the trace. Intensity modulation is very useful in the establishment of "dot wheel" patterns for a.f. comparisons.

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MINIATURE TESTER USES 1-INCH-DIAMETER METER

By Rufus P. Turner, K6A1

The new 1-inch-diameter, zero-center, d.c. milliammeters (manufactured by International Instrument, Inc., formerly MB Mfg. Co., Inc.)* make it possible to construct a unique pocket-sized, multi-range, d.c. voltmeter having 2,000 ohms per volt sensitivity, with the entire instrument in the probe handle. The author employed a slender plastic box as the handle (see photo). It is small enough to be grasped comfortably in the operator's hand as the prod tip is touched to voltage points in a circuit under test.

The voltmeter has the additional advantage that no polarity switching or shifting of leads is necessary. Zero is at center-scale: the meter reads volts upscale when the test prod is touched to a positive point, and volts down-scale when the prod tip is touched to a negative point. The instrument may be connected semipermanently into a circuit for long-period tests, or it may be used intermittently, as in trouble shooting.

The instrument is shown ready to be picked up and used for testing. The removable test prod extends from the top of the case, which acts as the prod handle. A cigarette gives an idea of its small size.

In use, the voltmeter is handled just as if its small case were the handle of an ordinary test prod. One of its pin jacks is connected to the common terminal of the voltage source (such as

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a receiver or amplifier chassis) with a clip lead. The instrument is picked up by its case, and the protruding test prod touched to any circuit point.

The test prod screws into a small, threaded brass block on the top of the case, and may be removed when the instrument is placed in the operator's pocket. The block will also take a threaded banana plug or similar phone-tip plug, the long prod then not being needed. This brass block is visible in both photographs.

The voltmeter has four ranges: 0-0.5, 0-5, 0-50, and 0-500 volts. Ranges are switched with another interesting subminiature component—a ¾-inch-diameter Grayhill No. 5004 single-pole, four-position, nonsnapping, rotary selector switch. Two input jacks are connected directly to the meter terminals to permit an additional range of 0-0.5 ma (0-9 millivolts).

The voltmeter is housed in a colored plastic case, one of a new line manufactured especially for applications of this type.

Switch and resistors complete the tester. 0-5, 0-50, and 0-500 volts. Ranges are switched with another interesting subminiature component—a ¾-inch-diameter Grayhill No. 5004 single-pole, four-position, nonsnapping, rotary selector switch. Two input jacks are connected directly to the meter terminals to permit an additional range of 0-0.5 ma (0-9 millivolts).

The voltmeter is housed in a colored plastic case, one of a new line manufactured especially for applications of this type.

**Circuit features**

The circuit schematic of the miniature voltmeter is simple.

The multiplier resistors R1 to R4 may be ordinary carbon units selected carefully for exact values. The only really critical resistor is R1, which should have a resistance of 982 ohms for best accuracy on the 0-0.5 volt range. This odd value allows for the internal meter resistance of 18 ohms. A quantity of regular 10% tolerance, 1,000-ohm resistors may be checked to find one with the 982-ohm value; or, if the builder does not object to an error of approximately 2%, he may use a 1,000-ohm resistor for R1. The other resistor values are so high as not to require subtraction of the meter resistance.

In ordinary use of the voltmeter, jack J1 is connected to the common voltage point (such as chassis) by a short, flexible lead terminated by an alligator clip. The test prod then is touched successively to the voltage points. When reading current (up to 0.5 ma) or millivolts (up to 9 mv), use both jacks J1 and J2 and remove the test prod if it is in the way.

The rear view shows the arrangement...
ment of the components inside the meter housing.

The range scale (see picture of front) is a 1½-inch disc of stiff white drawing paper on which the numbers are drawn with black India ink. After the lettering is completed, the disc is cemented to the instrument panel, covered with transparent celluloid to prevent soiling, and is further secured by a shank nut of the selector switch. The knob is a standard ¾-inch-diameter item commonly employed on mid-girt radios and test instruments.

The block into which the test prod is screwed is of brass, ¾-inch in diameter and ¾-inch high. It is drilled straight through its center and threaded for a 6-32 screw. The block is held to the top of the case by a short 6-32 screw extending a short distance into its bottom. The test prod is threaded into the top of the block when needed in testing. The prod is a 2-inch length of stiff ½-inch brass rod, ground to a point at one end and threaded (6-32) at the other so that it will screw into the block.

Calibrating Frequency Bridge
By I. Queen

The Wien bridge and the parallel-T network are useful frequency-selective circuits. Either type can be used as a wave filter (like the heterofilter), as the inverse feedback path for an R-C oscillator, or to measure frequency. If a.c. is applied to the input terminals (Fig. 1), the output progressively decreases as the frequency approaches the cut-off frequency. As the frequency approaches the cut-off frequency, the heterofilter (Fig. 1), the output progressively decreases as the frequency approaches the cut-off frequency. Therefore, a meter in series with a battery and resistance could measure frequency (Fig. 2).

When the switch is closed, current flows from the battery through the test prod and the meter. The indication is proportional to 1/RA and, therefore, to the frequency. With proper choice of meter scales, the indications could be direct-reading. If the calibration is made correct at one point, it becomes correct throughout, disregarding error in the meter or discrepancy in the frequency network itself.

A spring return switch in the measuring circuit is advisable. When it is depressed, the frequency is read off; and when it is released, the frequency network functions normally.

Turntable Speed Checker

The number of lines or dots in the pattern depends on the line frequency of the voltage applied to the lamp and the speed of the turntable in revolutions per minute. The formula for the number of points in the pattern is:

\[ 120 \times \text{line frequency (c.p.s.)} \]

\[ \div \text{turntable speed (r.p.m.)} \]

For 60-cycle lines, there are 92, 160, and 216 bars or dots to a circle for turntable speeds of 78, 45, and 33⅓ revolutions per minute respectively.——Mark A. Holld

Fig. 1.—Wien bridge and parallel T. It is more often used of the two. However, the parallel-T can give better results.

The frequency equation shows that the calibration will not be uniform when the variable resistor (or capacitor) has a linear variation. The lowers are well-spaced and the highs closely crowded, making it difficult to secure accurate calibration outside the lab or factory. Each calibration point should be made individually since interpolation can cause considerable error.

An easier calibration method is here-with suggested. As has been shown, the

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DON'T DISCARD old picture tubes or leave them lying around! Either break the vacuum or, better yet, pack old tubes in their original cartons, and shatter them by hitting the carton a heavy blow with an iron bar.

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New Patents

MICROWAVE MODULATION
Patent No. 2,499,855
Charles H. Brown, Baldwin, N. Y.
(assigned to Radio Corp. of America)
A cavity resonator has very high Q and can transmit only a very narrow band of frequencies, the resonant frequency being determined by its physical dimensions. This patent discloses how the dimensions of a cavity may be varied in accordance with a modulating voltage. This results in frequency modulation of a microwave carrier.

RADIOLOGICAL MEASUREMENT
Patent No. 2,476,810
Eugene M. Brunner, El Cerrito, and Edwin S. Mardock, Berkeley, Calif.
Fast-moving neutrons move freely through heavy elements but are slowed and scattered by hydrogen and other light elements. This is a useful property for investigating liquids and gases containing hydrogen. Neutrons possess no charge, however, and cannot be detected directly by the usual Geiger counter or similar methods.

In the figure, A is a source of neutrons, which may be a cadmium-beryllium mixture. The radium gives off alpha particles which bombard the beryllium and cause it to emit neutrons. The fast neutrons pass freely through the metal enclosure B but are slowed down and scattered by hydrogen atoms in the liquid within. Some of the particles bombard the Geiger counter C, which has a cathode made of silver or manganese.

After a short neutron bombardment (with SW left open) A is removed and the switch closed. The silver or manganese cathode now emits beta particles which are detected by the Geiger counter. The total count within a fixed period of a few minutes is a measure of the hydrogen content of the liquid or gas whose characteristics are being evaluated.

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izes "ghosts and snow" effects.
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  tunned.
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- Highest signal to noise ratio.
- Input and Output Impedances: 300 ohm balanced to
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New Patents

SAFETY CONTROL
Patent No. 2,490,679
Allen R. Davidson Erie, Pa.
[Assigned to Reliable Radio, Inc.]

The operator of a molding press must be careful not to come too close to his machine while it is in motion. Since the most experienced operator can make a mistake, a safety control should be used. This circuit automatically shuts off equipment if the operator comes too close.

TELETYPETE MODULATOR
Patent No. 2,474,261
Frank A. Lefeb Quakertown, Pa.
and Benjamin B. Mohler, Newport, N. J.
[Assigned to Federal Tel. & Radio Corp.]

In teletype circuits, characters are transmitted by a code using combinations of two different audio frequencies. Known as "space" and "mark" frequencies, they are separated by about 210 cycles. The space and mark combinations are formed automatically as the keyboard is operated.

This modulator converts the "space-mark" switching operation to a corresponding frequency change. The figure shows a phase-shift oscillator with four sections. The circuit oscillates when the total phase shift equals 360°. The frequency range may be increased by adding a shunt across one of the resistors, for example R2.

As the teletype keyboard is operated, SW is switched rapidly between the two contacts. When it touches the "mark" terminal, a negative bias appears on the cathode of D1 which conducts and shunts R2. In this position a higher frequency is generated. When SW is thrown to the left, a positive bias is placed on the D1 cathode and the diode blocks. Since R2 is no longer shunted, the oscillator frequency is now lower. In this way the space and mark frequencies are transmitted.

R1 is added for symmetrical charging and dis-
charging of C. Regardless of the switch position, one diode is conducting and the other is blocked. If R3 is made equal to R2, the current through R1 has the same magnitude whether it flows in one direc-
tion or the other. The filter R1-C minimizes key clicks.
AC-DC POCKET TESTER

This analyzer, featuring a sensitive responsive type meter housed in a bakelite case, is the result of 15 years achievement in the instrument field by a large company specializing in electronic test equipment. Specifications of the AC-DC Model Volt-Ohm-milliammeter: AC and DC Volt- 0-25, 0-100, 250, Milliampere AC-0-50, Milliamperes DC-0-50. Ohms Full Scale-100,000.

2400. Capacity-6 to 15 Mfd. Total price prepaid anywhere in the USA $7.90. Similar DC Miller, lacking AC operated ranges of above, $5.90 prepaid.

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ELECTRONIC COUNTER

Patent No. 2,949,243
Joseph C. Tellier, Penns Wyne, Pa. (Assigned to Philco Corporation)

This clever arrangement for counting alternate half-cycles of an input wave uses a number of stages, each including a capacitor and a rectifying diode. The stages are operated in order by successive half-cycles. If 10 stages were used, the last one would operate at the completion of five full cycles or 10 half-cycles.

Originally all capacitors are discharged. At the first positive half-cycle, C1 is charged by current flowing through D1. Therefore the capacitor is charged to E volts with polarity as shown. D1 being effectively a short, the following stages are not affected. When the input becomes negative, -E, is applied at the D1 plate. Therefore this diode is blocked. However, because this potential has the correct polarity to operate D2, the second rectifier C2 is charged with polarity as shown. The following states are not affected because of the low resistance of D2.

When the wave goes positive again, the voltage across D2 is the sum of E (positive across C1), which is zero. D2 is blocks because of the positive voltage on its cathode. Therefore the charge on C2 is applied across C3 and D3 in series. This diode conducts and charges capacitor C3 with polarity as shown. The step-by-step process continues. At the nth half-cycle, the nth diode conducts and the nth capacitor is charged. All preceding diodes are blocked (note sign of potentials across them). All following diodes are unaffected because of the low resistance of the nth diode.

The voltage at the output capacitor may be used to operate a relay or another electronic circuit. The network can be used to divide frequency.

PULSE WIDTH CONTROL

Patent No. 2,949,026
John A. Buckbee, Fort Wayne, Ind. (Assigned to Farnsworth Research Corp.)

This invention controls the width of pulses such as TV sync signals or pulse modulation signals.

The pulses originate in a sine-wave or sawtooth generator. The generator is connected to a pair of rectifiers with means to bias them.
WILCOX-GAY A-52
When this receiver is dead except for a faint hum from the speaker, check the .004-mf, 600-volt capacitor between the plate of the 42 and ground. Replace this capacitor with a 1,000-volt unit. Check the output transformer to make sure that it has not been damaged by the excess current which passed through it because of the shortened capacitor.—V. D. Kinard

OLDSMOBILE 1941 MODELS
If the set stops playing a few seconds after it starts to operate, try replacing the OZ4 rectifier. This tube may check good in standard testers and yet fail to operate properly when used under conditions like those encountered in the power pack of an auto radio.—F. Byrne

INTERCARRIER BUZZ
A consistent overmodulation buzz on one channel was cured by placing a 100-uf variable capacitor across the 300-ohm lead-in at the set. The hum could be tuned out and the picture improved on other channels by adjusting this capacitor. I believe that this capacitor attenuates the video carrier so that the video or i.f. amplifiers will not be driven to cutoff by the white or sync signals.—John C. Strole

MIDWEST 20-38
If the filter capacitors will not hold up any length of time, the trouble may be caused by excessive B-voltage or by improper capacitor replacements. It is advisable to use 600-volt wet electrolytics if they are available. Check to see if one side of the push-pull a.f. section is inoperative because this can cause the B-supply voltage to rise to higher-than-normal values.—Peter J. Foradas

HALLICRAFTERS S-20R
Severe distortion in the Sky Champion is almost invariably caused by a bad 6SQ7 cathode resistor. This resistor changes its value and shifts the operating bias. Replace it with a high-quality unit of the same value. A higher-wattage unit will guard against future failures.—Gerald Samkofsky

PHILCO 48-1001
The complaint was that the horizontal hold control was critical to adjust and the picture would jump out of sync at irregular intervals.
Tests with a Variac showed that a 1- or 2-volt drop in line voltage would cause the picture to jump after approximately 20 seconds. The horizontal multivibrator tube was replaced with one having reserve emission. The selection was made on the basis of satisfactory operation as the line voltage was reduced. With a good tube, these sets will operate without adjustment as the line voltage is varied between 135 and 90 volts. The picture goes from almost black to a washed-out white, but the sweeps don't even quiver.—Gray Trembley

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Focus Coil, Stancor Part Number FG-10. Exact Duplicate of RCA type 202D1. For use with magnetically focused kinescopes such as RCA type 10BP4.
Horizontal Deflection Output and HV Transformer, Stancor Part Number A-8117. Exact duplicate of RCA type 211T1. For use with direct viewing kinescopes such as types 7DP4 and 10BP4.
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For Television Catalog 337.
CHEVROLET RADIO 984240

Some of these sets are intermittent because of failure in the oscillator circuit. I have traced this fault to the oscillator coil. These coils are wound with wire covered with an almost invisible nylon insulation. In some cases the insulation is not sufficiently removed to permit a well-soldered connection at the coil terminals. Unsolder the leads, carefully clean them, and resolder.—Frederick Rosen

HALLCRAFTERS 5-38

If the cabinet is hot enough to give a nasty shock even when the set is turned off, look for a direct contact between the chassis and cabinet, which are insulated from each other by two rubber grommets and screws at the bottom. Loosening the screws sometimes removes the short and clears up the trouble. If the line polarity makes the chassis hot, the cabinet will also be hot because of the 0.25 uf capacitor C-30 between them. Remove this capacitor and connect the cabinet to a good external ground.—P. T. Navasiman

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PHILCO 48-1000 and 48-1001

If these sets break down in the high-voltage section, the bridge between the plate cap of the 6BG6-G and the terminal board. If the lead is too near the metal shield of the high-voltage compartment, current will arc through the insulation to ground. Replace the lead and dress it away from the shield. Check the 6BG6-G because it is likely to have shorted if the set was left on too long after the arc-over occurred.—Harry Asbhy

RCA MODEL 6TS

This set and a number of other pre-war models have terminal boards on the rear of the chassis for connecting phone pickups. These terminal boards have a link or jumper which must be removed when playing records. Many users fail to tighten the screws with a screwdriver when replacing the link. When the link gets dirty and corrodes, the high-resistance contact causes intermittent fading and blaring.

Cleaning the link and screws will effect a temporary cure. I prevent this trouble by installing a small s.p.a.t. switch across the terminals and throwing the link away.—Joseph Domanoski, Jr.

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POSTWAR PHILCO COMBINATIONS
Some of these sets have a voltage doubler which is connected so there is a high potential difference between the heater and cathode of the 7C6 detector and first a.f. amplifier. A heater-to-cathode short in this tube will cause the rectifier tube to burn out. One set had an intermittent short in the 7C6, and we burned out two rectifiers before we spotted the trouble.—DeLoss Tanner

RCA MODEL Q-10
If this set motorboats at low frequencies, try replacing the 12S37. Some of these tubes will cause motorboating in some sets, even though they may work perfectly in others and check good on a tube tester.—Migues Vega Vasquez

ZENITH 4G800
Low volume and severe distortion may be caused by low screen-grid voltage on the 1ST. The 4.7-megohm screen dropping resistor has been found to have a much higher value in several of these sets. Replace it with a high-quality 4.7-megohm resistor.—Andrew Pidig, Jr.

TRUE TONE AUTO RADIO—4842
Several cases of interrients in this model have been cured by replacing the 10,000-ohm resistor R3 in the plate circuit of the 6BA6 r.f. amplifier. If this resistor is intermittent, it is likely to check good on a meter; replace it and save time if the trouble seems to be in this part of the circuit.—Sidney S. Goodkin

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Although the wrinkle-finish enamel used on radio equipment is extremely
durable, it will gradually chip, scuff, and wear thin under hard usage. A
good way of restoring the original finish is to brush over the scuffed sur-
face with a quick-drying lacquer of the same color, and then a minimum of lacquer
on the brush, brush hard, and spread the lacquer as thinly as possible. This
thin layer of lacquer will preserve the wrinkle finish and restore the original
appearance or something very near it.

—SOLDERING HINTS—

If you are annoyed by stray drops of solder sticking to a chassis which you are
wiring, try rubbing the areas likely to be so damaged with a wax crayon or piece of candle dripping on them;

If, on the other hand, you have trouble making rosin core solder stick to a chassis, try Kester or some other
brand of aluminum solder._—John W. Winder

—OVERLOAD PROTECTION—

By installing an overload switch in series with the a.c. line to your work-
bench, I have saved many a.c.-d.c. sets from possible damage through short circuits to ground or test instruments.
The switch I used was made for an Easy Wash machine and can be
purchased from appliance supply stores for a few dollars. It breaks the power
as soon as the overload occurs. Power is restored by merely throwing the switch.—Don Tsugi

—MAKING SPECIAL CONTROLS—

Nonstandard shafts have been used on volume and tone controls on a number
of receivers. On some sets, the dial string runs around a pulley which is
centered on the volume control shaft and held in place by retaining rings. On
others, the control shaft may be turned to two diameters for operating an indicator
or to fit a special knob. Such controls are annoying to service techni-
cians, particularly when replacements for the control are no longer
available.

Some types of control shafts can be turned down without a lathe. A breast
drill is locked in a bench vise so its handle and chuck are free to turn. Put
the control shaft in the chuck and tighten it. Turn the drill with one hand
while the other holds a pair of gas pliers which are used as a cutting tool.

The depth of the cut is regulated by the pressure on the pliers. If it is neces-
sary to notch the shaft for a retaining ring, cutting pliers may be used for this purpose.

This type of turning is limited to the soft metals used for shafts on many
controls. Precision turning cannot be done by this method, but it will serve
when other tools are not available. The process does not harm the pliers be-
cause they are made of metal much harder than most control shafts.—
Wilbur J. Hants

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Those red plastic towel-rod brackets that sell in dime stores at two for a nickel make fine standoff insulators and mounting brackets for coils and capacitors in ham transmitters.

Fig. 1 shows a bracket as it comes from the store. Saw off the cup and file the top of the post smooth with a fine file. As shown in Fig. 2, the end of the screw in the post is bored with a % inch round-head brass machine screw is twisted into the hole, threading the hole as it goes in. Now back up the screw and bore a % inch hole through the post at right angles to the screw hole.

Fig. 1 (left)—Bracket comes with cup at top to take towel rod. Begin conversion by sawing off cup as indicated. Fig. 2 (right)—Twist a half-inch screw into a slightly undersized hole bored in the post; then bore a transverse hole to pass the wire through the new insulator.

In use, the wire is passed through the hole and held fast by the setscrew, or, if you wish, place a washer under the head of the screw and use the unit as a conventional standoff insulator.

ARTURO SEFF

MARCH, 1950
NEW LOW PRICE ON TECHMASTER BLUE RIBBON TELEVISION KIT!

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For 10" or 12" Kinescope

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All parts mounted on chassis. Four-stage plus IF-140
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TV-FM SWEEP SIGNAL GENERATOR

Crystal Markov oscillator with
variable amplitude. Covers all
TV and FM alignment frequencies.
Sweep width variable from 0-50
kHz. Simple circuit. Low cost.

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Complete With Mast Sections
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We don’t believe you’ll find a finer antenna system anywhere anywhere.

Two puzzled sections fitted and fixed together.
Complete with two 3½ ft.
mast sections, guy rings, standoff
insulators. Ready for easy, quick installation.

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TUBE TESTER $39.50

Tests all tubes including A.K.T., Dual Lock-
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with the well-established emission method. Operates from
100-120 volt A.C. Built-in roll chart provides complete data for all tubes.

Assures Best Picture in Fringe Area
Anchor All Channel T.V. Booster

Increases Signal
2½ Times

Cover all TV's. Twinlight, single light, new type, old type, all channels, in motion.

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ADDRESS ORDERS TO DEPT. OR 21
OR PHONE MULLBERRY 2134

WHOLESALE RADIO PARTS CO., Inc.
311 W. Baltimore St.
BALTIMORE 1, MD.

THYRATRON TRIGGER CIRCUIT

When thyatrons such as 2050’s, 2051’s, and 2201’s are used to dis-
charge capacitors in timing and trigger circuits, their cathode current some-
times exceeds manufacturer’s specifi-
cations for the tube. This shortens the
life of the tube and makes its opera-
tion erratic. Connecting two tubes in
parallel does not ordinarily provide a
solution to the problem because slight
differences in tube characteristics will
cause one to fire first, with the result that
the anode voltage on the other will be
lowered and it will not fire.

This circuit, described in The Re-
view of Scientific Instruments, is
designed to fire parallel-connected thy-
trons simultaneously. The scheme,
shown in the diagram, was used in an
electronic flashphotoflash circuit. The
shield grid of each tube is connected to the
cathode of the other. The plates and
control grids are in parallel. Induc-
tors consisting of 20 turns of No. 26
wire on a ¼-inch form are connected in each cathode return circuit.
When a trigger pulse is applied to the control
grids, one tube may fire first. The rush
of cathode current will develop a posi-
tive pulse across its inductor. This pulse,
being applied to the shield grid of the
remaining tube, will cause it to
fire. The firing delay is very small.

BATTERY OSCILLATOR

Experimenters and service techni-
icians are sometimes asked to convert
an a.c.-d.c. receiver for dry-battery
operation. Since most a.c.-d.c. sets use
tapped oscillator coils, the installation of
a filament-type oscillator tube may
present no end of problems unless the
coll is changed to the two-winding
type.

A method of using tapped oscillator
coops with battery-type was de-
scribed in The Radioman (Delhi, In-
dia). The circuit shows the oscillator
section of a 1RS. However, this circuit
be used with almost any battery-
type oscillator tube. The positive side
of the filament connects to A plus
through a low-resistance r.f. choke, and
the negative side returns to ground

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or A-minus through the tap on the coil.

Although a 27,000-ohm grid resistor gives good results in most cases, other values may improve performance. The capacitor across the filament may not be necessary in all circuits. The resistance of the r.f. choke should be not more than 2 or 3 ohms if excessive voltage drop is to be avoided.

A NOVEL MILLIVOLT METER

A change as small as 1 mv in a 100-volt potential developed across a transformer winding or load resistor has been measured by this circuit. It can be used to measure the change in output of regulated power supplies when the load or line voltage is changed, and to show the effects of cathode temperature, grid bias, plate-supply voltage, and other factors on the output of an amplifier.

The measuring instrument consists of a peak-reading voltmeter with an adjustable bucking or compensating voltage. When properly adjusted, approximate peak values are read on a voltmeter across the compensating voltage, and precise voltage changes are read on a 100-µa meter in series with the diode rectifier.

Close the switch to shunt the meter with the 10-ohm resistor; then connect the voltage to be measured across the input terminals on the instrument. Adjust the compensating voltage until the microammeter returns to zero. Open the switch and slowly adjust the compensating voltage until the meter reads approximately 10 µa if you are expecting the voltage to rise, or to 50 µa if you expect it to fall and rise again. Approximate peak voltages are read on the voltmeter, and fractions of a volt are indicated on the microammeter.

The microammeter must be calibrated for each setup because its accuracy depends on the internal resistance of the generator. Adjust the compensating voltage until the meter reads zero, then 100 µa, noting the reading on the voltmeter for these two conditions. If the compensating voltage changes 0.2 volt as the current changes 100 µa, each microammeter represents 0.02 volt. The upper frequency limit depends on the winding and rectifier capacitances and the lower on the size of capacitor C. When C is 1 µf, the instrument will go down to approxi- mately 10 cycles without too much loss in amplitude.

A germanium rectifier such as a 1N34 can be used in place of the diode, but the voltmeter will read approximately 20% lower because of the low back-resistance of the germanium diode.—Otto von Guericke

TELEVISION BOOSTER

In this two-stage television booster, which works better than any other I have tried, the amplifiers and their tuned circuits are shielded from each other and coupled together through eight-turn coupling links.

The grid coils L2 and L6 are six turns of No. 18 enameled wire spaced two inches apart, and each winding is wound through two inches of the respective tank coils.

Performance may be noticeably im-

proved by grounding the link coupling at A or B. Try both.

We used a five-pole, two-position rotary switch to turn on the booster and insert it in series with the antenna lead-in.—John Sager
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If you have an electric motor that is giving you trouble, the ELECTRIC MOTOR REPAIR book is the perfect guide for you. It will help you to solve the problem and get your motor working again. It will help you to solve the problem and get your motor working again. It will help you to solve the problem and get your motor working again.

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HUGO GERNBACK
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Electronic Experiments 1913
Radio News 1919
Science & Invention 1920
Radio-Craft 1927
Short-Wave Craft 1928
Television News 1931
Wireless Association of America 1930

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTS on file for interested readers.

MARCH, 1916, ELECTRICAL EXPERIMENTER

The Future of Wireless, by Hugo Gernsback

The Tesla High Frequency Oscillator, by H. Winfield Secor

How to Organize and Conduct a Radio Club

New 500 Watt Military Radio Pack Set

New Electrolytic Interruptor Electrode

The Evolution of Wireless Telegraphy

The Use and Construction of a Decimeter, by Milton B. Sleeper

How to Build a Photophone

Hook-up for Talking Wirelessly with Audion

NEW TUBE DESIGNATIONS

RCA announces that dual type designations have been dropped from the OA5/V75, OCV/V105, and OD3/V115 voltage-regulator tubes, and the 6U5/6G5 electron-ray tube. They will henceforth be known as OA3, OVC, OD3, respectively.

The VR numbers were easy to remember because they corresponded to the operating voltage of the regulator tubes. If you will remember that the VR's A, B, C, and D correspond to the operating voltage of 75, 90, 105, and 150, respectively, it will be easy to select the correct regulator tube.

CORRECTIONS

There are an error and two omissions in the parts list for the video i.f. strip shown on page 35 of the January issue. Three .001µf capacitors are shown on the list; however, only one is needed in this part of the circuit. Add two .001- and seven .0001µf mica capacitors to the list.

Our thanks to Mr. Leo H. Wilkins for these corrections.

Alert reader Stephen Langenthal, of New York, N. Y., chides us for calling the 3° Pilot Candid TV (January 1950 page 44) an ac-dc receiver instead of a transformerless receiver. He's right! There is a difference. All ac-dc receivers are transformerless, but not all transformerless receivers are ac-dc. The Pilot Candid TV uses a pair of selenium rectifiers to reconstruct the positive and negative d.c. voltages. It is not designed for, nor can it be used on, the d.c. line.

There is an error in the table of sweep-generator characteristics on page 29 of the February issue. Mr. Harper Johnson, Jr. of Supreme, Inc., informs us that the Supreme model 675 sweep generator has a separate crystal oscillator and has an external socket for marker crystals.
M-1—CONICAL TV ANTENNAS
Two folders have been put out by Telrex. One describes their line of conical antennas and the other gives a technical explanation of their advantages.—Gratix

M-2—TRANSFORMER CATALOG
Catalog 1950-1 lists all transformers manufactured by Peerless. An insert on the special 20-20 line of high-quality audio units is included. The information is unusually complete, except that no prices are cited.—Gratix

M-3—TV TRANSFORMER GUIDE
A 20-page booklet, Stancer Television Components Replacement Guide, is now available to service technicians. It lists Stancer replacement transformers for 215 TV receivers and chassis made by 45 manufacturers. Both Stancer and the manufacturer’s replacement parts numbers are listed.—Gratix

M-4—METAL-TO-GLASS SEALs
A folder containing specifications and illustrations of hermetically sealed terminals and gasket-type feed-through bushings is produced by Electrical Industries, Inc. These terminals and bushings are used on transformers, capacitors, crystals, and vacuum tubes.—Gratix

M-5—BEACON ANTENNA BROCHURE
A four-page brochure describes five new high-gain beacon antennas manufactured by The Workshop Associates, Inc. These vertical antennas are designed for use on the 144-162, 162-162, 162-171, 450-460, and 460-470-mc bands.

M-6—GEOPHYSICAL TRANSFORMERS
Catalog No. GP-49, published by Triad Transformer Manufacturing Co., describes their line of Geoforers (transformers especially designed for use in geophysical exploration equipment).—Gratix

M-7—TBA QUARTERLY REPORT
A comprehensive summary of the television situation during July, August, and September, 1949, is given in Television Broadcasters Association’s 40-page quarterly “Status of the Industry” report, which lists TV stations now in operation, network hookups, receiver specifications, receiver ownership figures, audience surveys, programming costs, and many other facts of interest to members of the industry. —$1.00 to Association nonmembers.

MARCH, 1950

ELECTRONIC LITERATURE
Any or all of these catalogs, bulletins, and periodicals are available to you if you write to us on your letterhead (do not use postcards) and request them by number. It is necessary to send only the number of items you want. We will forward the request to the manufacturers, who in turn will send the literature directly to you. This offer void after six months.

“FAN MAIL”
for a Star Performer

2653 Int. 1, W. Nativida
Manila, Philippines
31 August, 1949

Gentlemen:

I am a user of a number of Turner Microphones and I know just the right mike for me. My job requires rugged performance because the Philippine climate is very rainy at times, then excessively humid, then hot . . . . If a wrong kind of microphone is used, it is very sure of not lasting long.

The Turner 99 solved for me the problem of the right microphone. I have a mike of this type which was caught several times in sudden showers and believe me, it is still excellent if not perfect. These microphones are the only types I can find suited to my requirements. I recommend Turner microphones for quality and the best performance.

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COLOR TV STANDARDS

Color television standards must meet a number of conditions to be acceptable to the public and industry, stated David B. Smith of the Philco Corporation, during a recent FCC hearing. Most important of these conditions are:

1. The television viewer must be able to enjoy color or black-and-white with no loss of program either way.

2. Both color and black-and-white must be transmitted on a single set of standards, so that either can be received interchangeably on both color and black-and-white receivers.

3. Quality of television service must be at least as good as that now provided.

4. Continuity of existing television service to receivers owned by the public must be maintained.

5. There must be no experimenting at the expense of the public.

NEW COLOR SYSTEM

A novel color television system requiring no light filters is proposed by Louis W. Parker of Jackson Heights, N.Y., in a patent assigned to the Federal Radio and Telephone Corporation. He first converts the radio waves to ultraviolet — instead of visible — light. The ultra-violet rays are then scanned by a rotating polygonal drum, each of whose faces fluoresces with a different color when excited by the ultra-violet light, producing a colored image.
Called the Electronic Blackboard, Television Education Company's T-602 projection oscilloscope is designed to display patterns on 18 x 21-inch or 8 x 10-foot screens for viewing by large groups. It features driven and recurrent sweeps and Z-axis modulation in addition to the other functions of general-purpose oscilloscopes. The controls, mounted on a sloping panel, are convenient for the lecturer to operate. Casters make the entire scope movable.

ASSOCIATION ACTIVITIES

Officers of The Associated Radio-Television Servicemen of New York (New York City) for the 1950 term are: Max Liebowitz, president; Arthur Silverberg, vice-president; Jack Edel, treasurer; Jerry Maccherone, recording secretary; and Noel Payne, corresponding secretary.

The following members were elected to the board of directors: Sam Marshall, Louis Bennett, George Day, Henry Levine, John A. Bradley, Joseph Wolk, David Sohmer, H. A. Gibbs, Paul Abraham, Chester Kaplan, and John Wagonny.

The Associated Radio and Television Servicemen of New York (New York, N. Y.) reports that 120 applicants have registered for the radio, electronics, and television courses offered by the Board of Education in cooperation with ARTSNY. Courses will cover elementary, industrial, advanced, and television subjects. If the first term is successful, a second term will be opened in the fall to continue the studies of the first-term graduates.

The Radio-Television Service Guild, Denver, Colo., elected officers for 1950 at its December meeting. Lee A. Martin, director of Western Radio Institute, was elected to the presidency. Bill Thoes was made vice-president, Harry Matsumaka secretary, and Donald R. Dixon treasurer. The technical portion of the meeting was a lecture and demonstration on audio given by Harold Wright of the Western Radio Institute instructional staff and William Oltersdorf of Sound Service.

MARCH, 1950
New Devices

VOLTOHMETER
Electronic Measurement Corp.,
New York, N. Y.

Model 104 Voltmeter is a rugged and flexible 20,000-ohms-per-volt meter with a 4½-inch-square case, 50-microammeters, movement, and Alnico magnet. Weighting 2 lbs. 5 oz. and housed in a high-impact, round-cornered Baseline case with carrying strap, it measures 9½ x 6½ x 7½ inches.

It has five d.c. voltage ranges of 20,000 ohms per volt to 100 volts; five a.c. voltage ranges of 3,000 volts; three resistance ranges to 20 megohms. There are three a.c. and d.c. current ranges and five db ranges.

10-50-KV POWER SUPPLY
RCA Victor Division
Radio Corp. of America
Camden, N. J.

Type EME-2 is a highly regulated d.c. power supply, designed for any application requiring 10 to 50 kv with a maximum output-current requirement of 2 ma.

The unit is an ideal accelerating supply for cathode-ray tubes in experimental equipment or permanent setup for testing these tubes. It is also designed for use in electronics and laboratory test equipment.

TEST METER
Triplet Electrical Instrument Co.
Bluffton, Ohio

Model 630-A volt-ohm-milliammeter is a new laboratory-type meter with mirrored scales. Its accuracy is made possible through the use of special 1% resistors, each mounted in its own compartment. The long scales on the large 5½-inch instrument are hand-drawn for greater meter accuracy at all scale points.

There are six d.c. volt ranges from 0 to 6,000, at 20,000 ohms per volt; six a.c. volt ranges from 0 to 6,000, at 5,000 ohms per volt; five d.c. current ranges; declamps; output; and resistance ranges from 0 to 100 megohms (compensated for greatest measurement accuracy).

CODE CALCULATOR
Sprague Products Co.

A new capacitor code indicator makes it easy to decipher molded paper, tubular capacitor color coding. The Sprague capacitor indicator consists of a pocket-size plastic device with rotating dials printed in full and accurate colors. When flicked to the proper-color bands, the dials instantly indicate capacitance, tolerance, and rated working voltage.

V.T.V.M. KIT
Heath Co.,
Benton Harbor, Mich.

In the new model V-4 vacuum-tube voltmeter kit, positive automatic meter protection on all functions is given by the electronic d.c. voltmeter and push-pull d.c. voltmeter circuit. The d.c. circuit incorporates a new balance control which allows complete elimination of contact potential, removes meter shift with various ranges, gives accurate readings on all ranges, and compensates for variations in tube elements. A 200-µa meter uses an Alnico V magnet. One percent precision ceramic divider resistors are used. Twenty-four complete ranges are included. The meter pointer can be offset from zero for i-f and TV alignment. The d.c. probe is isolated for making dynamic measurements at receiver voltages without disturbing receiver operation in any way.

SPIRAL-TYPE INPUTUNER
Allen B. Du Mont Laboratories, Inc.
E. Paterson, N. J.

A new 4-section Inputuner incorporating the latest Malloy-Ware spiral-type Inductor is announced.

Its gain is double that of the previous Du Mont Inputuners, and it has greatly improved selectivity. The tuning range is continuous from 64 to 216 mc. covering TV channels 2 to 13 as well as the i-f band. The new Inputuner, which requires only 3½ turns of tuning motion, as against 10 turns for previous models, provides an advancement in the high-band spread, making exact tuning easier on channels 7-13.

Another notable refinement is efficient operation on either 300- or 72-ohm antenna systems, by means of an input transformer, connections to which may be altered for the desired impedance.

www.americanradiohistory.com
UTILITY TESTER
Superior Instruments Co.
New York, N. Y.

This new pocket-size utility tester measures the current consumption of any appliance or utility, either a.c. or d.c., while the unit is in operation.

When the appliance is plugged into the front-panel receptacle, a reading is registered. A special pair of insulated clip ends is supplied for motors. The tester incorporates a sensitive, direct-reading resistance range for measuring all resistances commonly used in electrical appliances, motors, etc.

ANTENNA ROTATOR
Alliance Mfg. Co., Alliance, Ohio

Model DIR is a new deluxe model Antenna-Rotor featuring a directional in-director control case. An indicator dial on the control case panel enables the television viewer to select and show the actual compass direction to which the antenna is pointed. The rotor is similar to the standard model ATR.

TV ANTENNA
La Pointe Plascomold Corp.
Unionville, Conn.

A new low-cost, four-ray, stacked array is known as the Challenger Model HL Series, designed to meet the requirements of viewers in areas where both high- and low-channel reception is desired.

The antenna affords twice as much gain on the high channels as on the lows.

The Challenger comes custom-cut to favor any particular high-channel desired, but because of its broad-band characteristics is also a good performer on the lows. It maintains 300-ohm line with negligible impedance variation throughout the TV spectrum. It is furnished with an integral 10-foot mast (1½ inches o.d.) and will fit all rotators without special adapters.

PREAMPLIFIER
Heron Hosmer Scott, Inc.
Cambridge, Mass.

A professional type of preamplifier for television receivers which incorporates the new Scott Decoupled noise suppression circuit is now available for high-fidelity enthusiasts. It includes variable turn-over control to compensate for different recording characteristics as well as an adjustable distortion filter. The preamplifier is completely remote-controlled, permitting the controls to be mounted at any convenient location.

INDOOR ANTENNA
Tricraft Products Co., Chicago, Ill.

The Vidette indoor TV antenna model 7007 requires no pushing and pulling of rods. Simply move the knob to the channel desired. The antenna is electrically tuned.

TERMINAL LUGS
U. S. Engineering Co.
Glendale, Calif.

New miniature terminal lugs have been designed to meet the trend toward lighter radio component parts and smaller size equipment. The miniature series, like the standard series, are silver-plated and specially treated to prevent corrosion.

REPLACEMENT KIT
International Resistance Co.

A packaged set of specially designed parts, Concentric, allows radio technicians to assemble a variety of concentrics to meet over 90% of replacement requirements. Each Concentric contains 17 IRC universal parts. These are combined with a selection of shaft ends and base elements—which are purchased separately—to provide maximum coverage of concentric dual replacements in home and auto radios as well as television sets. Base elements supplied in conjunction with Concentric units are complete with all loose parts. The bronze-molded base has element, collector ring, and terminals installed.

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and Television!

Designed Especially for
Power and Bias Supplies in Television

NOW SELETRON brings you these two new models ideally suitable in size and rating: No. S51 at 500 Mills — No. 8Y1, the "baby" of them all, measuring only 1½ square and rated at 150 kca, 130 volts. While these rectifiers are designed to meet television needs, engineers will find many applications for them in other electronic circuits. Other bias type rectifiers rated up to 250 volts will also be available.

A new leaflet on Bias Type 8Y1, describing its circuit possibilities is available. For a copy, write Dept. RS-25

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The vertical response of this economy TV scope is usable to 5000 kc, not 50 kc. Response is flat to 750 kc, down 3 db at 1000 kc. Amplifier supplies a voltage gain of 20 or 50 kc.

Check this necessary feature before you buy any scope for TV use.

The R.S.E. AR-3 Scope has been built by Ross Armstrong to our rigid specifications. It's a complete unit that embodies standard horizontal amplifier and sweep circuits with normal sensitivity.

The case is 8" high x 5" wide x 14" long, attractively finished in "hammered" opalescent blue enamel. Operates on standard 110 volts — 60 cycles — 40 watts. Tubes, 3BP1-6AC7, 657-6X5S-5Y3-884. Instructions included. Complete specifications upon request. Satisfaction or your money back.

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<th>DRY FEED</th>
<th>LOSS FEED</th>
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<tbody>
<tr>
<td>22</td>
<td>BLACK-BROWN</td>
<td>.90</td>
<td>2.37</td>
</tr>
<tr>
<td>20</td>
<td>RED-WHITE-BLUE</td>
<td>.67</td>
<td>2.49</td>
</tr>
<tr>
<td>18</td>
<td>BROWN</td>
<td>.69</td>
<td>2.59</td>
</tr>
</tbody>
</table>

**ORDINANCE INSTRUCTIONS**

Minimum order — $2.00. 25% deposit with order required for all C.O.D. shipments. Be sure to include sufficient postage. Orders received without postage will be slipped express collect. All prices F.O.B. Detroit.

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**SPECIAL PROBLEM IN RESISTIVE NETWORKS**

*Please find the battery voltage, line current, and the total resistance in the enclosed circuit and explain each step in the solution.*

**A.** Your diagram is shown in the figure. The first step is to determine the line current. Because the voltage drop across the parallel combination of R3 and R4 is 200, we reduce this combination to its equivalent resistance by dividing the product of R3 and R4 by their sum, or 100 x 50/100 + 50 = 33.3 ohms. (We carry the answers to only three significant figures, as greater accuracy is seldom useful.)

The line current flows through this 33.3-ohm network. The voltage drop across it is 200; the current is equal to the voltage divided by the resistance, or 200/33.3 = 6 amperes.

The 6-amper line current flows through the combination of R1 and R2; however, since only 2 amperes flow through R1, 4 amperes must flow through R2. Because current varies inversely as resistance, the resistance of R1 must be twice that of R2, its current being one-half that of R2. Therefore, R1 equals 2 x 65 or 130 ohms.

R1 and R2 are in parallel and their equivalent resistance is

\[ \frac{130 \times 65}{130 + 65} = 43.3 \text{ ohms.} \]

The voltage drop across the combination of R1 and R2 is the product of the line current and the equivalent resistance or 6 x 43.3 = 260 volts.

**TROUBLES IN A POPULAR SIGNAL TRACER**

* I constructed the signal tracer shown in Fig. 2 of the article "Signal Tracers Are Popular" in your November 1948 issue. The tracer motorboats when the a.f. gain control is advanced. It howls when the r.f. gain control is advanced beyond the half-way point. Can you suggest a remedy? — J. G. S., Hollywood, Calif.

**A.** To cure the motorboating, try using a large capacitor (20 to 40 µf) on the output of the power supply filter. If this does not help, try replacing the 0.1-µf plate decoupling capacitors in the 6AC7 circuits with much larger values — 8-µf or larger — and increase the detector plate bypass to 0.25 µf.

The howling seems to be caused by feedback between input and output circuits. Your parts layout diagram shows the two 6AC7's and a 6C5 placed close to the output transformer and the 6V6 placed some distance away from it. I would suggest that you use another parts layout. Confine the power supply and output circuit to one section of the chassis and the remaining stages to another. The r.f. input jack and the first 6AC7 should be as far as possible from the output transformer and speaker and the power supply components — including the choke. All grid and plate leads should be as short as possible and shielding should be used where necessary. Avoid the wiring in the 6AC7 circuits if it is possible to do so. Be sure to ground the No. 1 pins on the 6AC7's and 6C5's solidly.

**88 TO 108-MC TUNER FOR FM RECEIVER**

The secondary of the antenna coil consists of 1½ turns of No. 18 enamelled wire, wound 1 inch over-all, with 9/16 inch diameter. One end is connected directly to the stator plates of the antenna-tuning capacitor and the other to the a.v.c. terminal. The primary has 1½ turns of No. 18 tinned copper wire, wound 0.16 inch in diameter with ¼-inch leads.

The primary and secondary coils are placed on a common axis and the pri-
mary positioned for maximum output from the set. Locate the electrical center for the ground connection by connecting a short lead to ground and moving it along the primary until equal signal outputs are obtained when a signal is applied to either antenna terminal.

The r.f. coil consists of 1½ turns of No. 18 enameled wire, wound with an inside diameter of 9/16 inch. Its overall length, including leads, is 1½ inches. The r.f. choke in the plate circuit of the 6BA6 has 6½ turns of No. 22 enameled wire, spaced to a 1/4-inch winding length. The lead on the plate end should not exceed 1½ inches, and the lead to the 0.01-megohm bypass capacitor and B-plus should be not longer than 1 inch.

The oscillator inductor is a 2 3/16-inch length of No. 18 tinned copper wire bent into an arc and soldered directly across the plates of the tuning capacitor. Because the cathode tap should be as short as is physically possible, the coil was bent to allow soldering directly to the cathode pin on the tube socket. The position of the tap is determined by connecting one end of a short piece of flexible wire to the cathode pin and moving the other end along the coil until the best signal-to-noise ratio is obtained.

**RECEIVER FOR WWV**

2 I have an a.c.-d.c. broadcast receiver using a 12SA7-GR converter tube and 455-ke i.f. amplifiers. Please show how this receiver can be converted to a crystal-controlled receiver to tune in WWV on 5 mc.—A. P., Emeigh, Penna.

A. The antenna and oscillator circuits can be rewired as illustrated for 5-mc reception. The oscillator section of the 12SA7-Gr is converted to a Pierce oscillator for use with a 4,545- or 5,455-ke crystal. The antenna coil or loop antenna must be replaced by a 2- to 6-mc antenna coil, and the tuning capacitor replaced by a 9- to 180-megohm trimmer. If the oscillator is sluggish, try shorting a small mica capacitor across the oscillator grid resistor. Values between 25 and 100 megohms should be about right.

The antenna trimmer should be adjusted for the strongest signal from WWV. Correct tuning will be indicated by an increase in a.c. voltage. Peak the i.f. transformers for maximum signal.

WWV’s 2.5- and 10-mc transmissions may be received by switching in suitable antenna coils, tuning capacitors, and crystals. Use 2,045- or 2,055-ke crystals for 2.5 mc and 9,545- or 10,455-ke crystals for 10 mc.

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No other antenna combines all the mechanical and electrical features engineered into the Circle-X. The high gain of the Circle-X is equal to stacked arrays. It is made of light weight, corrosion resistant aluminum alloys that stand up in all atmospheric conditions.

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We urge you to compare Circle-X TV Antennas to any other TV antenna on the market.

Use Circle-X on your next tough TV installation. It may save you a lot of "no profit" call backs.

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**TV SCOPS!**

**FOR HAMS—DON’T BE BLAMED FOR TV!**

Tests have proven that the new Hi-Pass Filter Kit* developed by W2GX, attenuates all frequencies below 1500 cycles. This "M" derived filter for 160 through 10 meters prevents TV while you're operating. Eliminates all frequencies above 40 MHz at 60 db or better, passes all frequencies below 40 MHz. Fits any 52-72 ohm feeders. Insertion loss less than 0.150 db of 1 db. Full directions included.

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$4.99 each

plus 25¢ shipping charges in U.S.

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Sound powered phones talk up to 10 miles with built-in sound powered headphones. Ideal for police, fire, and other use. Excellent type rubber-soft ear-buds prevent tuning away mis.

M-1–2454

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plus 15¢ postage and handling in U.S.

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**Niagara Radio Supply Corp.**

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Dept. C39

160 Greenwich Street, New York 6, N. Y.
B. K. V. (Ron) French has been appointed application engineer of the Electronic Parts Division of ALLEN B. DU MONT LABORATORIES, INC., at its East Paterson, N. J., plant.

French brings to Du Mont a background of 26 years of varied experience in radio engineering. While associated with P. R. Mallory Co. (1937-1946), he was instrumental in the development of the Mallory-Ware Inducteur now incorporated in the Du Mont Inducteur used in Du Mont and other makes of TV sets.

French was also responsible for the introduction of push-button station selection and wave-band switching. During the early part of the recent war, he served on the Joint Army-Navy Standardization Board, and late in 1944 he became supervisor of Mallory research for the development of the mercury-type dry battery extensively used in Armed Forces radio equipment.

In 1946, French joined the executive staff of Howard Sams in the presentation of Photofact radio service literature, and served as a consultant to Stupakoff Ceramics.

French began his active career in 1923 with Federal Telegraph & Telephone, as development engineer. Later, he was with American Bosch in its development of the first all-wave radio sets, auto radios, and personal receivers, with RCA's License Division Laboratory, and with Case Electric as chief engineer.

He is a Senior Member of IRE, member of the Radio Club of America, and a frequent contributor to radio publications.

Ralph L. Hartley, inventor of the Hartley oscillator and formulator of the Hartley law of information transmission, has retired from active duty as transmission research consultant for BELL TELEPHONE LABORATORIES, Inc. Mr. Hartley first came to Bell in 1911, his oscillator was invented a year later.

Among the contributions Mr. Hartley made to communications was his now widely accepted theory, that people perceive direction of a sound source because of the phase difference between sounds received by the two ears. He was instrumental in developing the treatment of telegraph pulses by Fourier analysis so that a.c. measurements could be used. He is the originator of the frequency-inversion system which allows communication privacy. Broadly, however, according to Bell officials his main contribution was the intangible one of clarifying ideas and arranging them in a useful pattern.
Brig. General David Sarnoff, chairman of the board of Radio Corp. of America, was awarded a United Nations citation for his "notable cooperation in the development of public understanding of the work of the United Nations and for his contributions in the field of human rights through advocacy of concepts of Freedom to Listen and Freedom to Look as fundamental expressions of Freedom of Information."

Upon receiving the citation, General Sarnoff described the award as a "generous commentary and kind recognition... directed more to a principle than to a man." He said, "I had the privilege of discussing this principle on several occasions with President Roosevelt, President Truman, Secretaries of State and Marshall, and with other high officials of our government. It was gratifying to see the creation of an international broadcasting service that disseminates information to the rest of the world and that is now so well known as the Voice of America.

"Shortly after the United Nations was organized, I presented to Mr. Trygve Lie and other ranking officers of the UN, a plan for international broadcasting that would be known as the Voice of UN. And it is encouraging to observe the steady growth of your broadcasting service."

"May these Voices continue to be heard over an ever-widening circle and bring hope to an anxious world."

Edward A. Malling has been appointed sales manager for component parts in the General Electric Receiver Division at Electronics Park, Syracuse, N.Y., according to an announcement by W. M. Skillman, manager of sales for the division.

A native of Cleveland, Ohio, Mr. Malling has been employed by General Electric since 1935 when he joined the Electric Refrigeration Department at Nela Park in Cleveland.

He was graduated from Miami University, Oxford, Ohio, in 1934 with a Bachelor of Science degree in business administration.

John D. Small has joined the Emerson Radio & Phonograph Corp., New York, as executive assistant to Benjamin Abrams, president of the corporation.

Irving L. Wilson has been named general sales manager of the cathode-ray tube division of Arcturus Electronics, Inc., Newark, N.J., tube manufacturer.

Previous to his appointment, he was commercial manager of the components division of the North American Philips Co.

MARCH, 1950
TV TOO PROMINENT

Dear Editor:

Radio-Electronics? Nuts! "Television News" would be a more likely name for your publication. Rapid advances in the field or not—there's no excuse for such excessive, constant articles of this type. Gone are the days of meaty servicing and construction articles—of Short-Wave Craft and Radio-Craft. I have read your publications since 1930 and still have the copies since that time, but now I'm fed up! Too much television. Your December, 1949, copy is my last and you can bet I won't be purchasing your Annual Television Issue.

ART RADIO SERVICE

Buffalo, N. Y.

WELL BALANCED MAGAZINE

Dear Editor:

I feel that the magazine is quite well balanced. Since it is primarily a service technicians' publication, your recent emphasis on television is understandable, and those who criticize it must be very short-sighted.

My own hobby is experimenting with audio equipment; hence I enjoy Mr. Langham's articles. His knack for putting across a technical subject while keeping up the pretense of being a humbling novice is unique. I would like to see more articles on high-fidelity audio equipment, distortion measurement, horn loudspeakers, and so on.

Month after month, Radio-Electronics offers me the most for my money.

ALFRED E. ALLEN

Sharon Hill, Pa.

RAILWAY-STATION PA

Dear Editor:

I buy Radio-Electronics primarily because of your stimulating editorials. In the December, 1949, issue, you called attention to the need for blast-proof mikes and PA systems for airplanes. Another audio problem that could be solved without too much work is the poor PA systems in railroad stations. The reflecting surfaces in the larger depots make the announcements unintelligible.

A possible simple solution is to place many small speakers with low power output around so that addition and subtraction of the present few speakers would be eliminated. Each small speaker would serve a small area and its power would be dissipated before it could interfere with the others.

WILLIAM L. MORRISON

Wilmette, Ill.

TUNABLE SIGNAL TRACER

Dear Editor:

I am writing to say how much I like Radio-Electronics.

Please print a circuit for a tunable signal tracer. I have built a simple one but would like to try one of the others.

Keep up the good work and send along the same useful material you have in the past.

K. MYERS

East Liverpool, Ohio

Communications
OPPORTUNITY AD-LETS

Advertisements in this section cost 25¢ a word for each insertion. Name, address and initials must be included. Cash should accompany all classified advertisements unless paid for by an accredited newspaper. No advertisements for less than ten words accepted. Ten percent discount for ten or more insertions. Sixteen line minimum. Advertisements for March, 1950, must reach us not later than February 19, 1950.

AMATEUR RADIO LICENSING. COMPLETE THEORY preparation for passing amateur radio examination. Home study course. $16.00. Hartford Radio Institute, 101 West Sixty-eighth St., New York City. See our ad in Page 94.

"A" Radio License in preparation. Order your $25.00 Pass Paks at COD. Booklet new, sure-fire tech-nique, more than 450 pages. Write for complete details on this practical information. ";" says Engineer Weing, Hackensack Co. 2222 Southern Blvd., Jamaica Heights, N. Y.

MAGAZINES (BACK DATED)—FOREIGN, DOMESTIC, arts, books, booklets, subscriptions, pin-ups, etc. Catalogue of local and national. Write for directory. 331 Broadway.

FREE RADIO PARTY JOURNAL—Telegraph Code Instructions and Catalog of Kits printed from life, build your own receiver, transmitter, test equipment with our easy-to-assemble F-CTO-GRADE instructions. Write Texas: ELECTRONIC KIT CO., 3405 York Blvd., N. Y. T.

WE REPAIR ALL TYPES OF ELECTRICAL INSTRUMENTS, tube cleaners and analyzers. Hartford Instruments Co. 1201 Electric Meter Laboratory, 14 Liberty Street, New York, N. Y. Telephone—Baltimore 5-4729.

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SALE—STANDARD BRANDS RADIO TUBES. Parts for Holstein, Joseph Kase, electrode, 710 Echo Pines, Bronx 57, N. Y.

TV ALL CHANNEL CORAL ANTENNA WITH Reflex, $5.00. Send 36c for 2000 and $5.00 in 5000. Send $3.95, shipped on quantity purchases. Joseph Kase Electro-Designs, Bronx 27, N. Y.


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SATISFIED READER

Dear Editor:

I am satisfied with Radio-Electronics. As usual, I especially liked the series on electronics in medicine.

What surprises me is the fact that there are so many who want only their own selfish interests served. In the letter by Robert O. Barg in the December issue, he is trying to convey to the reader a feeling of inferiority and that he is trying to come up with a lack of knowledge with a long gust of wind. I have seen a lot of television sets that were as good as any 16-mm movie and I suggest he look around a bit more.

E. J. SHEFFES

Kansas City, Mo.

MARCH, 1950

R-E NO HELP TO HIM

Dear Editor:

I have been a reader of your magazine for a good many years. For the past two or three years, Radio-Electronics hasn't been worth the paper it is written on and from now on I am not going to buy another issue of your very poor magazine. I just bought the July issue and read the letter from Mr. William Krier telling what he thinks about publishing your too many articles on television, taking space away from material devoted to sound radio.

I am in favor of him and his ideas. Out here in Oregon where there are no television transmitters and a person cannot receive any TV programs, television articles are no use. I like articles on the construction of radio receivers and the like. Television is O.K. and will be a grand thing, but that is for the future. I am studying television myself, but I still like plain radio. I read the reply you wrote to Mr. Krider, and of course you said that you are with a lot of junk in favor of television.

You people are on the East Coast where there are lots of TV programs to pick up. Try coming way out here to Oregon, where such programs cannot be viewed only rarely.

To tell the truth, I haven't been able to get any help from your magazine in the construction line and I am going to do all I can to keep others from reading it. I intended to subscribe but will never do it.

If you like you can publish this letter word for word; but don't think you will use it, as you won't want to let the people read what I and a lot of others think of your radio magazine (whew, what a smell).

HOWARD D. THOMPSON

Salem, Ore.

(Mr. Thompson is right; the above is not quite what he wrote us. We felt that good publishing practice required us to clean up most of the grammatical and typographical errors and to round out his incomplete sentences. We also omitted sentences about extraneous matters for reasons of space and clarity.

As accurate reporters we are unable to testify about the odor Mr. Thompson mentions, as we may have become acclimated. Our daily mailbag and mounting circulation figures, however, indicate, that it is composed of printer's ink and melting solder in fairly satisfying proportions.

After sober reflection, Mr. Thompson may agree with us that, while continuing to publish construction articles on radio receivers and similar long-time favorite projects, we would be shirking our responsibilities if we failed to prepare him for the day—it's coming soon!—when television does invade Oregon. If reflection doesn't change his attitude, shock may—when the first TV transmitter starts percolating within his range and he suddenly finds himself out on a limb with a couple of dozen ailing TV sets staring him in the face. There are now more than a dozen TV stations on the West Coast. —Editor.)

PROSPECTIVE DX-ER

Dear Editor:

Our city is 230 miles from the nearest television transmitter but a number of us are building our own receivers. Even though it is likely to be five years before we get a local station, we find we can learn a lot by building. I have monitored the sound signal of WHAP-TV in Fort Worth on an FM receiver and we are determined to pull in the picture as well. It may sound foolish, but the bug has hit us!

ROBERT G. ELLIOTT

San Angelo, Tex.
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RADIO- ELECTRONICS for

The pages of this volume contain the most complete (though not always the most thorough) description of the television systems this reviewer has seen to date. Starting with a chapter on the history and present status of television, the book goes on to explain the entire process from camera tube to viewing screen. The material on C-R tube construction is not new but is unusually full. Camera tubes are treated in detail and station transmission standards are listed. A large section on the television station includes many diagrams. The television receiver has a 174-page section to itself, in which its operation is discussed from beginning to end. The treatment is, of course, less exhaustive than would be possible in a book devoted solely to receivers. Other receiver material, however, includes a section describing typical commercial receivers in some detail, another outlining installation methods, and a third on servicing. A 24-page section discusses test equipment.

One interesting feature is a set of instructions for building a television. Schematic diagrams and some drilling templates are given, but it is doubtful that the instructions are sufficiently complete to make the project practicable for any but advanced technicians.

Some information perennially hard to find is in the book—data on remote TV pickup equipment, microwave relays, and other broadcast-station practices. A data section gives a sample service contract, a list of channel assignments in 150 cities, and characteristic and basing charts for 29 C-R tubes. The final sections are a glossary of TV terms and a bibliography of books on television.—R. H. D.


Designed as a course in television for those who expect to do service work on receivers, this book gives very complete information on receiving circuits. The parts dealing with service procedures use actual sets as examples. A final chapter on television mathematics is included for those who wish to do more advanced work; the earlier sections contain almost no mathematics.

---

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The pages of this volume contain the most complete (though not always the most thorough) description of the television systems this reviewer has seen to date. Starting with a chapter on the history and present status of television, the book goes on to explain the entire process from camera tube to viewing screen. The material on C-R tube construction is not new but is unusually full. Camera tubes are treated in detail and station transmission standards are listed. A large section on the television station includes many diagrams. The television receiver has a 174-page section to itself, in which its operation is discussed from beginning to end. The treatment is, of course, less exhaustive than would be possible in a book devoted solely to receivers. Other receiver material, however, includes a section describing typical commercial receivers in some detail, another outlining installation methods, and a third on servicing. A 24-page section discusses test equipment.

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Ranges in Jumper Volt. Also a $13.50 D.C. Current Ranges.

MODEL 103
(1000 ohms per volt meter)
* 4 1/2 SQUARE METER
* 3 AC CURRENT RANGES
0 - 30/150/500 ma.
- Same zero adjustment for both resistance ranges
5 DC & 5 AC Voltages
Ranges in Jupeper Volt. Also a $17.50 D.C. Current Ranges.

MODEL 104
(20,000 ohms per volt meter)
* 4 1/2 SQUARE METER
(10 micro-amp to 10,000 ohms)
also a nice maplet.
- Including carrying strap
5 DC Voltages ranges
20,000 ohms volt to 3,000 V. 3 AC Voltage Ranges
3000 V. 3 Resistance Ranges
4 to 500,000 ohms. 3 AC & DC Current Ranges
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The inside story of Cunningham quality

1. How Cunningham "Inverted" Pinched Cathodes Minimize Microphonics

Engineering progress is part and parcel of Cunningham quality. For instance... unlike most tubes Cunningham use "inverted" pinched cathodes to minimize microphonics by preventing cathode vibration or displacement.

These important features are achieved by clamping the mica firmly between the embossed bead and the pinched top end of the cathode. This arrangement holds the upper end of the cathode rigidly, but permits the heated cathode to expand freely downward through the bottom mica without producing cathode strain. The lower end of the cathode is prevented from vibrating by means of the damping tab connected between the cathode and a stem lead.

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