RADIO-ELECTRONICS

SEPTEMBER 1954

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor

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TV Antenna Repairs

•

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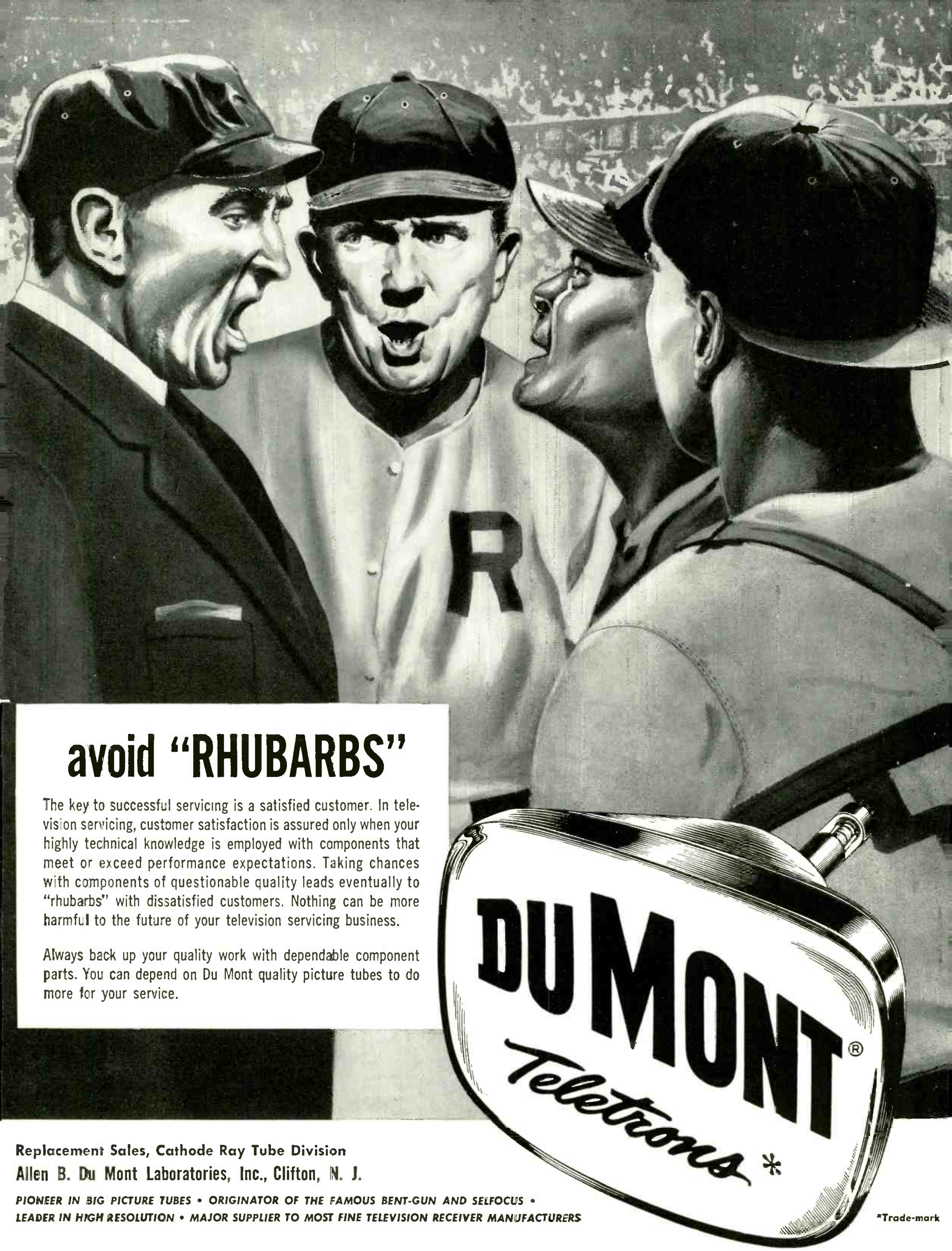
Sensitive Pin-Jack Multimeter

35¢
U. S. and CANADA

**Modifying Marine Radiophones–
New Opportunities for the Technician** (See page 4)



avoid "RHUBARBS"

The key to successful servicing is a satisfied customer. In television servicing, customer satisfaction is assured only when your highly technical knowledge is employed with components that meet or exceed performance expectations. Taking chances with components of questionable quality leads eventually to "rhubarbs" with dissatisfied customers. Nothing can be more harmful to the future of your television servicing business.

Always back up your quality work with dependable component parts. You can depend on Du Mont quality picture tubes to do more for your service.

Replacement Sales, Cathode Ray Tube Division

Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

PIONEER IN BIG PICTURE TUBES • ORIGINATOR OF THE FAMOUS BENT-GUN AND SELFOCUS • LEADER IN HIGH RESOLUTION • MAJOR SUPPLIER TO MOST FINE TELEVISION RECEIVER MANUFACTURERS

*Trade-mark

RADIO-ELECTRONICS

Formerly RADIO CRAFT ● Incorporating SHORT WAVE CRAFT ● TELEVISION NEWS ● RADIO & TELEVISION*

ON THE COVER *(See also page 82)*

Model Mary Gardner puts a call through from offshore. Transmitter is on the deck below—the equipment in sight consists of a receiver and direction finder.

(Color original by Avery Slack)

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*Trademark registered U.S. Patent Office.

THE RADIO MONTH

HOWARD E. ANTHONY owner of the Heath Co. and originator of Heathkits, was killed July 23 in the explosion of a plane in the air near Dayton, Tenn. With Mr. Anthony were the company's pilot, Lawrence Durham, and six other persons. The flight was for the purpose of trying the plane—a De Haviland Dove eight-place executive type—with the idea of acquiring it for the company.

Mr. Anthony was born in Dowagiac, Mich., and received his education at Hillsdale College, Hillsdale, Mich. He bought the Heath Co. (then an aircraft firm) in 1935, continuing the manufacture of aircraft accessories till 1946, when he turned the activities of the company over completely to electronics. At the time of his death Mr. Anthony was a member of the Airport Board and of the boards of the Farmers' and Merchants' Bank and of Mercy Hospital, all of Benton Harbor, and a trustee of Hillsdale College.

His wife, Helen C. Anthony, his mother, and two sisters survive him.

19-INCH COLOR TV receiver sells for $895. Using the CBS color tube, Motorola claims it is the first receiver with this size tube on the market for less than $1,000.

The receiver cabinet is about the size of present 24-inch monochrome sets and has only 29 tubes.

BIGGEST RADIO TELESCOPE in the world is searching the sky for new radio "stars." The new radio telescope is not a parabola, but consists of dipole antennas strung in a straight line for 2,000 feet.

Two poles 25 feet apart and 15 feet high, linked together by taut wire, form each dipole. All the dipoles are connected to the recording point by a coaxial cable.

The telescope, built by the Carnegie Institution of Washington, will survey radio noise received on earth from space in the 20-mc range.

SMALLEST TV STATION in the world has been unveiled at the U.S. Air Force Base in Limestone, Maine. The miniature station (see photo) broadcasts with a power of 8 watts and has a coverage of 3 miles in radius. The television studio and equipment, installed by RCA, is housed in a 10 by 13-foot area atop the four-story base hospital.

The station has been on the air approximately 6 months on an experimental basis, and broadcasts kinescope recordings of top network programs from major broadcasting systems.

A similar station, government operated, has begun operation near White Sands Proving Ground, New Mexico, to provide TV service to the 3,000 military and civilian personnel at the installation.

Photo Radio Corporation of America

Staff Sergeant James R. Dean mans the controls of the little TV station

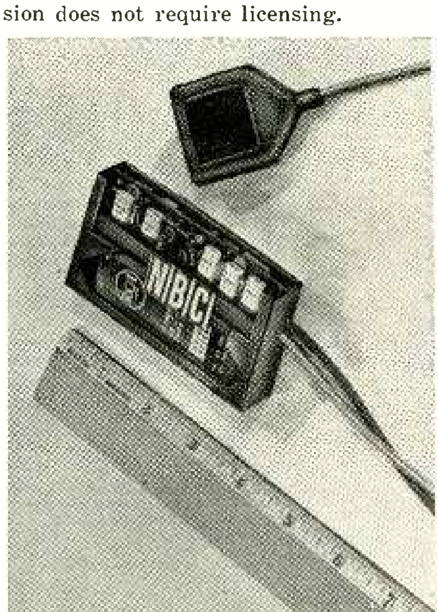
THE RADIO MONTH

SERIES-STRING TUBES especially designed for TV have been announced by RCA. The new tubes, the 3BC5, 3CB6, 5AN8, 5AT8, 5J6, 5U8, and 12L6-GT, have 600-milliampere heaters. They are designed for receivers using series-connected heaters, including the heater of the picture tube. These new tubes have heaters designed for the same warmup time to minimize voltage unbalance during starting.

RCA recommends that a high-wattage resistor, preferably with a positive temperature characteristic, be used in series with the string of tubes to minimize voltage unbalance across any individual tube during starting.

TINY TRANSMITTER for TV performers demonstrated by the National Broadcasting Co. weighs only 8 ounces. The unit, consisting of a microphone, transmitter, and antenna, can be concealed on a performer, giving him complete freedom of movement, otherwise limited by conventional fixed or boom-mounted microphones.

The small size of the unit is primarily due to transistor circuitry. Since the transmitter—working on the inductive principle—radiates almost no power, the Federal Communications Commission does not require licensing.



The transistor transmitter. The two "leads" are part of the inductive transmitting loop, which consists of a number of strands of fine wire. The performer can wear it as a belt.

DR. DAVID GALEN McCAA, a pioneer in the early development of radio and an associate of Marconi, died June 23 at the age of 72.

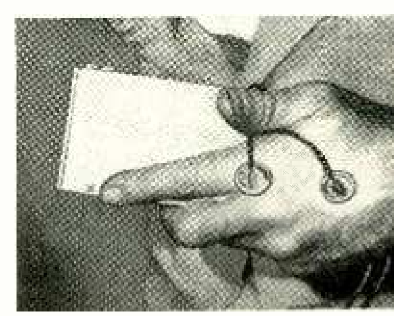
While doing research with X-rays in 1906, McCaa discovered that the human voice could be transmitted over an electric arc. In 1914 he sailed from New York City to Norfolk, Va., transmitting to a receiver located in N.Y. in an experiment to determine how far wireless sound could be sent.

In the '20's he was prominent in the development of anti-static devices.

NEW TECHNIQUES in shortwave communication—including miniature receivers with skin-conduction transducers instead of earphones—were used by a group of gamblers operating from Jamaica Racetrack, near New York City, and possibly other points. Twenty-eight supposed members of the gang were arrested by the police, including a radio service technician and electronics expert of the Cortlandt St. area, who was said to have designed the equipment for the ring.

Using pocket transmitters, gamblers at the track radioed the numbers of winning horses the instant they crossed the finish line. The inforamtion, picked up on a sensitive receiver by a ringleader less than a half mile from the track, was phoned to confederates in various parts of the country, long before the official returns could be received.

Information received from New York was in some cases used by gamblers to transmit information to partners in nearby "horse parlors." Suitcase transmitters—more powerful than the pocket ones—were used. The gambler in the betting parlor, wearing an inconspicuous receiver which used two dimes held against the wrist by adhesive instead of an earphone, could receive the results of a race while in full view of the bookmaker, who would be sure he had no means of obtaining advance information.



Radio has skin-shock wrist electrodes.

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

WMSL-TV	Decatur, Ala.	23
WISH-TV	Indianapolis, Ind.	8
KDRO-TV	Sedalia, Mo.	6
KWK	St. Louis, Mo.	4
KGVO-TV	Missoula, Mont.	13
WCET	Cincinnati, O.	48
KGEO-TV	Enid, Okla.	5
WLAC-TV	Nashville, Tenn.	5
WKBT	La Crosse, Wisc.	8

Nine stations have gone off the air:

KOY-TV	Phoenix, Ariz.	10
WRAY-TV	Princeton, Ind.	52
WFTV	Duluth, Minn.	38
KMBC-TV	Kansas City, Mo.	9
KCTY	Kansas City, Mo.	25
WECT	Elmira, N.Y.	18
WKJF-TV	Pittsburgh, Pa.	53
KNUZ-TV	Houston, Tex.	39
WROV-TV	Roanoke, Va.	27

One Mexican station went off the air this month, XELD-TV, Matamoros, channel 7. END

Now, TV set owners can understand benefits of Aluminized Tubes!

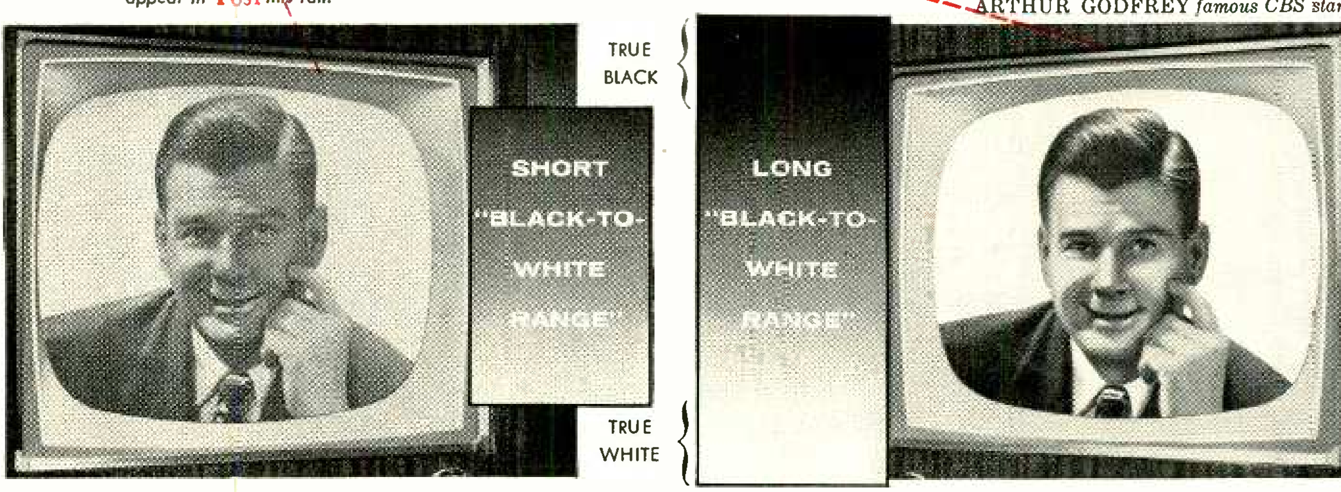
These three advertisements will appear in POST this fall.

THESE ADVERTISEMENTS IN POST EXPLAIN THAT:

1. **IN MAGAZINES,** *the pictures* you see (when magnified) are made by a series of tiny dots applied to the paper *mechanically*.

ON YOUR TV SCREEN, *the pictures* are also made by a series of dots (which appear as lines) applied *electronically*. These dots, in both cases, create a variety of tones including black, a range of grays, and white. BUT, it is the LENGTH of this "Black-to-White Range" (the gray scale) that makes the picture excellent, good, fair, or poor.

ARTHUR GODFREY *famous CBS star*



2. **ORDINARY PICTURE TUBES** used in most TV sets made before 1953 produce a *short* "Black-to-White Range." While the picture is good, the picture tube cannot develop enough *light output* for a *long* "Black-to-White Range."

3. **CBS-HYTRON MIRROR-BACK TUBES** produce up to *twice the light output* of ordinary picture tubes. Like the silver backing on a mirror, the *shiny* aluminum backing on a Mirror-Back tube reflects to the viewer *all the light* on the screen. The resulting increased brightness and reduced halation (unwanted spreading of light from one dot to another) is *essential* to give you a *long* "Black-to-White Range." The full range you *must* have for the clearest, sharpest, brightest pictures that are a joy to watch.

TALK LONG "BLACK-TO-WHITE RANGE" PICTURES ...SELL BIGGER-PROFIT

CBS-HYTRON MIRROR-BACK PICTURE TUBES

Talk . . . demonstrate . . . and sell "Long-Black-to-White-Range" clearer, sharper, brighter pictures. It's easier to sell premium-grade, brand-new CBS-Hytron Mirror-Backs . . . with their controlled quality and dependable full-year guarantee. Profit more. Tie in with POST. Get this Mirror-Back Promotion Kit . . . from your CBS-Hytron distributor, or mail coupon.

CBS-HYTRON Main Office: Danvers, Massachusetts

A Division of Columbia Broadcasting System, Inc.

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

CBS-HYTRON, Danvers, Mass.

I want all the material to identify me as a *Certified* Quality Service dealer who sells Mirror-Back tubes. Please rush me CBS-Hytron Mirror-Back Promotion Kit containing:

1. 22 x 28-inch Advertised-in-POST window poster.
2. 25 consumer self-mailers, "How *You* Can Have Clearer, Sharper, Brighter TV Pictures."
3. *Certified* Quality Service decalcomania.

I enclose 25¢ for postage and handling.

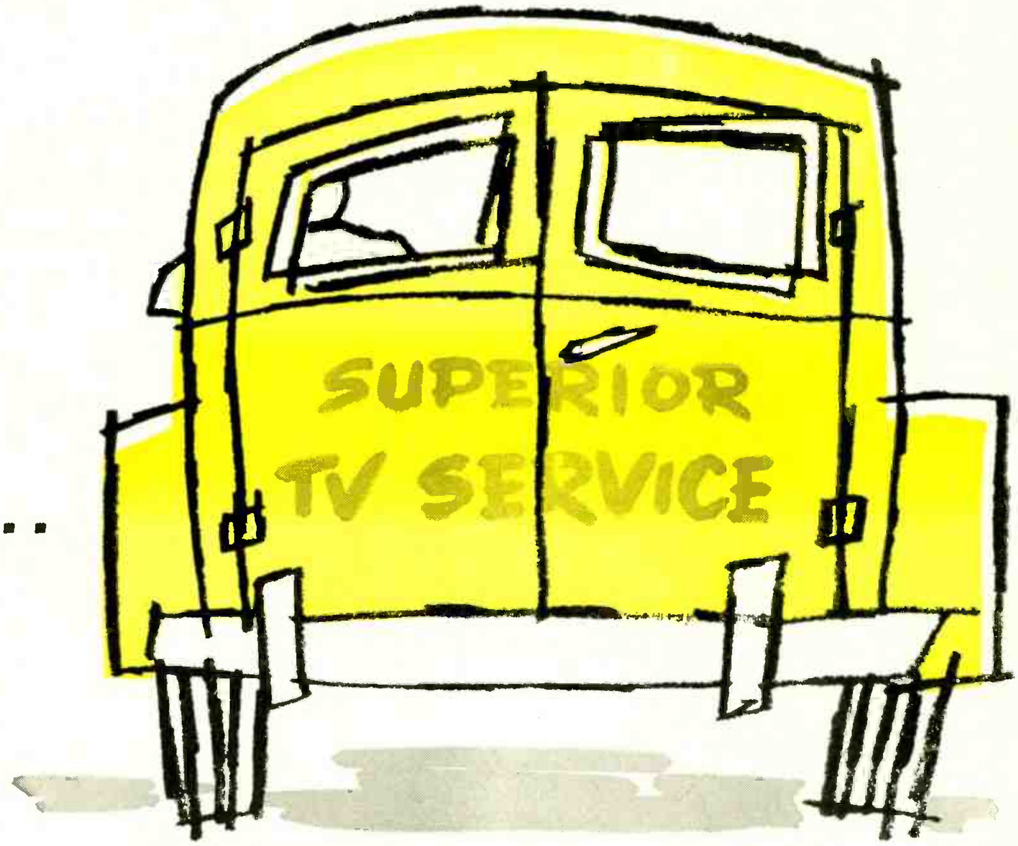
I want ...... more consumer self-mailers at 1¢ each, for which I enclose an additional $.........

Name.......................................
(please print)

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

City........................*State*..............

after
you
leave . . .



ASTRON **capacitors** **build your reputation**

Consumer satisfaction means repeat business. That's why smart servicemen install ASTRON BLUE POINT® capacitors and SAFETY MARGIN* electrolytics.

They know ASTRON capacitors are worthy of their trust.

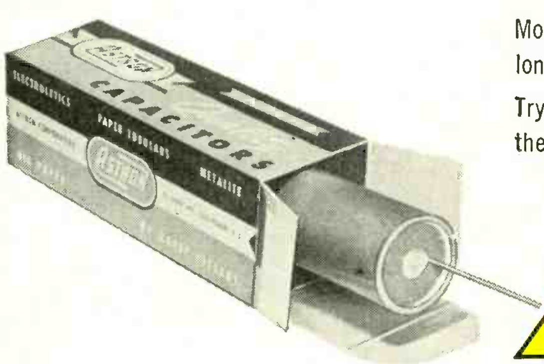
Exclusive ASTRON-developed material treatments, electrolytes, tough element-proof shells and contamination free assembly . . . stop call-backs, insure consumer satisfaction.

Servicemen install ASTRON capacitors because they know that more and more TV & Radio manufacturers use them in original equipment.

More and more manufacturers are using them because of their surprisingly long life and utmost dependability!

Try something new . . . start installing ASTRON CAPACITORS today . . . they work for you long after you leave the call.

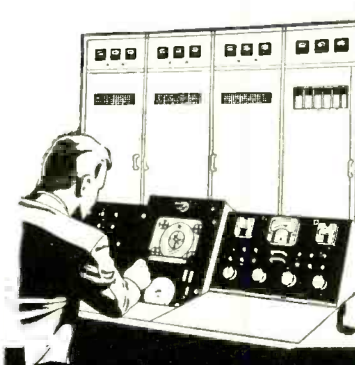
*TRADEMARK



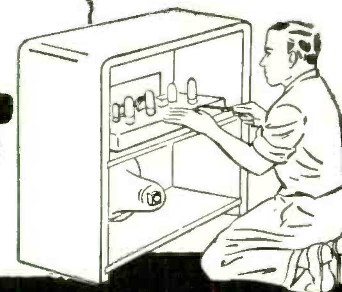
ASTRON
CORPORATION

255 GRANT AVENUE, E. NEWARK, N. J.

Export Division: Rocke International Corp. 13 E. 40 St., New York, N. Y.
In Canada: Charles W. Pointon 6 Alcina Ave., Toronto 10, Ontario



Where Will You Be in ELECTRONICS 6 Months from Today?



ADD TECHNICAL TRAINING to your practical experience

Get Your FCC License In A Hurry!

Then Use Our Amazingly Effective JOB FINDING SERVICE

Get This Valuable Booklet FREE

TV ENGINEERING INCLUDED IN OUR TRAINING & COACHING

TELLS HOW—

HERE IS YOUR GUARANTEE

If you fail to pass your Commercial License exam after completing our course, we guarantee to continue your training without additional cost of any kind, until you successfully obtain your Commercial license, provided you first sit for this examination within 90 days after completing our course.

WE GUARANTEE

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

YOUR FCC LICENSE

If you have had any practical experience —Amateur, Army, Navy, Radio repair, or experimenting.

TELLS HOW—Employers make JOB OFFERS Like These to Our Graduates Every Month

Letter from nationally-known Airlines, "We would also appreciate if you would place the following additional advertisement in your bulletin—Wanted —Superintendent of Communications . . . Salary $666.66 per month."

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

These are just a few examples of the job offers that come to our office periodically. Some licensed radioman filled each of these jobs . . . it might have been you!

HERE'S PROOF FCC LICENSES ARE OFTEN SECURED IN A FEW HOURS OF STUDY WITH OUR COACHING AT HOME in Spare Time.

Name and Address	License	Lessons
Lee Worthy, 2210½ Wilshire St., Bakersfield, Calif.	2nd Phone	16
Clifford E. Vogt, Box 1016, Dania, Fla.	1st Phone	20
Francis X. Foerch, 38 Beucler Pl., Bergenfield, N. J.	1st Phone	38
S/Sgt. Ben H. Davis, 317 North Roosevelt, Lebanon, Ill.	1st Phone	28
Albert Schoell, 110 West 11th St., Escondido, Calif.	2nd Phone	23

CLEVELAND INSTITUTE OF RADIO ELECTRONICS
CARL E. SMITH, E.E., Consulting Engineer, President
Desk RE-68, 4900 Euclid Bldg., Cleveland 3, Ohio

TELLS HOW—

Our Amazingly Effective JOB-FINDING SERVICE Helps CIRE Students Get Better Jobs

Here are a few recent examples of Job-Finding Results!

GETS AIRLINES JOB

"Due to your Job-Finding Service, I have been getting many offers from all over the country, and I have taken a job with Capital Airlines in Chicago, as a Radio Mechanic."
Harry Clare, 4537 S. Drexel Blvd., Chicago, Ill.

GETS FIVE JOB-OFFERS FROM BRDADCAST STATIONS

"Your 'Chief Engineer's Bulletin' is a grand way of obtaining employment for your graduates who have obtained their 1st class license. Since my name has been on the list I have received calls or letters from five stations in the southern states, and am now employed as Transmitter Engineer at WMMT."
Elmer Powell, Box 274, Sparta, Tenn.

GETS CIVIL SERVICE JOB

"I have obtained a position at Wright-Patterson Air Force Base, Dayton, Ohio, as Junior Electronic Equipment Repairman. The Employment Application you prepared for me had a lot to do with me landing this desirable position."
Charles E. Loomis, 4516 Genesee Ave., Dayton, Ohio.

OURS IS THE ONLY HOME STUDY COURSE WHICH SUPPLIES FCC-TYPE EXAMINATIONS WITH ALL LESSONS AND FINAL TESTS.

Your FCC ticket is recognized by employers in the electronic field as proof of your technical ability.

GET ALL 3 FREE!

MAIL COUPON NOW!

CLEVELAND INSTITUTE OF RADIO ELECTRONICS
Desk RE-68, 4900 Euclid Bldg., Cleveland 3, Ohio
(Address to Desk No. to avoid delay)

B I want to know how I can get my FCC ticket in a minimum of time. Send me your FREE booklet, "How to Pass FCC License Examinations" (does not cover exams for Amateur License), as well as a sample FCC-type exam and the amazing new booklet, "Money-Making FCC License Information."

Be sure to tell me about your television engineering course.

Name...

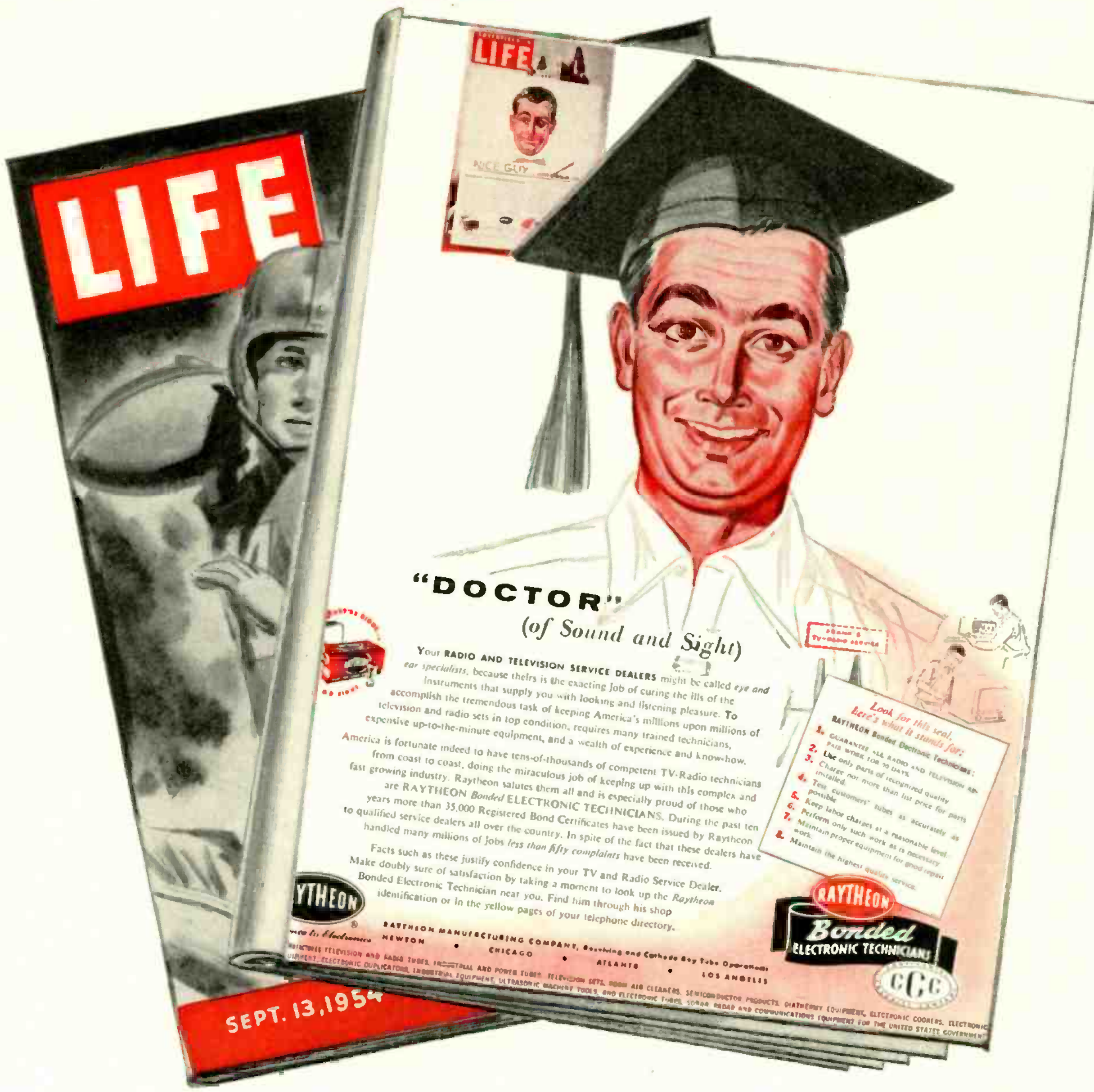
Address...

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

Special tuition rates to members of the U.S. Armed Forces.
Paste on 2-cent postcard or send air mail.

Mr. Service Dealer:

THIS RAYTHEON AD IS YOUR AD



More than twenty-six million people will read about you and the good work *you* are doing, in the September 13th issue of LIFE Magazine. We at Raytheon are publishing this advertisement because we believe you deserve a public pat on the back for the successful way you have met every challenge of the Radio and Television Service industry. We are telling you about it in advance so that you can take full advantage of its appearance to help increase your volume and profit. It's our way of saying thank you for using and recommending *Raytheon Quality Radio and Television Tubes.*

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Receiving and Cathode Ray Tube Operations

Newton, Mass., Chicago, Ill., Atlanta, Ga., Los Angeles, Calif.

RAYTHEON MAKES ALL THESE:

RECEIVING AND PICTURE TUBES • RELIABLE SUBMINIATURE AND MINIATURE TUBES • SEMICONDUCTOR DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES

It's New! It's Here!
"SILVER
IT'S FULLY GUARANTEED!
IT'S SHARPER!
1 YEAR WARRANTY
THE NAME'S ON THE FACE FOR YOUR PROTECTION!
IT'S CLEARER!
SYLVANIA SILVER SCREEN 85

IT'S SYLVANIA'S

"SCREEN 85"

The Picture Tube with three amazing design features!

SILVER-ACTIVATED SCREEN...SUPER ALUMINIZED REFLECTOR
PRECISION-FOCUS ELECTRON GUN

YOU CAN BE PART OF THE BIGGEST PICTURE TUBE CAMPAIGN IN THE INDUSTRY!

All this promotion material is yours FREE —All you have to do is ask for it!

- attractive window streamers . . .
- colorful counter and window displays . . .
- radio and TV commercials for you to use on your local stations . . .
- newspaper mats . . .
- publicity releases . . .
- postcards . . .
- envelope stuffers . . .
- a brand new booklet to describe the revolutionary "Silver Screen 85" to your customers . . .

Here is a truly great achievement in television picture tubes! Sylvania's "SILVER SCREEN 85" is the last word in design and engineering perfection. It's the picture tube with the SILVER-ACTIVATED SCREEN, to produce television's sharpest, clearest pictures; the SUPER ALUMINIZED REFLECTOR to catch and use all available light, giving pictures more depth, more dimension than ever before; the PRECISION-FOCUS ELECTRON GUN that scans every inch of the screen, making images stand out in pinpoint detail.

From foreground to background, pictures are razor-sharp, crystal clear! Blacks are *really* black—whites are *true* white. Only professional movies can duplicate the "Silver Screen 85" picture. It's a SUPER ALUMINIZED PICTURE TUBE, designed to give top performance, made to the highest quality standards, and backed by the world's most experienced manufacturer of picture tubes!

YOUR SYLVANIA DISTRIBUTOR HAS THE "SILVER SCREEN 85" NOW! MAKE SURE YOU ARE PART OF THIS PROFIT-PACKED PROMOTION—CALL HIM, WRITE HIM, SEE HIM TODAY!

24 MILLION PEOPLE—INCLUDING YOUR CUSTOMERS—WILL HEAR ABOUT THE "SILVER SCREEN 85" EVERY WEEK ON "BEAT THE CLOCK"! 80 STATIONS NOW REACH 93% OF THE TV HOMES IN THE COUNTRY.

Right in your own town! That's where Sylvania will help you sell the "Silver Screen 85"! Hard-selling commercials will tell millions of people every week that you're the man to see for a new "SILVER SCREEN 85."

SYLVANIA

Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

In Canada: Sylvania Electric (Canada) Ltd., University Tower Building, St. Catherine Street, Montreal, P. Q.

LIGHTING • RADIO • ELECTRONICS • TELEVISION

CORRESPONDENCE

TRAINING PROGRAMS

Dear Editor:

In a recent editorial you urged that bright youngsters be mustered into the radio-electronic field—a sentiment with which I agree wholeheartedly. I am an educator (?) and because I have had some dozen years of teaching experience, I think I know why we will not get the bright boys and girls into our field unless we go after them ourselves.

The "why" is wrapped up in the approach schools—public and private—make to counselling. Students are all too frequently tested for IQ and interests, then influenced to aim at an objective consistent with their abilities, in a field in which their interests lie. Doesn't sound so bad, does it? Unfortunately, the student must express some interest in radio-electronics to be counselled into it. Where does he acquire this interest? In too many cases it isn't available. Simple articles showing a kid how he can make things himself for a few cents are rare today, and it is the bright, underprivileged kid who sometimes becomes a delinquent.

Many counsellors—totally ignorant of the ramifications of the electronic field—assume all bright boys should become engineers, and steer them into an engineering program. Then the boy —frustrated because his hands are not busy on the things his head is learning —gives up and tries something else.

In a small high-school district nearly 10 years ago I added a radio class to the shop offerings. Fourteen boys were entrusted to my care. All but three had long records on the local police blotter. Every cent of the class budget had been spent on the benches. There were no tools, no test equipment, no radio sets nor components, no solder. The local shops provided cast-off dynamic speakers for wire, obsolete sets for parts and tubes. Many parts for the first sets were constructed in the shop. The studies went on in chemistry, physics, radio-electronics, the social sphere.

Not one of the "delinquents" had another mark on his record during his high-school career. Two of them now are nearly engineers, one is starting a doctoral program. Most of the rest are in radio-electronics as a livelihood.

Radio-electronics must be added to every junior high-school curriculum. When even the juvenile delinquent becomes so fascinated by the world openings up to him that he spends his evenings in study and experiment and drops his aggressions, what is its value to the luckier "average" student?

What can be done about it? One thing is to provide material for the present teachers—most of whom read RADIO-ELECTRONICS—and for the bright students, nearly all of whom also see the magazine. The material should include articles and items which will start from virtually nothing and build an understanding by showing how to construct sets, circuits and even components.

CHARLES R. MULKEY

San Jose, Calif.

Give your customers the most sparkling pictures they've ever hoped for . . . pictures with all the dramatic highlights and tones of a portrait photograph . . . with the revolutionary new Winegard Interceptor TV Antenna! Restores vibrant life to the dull, blurred image of many old sets . . . brings out every last ounce of performance in the newest.

For only the Interceptor has that amazing "Electro-Lens Focusing" . . . the patented design that pulls in all *the signal . . . actually builds up its intensity . . . then focuses the* amplified *signal to the screen, much as an optical lens focuses and intensifies light rays.*

And—the Interceptor gives maximum rejection of side and back interference . . . vastly superior reception in outlying areas. Particularly suited to color TV, designed to give performance unmatched by any other antenna on all VHF channels. Lightweight, compact, wind resistant.

An obsolete antenna can make even the finest set unsatisfactory. So give your customers the best performance from any set, old or new . . . insure their utmost satisfaction. Write for complete information about the Winegard Interceptor Antenna today!

*Patent Pending

WINEGARD ***Interceptor* ANTENNA**

with Exclusive Electro-Lens Focusing

WINEGARD COMPANY, 3000 Scotten Boulevard, Burlington, Iowa

NEW

WESTON INTRODUCES NEW LINE OF INSTRUMENTS THAT SIMPLIFY
AND SPEED-UP SERVICING AND ALIGNMENT OF ALL TV RECEIVERS
INCLUDING COLOR. PRECISION BUILT-- DESIGNED TO DEFEAT
OBSOLESCENCE -- PRICED RIGHT FOR SERVICEMEN

WESTON 980 LINE
TV TEST EQUIPMENT

In the new 980 Line, WESTON offers TV technicians not only a group of superior, up-to-the-minute instruments, but a new, *greatly simplified* and *time-saving method* of TV receiver alignment as well.

The instruments in this line represent a completely new approach in test equipment design and operation . . . instruments that set entirely new standards in *performance* . . . in *operating simplicity* . . . in *value!*

In the new simplified method of alignment which they provide, it is no longer necessary to connect the calibrator to the receiver. This simplified hook-up eliminates the spurious markers and receiver oscillations encountered with conventional hook-ups. Further, there is no disappearance of markers at trap resonant frequencies. And there are many other advantages, too; all enabling you to do a *better alignment job,* in *one-half the usual time,* and at *far higher profit.*

980 Line instruments are available to TV technicians through leading distributors. Literature giving complete information gladly sent on request. Return the coupon today.

MODEL 985
CALIBRATOR

—a time-saving instrument for TV shop, engineering laboratory, and industrial alignment applications. Negative and positive Z-axis markers are provided for wave-form pattern analysis. Extremely useful for making linearity adjustments, calibrating signal generators, and determining signals of unknown frequencies. Generated markers are visible even at sound trap frequencies. Generated frequencies are *fundamentals* . . . not harmonics. Simultaneous multiple marker insertion . . . no distortion of response curve . . . fewer connections to TV receiver.

MODEL 983
OSCILLOSCOPE

—a high gain, wide band oscilloscope. Band width of 4.5 megacycles allows accurate display of video frequencies, including pulse wave forms and color synchronizing bursts. High sensitivity of 17 millivolts per inch makes it ideal for setting resonant traps, as a general null indicator, signal tracing in low level stages, phase measurements as well as for sweep frequency visual alignment of TV receivers. Has provisions for internal calibration, internal phased sine wave, and Z-axis intensity modulation. Reversal of polarity of both horizontal and vertical signals accomplished by means of toggle switching. Identical vertical and horizontal amplifiers . . . direct coupling used throughout.

MODEL 984
SWEEP GENERATOR

—for efficient trouble shooting and lab practice in problems of sound and video IF circuits, associated trap circuits, TV tuners, video amplifiers and all-purpose visual alignment. RF OUTPUT: Frequency modulated signal, TV channels 2 to 13 inclusive, complete FM coverage available by means of two preset selector positions. FREQUENCIES ARE FUNDAMENTALS OF THE OSCILLATOR FREQUENCY. IF/VIDEO OUTPUT: Frequency modulated signals ranging to 50 megacycles, continuous tuning, signals free from harmonics. SWEEP WIDTH: Full 10 megacycles on all channels. OUTPUT VOLTAGE (RMS): 0.1 Volt, sweep is linear. Output is essentially flat.

MODEL 981
PROPORTIONAL MUTUAL CONDUCTANCE
TUBECHECKER

—provides meter measurement of leakage resistance as high as 5 megohms between tube elements . . . nine single circuit, twelve position selector switches protect against obsolescence . . . three toggle switches make it possible to check and compare sections of twin-section tubes at only one setting of selector switch. Transconductance measurements high as 30,000 micromhos with filtered d-c plate, screen grid, and control grid potentials. Precision voltage divider network and switch provides signal voltages of 0.65, 1.3, 2.6, and 5.2 volts peak to peak at a frequency of 5000 cycles. Tubes checked more closely to circuit operating conditions. Better Gm accuracy obtained.

MODEL 982
VACUUM TUBE VOLTMETER

—a self-contained, battery operated Vacuum Tube Voltmeter, particularly adaptable to the Radio-TV servicing industry where the requirements of peak to peak measurements of a-c voltages exclude the use of conventional meters. Makes possible quantitative measurement of all complex wave form voltages utilized in video, sync and deflection circuits with no a-c line interference in critical measurements. Battery operation affords complete isolation from spurious response due to stray a-c fields and circulating ground currents. *Circuit loading on peak to peak measurements eliminated.*

MODEL 980
ANALYZER

—highly versatile, accurate and rugged volt-ohm-milliammeter with a combination of functional ranges which provide a wide range of test measurement applications in the electronic field. D-c sensitivity of 20,000 ohms/volt, a-c sensitivity 1000 ohms/volt. Accuracy 2% d-c, 3% a-c. Range and functional switching greatly simplified by use of a single dial for all ranges and functions.

for TV it's the 980 Line

WESTON

test equipment

WESTON Electrical Instrument Corporation
614 Frelinghuysen Ave., Newark 5, N. J.

Send copy of bulletin RE

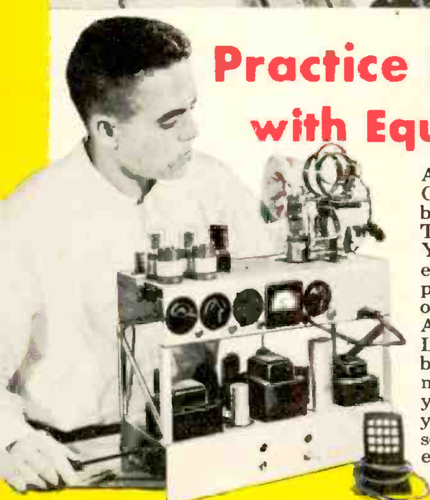
Name ______________________

Address ______________________

City ______________ State ________

J. E. SMITH
President
National Radio
Institute
Washington, D. C.
40 years of success
training men at
home in spare time.

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

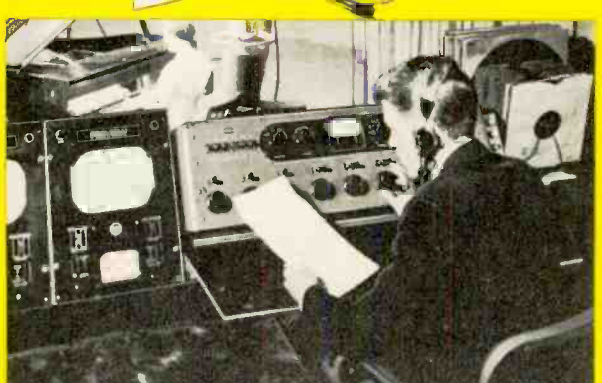


Practice Broadcasting with Equipment I Send

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

Practice Servicing with Equipment I Send

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



Television is Growing Fast Making New Jobs, Prosperity

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

AVAILABLE TO VETERANS UNDER G.I. BILL

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

CUT OUT AND MAIL THIS CARD NOW

Sample Lesson & 64-Page Book
Both FREE

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

NO STAMP NEEDED! WE PAY POSTAGE

Mr. J. E. SMITH, President,
National Radio Institute, Washington 9, D. C.

Mail me Lesson and Book, "How to Be a Success in Radio-Television." (No Salesman will call. Please write plainly.)

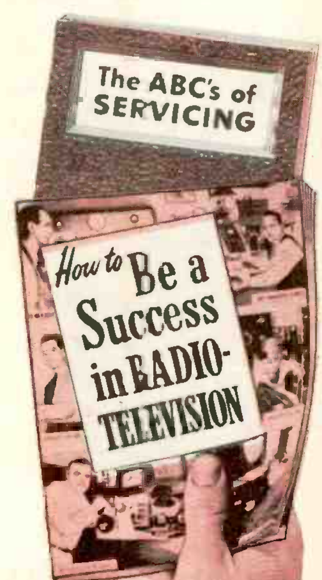
NAME .... AGE ......

ADDRESS ....

CITY .... ZONE .... STATE ....

VETS write in date of discharge ....

J K L M N O P Q R S



Train at Home to Jump Your Pay as a RADIO-TV Technician

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

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

Radio-Television is today's opportunity field. Even without Television, Radio is bigger than ever before. Over 3,000 Radio Broadcasting Stations on the air; more than 115 million home and Automobile Radios are in use. Then add Television. Television Broadcast Stations extend from coast to coast now with over 25 million Television sets already in use. There are channels for 1,800 more Television Stations. Use of Aviation and Police Radio, Micro-Wave Relay, Two-way Radio communication for buses, taxis, trucks, etc. is expanding. New uses for Radio-Television principles coming in Industry, Government, Communications and Homes.

My Training is Up-to-Date You Learn by Practicing

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

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

Find Out About the Tested Way to Better Pay

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

You take absolutely no risk. I even pay postage. I want to put an Actual Lesson in your hands to prove NRI home training is practical, thorough. I want you to see my 64-page book, "How to Be a Success in Radio-Television" because it tells you about my 40 years of training men and important facts about present and future Radio-Television job opportunities. You can take NRI training for as little as \$5 a month. Many graduates make more than the total cost of my training in two weeks. Mailing postage free card can be an important step in making your future successful. J. E. Smith, President, National Radio Institute, Washington 9, D. C. OUR 40TH YEAR.

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

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

SEE OTHER SIDE

J. E. Smith, President
National Radio Institute

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

I TRAINED THESE MEN

Consultant on Antenna Systems
"I resigned as Chief Engineer. Now I am on my own as consultant on private and commercial antenna systems." R.J. Bailey, Weston, W. Va.

\$10 a Week In Spare Time
"Before finishing, I earned as much as \$10 a week in Radio servicing, in my spare time. I recommend NRI". S. J. Petruff, Miami, Fla.

Control Operator, Station WEAN
"I received my license and worked on ships. Now with WEAN as control operator. NRI course is complete." R. Arnold, Rumford, R. I.

Has Own Radio-Television Shop
"Doing Radio and Television servicing full time. Have my own shop. I owe my success to NRI." Curtis Stath, Fort Madison, Iowa.

Radio-Television Service Chief
"Am chief Radio and Television serviceman for large repair shop. Pay very good; working conditions pleasant." P. G. Brogan, Louisville, Ky.

Got First Job Thru NRI
"My first job was with KDLR. Now Chief Engr. of Radio Equipment for Police and Fire Dept." T. Norton, Hamilton, Ohio.

My Training Leads to Jobs Like These

BROADCASTING
Chief Technician
Chief Operator
Power Monitor
Recording Operator
Remote Control Operator

SERVICING
Home and Auto Radios
P.A. Systems
Television Receivers
Electronic Controls
FM Radios

IN RADIO PLANTS
Design Assistant
Transmitter Design Technician

Service Manager
Tester
Serviceman
Research Assistant

SHIP AND HARBOR RADIO
Chief Operator
Assistant Operator
Radiotelephone Operator

GOVERNMENT RADIO
Operator in Army, Navy, Marine Corps, Coast Guard
Forestry Service Dispatcher
Airways Radio Operator

AVIATION RADIO
Plane Radio Operator
Transmitter Technician
Receiver Technician
Airport Transmitter Operator

TELEVISION
Pick-Up Operator
Voice Transmitter Operator
Television Technician
Remote Control Operator
Service and Maintenance Technician

POLICE RADIO
Transmitter Operator
Receiver Serviceman

FIRST CLASS
Permit No. 20-R
(Sec. 34.9, P.L.& R.)
Washington, D.C.

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed In The United States

POSTAGE WILL BE PAID BY
NATIONAL RADIO INSTITUTE
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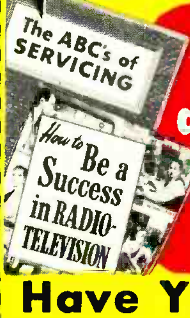
Washington 9, D. C.

CUT OUT—MAIL Postage Free CARD



SAMPLE LESSON and 64-PAGE BOOK Both FREE

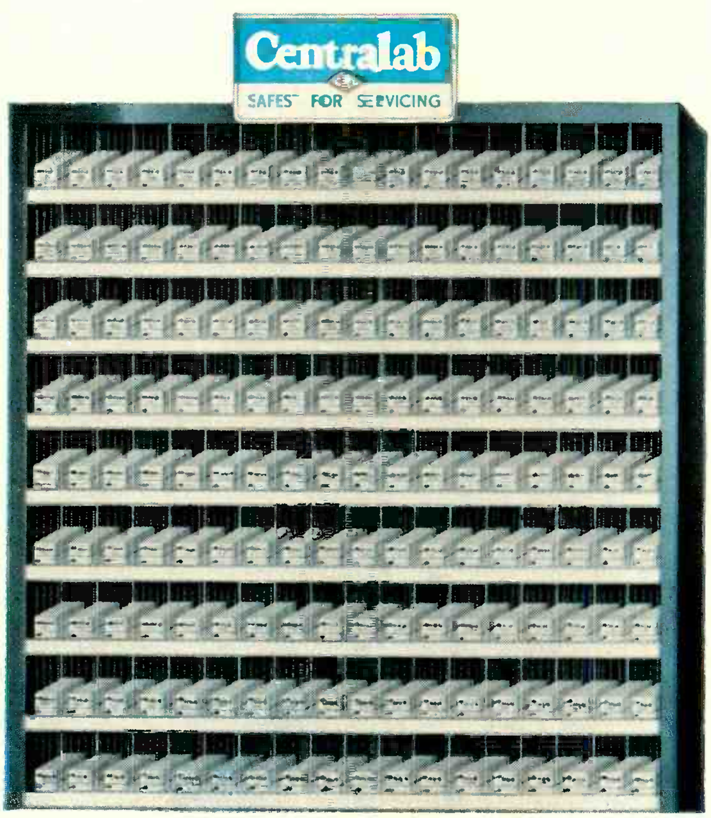
Have Your Own Business

Many NRI trained men start their own successful Radio-Television sales and service business with capital earned in spare time. Joe Travers, a graduate of mine, in Asbury Park, N. J., writes: "I've come a long way in Radio and Television since graduating. Have my own business on Main Street."

Don't waste time and money hunting for exact replacements or waiting for delivery of out-of-stock items!

Making the most of Centralab's new Fastatch Custom Controls?*

Unique plan keeps 4,000 combinations of resistance and taper IN STOCK at your Centralab distributor



Never before has it been so easy to get the right replacement for practically any dual control, current or future (including color TV)!

With Centralab's new custom-control system, you take Fastatch front and rear units and simply do this:

Snap front unit . . . (with outer shaft cut to length)

To rear unit . . . (with blue shaft cut to length)

Snap on switch . . . (from Fastatch KB series)

Add the knobs —and there's your custom dual

Note that you don't do the manufacturer's job —there are no loose parts . . . no lugs to bend . . . no tricky assembling. Fastatch units are completely assembled, tested, and guaranteed by Centralab.

Have your Centralab distributor tell you more. And send coupon for bulletin 42-218.

Centralab

Tear out coupon and mail today!

CENTRALAB, A Division of Globe-Union Inc.
9221 E. Keefe Avenue, Milwaukee 1, Wisconsin
Send me free bulletin 42-218.

Name..............................

Company..............................

Address..............................

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

B-3854

*Trademark

See For Yourself!

New!

PHILCO

SUPER PERFORMANCE

TV

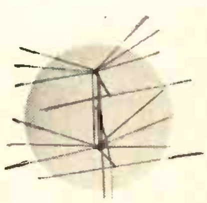
ANTENNAS

PHILCO
Famous for
QUALITY
the World Over

GUARANTEED TO OUTPERFORM ANY EQUIVALENT TYPE ANTENNA OR

YOUR MONEY and LABOR COSTS BACK!

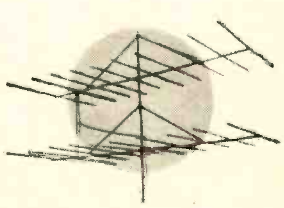
There's been enough words written about TV antenna performance. Now . . . *see the facts for yourself!* Compare any of the new PHILCO Super-Performance TV Antennas with any equivalent type on the market. If the new PHILCO does not give you the finest picture possible, your money back for the antenna *plus* your labor costs up to $10.00. Ask your PHILCO Distributor for complete details on this amazing offer!



PHILCO VHF SUPER CONICAL

PHILCO TWO-BAY SUPER CONICAL ALL-CHANNEL ANTENNA

Strong signal pickup on VHF channels 2 through 13 . . . UHF channels 14 through 83 . . . ideal for fringe area reception . . . all-aluminum construction with dowelled elements: Part No. 45-3096-2. Rugged single bay design: Part No. 45-3096.



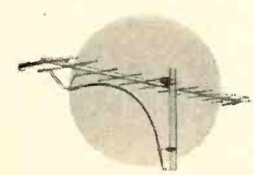
PHILCO VHF LOW BAND YAGI

PHILCO TWO-BAY VHF LOW BAND YAGI ANTENNA

10 elements . . . all-aluminum . . . factory pre-assembled. Top performance on channels 2 through 6 . . . 13 db to 15 db gain on various channels. Single bay Part No. 45-3112-2 through 6. Stacked version harness Part No. 45-3267.

PHILCO GOLDEN YAGI UHF ANTENNA

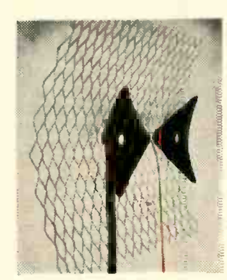
Designed for 300 ohm operation . . . all metal construction . . . 11 db to 12 db gain on various channels. "Cronak" coated components resist salt air . . . humidity. Six models cover entire UHF spectrum: Basic Part No. 45-1996.



PHILCO UHF GOLDEN YAGI

PHILCO PARAFLECTOR ALL-CHANNEL UHF ANTENNA

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



PHILCO UHF PARAFLECTOR

PHILCO CORPORATION ACCESSORY DIVISION

"A" AND ALLEGHENY AVE. • PHILADELPHIA 34, PA.

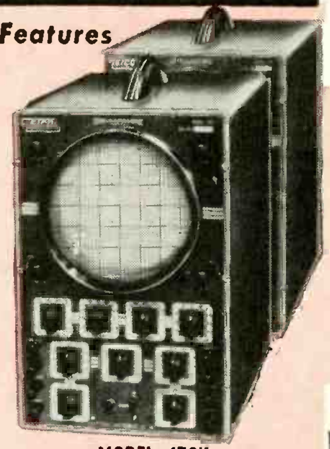
NOW . . . 2 SENSATIONAL EICO SCOPE VALUES!

NEW AMAZING FEATURE PACKED

7" PUSH-PULL OSCILLOSCOPE

Only EICO Has All These Features

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



MODEL 470K
KIT $79.95. WIRED $129.50.

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

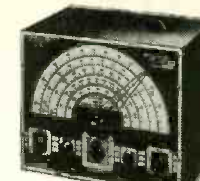
- PUSH-PULL V & H amplifiers. Sens: 0.5-.1 rms v/in. Useful to 2.5 mc.
- SWEEP. 15 cps-76 kc. Z-axis intensity modulation. Dual trace positioning controls.

221K VTVM KIT $25.95. WIRED $39.95.

- AC/DC volts: 0-5, 10, 100, 500, 1000 (30 kv with HVP probe)
- Res.: 0.2 ohms—1000 megs, 5 ranges
- DC input R: 25 megs
- 4½" meter in can't burn out circuit
- 1% mult. resistors

HIGH VOLTAGE PROBE $4.95
- Extends range of VTVMs & voltmeters to 30 kv.

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



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

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

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

214K VTVM KIT $34.95. WIRED $54.95.

Large 7½" meter

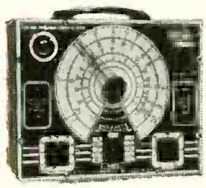
- Large 7½" meter, can't-burn-out circuit.
- AC/DC volts: 0-5, 10, 100, 500, 1000 (30 KV with HV Probe).
- 5 ohms ranges from .2 ohm to 1000 megs.
- DC input R:25 megs.
- 1% mult. resistors.

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

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

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

950B·K R-C BRIDGE & R-C-L COMP. KIT $19.95. WIRED $29.95.

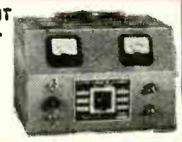


- Measures & tests all resistors; .5 ohm to 500 megohms.
- Every type condenser, 10 mmf to 5000 mfd.
- 0-500 DC voltage source for capacitor leakage testing.

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

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

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



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

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

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

352K BAR GENERATOR KIT $14.95 WIRED $19.95

- Reliable, accurate, portable, easy-to-use.
- Operates on channels 2-6. 16-23 vert. bars to check H linearity. 13-22 hor. bars to check V linearity.
- Shows pic size & V & H sync circuit stability.
- Entirely independent of station sent signals.

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

New! EICO SCOOPS!

232 K PEAK-to-PEAK VTVM with DUAL-PURPOSE AC/DC Uni-Probe*

KIT $29.95 WIRED $49.95

(Pat. Pend.)

Measures directly p-p voltage of complex and sine waves: 0-4, 14, 42, 140, 420, 1400, 4200 V DC/RMS sine voltage range: 0-1.5, 5, 15, 50, 150, 500, 1500 v. Ohms: 0-1000 megs. 7 non-skip ranges on every function. Calibration without removing from cabinet. Zero center. Freq. Resp. 30 cps-3mc. 1% precision ceramic multipliers. Exceptional stability and accuracy. Compact, portable (8½x5x5"), smart, rugged.

NEW! UNI-PROBE! Terrific time-saver! Only 1 probe for all functions—a half-turn of probe-tip selects DC or AC (Peak-to-Peak or RMS)/OHMS!

249 K PEAK-to-PEAK VTVM with 7½" METER KIT $39.95 WIRED $59.95

944 K FLYBACK TRANSFORMER AND YOKE TESTER
Kit $23.95 Wired $34.95

Tests all flybacks and yokes, in or out of TV set —in just seconds! Detects even 1 shorted turn! Exclusive separate calibration for air—and iron-core flybacks assures utmost accuracy. Large 4½" meter, 3 colored scales. Compact, portable (7 x 5 x 4"), smart, rugged.

488K ELECTRONIC SWITCH KIT $23.95. WIRED $39.95
1171K DECADE RESISTANCE BOX KIT $19.95. WIRED $24.95
1180K DECADE CONDENSER BOX KIT $14.95. WIRED $19.95

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

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

565K MULTIMETER KIT $24.95 WIRED $29.95.
555K MULTIMETER KIT $29.95 WIRED $34.95. (1% precision resistors)

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

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

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

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

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

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

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

320K SIG. GEN. KIT $19.95. WIRED $29.95

- Vernier tuning condenser.
- Stable Hartley RF osc., range: 150 kc to 34 mc, calibrated harmonics to 102 mc.
- Pure or modulated RF, & Colpitts oscillator 400 cps sine outputs.

322K SIG. GEN. KIT $23.95. WIRED $34.95. (As above, plus individual calibration of each of its 5 bands)

Write Now for FREE latest Catalog C-9

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Seperate Assembly & Operating Manuals supplied with each EICO KIT!

You build EICO Kits in one evening, but . . . they last a lifetime!

SAVE OVER 50%! See the famous EICO line TODAY, at your local jobber.

ELECTRONIC INSTRUMENT CO., Inc., 84 Withers Street, Brooklyn 11, N. Y.

RADIO-ELECTRONICS
Hugo Gernsback, Editor

AUTOMATION

. . . . *Electronic Hands are fast superseding human ones* . . . .

AUTOMATION, a recent word coined to designate an old art, is taking the modern electronic world by storm. *Automation,* stripped bare of its technicalities, simply is the use of a robot-like machine which can do a given job better and faster than is possible for any human. Automation also outrivals all humans because it can stay on the job for 24 hours a day, if necessary, without a break. It doesn't tire or loaf on the job.

Ideal automation envisages a factory with few or no humans—the raw materials flowing in at one end, the finished product (packed and crated) leaving by truck or rail at the other.

Automation *is not new.* It ushered in the Industrial Revolution in England when a number of inventions were perfected in the 18th Century. These were responsible for the Textile Revolution based upon the flying shuttle invented by John Kay in 1733; the spinning jenny by James Hargreaves in 1770; the roller spinning frame patented by Richard Arkwright in 1769 and the "mule" invented by Samuel Crompton in 1779. These enabled English factories to duplicate fine muslins formerly produced by laborious, slow Indian handwork at a rapid rate. (Hand weaving was the main English and Indian industry.) The resultant effect of these automatic new machines was so devastating that tens of thousands of factory workers were made idle, causing great distress and resentment. Much later, of course, workers learned that automation creates more work, more jobs due to increased trade, which in turn creates new prosperity.

Today automation is all around us: the dial telephone is an excellent example, because it is almost 100% automatic. Electric current production—particularly when generated by water-power—automatic elevators, signal lights in our city streets, the teletype, paper-making machines and countless others.

Add to these, thousands of automatic machines that turn out myriads of mass-produced articles, such as screw-machine products; machines that stamp, draw, press, form articles of metal, paper, plastic, glass, fabric, yarn, thread —and combinations of these.

Ever since its start over 30 years ago, radioelectronics has actively pursued automation. We started by winding single inductance coils by hand. Soon we made 50 and more simultaneously by machine. The same was true of capacitors wound of insulating paper and metal foil. From here to the automatically produced transistor is but a short future step. Indeed one would be hard-pressed to name a single radioelectronic component that is not now or will not soon be mass-produced automatically. Even such a tremendously complex component as the TV color picture tube is beginning to be mass-produced as this is being written.

From mass-producing components to the automation of complete radio and television receivers was an inevitable step. In 1947 an English firm had already produced a complete radio receiver on an automatic assembly line—the parts fed in at one end, the complete radio emerging at the other, without a human hand touching the growing receiver in transit through the robot-machine. (See our September 1947 issue for details.)

It comes therefore as no surprise that a large Chicago radio and TV manufacturer has announced the actual building by this fall of a line of 30% finished, automatically assembled 21" television receivers. At a cost of over $250,000 an automation machine was built whereby radio-electronics components are fed in at one side, while a partly assembled TV chassis is pushed off the line.

The robot-produced TV chassis is the answer to the otherwise prohibitively high price of color TV. Manufacturers, it seems, learned rapidly that multichrome TV sets at $1,000 and over just do not sell readily by the million, particularly if you can buy a good 21-inch black and white set for less than $200.00. It would seem certain—if we consider the economics of today's manufacturing, with its ever rising labor costs—that automation in radio and TV receiver production is not only here to stay, but will keep accelerating rapidly in the immediate future. We endorse it as an important step in the right direction.

Nevertheless, at this point we feel it our duty to sound a sharp warning, before TV set automation has become irremedially fixed. It was the elder John Pierpont Morgan who once sagaciously remarked, with a finality that has never been challenged to date:

"YOU CANNOT UNSCRAMBLE AN OMELET"

In applying this reasoning to our future, indescribably complex, automatically produced color TV chassis, we are concerned what will happen if our robot engineers do not keep a constant vivid servicing picture before them. The engineers' temptation to build an efficient automation production line is a most powerful and compelling lure. He must sacrifice many things to achieve speed in assembling, smooth flow, efficiency, foolproof connections—to mention only a few essentials—of the final assembled chassis.

It is only natural therefore that he may not—in such a complex undertaking—give too much thought to the service technician, who later on must repair and put in order even the best engineered receiver. Will all the parts be accessible readily? Can they be replaced in a reasonable amount of time—or will it be necessary to tear the whole chassis apart?

If hand-assembled TV chassis in the past have—in some models—proved servicing nightmares, how much more will machine produced—infinitely more complex—color TV receivers become? Will they be so difficult to service that the average servicing technician will refuse point blank to touch them? If this is true of certain black and white TV sets today, how much truer must it become with future automation produced color TV sets? In the last instance the public will learn how to avoid buying such unserviceable receivers.

May we therefore, earnestly impress our automation engineering fraternity to give a great deal of consideration to the servicing phase and *its* problems—before automation is finally frozen irrevocably.

A TV SET IS ONLY AS GOOD AS ITS SERVICEABILITY

MATCH YOUR SPEAKERS *the easy way...*

How to calculate and use the 70-volt line

By RICHARD H. HOUSTON

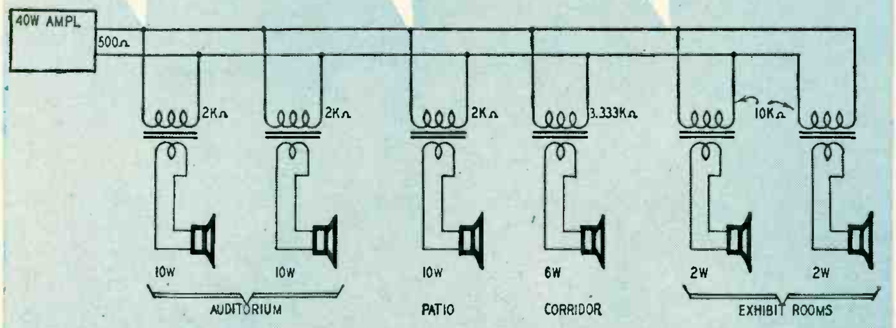


Fig. 1—Diagram shows power distribution in a conventional installation.

A FRIEND of mine had just gone over his budget to buy two high-fidelity public-address horn speakers rated at 25 watts each, according to the catalog. Now he was dismayed to find the 1,000-ohm terminals clearly labeled "5 watts." Since he had to match a 500-ohm line with the two speakers in parallel, he was obviously limited to 10 watts output instead of the desired 50, or so he thought. This true story had a happy ending, because I was able to assure my unhappy friend that his speakers were good for 50 watts total. Then why the 5-watt label? It's really no mystery.

Many technicians seem to be unaware of a relatively new system which greatly simplifies the problem of matching several speakers to an amplifier, especially when the speakers must accept different amounts of power. The most complicated matching problem can be solved in a short order with no mathematics beyond simple addition. Known as the constant-voltage system, this method was standardized by the RMA (now RETMA) several years ago but has never reached its deserved popularity.

The old way

Before investigating *how* the system works, let's see what it will do. Assume that you, a public address operator, have landed a lucrative contract to supply sound facilities for a small convention in your town. The setup is to provide background music and announcements during the day as well as sound reinforcement for the guest speakers on the evening program. Furthermore your contract calls for changes to be made in the speaker arrangement at a moment's notice depending upon requirements that might develop during the convention. You survey the problem and decide to place speakers in the main auditorium, two exhibit rooms, a corridor, and an outdoor patio. Obviously the audio volume requirements will be different in the various locations.

You plan to use a 40-watt amplifier and decide that a fair distribution of power would be: auditorium, 10 watts into each of two speakers; exhibit rooms, 2 watts each; corridor, 6 watts; patio, 10 watts. Just to be conventional you select an amplifier output impedance of 500 ohms and then begin determining how to match each speaker. The calculations aren't difficult, but they *do* take time.

Now comes the mathematics—but not too much. You probably have your own set of formulas, but this is the most simple:

$$\text{Speaker impedance} = \frac{\text{amplifier power} \times \text{line impedance}}{\text{speaker power}}$$

From this formula the impedance of the 10-watt speakers is:

$$\text{Speaker impedance} = \frac{40 \times 500}{10}$$

$$= \frac{20{,}000}{10} = 2{,}000 \text{ ohms.}$$

The other impedance, from the formula, are: 6-watt speaker, 3,333 ohms; 2-watt speakers, 10,000 ohms.

Your complete system is shown in Fig. 1.

If you care to check your results, you may calculate the impedance of all the speakers in parallel using the simple parallel resistance formula. The result should be the amplifier output impedance. The speaker impedances can be obtained by using line-to-voice-coil transformers with the required primary impedances. Of course you will have to compromise and select the nearest obtainable values on your transformers.

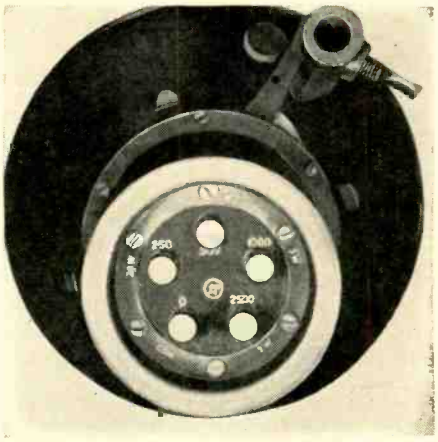
Now that wasn't difficult, was it? If you're lucky you even have time to do the figuring in the shop before you go out on the installation. But don't forget that agreement to change things at a moment's notice! The evening program is about to start and attendance is away over what was anticipated. A harried committeeman appeals for help. The exhibit rooms must be used to handle the auditorium overflow. Can you pipe the speech into these rooms —but not into the corridor or patio, which another group is now using? The guest big shot is about to speak at this minute—for Pete's sake, DO SOMETHING—QUICK!

We leave you now, with your formulas, paper, pencil, maybe even a slide rule. Good luck—your reputation depends on your bearing up under the strain. When it's all over and you feel up to it, look into the constant-voltage matching system. All you need to do is to add a few simple figures—you can do it in your head—to set up any combination of speakers. Does it sound simple? It is!

The new way

Perhaps you have noticed in the catalogs or on your own amplifiers, in addition to the customary output impedances, a constant-voltage output of 70 volts (Fig. 2). You might have wondered how a constant voltage is obtained, since the output voltage certainly must vary with different levels of sound output. There's no trick. The constant-voltage output is merely a tap on the output transformer, in many cases the same tap as one of the output impedances. Why, then, call it constant voltage?

It's like this—the output transformer secondary is tapped at some point which will deliver 70 volts a.c. when the amplifier is operating at its *rated* power output. Whether it be a 2-watt, 10-watt, 50-watt, or 500-watt amplifier, the transformer is tapped so that full power output will deliver 70 volts at



Military surplus speaker labelled for use in constant-voltage matching system.

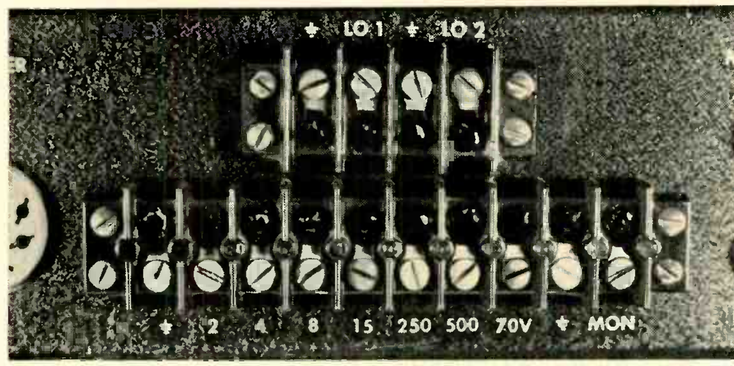


Fig. 2—Output terminal board for 20-watt amplifier. The terminal marked "70 V" is actually connected internally to the 250-ohm output terminal.

the constant-voltage tap. Thus the voltage is constant in the sense that it is the same for all amplifiers operated at full output rating. The voltage is actually a bit over 70.7, or the square root of 5,000, but for simplicity it is usually called 70 volts.

Now here's how the constant-voltage system simplifies an installation, if you will pardon a bit more math. To find the power dissipated by a certain impedance, you square the voltage (multiply it by itself) and divide by the impedance, or:

$$\text{power} = \frac{(\text{voltage})^2}{\text{impedance}}$$

Regardless of the output power of the amplifier you use, if it has a constant-voltage output, the numerator of this equation will always be 70.7^2, or 5,000. Notice what this means. A certain impedance speaker, or line-to-voice-coil transformer will *always* take the same power, whether you connect it to your little 10-watt amplifier or your big 100-watt booster. Then there's no reason why that speaker or transformer can't be labeled directly in watts instead of in ohms! See what this is leading to?

In the constant-voltage system all matching is done in terms of power. You need no formulas. All you need to do is to be sure all the speakers add up to the *rated* power of the amplifier, tie them to the line, and you're ready to roll!

Let's go back to the convention, but this time we'll use the constant-voltage system. The estimates of power requirements will be the same—a watt is a watt in either system. We select a 40-watt amplifier and connect the speaker distribution line to the 70-volt output. Our power requirements were selected to add up to 40 watts, so we merely connect the auditorium and patio speakers on their 10-watt (500-ohm) terminals, the corridor speaker on its 6-watt (850-ohm) terminals, and the exhibit room speakers on their 2-watt (2,500-ohm) terminals. That's it—let the convention begin!

Depending on what matching transformers you have on hand, you may have to juggle powers a bit to make things come out even. If, for example, you have no transformer with a 6-watt tap, you could use a 5-watt tap for the corridor speaker with insignificant mismatch. If a 3-watt tap were available, you could send that extra watt from the corridor to one of the exhibit rooms, and *exactly* match the system again—still with no calculations beyond simple addition!

The same harried committeeman dashes up, out of breath, demanding that you DO SOMETHING. You do—immediately. You merely reconnect the auditorium speakers on their 15-watt terminals, tie in the exhibit rooms for 5 watts each—adding up to 40 watts—and the big shot speaks without delay!

Of course, the full power output of the amplifier need not be used. If the amplifier gain is adjusted for half power, each speaker will take half the power indicated by its terminals. However, the *rated* power must be used in the matching calculations.

Equipment

Most modern PA amplifiers are equipped with a 70-volt output terminal. A complete assortment of matching transformers is also available from the leading transformer manufacturers. If you are just starting out in the PA field, it would be wise to consider the advantages of the system before buying your equipment. You will find other accessory equipment especially suited to the specifications of the constant-voltage system.

One manufacturer, for example, markets an instrument with which it is possible to determine directly the power required for any given speaker installation. This device is essentially a calibrated attenuator and dummy load. It is connected to the 70-volt tap of any amplifier and the speaker is connected to the output terminals of the instrument. With the amplifier delivering the actual program material to be used, a calibrated dial is adjusted for desired volume from the speaker. The dial then indicates the power required to produce that volume.

Converting present system

If you already have a large inventory of equipment, but would like to take advantage of the constant-voltage system, you still may do so. Some of your amplifiers may already have a standard 70-volt output, even though they are not so marked. The table shows the impedance tap that will deliver 70 volts for a typical amplifier:

Amplifier rating (watts)	Output impedance (ohms)
5	1000
10	500
20	250
25	200
40	125
50	100
100	50

If, for example, you have a 25-watt amplifier with a 200-ohm output, mark that output terminal "70 volts" and you will have a standard constant-voltage output.

The table works in reverse, too. You may "modernize" your speakers and matching transformers by marking the listed impedance taps with the corresponding powers. A 500-ohm terminal, for example, would be marked 10 watts. The power rating for any impedance not listed in the table may be determined from the formula given earlier in this article.

If your amplifiers have no output impedances which fit into the standard scheme, you still may be able to do something about it. Maybe your amplifiers have only voice-coil impedance outputs. For an 8-ohm tap to be a 70-volt output, the amplifier would have to be rated at 625 watts! The best solution in this case is to use a line-to-voice-coil transformer in reverse. For a 10-watt amplifier the table shows that a 500-ohm output will deliver 70 volts. A 500-ohm-to-8-ohm transformer, with its voice-coil winding connected to the 8-ohm amplifier terminals, will convert such an amplifier to the standard constant-voltage system.

One other possibility exists. If you have only one amplifier, or several identical amplifiers, you may set up your own nonstandard constant-voltage system. Since such a system could not be used in conjunction with standard components, such a step should be taken only if no future expansion of facilities is anticipated. To set up your own system, choose an output impedance tap nearest that which would match the standard system (since the 70-volt standard is a good practical level). Calculate the voltage at this tap when the amplifier is delivering full rated power. This is your own "standard" output voltage. Next determine what power will be taken by your speakers when they are connected across this output voltage. Label the amplifiers and speakers, and you're in business. An example will clarify the calculations.

Say you have several 30-watt amplifiers with output impedances including 2, 4, 8, 15, 200, and 500 ohms. Your speaker matching transformers have taps for 100, 200, 333, 500, and 1,000 ohms. The table shows that the available impedance nearest the standard system is 200 ohms. An output of 30 watts into a 200-ohm impedance produces 77.5 volts, as determined from the formula:

$$\text{voltage} = \sqrt{\text{power} \times \text{impedance}}$$

Using this value of voltage in the formula given earlier, you determine the following:

Impedance	Power
1,000	6
500	12
333	18
200	30
100	60

With your new "standard" system, you could make up the following combinations of speakers, all of which would add up to 30 watts:

one 30-watt
one 18-watt and two 6-watt
one 18-watt and one 12-watt
five 6-watt
two 12 watt and one 6-watt
three 6-watt and one 12-watt

The mathematically minded technician will quickly spot the fact that the old impedance-matching system and the newer constant-voltage system accomplish exactly the same purpose. The constant-voltage system simply nails down one variable factor, that of the amplifier output, and thereby reduces the problem to extremely simple proportions. It should be clear now why the befuddled gentleman in the opening story was worried unnecessarily about his expensive PA trumpets! If you have been similarly confused, maybe you are straightened out now and can put the constant-voltage system to work for you. It's a cinch—why not try it? END

Low-Drain Hearing Aid

Transistors require little power

TRANSISTORS have distinguished themselves in many fields, but in none more than that of hearing aids. Their small size and low power-supply demands have produced a complete new line of ultra-compact instruments. Even more important, the low power requirements have made hearing aids vastly more economical to operate. Since a hearing aid user may keep the device on during the wearer's whole waking period, battery expense with old-style instruments is no small item.

The Zenith Royal-T hearing aid.

One of the latest, the Zenith Royal-T, uses a single 1.5-volt cell, which will last approximately one month. This aid uses three CK-718 PNP junction transistors in a grounded-emitter circuit, with special magnetic microphone and earphone. A phone magnet makes telephone conversations easy.

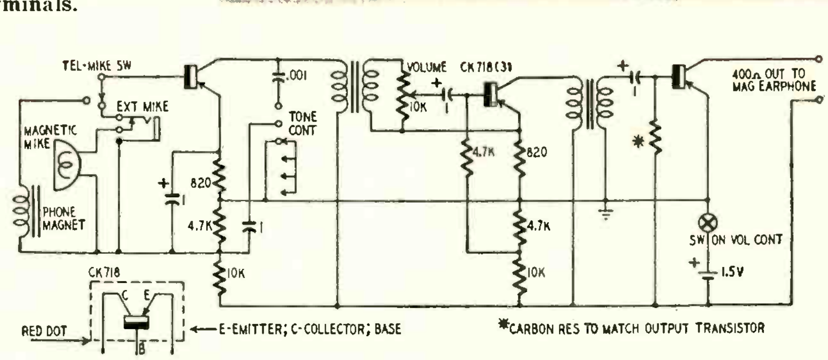
A small slide switch on the side of the case switches from the microphone to the built-in inductive type telephone pickup coil. Sounds are picked up by holding the hearing aid close to the telephone receiver or close to the bottom of the cradle.

The tone-control switch is a special type that is a bit more complex than the diagram illustrates. It is set into the top of the case on the opposite edge from the volume control. In the diagram, the switch is shown in the full-range position. In the next position, high, the 1-μf capacitor is grounded. In the medium position, the 1-μf and the .001-μf capacitors are both grounded. When the switch is turned to low, the .001-μf capacitor is grounded while the 1-μf unit is not, although this is not possible with the simplified switch diagram in the manufacturer's schematic shown here.

The unit also includes a miniature circuit-transfer type jack that is used with an external microphone. The built-in unit cuts out automatically when the external unit is plugged in. END

Right, low power requirements of hearing aid permit operation on a single 1.5-volt cell.

Below, schematic diagram of the Zenith Royal-T hearing aid, and layout of CK-718 terminals.



FOR GOLDEN EARS ONLY

A review of the latest in audio components and recordings of interest to the hi-fi enthusiast

By MONITOR

D. T. N. Williamson, whose amplifier has become the international hi-fi workhorse, has come up with another notable—and in some respects revolutionary—design in the ribbon pickup being produced and distributed by Ferranti of Great Britain.

The frequency response of the Ferranti is flat from 20 to 20,000 cycles and extends for a considerable range on each end. Indeed, the high-frequency response is limited principally by the transformer and amplifier into which it is fed, since the transducer itself has some response for a couple of octaves beyond 20 kc. On the low end, it is still so flat at 20 cycles that (though I have no means of measuring it) I suspect it goes down at least another octave. In any case the over-all bandwidth not only embraces the entire audible range but complements that of our better amplifiers. This extended response is not directly apparent to the ear since very few recordings possess much material above 12 or 15 kc and below 30 or 40 cycles; but it does seem to me to result in a cleaner reproduction of such severe transients as those on the Cook *Fiesta Flamenca*, and is clearly evidenced with the Cook *White Noise* record.

In some 5 weeks of use I found that it tracked even the most critical records without a single instance of skip or skating despite the low pressure of 3 grams—which incidentally is obtained in the production models and is not simply a claim of what can be attained in the laboratory. The arm (see photo) departs from conventions markedly. It appears to be excellent from electrical and mechanical points of view. Arm resonance is said to be 3 cycles. I could find no evidence of it on the low-frequency sweep band of the Cook series 10, or the low-frequency band of the *White Noise* record; but on the innermost band of the Dubbings D-100 record, there was a trace of it to the touch. This low resonance is rather surprising because the arm is formed of tubular light metal, and implies a very clever and careful design.

The needle chatter is at least as low as any I have come across so far, and is, in fact, normally audible only a foot or two from the pickup. The element is a low-impedance device and despite its extremely low output is, I was surprised to discover, little if any more susceptible to hum than the G-E. A transformer is necessary to couple it to an amplifier. The Ferranti transformer supplied with it is compact, triple-shielded and easily positioned for minimum hum. With the D & R turntable the hum is inaudible at all home-listening levels. With the Ferranti transformer it will deliver around 15 mv on 78-r.p.m. records and about 8 on LP's—or roughly 3-5 db less than a G-E high-impedance cartridge.

The pickup (with the transformer) works into a 100,000-ohm load and when this load is provided it will be equalized for all recording curves by any of the equalizers designed for magnetic pickups. (This includes the Golden Ear preamplifier which uses a feedback equalizer directly to the input.)

Two plug-in heads with diamond styli are available—one for the 78 r.p.m. and 33 r.p.m. transcription grooves, the other for microgrooves. The standard needle presents a revolutionary shape—an elliptical cross section 2.5 mils wide on the axis perpendicular to the grooves, but only some 0.6 mil wide on the axis of the groove. This is intended to correct for the great difficulty of 78-r.p.m. recording, namely: that a 2.5- or 3-mil stylus is larger than the sharp movements produced by the chisel-shaped cutting needle at frequencies higher than 10,000 cycles.

Ferranti says that the 78-r.p.m. head with this needle will track with very low distortion frequencies up to 20,000 cycles on the innermost groove of a 78-r.p.m. record. It tracked the Cook series 10 record to 20,000 cycles very nicely. It is rather amazing what this reveals on some of the best of the 78-r.p.m. records, particularly the Decca ffrr's; and I think indicated clearly that the old speed is capable of providing at least as good a high-frequency response on the outer grooves and a superior one on the inner grooves than 33-r.p.m. microgrooves. This might be an excellent head for those audiophiles who own large libraries of the older shellac recordings. It seems to produce as good a sound from many of them as that of the better LP's; and while the noise level is higher of course, the very flat response and the light pressure (5 grams at 78 r.p.m.) minimizes it.

A very nice little detail is the white dot on top of each cartridge which marks the position of the needle and makes the placement of the pickup easy. Indeed, what with this, the smallness of the head, and the well proportioned fingerlift, I personally found the Ferranti to be the easiest pickup to position exactly on a record I have so far used. However, I must report that men with larger hands, accustomed to handling

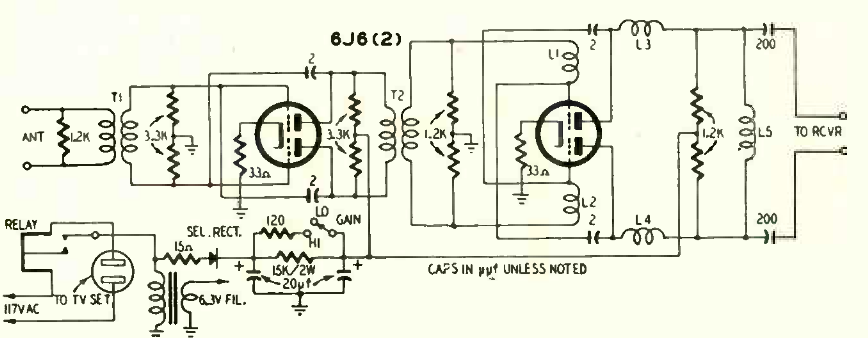
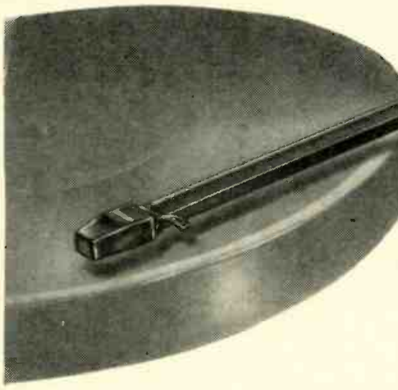


Fig. 1—Schematic of the Electro-Voice 3005FM booster—a wide-band amplifier.



The Ferranti high-fidelity pickup.

Electro-Voice booster—has 300-ohm input.

much larger and heavier pickups, have been bothered by the smallness and extreme lightness of the Ferranti—it does take some getting-used-to.

The pickup requires a large hole (a little over an inch and three-eights) for mounting but the method of mounting and the mechanical design produce an exceptionally stable, exact, and very neat mounting. At first glance the tracking angle seems all wrong. However, the element is mounted at an angle of 23° to the axis of the arm, so that, despite the straight arm, the tracking angle is very exact. This oddity, incidentally, almost eliminates the possibility of using the Ferranti cartridge in other arms—in case you've been thinking of that. It might be possible to find some means of adapting the mount, but either it would have to be mounted at a "reverse" offset of around 23° or the whole arm would have to be repositioned.

I doubt that it would yield the highest quality in another arm anyhow since the cartridge and arm were obviously designed to form a well-integrated unit, in which arm and cartridge complement each other. There is a built-in rest—when the arm is moved all the way to the right and placed down, it falls into a built-in, but invisible, notch which holds it firmly in place. The arm, however, will mount properly only on a base which provides at least 2½ inches of clearance between the edge of the turntable and the edge of the mounting board. If the spacing is less, the arm will overhang the edge of the board in the resting position.

Whether or not the Ferranti lives up to its advertised slogan—"the ultimate in record reproduction"—I am not qualified to say. But since I have not heard better quality on LP's and on 78-r.p.m. records, it is pretty much in a class by itself. The highs on both speeds are very clean and the definition throughout the whole range is exceptional. I think it represents a notable step on the way to complete fidelity of record reproduction. It has only one fault from my point of view and that is the price of around $75 for arm, transformer, and a single head (although, that doesn't compare unfavorably with the cost of an independent "professional" arm plus a diamond-stylus cartridge of other makes). Those who can afford it will find the Ferranti capable of delivering very realistic reproduction with the best amplifiers and speakers available today.

Electro-Voice 3005FM Booster

If the descriptions of some of the new, highly sensitive tuners have made your mouth water, but an examination of the budget has brought tears of frustration to your eyes, all is not lost. The Electro-Voice 3005FM fixed-tune booster (Fig. 1) may well bring up the usable sensitivity of your old tuner to that of the newer ones and at an outlay of only around $30.

This booster surprised me. I had had no doubts that it would deliver the 20 db of gain claimed for it, since it has two cascaded stages of amplification. But since it employs push-pull triodes (whose noise figure is considered to be inferior to that of a cascode stage) and is a wide-band job, I did not expect it to have usable sensitivity approaching that of a good tunable cascode booster. But it appears to have exactly that; certainly the sensitivity is high enough and the noise figure good enough to dig right into the antenna and atmospheric noise. It actually did a better job than my home-built tunable cascode booster which I had proudly considered to have a very good noise figure.

The figure of 20-db gain is conservative; the model I tested clearly had more than that. It is uniformly distributed over the whole FM band—there seem to be no hot spots and no cold spots. It turned out to be completely stable even with the rather critically "hot" front-end of my receiver, and apparently uncritical about the length of cable used between it and the receiver. Both the input and output are for 300-ohm twin-leads; but it worked very well into the unbalanced input of my set, without a matching transformer.

No tuning is required, of course. A thermal switch turns it on and off with the receiver. It is very compact—about 4 x 6 x 5½ inches—and can be tucked away in any odd corner of a cabinet or bookshelf; and drawing only about 12 watts of power at normal line voltages, it runs very cool.

There is a switch to reduce the sensitivity by lowering the applied plate voltage—a good idea since the tuned circuits and the antenna match are not disturbed as they are in boosters which switch the antenna leads from booster to receiver. In most locations in which a booster is necessary at all, the switch can be left permanently in the HI position.

Assuming you have a tuner with a sensitivity of between 15 and 25 microvolts, which is a pretty good average for the better old tuners, and the less expensive new ones, this booster will bring up the usable sensitivity to a point comparable with that of the best new receivers. Moreover, in very difficult locations it is possible that it may improve reception even with the new tuners just enough to make the difference between *hearing* a station and enjoying high-fidelity, noise-free reception of it. This is a long overdue gadget which should prove very useful under several types of conditions.

The New Records

To avoid confusion, let me define my idea of test, demonstration, and show-off records. A test record is one that offers a good means of testing distortion, intermodulation, transient response, definition, naturalness, presence, etc. A demonstration record is one that makes a system sound good—especially to the prospective customer. Thus a good test record will probably serve best to demonstrate a system to an engineer or skilled listener; but the typical test record used at audio fairs is likely to send the ordinary layman or music-lover back to his table-model radio. For demonstration records I look for a smooth high end, and a nice bass, an unusual degree of that something vague called "presence," or any quality that would reveal to an average ear the superiority of a good high-fidelity system over the ordinary record player or radio. A show-off record is one that gives a more or less spectacular effect, or stunning sound—the kind the proud audiophile can use to show his friends and neighbors why he wasn't nuts in spending all that money on a hi-fi outfit. I am not so interested in pointing out records suitable for use by manufacturers at audio fairs; they have their own means and ideas. I am more concerned with giving the small dealer, distributor, installer, and the audiophile, some idea of the suitability of the new records for their particular needs and purposes; and to point out any interesting "sound" (rather than musical) quality I may discern in the new records. Finally, I want to record the new developments in recording techniques and the progress on the road to that utopia—reproduction indistinguishable from the production.

Equipment makes a difference and where it makes a marked difference I will point it out. But I review each record through a variety of equipment representing every high-fidelity category from the low-priced to the cost-is-no-object grade. The reference system for absolute quality uses a D & R turntable, a Ferranti pickup, a 30-watt amplifier of my own design, and a wall-mounted array of five speakers, including two 15-inch woofers.

MUSICAL SOUND BOOKS

SAINT SAENS: *Carnival of Animals* MSB 78010-12 (3 records)
SAINT SAENS: *Phaeton* MSB 78201
AMERICAN MUSIC: *Juba Dance, Turkey in the Straw, Cheyenne War Dance, Gossips* MSB 78024

All performed by the Philharmonic Orchestra of Hamburg
($1.25 per disc, plus 50c packing and handling on orders less than 10 discs. Sound Book Press Society, Inc., Scarsdale, N. Y.)

I love to explore the byways, and once in a while such exploration pays off interestingly. In July I reviewed the remarkable *Plectra and Percussion Dances* by Partsch. This month I report another worth-while find.

The Musical Sound Books comprise a new library of recorded music for use in music appreciation classes in elementary and high schools, and represent a noteworthy experiment in recording technique. The original recordings were made in Europe on 30-inch-per-second tape with a response from 20 to 20,000 cycles. These were transferred here to 78-r.p.m. discs using somewhat closer groove spacing and variable pitch for extended play and to take care of dynamic range; they were cut with the hot stylus to the NARTB standards and curves.

At present the Musical Sound Books library consists of 51 10-inch records. By the use of extended-play techniques some of these discs run 5 minutes to a side. The catalog, though chosen for the musical education of children, is musically excellent and only the most sophisticated listener would be bored by it.

Carnival of Animals has always been excellent for test purposes, and this one is especially good. Above all, I think that MSB 78010 would find a worthy place in almost any show, sales, or demonstration room and the libraries of most proud audiophiles. The reason is the 2nd band on side B—*Elephants*, played here with a double bass as it should be. When have you last heard a double bass on records? I don't mean the slapped bass of popular records, or the usually boomy noodling of the double-bass section of a symphony; I mean close-up, bowed rather than slapped, growling so you can almost count the cycles? If your amplifier and speaker system can do justice to a double bass, this record will put a supremely happy smile on your face.

Aquarium on 78011 provides some lovely, clean, and unartificial highs! The neighing strings in *Long Eared Persons* are excellent for distortion testing, particularly because they are on the innermost bands—any pickup or system-distortion will throw them into painful fuzziness. *Fossils* on 78012 has always been good material for transient testing and this version has an extremely dry (as opposed to mellow) xylophone. Even that old chestnut *The Swan* is useful here, for the rather reedy character of the upper register of the cello, as contrasted with the mellowness of its mid and low range, comes through very nicely. The fact is, this inexpensive set of three is an excellent test set. And it provides a dividend: you can be pretty sure the rest of the family won't find these as unpleasant as the more spectacular test records.

Phaeton is a much more obscure piece of music but it is of hi-fi interest because of the various choir effects of massed brasses, strings, and winds, beginning with the opening fanfare of several beautifully matched horns. If system-definition is good enough you can almost count the horns. There is also a very unusual string background, the fiddles very high and stroked *(spiccato)* rather than bowed. The bouncing of the bows produces a high proportion of harmonics around 9 or 10 kc. The result is a very individual sound, and if you raise the treble a bit [or move the equalizer from NARTB to ORTHO (new RIAA standard) or old AES] you can almost hear the rosin.

The recording containing the four pieces by American composers is a good show-off record. There is a little distortion in the peaks, but it isn't bad except when compared with records such as the Cook *Masterpieces of the Theatre*. There is a good mixture of highs and lows, legatos and various percussives including good drums; the balance is splendid, to my taste, as it is on all this series. The resulting sound is very pleasant on almost any system. I have always liked plucked or *pizzicato* strings for transient testing and *Gossip* on side B is very good for this purpose, particularly since the whole range from a reasonably deep bass to a fairly good high is covered.

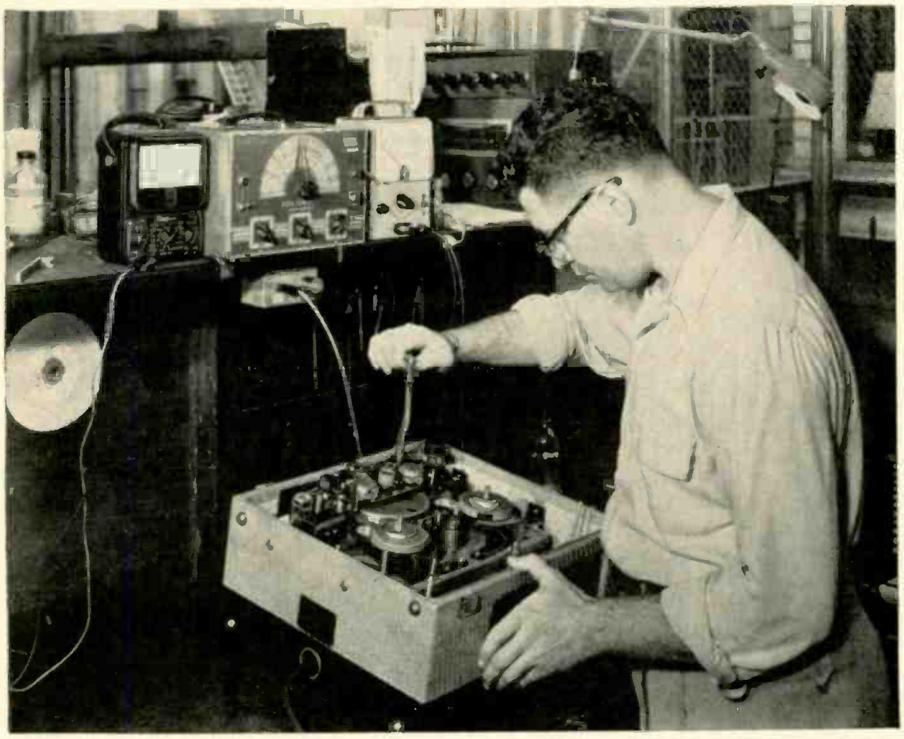
It strikes me that a stack of these records would be ideally suited for the small commercial hi-fi sales or demonstration room, although the material is not spectacular enough for audio fairs. First, the pieces are very short and, if you use a single-play turntable, will enable you to put in a good selling pitch between records. Second, these 78's are less susceptible to damage, will stand more playing, and should give good quality for a longer period. Third, at $1.25 per record, accidents and wear and tear will be easier on the budget. Fourth, the music is uniformly pleasant and few people are likely to be allergic to any of it. Fifth, they produce excellent sound with high-fidelity systems.

The recording curve is NARTB but they play back all right with the LP curve. With a spherical needle you might try, if your equalizer permits it, the NARTB or NAB bass and an RIAA (ORTHO) or even old AES treble; or boost the high-highs a little with the tone control, to make up for needle translation losses.

MUSIC APPRECIATION RECORDS BY CAPITOL

Chin-Chow and the Golden Bird. (Music from the "Nutcracker Suite") CAS 3193
El Torito the Little Bull. (Music from "Carmen") CAS 3194
The Seasons (Music from Glazuno's "The Seasons") CAS 3195

These are intended for use in the home with pre-school and slightly older children and I mention them because you may have seen and been intrigued by the ads. They may do the intended job; but in case you've wondered, they have no hi-fi value whatever. This is a shame because the music is from the excellent tapes in Capitol's classic library and at 99c apiece they would offer a very useful set of records for demonstration purposes. Unfortunately, the voice completely kills the music. It is recorded at a level some 12 db above the orchestral *peaks*, and it covers so large a portion of the record that the music is audible only as interference is audible behind a desired radio program. Personally, I question that these will have much musical effect on children, because of this submergence of the music; but in any case, it makes these records completely useless to the hi-fi tribe—even the voice is poor, obviously pre-emphasized for the cheap players used by children. If Capitol would put out the same things without the voice, they might well cause a stampede. END



A service technician using special bending tool to set critical mechanical clearance.

Photos Authorized Factory Service, New York, N.Y.

A few experiences on the bench, showing that recorders have their quirks but are not difficult to service

TAPE RECORDER SERVICING—

TAPE recorders being popular, your chance to service one of them will come; and when it does, it may be a hurry job. The novelty of a device can stump you for a while, but your knowledge of high-gain amplifiers plus advance information of this sort should enable you to give prompt attention to a tape recorder.

Tape recorders may have two kinds of trouble — mechanical or electrical. The mechanical troubles are simpler, but usually give the technician more agony, simply because they are likely to be new to him.

Depending on the nature of the trouble, you may not need to go straight at the wiring. Get acquainted with the recorder topside first. Remove the guards and carefully examine the recording head and the tape way. The head, against which the tape is pressed by a felt pad in both the record and play motion, should be perfectly clean and smooth. Any roughness will scrape the tape and collect a reddish deposit. If found, this deposit must be cleaned off with soft wood stick, brush, or soft cloth wrapped around an alignment tool.

The felt pad itself must be soft, clean, free from any hard particles imbedded in it, and free to move on its post under the tension of its spring. A worn, hard pad will cause distortion and excessive scraping of the tape.

For all other attention the chassis mechanism must be taken out of the case. Pull the plug! Don't be in a hurry to turn on the power. Make your safety checks first. Remove the most convenient tube, either power or rectifier, discharge the capacitors, and touch one prod of your ohmmeter to the chassis and the other to the pin in the socket that will give you the screen supply line. The needle should kick down and quickly rise to about 50,000 ohms. Any wide deviation from this value indicates trouble. Here is an example:

A resistance check showed 5,000 ohms from screen supply to chassis. This indicated a short. The bottom cover was then removed and the circuit was inspected. The filter resister was dark due to overheating. The d.c. line had three branches: power, screen, and first stage. Since the first stage must have a decoupler, the capacitor for this was located and the lead to it was opened. Two touches of the prod showed the first stage perfect. In two more steps the leaky bypass capacitor at the driver-tube screen was found.

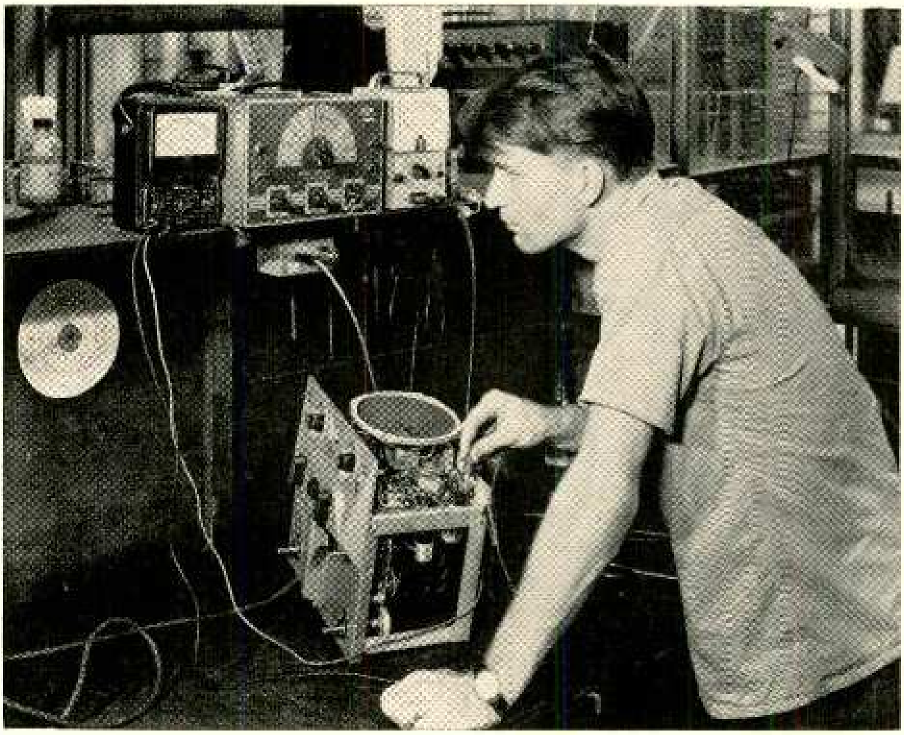
Once all resistance measurements were normal, the power was turned on and voltage readings were taken. There was no screen voltage on one of the first-stage tubes. Checking showed the loss was in the lead itself. Ohmmeter reading across the ends of the lead showed infinite resistance. At the screen pin the joint was dark and coarse. Reheating it solved the trouble.

By far the most frequent complaint in my experience has been noise. A recorder was rushed to me from a parish house. The machine was but three weeks old, still new to the users. The complaint was noise. The noise was a rumble, resembling motor-boating. It could be heard in play, record and rewind settings, and with the volume control down. The conclusion pointed to mechanical and not circuit trouble.

Unplugged, the chassis was taken out of the case and the mechanism was turned slowly by hand. Every part was carefully examined. Chewed into the rim of the rubber driver was a fresh nick like those we find on record players when the tire rests too long in one spot against the motor shaft.

Obviously, to remove the nick, the driver had to be dressed down. Inspection of the arrangement showed that after the resurfacing there would be enough rubber left to drive the mechanism. A medium-cut file was used and the job was successful. But bear this in mind when filing moving work. A rubber tire, especially, will yank the file out of your hands and may damage some parts. Grasp the file firmly and rest it first on a fixed member of the frame to assure an even cut.

Another caution. Rubber particles or dust falling on a tube will cause an objectionable smell when the tube gets



A recorder's electronic circuits are checked with standard equipment used for audio and radio.

By MICHAEL SMOLLIN

hot. Always brush out the interior well and be sure the tubes are clean.

A doctor brought his recorder for service, saying it was haywire. After preliminary checks the power was turned on and the selector set to play. I was greeted by a noise like that of a junior high school band warming up. That was a tough one. Routine measurements proved nothing. The multi-frequency noise indicated a sparking. It could not be squelched or isolated. Sometimes under shock, the offending part reveals itself. Every part was tapped sharply with a fiber tuning tool. When a mica capacitor was thus struck, the noise varied. All other parts were disconnected from it and it was left alone on the tie strip. With the capacitor analyzer connected across it, the magic eye quivered, indicating the spark was in the mica capacitor.

There was a case similar to this, but when I turned the power on, the machine worked perfectly. This showed that the trouble was intermittent. While running, the mechanism was set on each of the four sides to see if the weight-shift made any difference. As this was negative, the fiber tuning tool again went to work. When the main filter capacitor can was tapped from all sides, the trouble returned. It was a twist-prong affair that sometimes worked loose. A stiff lead was soldered between the can and a socket ground lug.

When the trouble is traced to a volume control that is concentric with a tone control, be careful when taking it apart. Some parts will spring out unless you expect this. Note which side of each part goes in first.

The oscillator may never need attention in the field. However, do not drive the brass screw down just for curiosity, since the inside metal slug will touch the high-voltage lugs and the coil will burn.

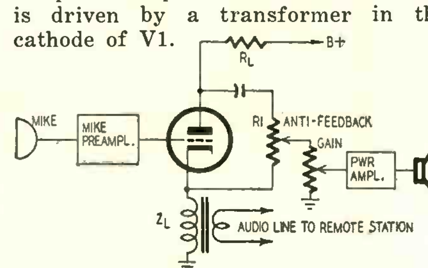
Microphonic, and especially, gassy tubes are another thing to watch for. Try new tubes. Try several. Echoes of previous recordings may cause double-talk in reproduction. The overload lamp must not flash bright in recording; reduce the volume so that only a faint flicker occurs. The mike should be away from the recorder by at least the length of its cable, and on a separate table to prevent vibration from reaching it.

For a final check see that the machine runs quietly, for any audible noise will be picked up and recorded. If the machine is noisy, check the motor fan on the lower end of the shaft. Rub some vaseline onto the spacer metal and felt washers. Don't use any oil. If you remove the fan, be sure to run a straightedge across chassis bottom after replacing, to make sure everything will clear the cover when it is attached. END

NEW LOCKOUT CIRCUIT

In broadcasting and recording studios, PA announcers' booths and similar installations, all monitor and intercom speakers must be silenced (locked out) when the mike is live to prevent picking up unwanted sounds. The usual procedure is to use a switch or relays to open one circuit as the other is closed. In large intercom systems a similar setup, activated by the talk-listen switch, eliminates feedback between speaker and microphone on the same unit.

The diagram shows a relay-less electronic lock-out circuit that appeared in *NYU Quadrangle* (College of Engineering, New York University). In this application it eliminates switching in intercoms. The stage including V1 is inserted in the intercom master between the microphone preamplifier and the power amplifier. The remote station is driven by a transformer in the cathode of V1.



When viewed from the power amplifier, V1 appears as a split-load phase inverter developing 180° out-of-phase voltages across R_L and Z_L (the impedance of the transformer) in the cathode circuit. The arm of R1 may be adjusted so the voltages cancel and are not passed on to the power amplifier.

Viewed from the microphone, V1 appears as a cathode follower transformer coupled to the remote station line.

Signals originating at the remote station and arriving on the audio line are transformer-coupled to the input of the power amplifier. Incoming signals, not amplified by V1, do not cancel.

MAGNET STRENGTH

The permanent magnet manufacturer makes many of his magnets to an exact specification. They are calibrated to a specified flux density. Special care is taken with meter magnets, which are treated to assure that their strength will remain constant for many years.

In many applications — such as speaker magnets — where great magnetic strength instead of exact calibration is important, the magnets can be magnetized after assembly into the unit. The magnetic field produced in the gap of a permanent-magnet loudspeaker, for example, with an Alnico V magnet magnetized *after assembly* is about three times as great as the field when the magnet is magnetized before.

Service technicians will see that such an assembly should never be taken apart—in the cases where disassembly is possible. The magnet will immediately lose most of its strength.

SERVICING HIGH-FIDELITY EQUIPMENT

Part VII—Checking the phonograph needle: its condition and alignment

By JOSEPH MARSHALL

THE phono pickup has more opportunities to ruin the performance of a high-fidelity system than any of its other components. Yet few audiophiles—and not all service technicians—know how to diagnose and repair phono troubles. As a result, many fine systems are limping along at only a fraction of their possible performance.

All needles — even diamonds — wear with use and need replacement to prevent record wear and damage. But how do you know when to replace a needle? It would be nice if we had some categorical answer like "20 hours for a sapphire and 100 hours for a diamond." But there is no such simple rule, nor ever can there be. The only way to tell if a needle needs changing is to check it often. Fortunately, we have several methods which—together or separately —can determine needle condition very accurately.

Visual inspection

The oldest method is to look at the needle through a magnifying glass or microscope. This is not as simple as it sounds—you have the problems of applying enough light and of getting a sharp focus at all angles. Also, assessing the damage requires skill and experience. True, if flats are visible or the needle is chipped, one can safely conclude that it is dangerous. But—on LP records especially—it takes a good hand and eye to recognize minor flaws that can cause high distortion and severe record wear. The needle or pickup must be turned and the light moved to hit it from various directions. A perfect needle has a uniform appearance and reflects lights uniformly on all sides; a needle with flats will reflect more light from the sides containing the flats.

Needles accumulate dust and grime—often enough to hide serious damage. Before examining them, brush them first with a fairly stiff dry brush, then with a softer brush dipped in cleaner fluid, to remove the film and expose the surface of the jewel.

We have substitutes for visual inspection which are often more effective in diagnosing early damage. An old technique, and still a good one, is to use a soft lacquer recording disc, part of it with unmodulated grooves. First place the needle on the portion without grooves, (a quarter can be placed on the cartridge to weight it down a little); and keep the pickup from skating clear off with a light presure of the finger on the inside to guide it in a spiral. The surface is then inspected. A good 78-r.p.m. needle will leave almost no sign; microgroove needles may leave a just visible mark, but they should not dig a definite groove. Scratches or grooves beyond this indicate that the needle is cracked or chipped at the point.

For checking flats on the side the needle is allowed to run in the unmodulated groove. Then examine the groove with a glass and cross-lighting. The cutting needle leaves a very distinctive pattern which is uniform and constant; when a needle with sharp edges is run through it, this pattern is changed. Comparison of the grooves through which the playback needle ran with those through which it didn't run will indicate the extent of the damage. This procedure, too, takes some experience and skill.

But a needle can be good enough to cause no visible damage to a record long after the distortion it contributes is intolerable for true high fidelity. Up to a couple of years ago, the total distortion of record reproduction was very high, since it included the distortion recorded on the disc, plus that caused by aging and distortion of the disc, the portion produced by needle and pickup, and finally turntable hum, wow, rumble, or flutter. Recorded distortion is today only a fraction of what it formerly was. Cartridges and pickups have been greatly improved, and engineers have been hounding the hum and rumble of turntables until in a few cases it has been reduced to so low a level that it can be disregarded. So now needle distortion accounts for much more of the over-all distortion than ever before—indeed it may be the dominant portion.

The Cook Series 10 test records are one of the earliest and still one of the most effective applications of needle distortion measurements. This method is to measure the translation loss of a needle at high frequencies. Here is how it works: You make a note of the pickup's output level at 10,000 cycles on the outer band of band A of side 1, then move it to the innermost band of the same side, which contains a sequence of 1,000- and 10,000-cycle tones. After readjusting gain so that the output at 1,000 cycles is the same as that of the 1,000-cycle band at the start of the record, you note the reading for the 10,000-cycle tone. The normal translation loss at 33 r.p.m. is a little over 6 db. So if the needle on the innermost 10,000-cycle groove gives a reading of between one-third and one-half of that on the outer 10,000-cycle band, the needle is fair to good; but if the reading is only one-fourth as much, or less, the needle is poor. This is a very sensitive method and will spot needles no longer capable of giving high-fidelity performance even when other methods pass them.

Distortion tests can be made with the Clarkstan Intermodulation records, or the IM bands of the Cook Series 10, plus an intermodulation analyzer. The Clarkstan record is the more sensitive indicator because it covers the whole

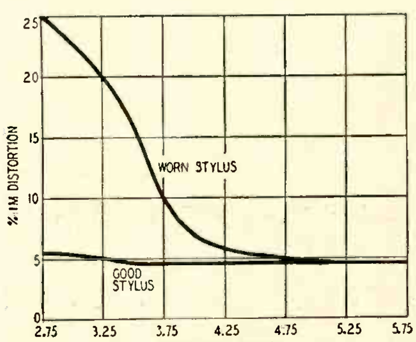


Fig. 1—IM rise due to worn stylus.

side, exposes differences more sensitively. The IM bands of the Cook record, though very valuable, occupy only the middle portion of the record and therefore do not provide as good a test of the IM due to unequal tracking at various groove diameters.

A good and properly tracking needle will produce very little difference of IM over the entire radius of the Clarkstan disc (Fig. 1). A rise from 4% on the outermost groove to 6% on the innermost one might be considered excellent for a good needle, tracking well on a good turntable. A worn needle may produce 25% or even more on the innermost groove, though starting with only 4% on the outermost.

Recently Cook has issued its AN record, which applies the A-N code technique used in airplane range-finding to give an audible indication of IM rise. With this record, if the increase of IM over that on the record exceeds 2%, the coded signal changes plainly. This gives one a go-no-go indication. If the distortion of the rest of the system—from pickup to amplifier output—is less than 2%, the condition of the needle is indicated by a change in the audible signal as the pickup travels toward the inside of the disc. If this change occurs in the outer half of the record, the needle (or the tracking) are suspect; but if it does not occur until the needle reaches the innermost grooves, it is a safe indication of a good needle.

There still seems to be some question of sapphire vs. diamond needles. There is no discernible difference in the play-

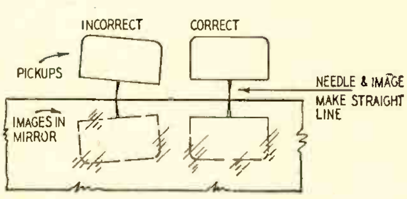


Fig. 2—Checking needle alignment.

back performance of a good sapphire and a good diamond needle. The diamond is superior purely because it takes much longer to wear damage-producing flats on it. Therefore it yields fine performance for a much longer period. When records are played only occasionally, the sapphire is probably the most economical needle; but when they are played every day or frequently, the diamond is cheaper in the long run and guarantees higher fidelity for a longer period.

Needle alignment

A properly cut groove is modulated on both sides, and to reproduce the modulation perfectly the needle should respond equally to the modulations on each side. It can do this only when the angle of the needle is perpendicular to the surface of the disc. A lean to either side of as little as 3 to 5 degrees can increase distortion and record wear.

Checking needle alignment is very simple, and so is—in the majority of cases—correcting the alignment. Take a small mirror—such as the unframed one milady of the household probably has in her handbag—and place it on the turnable instead of a record. Gently place the pickup on the mirror. Now facing the front of the pickup or cartridge, observe both the needle and its reflection in the glass. Even very small angles are easily observed because the mirror image has the effect of doubling the angle (Fig. 2). For perfect performance the needle and its mirror image should make a straight line.

Very few pickups or arms permit an adjustment for needle angle. To correct it, first, remove the cartridge from the pickup; make a shim of a small piece of paper, thin plastic, or old photographic film, and insert it between the cartridge and its mount on one side so that the whole cartridge will be tilted in a direction opposite to the tilt of the needle; then screw the cartridge back in and test again with the mirror. Ordinarily it will take only one or two thicknesses of 20-pound typewriter paper to produce perfect alignment. If misalignment is bad, you may have to use a piece of light card stock. In such cases, first check the mounting of the arm to the table. It may be loose or unequally tightened.

Alignment in the other plane—along the length of the grove—is not quite so important. When a single-play turntable is used, it usually is possible to make this angle good, too. Usually a slight forward angle of 3 to 5 degrees is best. It keeps the point from digging into the bottom of the groove. On changers, the angle will vary with the number of records on the table and nothing much can be done about it. However, you should check to see that with only one record on the table the needle does not dig into the groove. If it does, a shim can be placed at the back of the cartridge to lower the angle.

In variable-reluctance cartridges, especially the G-E and Audak, the alignment of needle and its mount in relation to the pole pieces is also important. This alignment is adjusted at the factory and should be satisfactory —even with the G-E Triple Play in which the whole needle must be moved to change points. However, occasionally the needle mount may have been distorted by a violent blow, or the pole pieces may have been bent toward the needle by striking the edge of the record or turntable. The G-E cartridge calls for an equal clearance of about 11/1,000 inch between needle and pole pieces (Fig. 3). This is best checked with a thickness gauge of the kind used to measure spark gaps. However, two thicknesses of 20-pound bond paper are

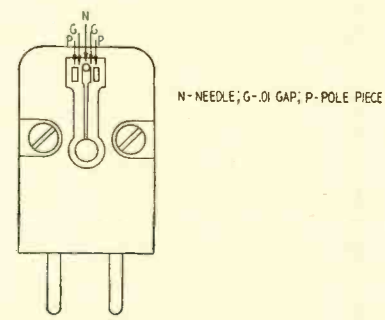


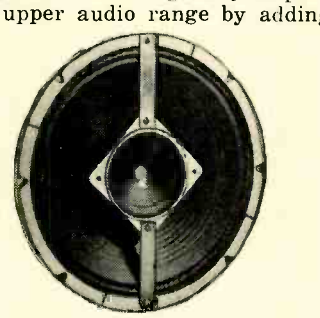
Fig. 3—Alignment of a G-E cartridge.

approximately 10/1,000 of an inch thick. If you take a small piece of such paper, fold it in two and crimp the edge with your fingernail, you will have a gauge very close to 11/1,000 of an inch. It should slide through both gaps with equal friction. If it doesn't, bend one or both pole pieces slightly toward or away from the needle.

No adjustment is possible on other cartridges, and I strongly recommend that if the gap appears to be wrong or asymmetrical, the cartridge should be returned. (TO BE CONTINUED)

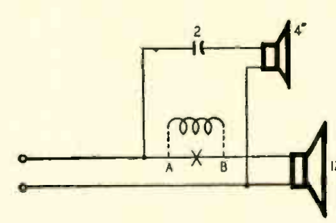
IMPROVING SPEAKERS

The performance of an ordinary 12-inch speaker can be greatly improved in the upper audio range by adding a



small 3- or 4-inch speaker, mounted either separately or coaxially, as shown in the photo. Make sure the large cone does not hit the mounting straps on low notes. The 2-μf coupling capacitor is a low-voltage paper type. Its impedance decreases with frequency, thus feeding the higher frequencies to the 4-inch speaker. At the same time it bypasses the large voice coil for these frequencies.

The model shown uses a 4-inch speaker reconed with a 5-inch cone. Trimming off the flexible outer ring makes a rigid cone with practically no low-frequency response. However, an ordinary 3- or 4-inch speaker will do.



If desired, the combination can be further improved by adding an appropriate audio choke between points A and B.—*John A. Dewar*

HIGH-QUALITY AUDIO

by RICHARD H. DORF*

Part XIII—The power amplifier; tubes, single-ended and push-pull stages

POWER-amplifier stages are no more difficult to understand than voltage-amplifier stages, but because the job they do is more difficult more careful design is required for high-quality results. A voltage amplifier produces a higher audio voltage at its output than at its input. The actual power at either point is of little interest because the following grid is excited by *voltage* changes.

A power amplifier, on the other hand, must furnish power to the loudspeaker, a unit required to do actual work—pushing air. Electrical power consists of current passing through an impedance. If current passes through a simple resistor, work is done in heating the resistor and the air around it. If current is passed through a solenoid coil with a movable core, the core is moved, and that is work. If it is passed through a loudspeaker voice coil, the voice coil is moved. The fact that a speaker cone is attached to the voice coil and that cone movement is opposed by air adds to the *amount* of work to be done.

The amount of mechanical energy required always depends on the resistance of the load—its weight, the forces resisting its movement, etc.—and the speed with which it is to be moved. You can push a dresser across the bedroom in perhaps 30 seconds, but more strength—power—than your body commands would be necessary to do the same job in 1 second.

A loudspeaker cone moves far but slowly at low frequencies and fast but not far at high frequencies. The amount of mechanical power required for equal sound output at all frequencies is thus the same. The same is true for the electrical power which is transformed by the speaker into mechanical power—at least over the range of frequencies for which the transforming action is linear. This depends on speaker quality.

Electrical power is the product of the square of the current and the impedance of the load through which it is passing —$P = I^2R$. Since current cannot flow through an impedance unless there is voltage across the impedance, voltage is definitely related to power. By substituting E/I for R, we get the simplified power formula $P = IE$ or current times voltage.

The original equation $P = I^2R$ shows that to have high power, either current or impedance (or both) must be high. A speaker voice coil is usually a low impedance, perhaps 4 to a maximum of 16 ohms. If we want an amplifier capable of putting say, 8 watts into a 4-ohm speaker, let us see what current is necessary. Rearranging the formula,

$$I = \sqrt{\frac{P}{R}} = \sqrt{\frac{8}{4}} = 1.41 \text{ amperes,}$$

obviously more current than we can expect any reasonable receiving type tube to pass.

The solution is to use an output transformer to present a much higher impedance to the output tube (Fig. 1). The transformer has a turns ratio of 40 to 1. Its impedance ratio is therefore the square of that or 1,600 to 1, and its primary impedance is 6,400 ohms. The primary current is reduced by the turns ratio and becomes only 35 ma, a very reasonable plate current. This solution to the problem is almost always used; primary impedances run between about 2,500 and 15,000 ohms.

*Audio Consultant, New York

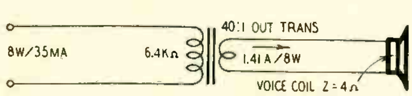


Fig. 1—Output-transformer circuit.

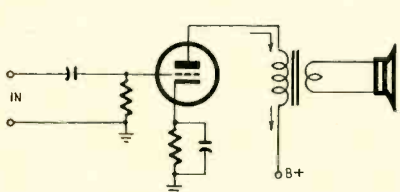


Fig. 2—A simple power amplifier.

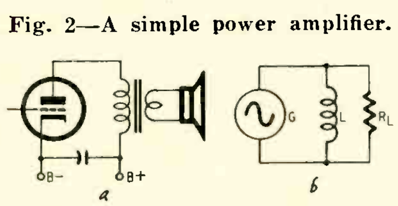


Fig. 3—Actual and equivalent circuit.

Power tubes

There is no basic difference of principle between voltage- and power-amplifier tubes, and each type can be used for the other's purpose. However, tubes built for power have more rugged elements, so they can dissipate the greater heat caused by the higher power dissipation, and the amplification factor and plate resistance are lower because of the close spacing between elements necessary for high plate current.

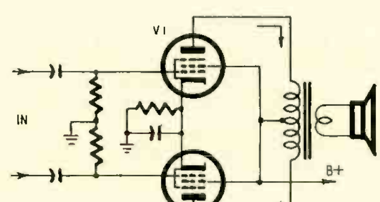


Fig. 4—A push-pull output amplifier.

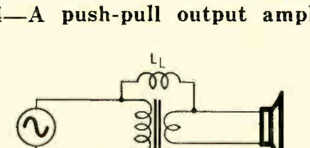


Fig. 5—Equivalent leakage inductance.

The simplest type of power amplifier (Fig. 2) works on exactly the same principle as a voltage amplifier. There are the same tube elements—grid, cathode, and plate—the same input circuit, and the same cathode-bias arrangement. The plate is loaded in the same way, by an impedance between B plus and the plate. Output is obtained as usual by plate-current variations passing through the load. There is only one difference: instead of connecting the voice-coil lead to the plate, we take output from the secondary of the transformer—and even this is not a real difference, since some voltage amplifiers in broadcast and commercial work have transformer-coupled voltage stages. The real differences cannot be seen in Fig. 2—that is, the different tube type, the lower load impedance, and the higher tube plate current.

There is one other point: In all choke- or transformer-coupled amplifiers, gain and power are higher than in resistance coupling for the same a.c. load value because the d.c. resistance of an inductor or transformer is comparatively low and almost the full B voltage is applied to the plate.

Tubes of several types are used in power amplifiers. There are triodes such as the old 2A3 (now obsolete), 6A3, and 6B4. Pentodes are used, such as the 6F6 and 6K6. And there are beam tubes like the 6V6, 6L6, 807, and variations of them. Triodes can pass more current than the others and thus require smaller turns-ratio output transformers (or can use higher turns ratios and give better speaker damping). However, they do not amplify very much and earlier amplifier stages must present high audio driving voltages to their grids. Beam tubes require much less driving voltage, and thus a lower-gain voltage-amplifier section can be used in the system. But since they can pass less plate current, output transformer primary impedance must be higher. The difference turns into a question of economy vs. quality. The beam tube permits economy in preceding stages, while the triode permits

The Brociner UL-1. Large output transformer provides enough primary inductance.

better speaker damping and more stable feedback circuits.

Why push-pull?

The single-ended stage of Fig. 2 is never used for high-quality work. It would not yield sufficient power output for even a modest home music system, and, more important, both frequency and waveform distortion can be drastically reduced by using a push-pull stage.

Frequency distortion in a single-ended stage takes place principally in the bass because of the output transformer. Fig. 2 shows that there is a d.c. flow through the transformer at all times in one direction, from plate to power supply. As in any inductor with an iron core, this unidirectional d.c. tends to saturate the core and reduce the inductance of the transformer. With the total transformer primary inductance reduced, the frequency at which the primary inductance is equal to nominal primary impedance rises; and at this frequency the response is down 3 db.

Fig. 3 shows how this works. At *a* is the actual output transformer circuit. The output impedance of any tube in this sort of circuit determines the output voltage. At *b* is the approximate equivalent circuit. The tube is represented by the a.c. generator, the transformer primary inductance by L, and the load resistance is reflected back to the primary, by R_L. L and R_L are in parallel, and R_L is fixed by the speaker voice-coil impedance and the transformer turns ratio. (For example, the 6,400 ohms shown in Fig. 1 would be R_L.) Assuming the speaker itself remains constant with frequency, L begins to short-circuit R_L as the frequency becomes lower. Where they are both equal, plate current has an equal effect on each. However, only the current acting on R_L actually drives the speaker, so the speaker power is reduced by one-half. Naturally at lower and lower frequencies, the shunting effect of L becomes still greater, and less current acts to drive the speaker.

This is why a 35-cent output transformer can have "correct" impedance characteristics but cannot possibly reproduce good bass.

It also shows why a single-ended output stage, in allowing unidirectional d.c. to flow through the primary of the transformer, reduces the primary inductance and thus the low-frequency response.

Fig. 4 shows how a push-pull stage gets around this difficulty. Plate current flows from the upper tube to the center-tap and power supply. It also flows from the lower tube to the center-tap and power supply. The two equal currents (d.c.) are opposite in direction of flow (assuming the circuit and transformer are properly balanced). As a result, they cancel and have no tendency to saturate the core and reduce inductance. It is of course true that even with a push-pull circuit a 35-cent transformer will not have good bass characteristics because it is simply too small, without enough iron to have high inductance. However, the same size transformer will perform a great deal better in a push-pull circuit.

Before leaving transformers, it is a good idea to examine another important characteristic limiting their frequency response. This is leakage inductance, which is inductance between the primary and secondary (Fig. 5).

If primary-to-secondary coupling were perfect (unity), the energy in the primary would be transferred to the secondary with the same efficiency at all frequencies. With less than perfect coupling there is inductive transfer between windings. The inductance involved is relatively small, and at low frequencies its reactance is negligible and coupling of energy is very good. But at some treble frequency the reactance of leakage inductance L_L becomes equal to the impedance of the voice coil. And then the circuit is that of a low-pass filter, with L_L as the series leg, rising in impedance with rising frequency, and the speaker as the shunt leg, remaining constant (ideally). At this frequency of equal impedances, response is down 3 db and falls off rapidly thereafter. In addition, phase shifts that are produced limit the amount of negative feedback which can be used without instability. Selection of an output transformer with high primary inductance and low leakage is therefore a highly important factor.

The harmonic-distortion reducing capabilities of the push-pull stage as well as its inherent hum reduction depend on phase relations which are very simple to show. Let us refer to Fig. 4 and assume that a sine-wave signal is applied to the grids from a phase splitter. The grid of V1 will be driven positive and V2 negative. At this instant, then, the V1 plate will become less and the V2 plate more positive. Since there are opposite polarities at the ends of the transformer primary and audio current therefore flows through it driving the speaker, the push-pull stage is functioning normally.

Now suppose that the phase of the V2 signal is reversed. Now both grids will be positive, both plates less positive and the two ends of the transformer primary will be the same potential. No audio current will flow through the transformer and thus no output. We may thus take it as a rule that there is output when any signal applied to the tubes is applied out of phase and no output when the same signal is applied to both tubes.

Let us look at how hum is affected. Hum may arise because the power supply is insufficiently filtered. This hum is applied to the tubes as 120-cycle variations in the B-supply. It is applied directly to both plates through the output transformer. Since it is in phase at the two plates it cancels and produces no output. Hum may enter also through the filament supply or a screen supply if there is one; in each case it is applied equally to the two tubes and produces no output.

Now for distortion. One type of distortion is caused by too small a negative grid bias, so that the peak of the grid wave draws grid current and causes a clipped or flat-top plate wave. As a result, the output of each tube has a negative flat top. But since one of the tubes goes negative each half-cycle of the input wave, one of them produces a negative flat top for each half-cycle. The combined output wave at the speaker is therefore flat at both top and bottom. This makes the wave symmetrical. Any symmetrical wave contains only odd harmonics, while an asymetrical wave contains either evens only or both odds and evens. What we have just seen, therefore, is that while each tube had both odd and even harmonics added to the original sine wave because of the clipping, the resulting output has only odd harmonics.

The push-pull stage thus cancels even-harmonic distortion. It does not simply translate it to odd harmonics; the output wave from a push-pull amplifier will contain only those odd harmonics which were created by the clipping, and of course the total distortion is less than that produced by either tube.

(TO BE CONTINUED)

NEW TOOLS for the Audio Technician

Better test equipment for high-fidelity servicing

By ROBERT F. SCOTT
TECHNICAL EDITOR

NOW that the public has really discovered high fidelity, the audio service technician must be prepared to service, test, and evaluate all types of amplifiers, record changers, preamplifiers, and equalizers. The multimeter and headphones used by the audio technician in the past have been replaced by audio v.t.v.m.'s and wave, distortion, and spectrum analyzers, and other specialized tools of the trade. The transition to high fidelity has been so rapid that many technicians—busy with TV and its problems—have found themselves with old-fashioned and inadequate audio servicing techniques and equipment.

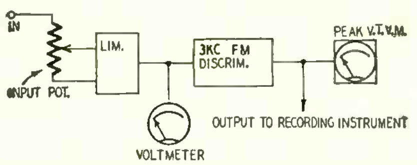


Fig. 1—Diagram of D & R model FL-3A.

This article is one of a series to bring the technician up-to-date on modern audio servicing methods and equipment. This month we will describe circuitry and applications of two instruments that are important to the technician.

Wow and flutter

Periodic variations in the speed of phonograph turntables and wire, tape, and film transport mechanisms produce an annoying type of audio distortion commonly called wow, or flutter. This speed variation causes an instantaneous change in the pitch of frequency (frequency modulation) of the signal being recorded or reproduced. In phonograph equipment, wow is usually caused by a warped or off-center turntable, by a record with an off-center hole, or by flat or slick spots on the belt or rubber-tired drive wheel.

In magnetic tape and wire recorders the trouble is usually caused by misadjustment of the take-up and rewind drives, off-center or misadjusted capstan, or defective tape or reels. High background noise on tape or wire is caused by a trouble similar to that causing wow. The wire or tape begins to vibrate so it slaps the heads at a fairly high frequency. This results in frequency modulation of the signal being recorded or reproduced.

Defects in the mechanical system of recording and playback devices may also cause an interference, called rumble. It is heard as a fairly low-frequency background signal caused by vibration of the drive motor.

Wow, flutter, and rumble are usually measured in percent using either of these two formulas:

$$\% = \frac{S_{max} - S_{min}}{S_{ave}} \times 100$$

where S_{max} is the maximum speed, S_{min} is the minimum speed, and S_{ave} is the average speed when S is measured in r.p.m. or inches per second.

$$\% = \frac{F_{max} - F_{min}}{F_{ave}} \times 100$$

where F_{max} is the highest frequency produced as the result of speed variations, F_{min} is the lowest frequency, and F_{ave} is the average or test frequency.

Measuring wow and flutter

A wow meter is basically an FM detector or discriminator operating at low audio frequencies. The carrier frequency, supplied by a signal generator, test record, or test film, is usually in the range of 1,000 to 3,000 cycles. The modulating signal, appearing at the output of the discriminator, is in the range of 0 to 500 cycles. The amount of low-frequency signal is read on a meter calibrated in percentage of wow.

A simple wow and flutter meter

The D & R model FL-3A wow and flutter meter is a comparatively low-cost instrument designed to assist the audio service technician and engineer in measuring wow and flutter from phonograph turntables and wire, disc, and film transports. A block diagram of it is shown in Fig. 1 and the schematic in Fig. 2. The instrument uses a 3,000-cycle test signal from an audio signal generator. This signal is used to modulate test records to be played back on equipment being tested. The 3-kc tone may be supplied by a standard test record.

The signal from the equipment under test is fed to the wow meter at a level of at least 2 volts. At this level, the signal saturates the 6AU6 limiter and thus eliminates hum, high-order harmonics, IM products, and interference that amplitude-modulates the test signal.

The limiter characteristic is shown in Fig. 3-a. The output of the limiter feeds a 6AL5 modified Foster-Seeley discriminator tuned to 3 kc with linear output response for all signals between 0 and 200 cycles.

The limiter drives a 6C4 cathode follower with a low-pass filter in its

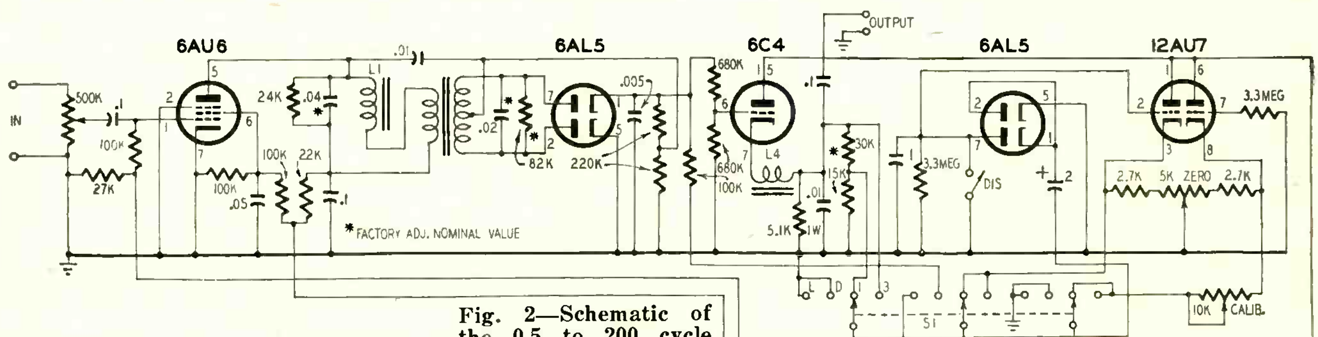
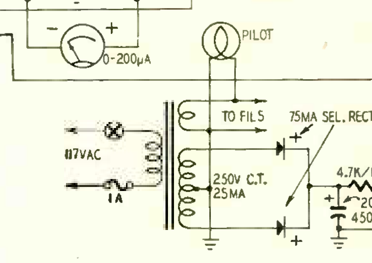



Fig. 2—Schematic of the 0.5 to 200 cycle wow and flutter meter.

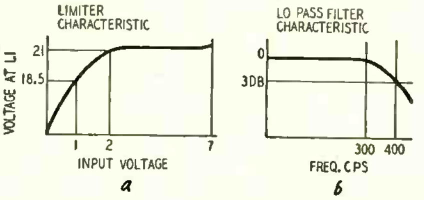
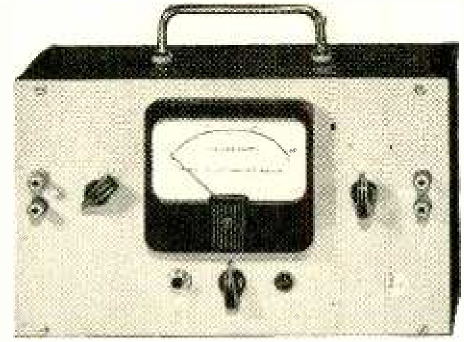


Fig. 3-a—Characteristic of the limiter.
Fig. 3-b—Response of low-pass filter.

Heathkit intermodulation analyzer.



The FL-3A wow and flutter meter.

output circuit. The response of the filter is shown in Fig. 3-b. The cathode-follower output is fed simultaneously to an internal v.t.v.m. and to OUTPUT terminals for connecting a scope or a recording oscillograph. The v.t.v.m. is an a.c. type with a push-pull 6AL5 rectifier with a time-constant of 3.3 seconds. The filter and the time-constant combine to enable the meter to produce accurate indications of peak flutter and wow voltages in the range of 0.5 to 200 cycles.

The meter has two ranges: 0 to 1% and 0 to 3%. Accuracy is within 10%. The output to the recorder is 0 to 8 volts with a 1% peak-to-peak flutter from a 440,000-ohm source.

Function switch S1 is for setting the meter range and making adjustments necessary for proper operation of the instrument. Position L measures the input signal level with the 5,000-ohms-per-volt meter across a section of the limiter grid resistance. The input potentiometer is set so the meter reads 0.4% on the 3% scale. This assures the correct level of the input signal.

Throwing the switch to D places the meter across the discriminator output and permits the test oscillator to be tuned precisely to the center frequency of the discriminator. The meter reads 0 when the oscillator is on frequency, and is deflected sharply when the oscillator is detuned. When this adjustment is made, wow and flutter percentages can be read directly from the meter by throwing the switch to 3 for a full-scale range of 3%, or to 1 for a 1% range.

Meter readings are in terms of peak flutter or wow voltage expressed as a percentage of the average signal frequency. The r.m.s. flutter present is approximately 70.7% of the indicated value.

The ZERO control is for resetting the 0 when switching between the 1% and 3% ranges. The switch marked DIS shorts the 1-μf time-constant capacitor to increase the speed with which measurements can be made on different instruments or devices.

Each FL-3A is supplied with a 33⅓-r.p.m. calibration record with 2% peak-to-peak flutter. When played on a turntable that is within 1% of its 33⅓ r.p.m. speed, the meter should read 1% (peak value). If it does not, the CALIBRATE control (on the rear of the chassis) must be readjusted. The manufacturer also supplies calibration tapes for 7½- and 15-inches-per-second speeds as optional accessories.

Intermodulation distortion

When two frequencies are applied to a nonlinear device, the output contains, in addition to the fundamentals and harmonics, spurious signals that are the sum and difference frequencies formed by beating the fundamentals and harmonics. Many of these new frequencies, called *intermodulation products*, are not harmonically related to either of the fundamentals, therefore they are unpleasant to the ear. Examining the waveform produced by intermodulation of two frequencies, we will find that the higher is modulated by the lower and that the resulting pattern looks like an r.f. carrier modulated by an audio sine wave.

Measuring IM distortion

Two sine-wave voltages, one considerably lower in frequency than the other, are applied simultaneously to the input of the circuit under test. The output of the test circuit is connected to the input of the analyzer where it is amplified and passed through a high-pass filter that removes the low-frequency signal and leaves the high. If the test circuit introduces intermodulation distortion, the high-frequency signal will be amplitude-modulated by the lower. The amplitude of the high-frequency signal is set to a predetermined level and its amplitude is measured. The high-frequency or carrier signal is then rectified and the high-frequency components are removed by filtering, thus leaving only the low modulating frequency. The meter compares the amplitude of this residual voltage with the carrier and translates the difference in terms of percentage of intermodulation distortion.

The diagram of the Heathkit model IM-1 intermodulation analyzer is shown in Fig. 4. The 6J5 oscillator generates a carrier signal at 2,000 or 7,000 cycles, depending on the position of the fre-

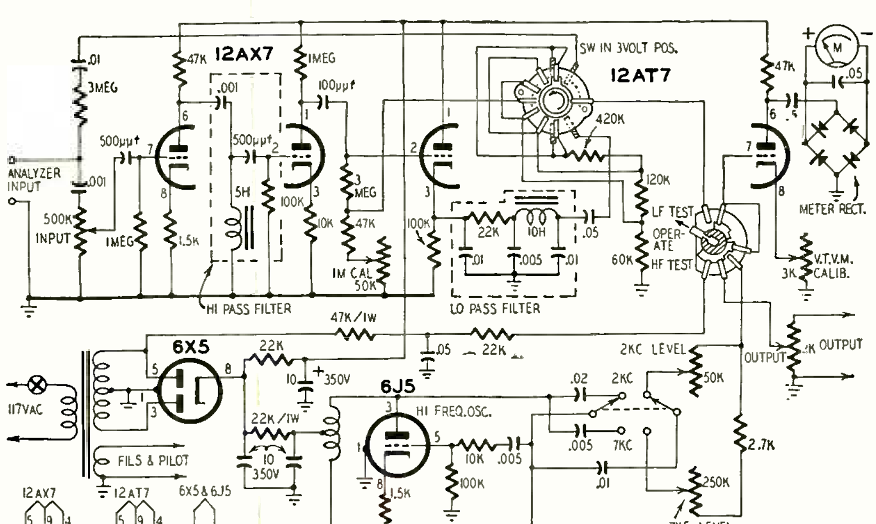


Fig. 4—Schematic diagram of the Heath-kit model IM-1 intermodulation analyzer.

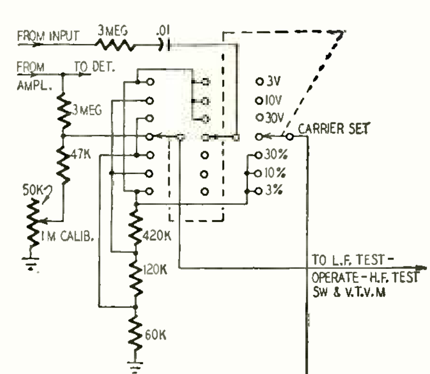


Fig. 5—Diagram of switching circuits.

quency selector on the panel. A 60-cycle signal voltage is tapped off the rectifier plate and applied to the output control through a voltage-dropping network consisting of the 47,000- and 22,000-ohm resistors. The .05-μf capacitor at the junction of these resistors filters out any 60-cycle harmonics that may be produced. The high- and low-frequency signals are mixed without distortion or intermodulation in the output circuit.

The ratio of the amplitudes of the two test signals is set with the level controls. These are usually set so the amplitude of the 60-cycle signal is 12 db above (four times higher than) the high-frequency test signal. The OUTPUT of the analyzer feeds into the input of the amplifier or circuit under test. The OUTPUT control sets the level of the signal applied to the amplifier. The output impedance is 3,000 ohms.

The analyzer or metering section of the IM-1 consists of a 12AX7 cascade amplifier with a high-pass filter between the stages. The filter provides maximum output at 3,000 cycles and the output is about 30 db down at 600 cycles. The output half of the 12AX7 feeds half of a 12AT7 working as an infinite-impedance detector. This circuit works into a low-pass filter cutting off at around 300 cycles.

There are two main switches in the metering section of the analyzer. The LF TEST-OPERATE-HF TEST switch is used when setting the ratio of the mixed test signals. In the LF TEST position, the v.t.v.m. measures the 60-cycle signal. The OUTPUT control is adjusted for full-scale deflection. Switching to HF TEST connects the v.t.v.m. across the output of the high-frequency generator. The desired signal level is set with the 2,000 LEVEL or 7,000 LEVEL control.

The seven-position switch is the range selector for the v.t.v.m. A simplified drawing of the switching circuits is shown in Fig. 5. Three positions are for measuring external audio voltages that may be applied to the INPUT terminals. Full-scale ranges are 3, 10, and 30 volts. The center (CARRIER SET) position is used for setting the input signal to the proper level. (The INPUT terminals are connected across the OUTPUT of the circuit being tested.) In this position, the v.t.v.m. connects to a voltage divider at the output of the second amplifier. The INPUT control is adjusted for full-scale deflection of the meter. The meter will then indicate percentage of intermodulation distortion when the switch is thrown to the 3%, 10%, or 30% positions.

Owners of model IM-1 intermodulation analyzers can improve the frequency response of the voltmeter by replacing the meter rectifier with a pair of 1N35 matched diodes. The instrument can be converted temporarily to read peak values of complex signals by replacing the .05-μf capacitor across the meter with a 50-μf, 25-volt unit and readjusting the calibration control. END

Novel Frequency Measuring Method

IF you own an accurately calibrated, stable, low-frequency oscillator, and a signal tracer, you can—with a high degree of accuracy—calibrate an oscillator or transmitter of an unknown higher frequency by listening for easily identified beats and making a few simple calculations.

The output of the low, variable-frequency oscillator and a portion of the output of the high-frequency oscillator are fed into the input of a signal tracer. The frequency of the low-frequency oscillator is then varied, producing a number of beats that can be heard at the output of the signal tracer. These beats are the result of heterodyning between the harmonics of the low-frequency oscillator and the fundamental and harmonics of the high-frequency oscillator. Between the loud-beat positions on the dial of the low-frequency oscillator will be beats of lesser intensity. The *loud* beats and their positions on the tuning dial are significant in determining the frequency of the high-frequency oscillator, as they indicate the points at which the harmonics of the low-frequency oscillator beat with the *fundamental* of the high-frequency oscillator.

Note the dial reading at which a loud beat occurs. Vary the frequency slowly (higher or lower) until another loud beat occurs. Then divide the product of the two loud-beat frequencies by their difference. The result will be the unknown oscillator frequency. Mathematically this can be expressed:

$$f3 = \frac{f1 \times f2}{f1 - f2}$$

where f3 is the unknown high frequency, f1 is a frequency at which a loud beat occurs, and f2 is the frequency of the next lower beat.

For example, if a loud beat is heard at 5760 kc and the next lower loud beat is heard at 5400 kc, then:

$$f3 = \frac{5760 \times 5400}{5760 - 5400} = 86{,}400 \text{ kc}$$

—*Sidney Appleby*

(Calibrating an oscillator or any other signal source is much easier if you know its approximate tuning range. You can use a grid-dip meter, wavemeter, Lecher wires, or a receiver covering the desired frequency range or its low-order harmonics. Don't overlook the possibilities of TV and FM receivers.—*Editor*) END

A PHASE-ANGLE PROBLEM

A LOT of my TV repair work is drive-in business. The customer delivers his set to my shop, then picks it up again after I've tinkered with it. One evil day, a 16-inch Admiral chassis was set on my bench by a gentleman of amiable disposition, but with a rather indifferent command of English. We didn't need any interpreter to point out the complaint. That was obvious, although slightly unusual. Sound was O.K. but the raster was a mere half inch or so in width, centered in the C-R tube. But no other information could I learn from him.

The trouble lay beyond the horizontal oscillator, because the scope showed a sawtooth of adequate height, proper shape, and proper frequency, at pin 5 of the 6CD6. Tube substitution turned up absolutely nothing.

I dug a little deeper and discovered that the waveform at the damper was O.K.; likewise for shape of sawtooth current in yoke. Clipping out the width coil didn't change the width of the picture a millimeter. A check of components in the area uncovered not a clue; whereupon, I shoved the job aside. Out of expensive experience I've decided that if a case of trouble can't be nailed within an hour, any further effort at the moment is usually wasted time. I keep rolling the problem around in the back of my mind as I went about other matters—for sooner or later I may get a sudden inspiration which often winds up the job in a hurry.

No brain waves developed in the case of this 16-inch Admiral. Late the next day, with everything double-checked and triple-checked, I'd gotten clear inside the yoke, checking for grounds, and possible connection between windings. I even measured the capacitance of that little capacitor across one-half of the horizontal section; checked it for leakage.

It wasn't exactly an inspiration which hit me then; more a hunch. I began pulling tubes in the chassis—no particular idea in mind—and all of a sudden I pulled one which reduced picture width to just about zero, a thin vertical line. The tube was a 6W6, which happens to be the *vertical output* tube in that particular box. In the tube checker it showed up flat as a rug. I plugged in another 6W6 and the raster spread out and filled the tube.

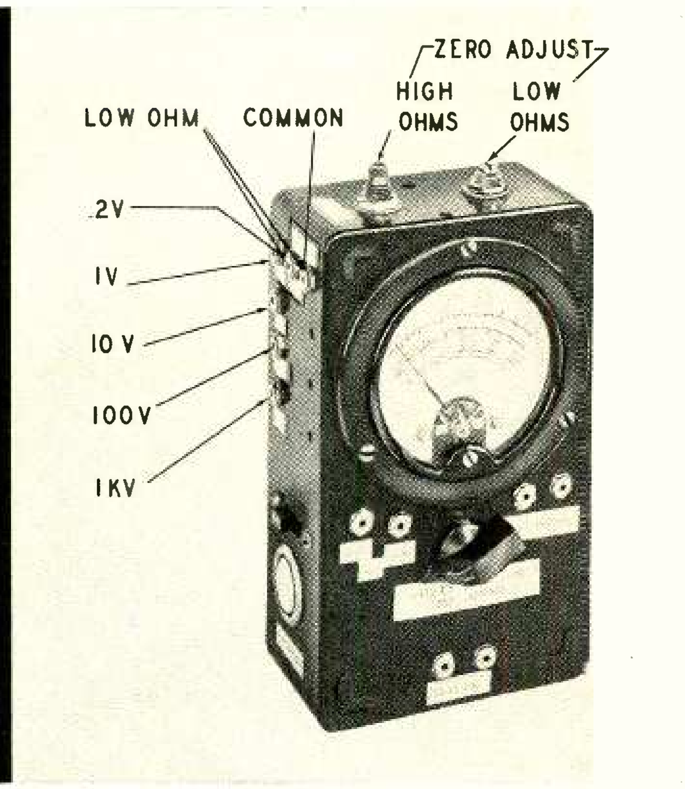
My pleasure was short-lived. The retrace lines were running vertically instead of horizontally—this was the payoff! After I batted my eyes for about the third time, I realized that this particular chassis happened to be one of those side-winders found in some Admiral consoles, where the whole shebang hangs with its base *vertical* in the cabinet and the control knobs run up the left-hand side of the screen instead of horizontally across the bottom as they do in all proper boxes.

My customer had brought in a chassis, remember—no cabinet. The language barrier obviated any chance of picking up a clue which I might have got otherwise. —*H. A. Highstone*

Constructing an inexpensive, dependable multimeter

Pin-Jack MULTIMETER

By I. QUEEN
EDITORIAL ASSOCIATE



The pin-jack multimeter—pin-jacks everywhere.

THE nonelectronic type of voltmeter has become very popular. It has certain important advantages over a v.t.v.m., being more compact and not depending upon a line or battery power supply. It cannot drift or introduce circuit errors as in a v.t.v.m. Furthermore, there is no warmup period and there are no tubes to age. If, in addition, the instrument has high sensitivity, it compares favorably with the v.t.v.m. in the matter of high input resistance. For example, with a 10-μa movement an instrument has an input resistance of 100,000 ohms per volt. This totals 10 megohms on a 100-volt scale, which approximates the input resistance of a conventional v.t.v.m.

I have designed a multimeter using a 40-μa basic movement (25,000 ohms per volt). A number of interesting features were incorporated. The instrument uses phone pin-jacks. A multipole rotary switch is usually expensive, difficult to wire up, and is often the source of mechanical trouble. A low current range has been included to measure d.c. in the order of 1 μa. This uses a transistor amplifier. There are high and low ohms ranges, and two low a.c. volt ranges. The low ranges are useful when experimenting with junction transistors. There are 15 different ranges altogether. The beauty of the pin-jack arrangement is that more circuits can always be added if desired; the only thing necessary is space on the meter box for additional pin-jacks.

Unfortunately, meter sensitivity and internal resistance have never been standardized. Values vary from one manufacturer to another. If you intend to use a surplus type movement, make sure you know the value of its internal resistance. Internal resistance can be measured by using the circuit shown in Fig. 1. A variable resistor, R1, is placed in shunt with the meter. A second resistor, R2, is in series with a d.c. supply which may be a single 1.5-volt cell. Adjust R2 for full-scale meter deflection with the switch open. Close the switch and adjust R1 for a midscale reading. The meter resistance is equal to the value of R1, which may be read off on a bridge or ohmmeter. R2 should always be much larger than R1. Watch that you always have enough resistance in it to avoid damage to the meter!

Voltage

Fig. 2 shows the voltage range circuit. It is in use when the selector switch is rotated to the VOLTS tap. Connections to the other positions are not shown in Fig. 1. To design the volts range we must know the *ohms-per-volt* value for the particular d'Arsonval movement to be used. If the meter has a full-scale sensitivity of 10 μa, it requires a total series resistance of 100,000 ohms to measure a full scale of 1 volt. This means that the meter is a 100,000-ohms-per-volt unit. In the same way, a 20-μa meter is a 50,000-ohms-per-volt unit.

If you have a 20-μa, 2,050-ohm meter, a series resistance of 50,000 ohms is required for every volt (full-scale) you wish to measure. Therefore, in Fig. 2, you need 50,000 minue 2,050 ohms for R1. For R2 you need a resistor that will drop 9 additional volts. At 50,000 ohms per volt, this comes to 450,000 ohms. In the same way you can easily calculate all other series resistors. Of course you may not wish to have ranges as marked in Fig. 2. You may prefer 5 volts, 25 volts, or any other. In any case, the computation is the same. You may include as many ranges as you have room for pin-jacks. The ranges you choose, however, should correspond to the markings on the meter scale. If your full-scale reading is 15, you will probably want to use 1.5 volts, 15 volts, 150 volts, etc.

To measure volts in Fig. 2, one test lead is plugged into the COMMON or

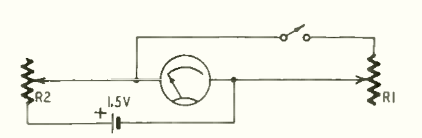


Fig. 1—Measuring internal resistance.

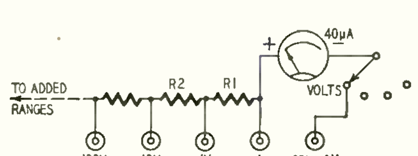


Fig. 2—Circuit for d.c. voltage range.

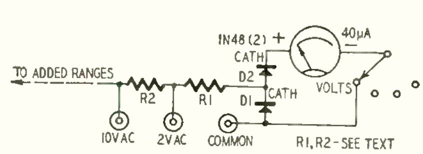


Fig. 3—Circuit for a.c. voltage range.

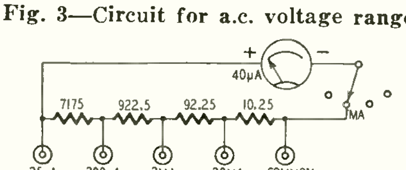
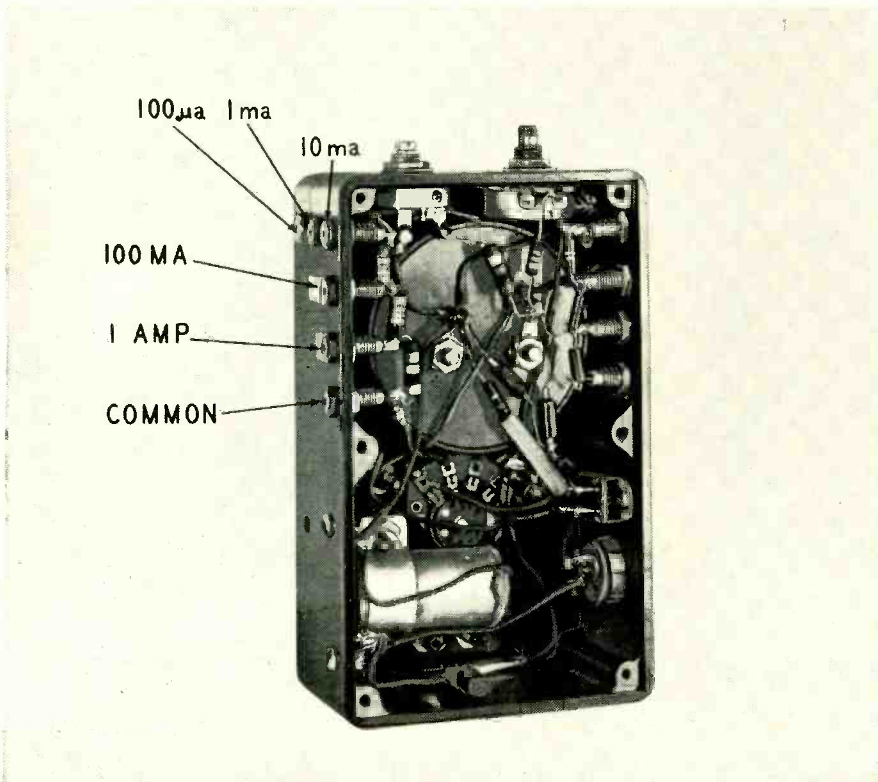


Fig. 4—The Ayrton shunt circuit.



View of the meter's internal wiring.

minus pin-jack; the other lead is inserted into the desired voltage pin-jack.

For a.c. volts, I used the circuit shown in Fig. 3. This particular instrument has only two low ranges—2 volts and 10 volts. These have been found very valuable for transistor output measurements. A pair of crystal rectifiers are used across the meter. One half of the a.c. wave is passed through the meter. The other half is shunted out by a crystal and does not flow through the meter. (When the COMMON pin-jack goes positive, D1 is conductive and D2 is blocked. Thus current flows through D1 and not through the meter.) The resistors for these ranges must be found by experiment. This meter has a 40-μa movement. It requires a 2,700-ohm resistor for R1 and 82,000 ohms for R2. The meter resistance is 5,000 ohms.

To measure a.c. volts, the range switch is left in VOLTS as for d.c. measurement. The leads are plugged into the COMMON and desired a.c. volt pin-jack. The rectifiers across the meter have no effect on the other meter ranges.

Current

Measurements of current are made by using the Ayrton shunt circuit (Fig. 4). The meter is shunted at all times by a ring of resistors. One test lead is inserted into the common ma pin-jack, the other into the desired current pin-jack.

An Ayrton shunt is calculated by the formula

$$R_t = \frac{R_m + R_s}{N}$$

Where R_s is the total shunt around the meter, R_m is the meter resistance, R_t is the resistance of the tapped section between the pin-jacks being used, and N is the multiplier number. If we have a 50-μa meter and wish to measure 500 μa, N would be 10.

Fig. 4 shows a network which can be used for a 20-μa movement with a meter resistance of 2,050 ohms. First we must decide on the lowest current reading we want. Let it be 25 μa. We must then shunt 5 μa around the meter and permit the other 20 μa to flow through it. If the shunt resistance is four times the meter resistance, the requirements are met. Therefore R_s must be 8,200 ohms—we know that R_m is 2,050 ohms. In this case N equals 1.25. For N equals 10 (fullscale reading of 200 μa) R_t is 1,025 ohms, etc. In this way, the remainder of the network may be calculated. As with volts, we may add as many ranges as we desire, the only limiting factor being the space we have for more pin-jacks.

One question may come up here. The constructor may wish to use the lowest possible current range, for example, 20 μa in the previous case. This is not possible with a ring shunt. To do this, switch the instrument to VOLTS to disconnect the shunt, and insert your test leads into pin-jacks which connect directly to the meter terminals. These are shown as jacks "A" and "common" in Fig. 2.

Ohms

The ohms network is a little more complicated than either current or voltage circuits (Fig. 5). Of course the meter you use must carry ohms scales, as well as volts and ma. Many of the available surplus type meters have this feature. If not, you can convert the meter by removing its scale and replacing it with one that includes ohms. We will assume here that the meter carries both a *high* ohms scale (reading from right to left) and a *low* ohms scale (reading from left to right).

To design the *high* ohms network, note the ohms reading that corresponds to meter midscale. In my particular meter this happens to be 30,000 ohms. With HIGH OHMS pin-jacks shorted we want full-scale (or zero ohms) deflection. With 30,000 ohms across the pin-jacks we want mid-scale reading. Obviously we need an ohmmeter circuit having a total internal resistance of 30,000 ohms (this includes meter resistance). This circuit can be traced in Fig. 5 as follows: R1 is the series resistor, in series with the HIGH OHMS pin-jacks (when selector switch is on ohms), the battery, and the meter. When the pin-jacks are shorted we want the battery to drive full-scale current through the meter. When 30,000 ohms is placed between the pin-jacks we double the total series resistance, therefore we halve the meter current.

This completes the high-ohms circuit except for one problem. What if the series resistance (30,000 ohms for our particular meter) is not correct for securing full-scale deflection? It may be too large or not large enough. In our own case it was not large enough. If you calculate the flow due to 1.5 volts through 30,000 ohms you will get 50 μa, yet we are using a 40-μa meter. Then all we have to do is add a shunt, R2. If R2 is 4 times as large as the meter resistance (5,000 ohms) I found that it would pass 10 μa when the meter flow is 40 μa. This satisfied all conditions and our high-ohms range was complete. On the other hand, it is possible for the series resistor R1 to be too large. It may not permit sufficient current to fully deflect the needle. Then the battery voltage must be increased. Add cells until R1 is just right or until it permits too much current flow through the meter. Then add a shunt as just described.

For convenience, R1 is shown as a

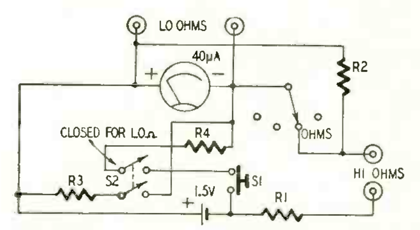


Fig. 5—Resistance measuring circuit.

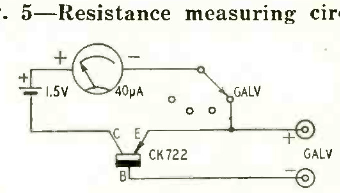


Fig. 6—A highly sensitive circuit.

single unit. However, it should be composed of a variable portion and a fixed portion. Thus we can compensate for an aging battery. The variable resistor may be about 20% of the total. In my own case, R1 should be 26,000 ohms because the meter (5,000 ohms) is shunted by R2 (20,000 ohms). The solution was to use a 24,000-ohm fixed resistor in series with a 5,000-ohm potentiometer. The potentiometer is adjusted by shorting out the pin-jacks and setting for full-scale deflection.

The low-ohms circuit includes a push-button switch S1 and a d.p.s.t. slide switch S2. On this range, zero ohms is at the extreme left and the scale reads upward. Again note the ohms reading that corresponds to mid-scale on the meter. In my case it happened to be 16 ohms. This gives the value of R3, a shunt resistor placed across the meter terminals and the low ohms pin-jacks, when S2 is closed. With the push-button switch, S3, also closed, R4 permits current flow from the battery into the meter. With the LOW OHMS pin-jacks left open, this current must be sufficient to produce full-scale deflection. Then if we place 16 ohms across the jacks we find that the reading drops to mid-scale as required. The smaller the resistance across the pin-jacks, the lower the meter reading.

Now for the design work. In most cases R3 is so much lower than the meter resistance that the latter may be ignored. In any case we want the resistance across the pin-jacks to equal the mid-scale ohms reading (16 ohms in my particular case). The limiting resistance, R4, produces full-scale deflection when the pin-jacks are left open. For my instrument, I calculated the total current flow when my meter showed full-scale deflection. The meter would pass 40 μa, of course. The 16-ohm shunt would pass $\frac{5,000}{16}$ or 312 times as much. This is 12.5 ma, so we may ignore the very much smaller meter flow. How much series resistance do we need to permit 12.5 ma from a 1.5-volt battery? The answer is 125 ohms, of which we already have 16 ohms between the meter terminals. Therefore R4 should be about 110 ohms. As before, it should be partly variable. I used a 91-ohm fixed resistor in series with a 30-ohm potentiometer. To adjust this range, leave the pin-jacks open and adjust R4 for full-scale deflection. Be sure S2 is closed and depress the push-button when you make the measurement.

The slide switch serves another useful purpose. When left closed it places 16 ohms across the meter. This damps out the movement and prevents the needle from bouncing around while the instrument is being handled. This is not necessary when the meter is used for volts, ma, or high ohms.

Galvonometer

This range measures weak currents or voltages. High accuracy is not required for most of these measurements, but high sensitivity is. Fig. 6 shows the schematic. The input current or voltage is impressed across the GALVONOMETER pin-jacks.

Present-day transistors don't have uniform and identical collector current flow. For the galvo application, the transistor should show low current when the input terminals are left open. This eliminates the need for an auxiliary circuit to balance out and zero the meter deflection when no input is applied. The transistor used here shows only 4-μa collector current with the terminals open.

To calibrate the galvo range, apply various known currents between base and emitter. The emitter is the positive terminal. Linearity will not be perfect but it should be very good. This instrument shows a 4-μa deflection for each μa fed to it, giving an easy and convenient method for increasing the sensitivity of a d.c. meter.

To read volts, add a resistor in series with the negative (base) lead. I used a 1-megohm series resistor, and the meter deflects approximately 4 μa for each volt applied. For better accuracy, draw a curve or chart plotting μa meter deflection vs. μa input (or volts input). To increase sensitivity, use a larger collector battery.

This multimeter has four functions: volts, current, ohms, and galvo. Ordinarily this would require a 4-position, single-pole switch, not a very common part. Therefore I "doctored" up a 3-position switch for this purpose. It is a Centralab unit with 4 terminals. Originally the tap could contact only 3 of them, the "common" terminal being excluded. By filing off the stop, the movable tap could also touch the common terminal—and I had a 4-position switch. This common terminal is used for the volt range, the only one that does not require a shunt or external circuit across the meter.

All parts used in this multimeter are easy to obtain at any radio store. The only expensive components are the meter and the transistor. The instrument has proven itself over many months. It has been used for experimental work, servicing, and ham-radio measurements.

END

Spot-Checking the Grid-Dip Meter

By HAROLD REED

Having purchased, assembled, and wired my Heathkit grid-dip meter, the next step was to run a test to see if it would perform on all frequencies according to the manufacturer's claims.

My home laboratory layout consists of communications receivers covering the frequency spectrum up to 50 mc; transmitting equipment for working up to 28 mc—then jumping to 420 mc; and a signal generator designed to operate to 120 mc.

The frequency range of the grid-dip meter is 2 to 250 megacycles. The manufacturer suggests that the ready-calibrated dial supplied with the kit can be more accurately adjusted with a calibrated receiver or signal generator. In my particular case, up to 50 megacycles presented no problem. I used one of my communications receivers. Above this range I tried the signal generator, hoping to extend the test to 120 mc, but found that the signal generator output was not great enough to be read on the grid-dip meter.

The grid-dip meter has a switch on the back of the case that makes it possible to use it as a high-frequency oscillator from 2 to 250 mc, or as a diode detector, when it is to be used as an absorption type wavemeter. Therefore, using it as a diode detector I tested the unit with my transmitting gear up to 28 mc. As a high-frequency oscillator it checked satisfactorily up to 50 mc with the communications receiver.

But was the instrument oscillating with the higher-frequency plug-in coils in the circuit?

Having an FM tuner, I decided to use it for spot-checking in the 88-to-108- mc band. With the tuner set to various FM broadcast stations, and the grid-dip meter switch in the oscillator position, as the meter was tuned to the frequency of each FM station the radiated signal from it was great enough to completely blank out the signal from the station. I was satisfied that the instrument was performing satisfactorily to over 100 megacycles.

Now remained only the higher range, up to 250 mc. Having used the FM receiver, the thought came to mind, why not the television set? I chose a time that would not interfere with the wife's favorite television shows, and checked through from the lowest to the highest TV channel. As the meter was tuned to the video carrier the picture completely disappeared from the screen; when the meter frequency approached the sound carrier the sound became inaudible. These tests were made with the grid-dip meter 10 feet away from the television set.

Having made these tests through channel 13, I was satisfied that the instrument was operating normally to approximately 216 mc. Since the instrument was still oscillating vigorously at this frequency, there was no doubt in my mind that it would perform satisfactorily throughout its range.

This grid-dip meter was wired carefully, using short and direct leads as recommended by the manufacturer. By just setting the ready-calibrated dial according to these instructions, it was astonishing how well the frequency indications on the dial of the instrument agreed with the signal frequencies of the FM stations and with both the picture and sound carriers of the television stations.

END

Transistor AM Test Oscillator

An extremely small and portable instrument for servicing radio receivers

By EDWIN BOHR

THIS pocket-size, battery-operated, transistor oscillator generates four spot frequencies for testing and servicing AM receivers. The frequencies are 455 kc, 600 kc, 1 mc, and 1.4 mc. These signals may be modulated or unmodulated. In addition, the oscillator will supply an audio signal for testing audio stages. The oscillator, in combination with a volt-ohmmeter, will lick just about any AM service job.

The oscillator is fine for i.f. alignment, tracking front-ends, and troubleshooting by signal injection. In contrast to signal tracing, signal injection makes the receiver under test supply all the amplification. Where a signal tracer must have many stages of amplification and a loud speaker, the signal injector may be a one-stage oscillator.

For signal-injection testing, hold the oscillator in one hand and move it from stage to stage, starting from the output tube and moving forward into the i.f. and r.f. stages. The trouble is located immediately behind or in the stage where the signal disappears.

Intermediate-frequency stages can be aligned with the 455-kc signal. Tracking is checked at the standard test frequencies of 600 kc, 1 mc, and 1.4 mc. And remember, the entire oscillator fits easily into a shirt pocket.

Test Oscillator

The instrument (Fig. 1) uses a single CK722 junction transistor. At audio frequencies this transistor operates on even less than 1 volt. However, at broadcast frequencies, most CK722 transistors require at least 15 volts. They are not designed to operate on the broadcast band. But, at this voltage, the operation is sometimes erratic, so a 22.5-volt battery is used for the collector supply. This voltage assures easy oscillation and greater interchangeability of transistors.

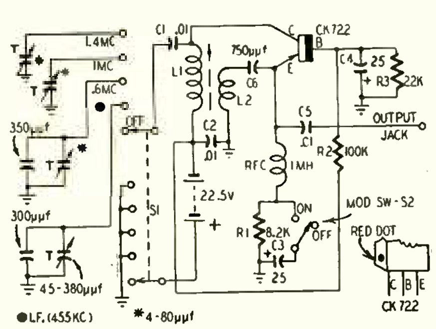


Fig. 1 — Schematic diagram of the transistor AM test oscillator. For stable operation, a 22.5-volt battery is used for the unit's collector supply.

The four test frequencies are obtained by switching capacitors across the collector tuning coil L1. Coil L2 is a tickler that feeds energy back into the emitter where it is reamplified by the transistor.

Fixed mica capacitors shunt the tuning trimmers for the two lowest frequencies. This "bandspreads" the trimmer tuning and makes the calibration adjustment easier.

Switching C3 across R1 produces audio modulation of the r.f. carrier and the audio test signal. The frequency of this modulation varies with individual transistors and may vary from a slow putt putt to several hundred cycles. The more actively the transistor oscillates, the lower the frequency of the modulation. If the frequency is too low, the oscillator will put harmonics all across the broadcast band when switch S2 is in MOD position. This is not always desirable. The modulation frequency in this case may be raised by decreasing the value of C3. The 1-mh choke prevents the r.f. signal from bypassing to ground when C3 is switched in.

An oscillogram of the oscillator's AM carrier is shown in Fig. 2. The modulation is greatly in excess of 100%. The r.f. is periodically blocked off completely. A.f. oscillations decrease the positive bias on the emitter until the oscillations stop. The emitter then begins to return to a higher positive bias as C3 recharges. When the bias reaches a high enough value, the r.f. oscillations begin again. The positive emitter bias comes from the divider network R2 and R3.

Capacitor C6 has appreciable reactance compared to the emitter input impedance. Therefore, should you wish to operate the oscillator at frequencies lower than 455 kc, the value of C6 must be increased accordingly.

When the frequency selector is rotated to any of the four spot frequencies, the unit is turned on. A fifth contact is the OFF position. With this arrangement, the operator is more likely to turn the oscillator off and not run down the battery.

A single jack serves for both the audio and r.f. test signals. The jack is isolated from the transistor circuit by C5. Since the output is taken from the low-impedance emitter circuit, the oscillator is virtually immune to loading effects. No ground jack is included to ground the oscillator to the circuit being tested. The reason is this: If the oscillator case were grounded and the oscillator output jack were accidently connected to a high-voltage a.c. wire in the receiver, there might be enough signal coupled to the emitter, through C5, to damage the transistor.

Construction

The design of a good layout for small pieces of electronic equipment is more difficult than seems obvious. A 1⅝ x 2⅛ x 3¼-inch aluminum case houses the oscillator. Volume-wise there is adequate space, but the size and shape of the parts is such as to oppose arrangement.

If the oscillator is built in the same size box that I used, follow the drilling details of Fig. 3; this is the only way the parts will fit. Some aluminum cases are made from 1/16-inch stock; others are made of less rigid stuff.

The measurements of Fig. 3 are based on a 1/16-inch wall thickness. Other boxes may require a slight revision of these measurements to compensate for a different thickness.

The largest component is the selector

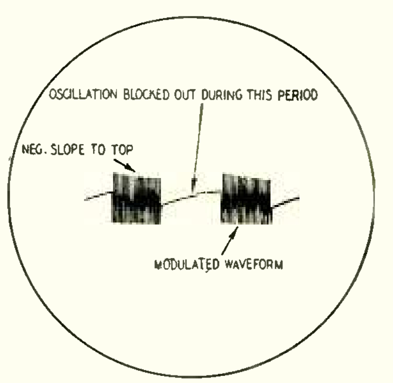


Fig. 2—Oscillogram of oscillator's AM carrier. Modulation exceeds 100%.

switch—one of the new miniature PA-1000 series made by Centralab. The trimmers and their shunt capacitors are wired to this switch. The selector switch also acts as the support for the phenol-board chassis. The chassis contains two holes that slip over the switch bolts. Two 4-40 nuts then hold the chassis board to the switch.

The exact chassis size is shown in Fig. 4. A 5-pin hearing-aid tube socket is used for the transistor and the cutout dimensions are for this type of tube socket.

Other holes must be cut in the chassis.

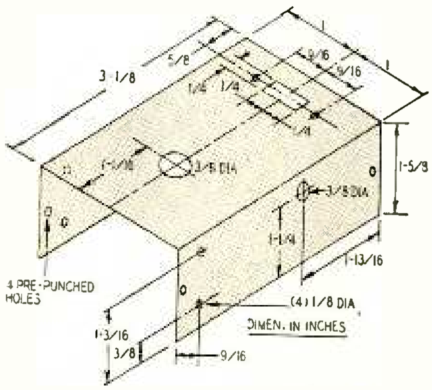


Fig. 3—Layout for the aluminum case.

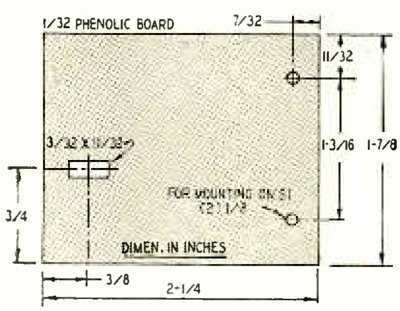


Fig. 4—Chassis layout dimensions.

Components are rigidly mounted to the board by pulling through and soldering their leads to the other side. Even the coil is mounted this way. The position of these holes is best determined by placing the component directly on the board and marking the best hole location.

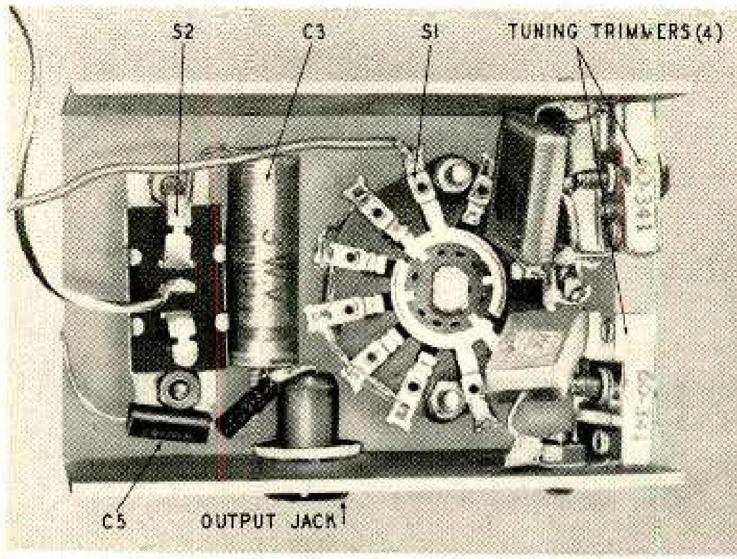


Fig. 5—Components mounted to case.

Several of the parts are mounted to the case under the chassis board (Fig. 5). The loose wires from these parts are soldered to appropriate tie points on the chassis board once it is in place and mounted to the switch.

Coil L1 is a Ferri-Loopstick, modified by removing all of the unnecessary coil form to reduce the size. The number of turns on the coil is unchanged and the slug is centered lengthwise in the coil for maximum inductance. Coil L2 is wound directly over L1 as shown in Fig. 6. Coil L2 is 7 turns of any convenient-size wire. If the coil is wound as shown in Fig. 6, the connections can be made with the assurance that the feedback polarity is correct for oscillation. (But if there are no oscillations, try reversing it!)

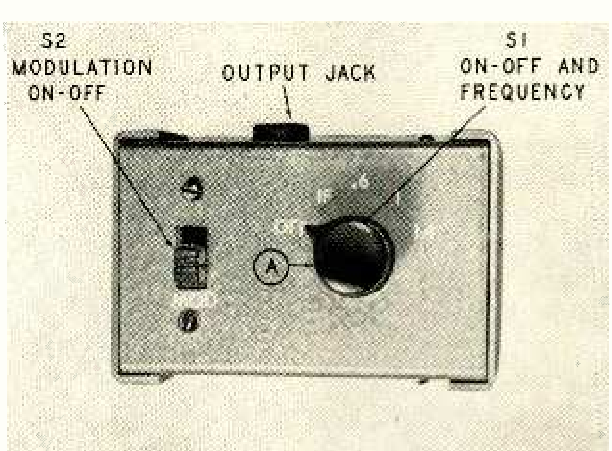
Capacitors C1, C2, and C5 are subminiature paper units made by Aerovox. The electrolytics are 3-volt d.c. units made by Cornell-Dubilier. C4 may be operated slightly beyond its rating but there will be no difficulty. It is important that the smallest parts obtainable be used. The battery is a small unit made especially for photo-flash purposes.

Calibration and use

An easy way to calibrate the oscillator is to track it with a communications receiver. Ordinary broadcast receivers are usually too poorly calibrated. The 455-kc spot could be set by adjusting it until the second harmonic is picked up at 910 kc. Another way to set the 455-kc trimmer is to feed the oscillator output directly into the i.f. stages of a receiver and adjust the oscillator until it generates a 455-kc signal. If this procedure is followed it is advisable to short out the oscillator section of the receiver beforehand.

There are many stations on 600 kc, 1 mc, and 1.4 mc and at least one station can be received on each of these frequencies. These stations can be used for calibration. For example, tune in a 1400-kc station, turn the transistor oscillator knob to the 1.4 position, and turn the 1.4 trimmer all the way in. Now back off the trimmer about ½ to 1½ turns. The oscillator should be heard as it passes 1400 kc. Place the modulation switch in the OFF position and slowly adjust the oscillator trimmer until it zero-beats with the station. All the trimmers will be adjusted within a turn or so of complete closure when they have been tuned to their proper frequency.

The accuracy of the 600-kc adjustment can be ascertained by checking the 600-kc harmonic at 1200 kc. Also, the third harmonic of 455 kc falls in the broadcast band at 1365 kc. For most work with the oscillator, the calibration



Front-panel view of test oscillator.

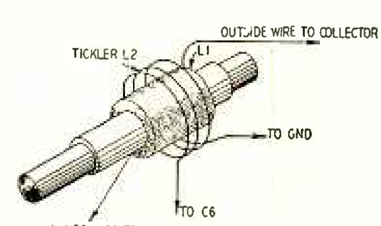
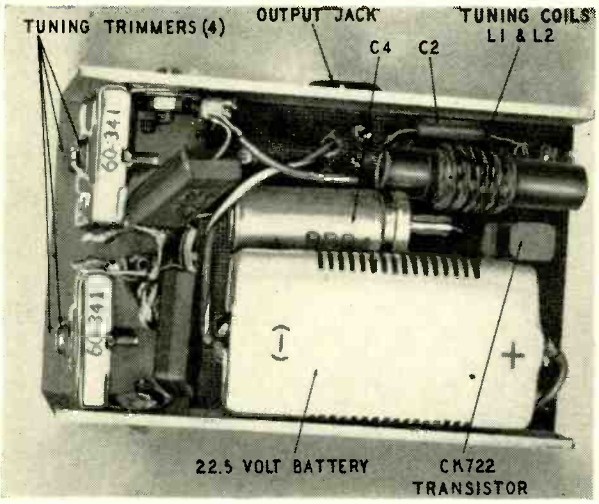
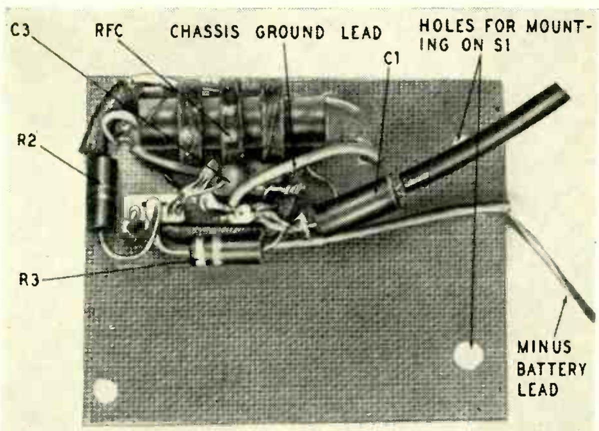


Fig. 6—Coil-modification details.



Parts layout—top side of chassis.



Under-chassis view of test oscillator.

does not have to be particularly precise.

Drift is very small. There is some drift when the oscillator is first turned on, but it takes only about a minute to stabilize. Compared to the 15 or more minutes warm-up for a vacuum-tube oscillator, this is very good. The large amount of tuning capacitance used at 455 kc lowers the tuned circuit impedance and gives the greatest stability.

The oscillator is simple to use. Suppose we want to check the audio stages of a receiver. Plug a short length of stiff wire or test-lead into the output jack and place S2 at MOD. Whenever the oscillator is in that position the audio test signal is available at the jack since C5 is large enough to pass both audio and r.f. In other words, both the modulated r.f. and audio are available at the same time.

The wire or probe can now be touched to various points of the audio circuit and the test signal should be heard. For example, if the signal disappears on one side of a coupling capacitor and is present on the other side, the capacitor is obviously open. If by signal injection one of the stages is shown to be inoperative, a voltage check usually locates the trouble. Essentially the same procedure is followed in servicing r.f. stages by signal injection.

A strong inductive field is created around the test oscillator by the Ferri-Loopstick. Receivers with loop antennas are very sensitive to this field and can pick up the oscillator many feet away, even though it has no probe or antenna plugged into the output jack. As the oscillator is slowly rotated in one hand, the signal strength from the inductive coupling to the loop-antenna will change tremendously. In some positions a complete null will be reached and in others the signal will be terrific. A 455-kc signal can be fed into some i.f. transformers this way.

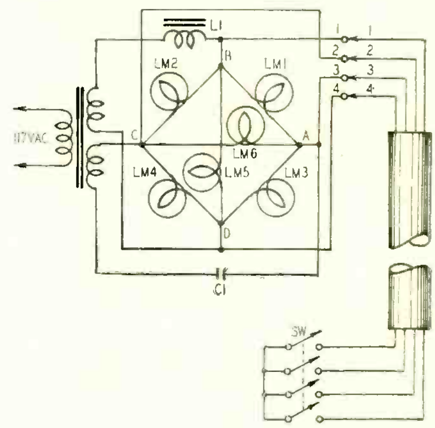
Parts list for AM test oscillator

Resistors: 1—8,200, 1—22,000, 1—100,000 ohms, ½ watt.
Capacitors: 1—300 μμf, 1—350 μμf, mica; 1—750 μμf, ceramic; 3—.01 μμf, 200 volts, paper; 3—4-80 μμf, 1—45-380 μμf, trimmer; 2—25 μf, 3 volts, electrolytic.
Miscellaneous: 1—CK722 transistor; 1—5-pin subminiature tube socket; 1—Ferri-Loopstick; 1—1-mh r.f. choke; 1—22.5-volt battery; 1—Centralab switch, PA1002; 1—s.p.d.t. slide switch; 1—aluminum case, 1⅝ x 2⅛ x 3¼ inches; 1—knob; 1—insulating board; 1—output jack.

There are other uses for the oscillator. You can make a wireless code-practice oscillator out of the test unit by substituting a telegraph key for S2 and reducing the value of C3 for a sharp practice tone. END

CONTINUITY TESTER

Most service technicians at one time or another have tested multiconductor cables for opens or short circuits while trouble-shooting defective PA or intercom installations, or radio or TV remote controls. This task is laborious and time-consuming because each conductor must be tested individually for shorts and opens. Tests on multiconductor cables are simplified by a new continuity tester invented by Jesse A. Cranford, of Buffalo, N. Y., (patent No. 2,610,229) and assigned to Western Electric Co. The circuit shown is for simultaneous testing of four conductors. A method of simultaneous testing of five conductors is also described in the patent.



The test circuit is basically a Wheatstone bridge with indicator lamps in each arm and in the leads connecting each pair of diagonal corners (A-C and B-D). The four conductors to be tested are connected to the corners of the bridge (points A, B, C and D) as shown. Points A and C and B and D are fed with equal voltages from secondary windings on a transformer. Inductor L1 and capacitor C1 are inserted in the circuit so the applied voltages are 90° out of phase. This phase difference permits all the lamps to light when there is no short circuit between any of the corners.

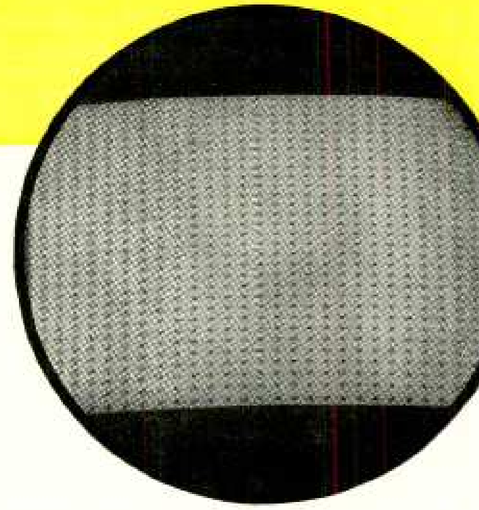
When testing a cable, conductors 1, 2, 3, and 4 are connected to corresponding terminals on the bridge. Should there be a short between any pair of conductors, the bridge corners to which they connect are shorted together and the lamp between them goes out. A short between conductors 1 and 3 short-circuits A and B so LM1 goes out. Similarly, a short between conductors 1 and 2 extinguishes LM2. A simultaneous short between all conductors places all bridge terminals at the same potential and all lamps go out.

The switch is closed to short all conductors together at the far ends so they can be tested simultaneously for continuity. All lamps will go out unless there is an open circuit in one or more of leads. For example, if lead 4 is open, there is no short circuit between bridge terminal D and terminals A, B, and C so LM3, LM4, and LM5 would not be extinguished. By glancing at the lamps you can tell which, if any, of the conductors is open.

VERTICAL INTERLACE *and* INSTABILITY

The causes and cures of troubles in the vertical oscillator circuit

By MATTHEW MANDL*



Linearity is best checked with the dot pattern, as shown in this photograph.

LACK of interlace — or intermittent interlace—in a TV receiver indicates critical vertical synchronization. If you can't get good interlace with the vertical hold control, be forewarned of trouble in the vertical oscillator circuit.

Believe it or not, many service technicians think they have good interlace when the horizontal line structure is clearest and easiest to see. The opposite is true. When interlace is lost, we have line pairing, and the horizontal line structure becomes coarser and so *more visible*. When the interlace is good, the horizontal line structure is much fainter, and twice as many lines are present. So the picture on a large screen appears less coarse and grainy.

The underlying principles

In television transmission 262.5 horizontal lines are transmitted in 1/60 second. This is known as a *field*, and two such fields make up a *frame* of 525 lines, each 1/30 of a second. The two fields are interlaced; that is, the horizontal lines of the second field fall between the horizontal lines traced by the first field. This interlaced principle of transmission increases the vertical resolution by doubling the number of lines visible, and also eliminates flicker.

When the two fields are not interlaced properly, the results are noticeable in a station pattern because of the effect on the horizontal wedge (Fig. 1). Notice that it has a lacy, moiré effect. This results from line pairing. A close inspection of the screen reveals a coarse horizontal line structure.

When the two fields are interlaced properly, the fine line structure makes the horizontal wedge look like Fig. 2. The lines are more clearly defined and are not interrupted by the moiré effect. Even with poor focus the line structure would still be unbroken.

In a receiver operating normally, the interlace loss effects shown in Fig. 1 can be duplicated by adjusting the vertical hold control near the point where sync instability occurs. At this critical setting interlace is lost and the line structure becomes coarse. The same condition exists when synchronization is lost and the picture rolls. This can be seen by adjusting the hold control so the picture rolls slowly and noticing the line pairing and coarse structure of the horizontal scan.

Since interlace can be lost if the hold control is adjusted near the point where synchronization is critical, the vertical hold control must be adjusted below that critical point. Proper adjustment not only restores interlace, but also prevents the occasional picture roll during impulse interference (such as generated by turning on a light in the house). If the vertical hold control range is limited, try a new vertical oscillator tube. If this does not help, check circuit components for off-value conditions. Two most likely circuits are the hold control resistive-capacitive network, as well as the R-C network which precedes the vertical oscillator.

This R-C network is known as the "integrator." A typical circuit is shown in Fig. 3. It has the dual function of filtering out the 15,750 horizontal sync pulses from the vertical system, as well as building up a charge from the incoming vertical sync signals. Thus, good stability in a vertical oscillator system depends to a considerable extent on the circuit values of the integrator network. Because a charge must be built up to a high enough level to overcome the negative potential on the vertical oscillator tube, the capacitors of the integrator network must have a good power factor so that leakage will not upset the charging level. Tube conduction in the oscillator starts the retrace portion of the vertical sawtooth developed at the output of the oscillator.

Since each field has some 262.5 lines, the half-line interval causes the vertical oscillator to be synchronized at a slightly different time interval for each successive field. If the vertical hold control is not adjusted properly, it will change the relationships of the free-running frequency of the vertical oscillator with respect to the timing charge which accumulates on the integrator network. Even though synchronization is not lost, line pairing will result. The same holds true if some component defect contributes toward intermittent vertical stability or loss of vertical synchronization.

Observe the screen to determine whether or not interlace is correct, and adjust the hold control to ascertain whether or not stable interlace can be secured. Always check interlace after servicing the receiver, particularly if the servicing involved the vertical oscillator and output sections. If interlace is not good, additional work must be done, to prevent callbacks.

Interlace may occasionally be lost for a fraction of a second because of the transmitter. If interlace is lost, and proper interlace only occurs once every three or four seconds, the fault is probably in the receiver and not the station. This can be verified by tuning to several other stations and checking the degree of interlace.

The stability of the vertical oscillator (and thus the interlace) is also affected by loading effects in the plate circuit. A change of height may affect the load on the oscillator, so it is often necessary to readjust the hold control when the height control is varied. Since the

*Author: Mandl's Television servicing.

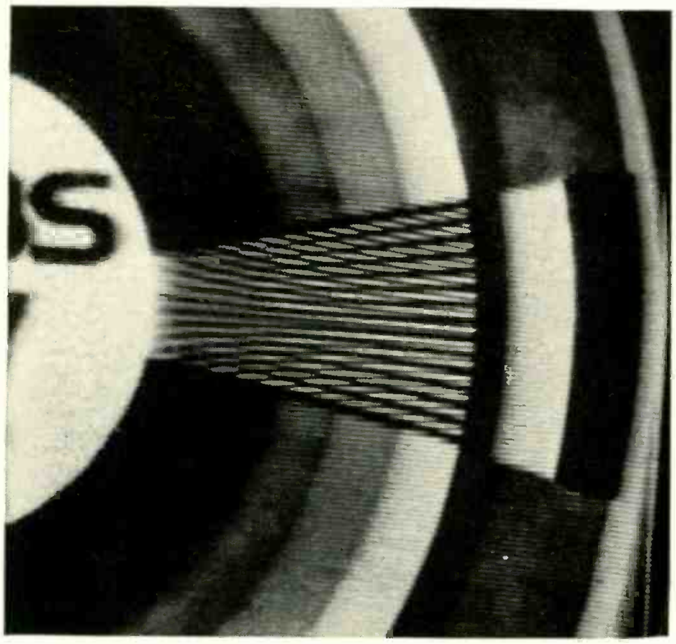


Fig. 1—Wedge shows loss of interlace.

Fig. 2—Lines are properly interlaced.

height control may also affect linearity, it is usually necessary to readjust the linearity control as well. When proper linearity or synchronization cannot be obtained for the proper height adjustment, recheck the component values of resistors and capacitors in both the integrator network as well as the other circuits associated with the vertical oscillator. Since capacitor values are critical, do not use the convenient method of checking their leakage resistance with the R × 1 megohm scale. It has two serious drawbacks. It does not apply a working voltage to the capacitor, and it will not ascertain an off-value capacitor. Use a capacitor checker which can subject the unit to the working voltages while the capacitance and leakage (power factor) are read.

The vertical output amplifier circuit also affects the loading on the vertical oscillator. Since the vertical oscillator is adjusted while the set is in operation, its final stability also depends on the load imposed by the vertical output circuit. A change in the characteristics of the vertical output tube alters the load on the oscillator and can affect its stability. The same holds true for a change in any of the resistors or capacitors in the vertical output amplifier. Any change in resistance which can cause an increase in current flow through the vertical output amplifier will increase the load on the oscillator and affect its performance. Thus, symptoms of vertical instability or loss of interlace call for a thorough check of the voltages on the vertical output amplifier as well as the oscillator. Try a new tube and make a check for off-value resistors and capacitors. If all such components check all right, test the vertical output amplifier transformer as well as the vertical deflection coils. This includes the damping resistors placed across the vertical deflection coils.

Another source of trouble is the coupling capacitor between the oscillator and the vertical output amplifier. Leakage here will seriously affect linearity and will usually cause foldover along the bottom of the picture. A leaky coupling capacitor will cause the grid of the vertical output tube to become positive and thus consume power. The increased current flow through the vertical output tube will cause the tube to be short-lived and the load on the vertical oscillator is increased. Instability occurs, but this can usually be corrected within the range of the vertical hold control, though interlace is usually lost.

Commercial circuits

Two primary types of vertical oscillators are the blocking oscillator and the multivibrator. When the blocking oscillator is used (Fig. 3) troubles can occur because of a defective transformer. Shorted turns in either the primary or the secondary will cause loss of synchronization to a point where the vertical hold control can no longer compensate for the change in circuit characteristics. In such cases the transformer should be replaced, though on occasion changing the resistance in the hold control circuit can restore normal operation. While this can be done as a temporary measure, a new transformer should be installed as soon as available. If the transformer has developed a few shorted turns, it will get worse in time.

The conventional multivibrator type of vertical oscillator is shown in Fig. 4. As with the blocking oscillator, an integrator network is also used. In

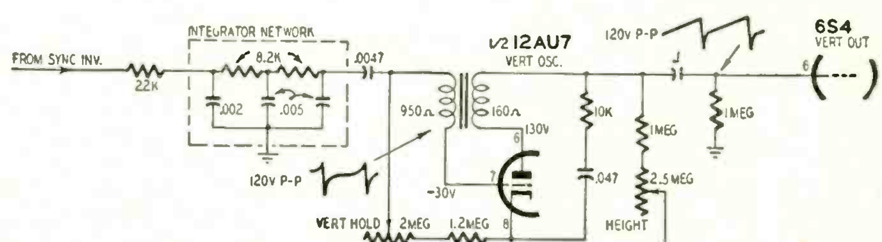


Fig. 3—Integrator network in vertical sweep circuit of Admiral chassis 20A2.

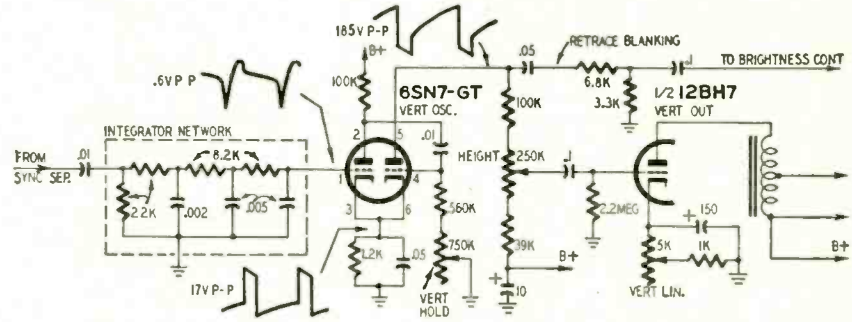


Fig. 4—Multivibrator-type oscillator used in Westinghouse chassis V-2247-1.

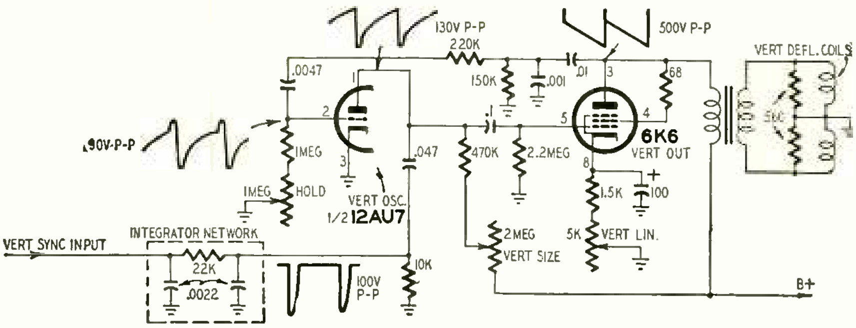


Fig. 5—Multivibrator in vertical oscillator circuit of Emerson 120182-D.

this circuit the vertical hold control is in the grid circuit of the second tube. The grid leak for the first tube of the oscillator consists of the series resistors which are part of the integrator network, plus the 22,000-ohm resistor to ground.

Since the two tubes are coupled by the common cathode, any defect in the cathode resistor or its bypass capacitor can change the frequency of the oscillator or cause it to stop oscillating.

This vertical oscillator is used in the Westinghouse chassis V-2247-1 television receivers and has several unusual features. One arrangement which differs from the conventional circuit is the height control. Normally the height control varies the anode voltage of the oscillator and thus the amplitude of the sawtooth formed as shown in Fig. 3. With the oscillator of Fig. 4, however, the height control consists of a potentiometer which selects the amount of drive signal applied to the vertical output tube.

Another unusual feature here is that the retrace blanking circuit is attached to the anode of the second oscillator tube. Normally the retrace blanking circuit is connected to the plate of the vertical output amplifier. In this circuit, defects in the brillancy control system or in the associated retrace blanking circuit can affect the load on the vertical oscillator and cause sync instability. For this reason the series capacitors and resistors, as well as the shunt 3,300-ohm resistor should be checked.

The cathode bypass capacitor in the vertical output amplifier of Fig. 4 has a value of 150 μf; such a large capacitance is necessary to bypass the 60-cycle sweep rate adequately. If this capacitor is defective, it can affect oscillator stability because of the change in load which results. If it decreases in value, or is replaced by one with a lower capacitance than the original, inadequate height will result. If the vertical height control is then adjusted to expand the picture vertically, it will load the vertical oscillator unduly and result in general sync instability. Therefore the vertical output amplifier must operate at peak efficiency so that the oscillator will not be overloaded.

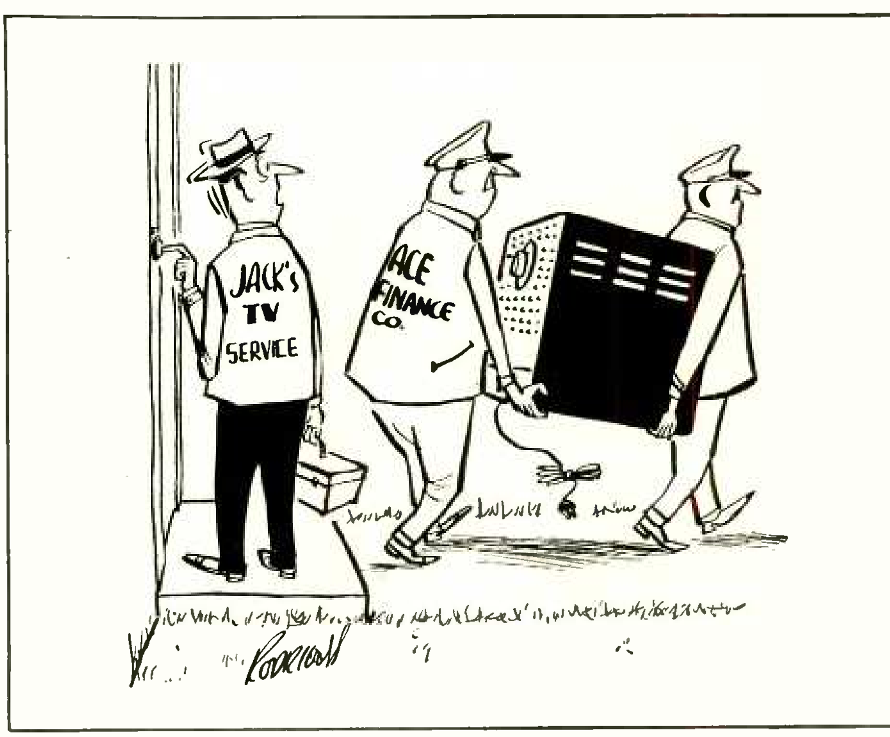
Another type of multivibrator used in vertical oscillator circuits is shown in Fig. 5. This circuit uses the vertical output amplifier as part of the multivibrator circuit. Thus, the first tube (½ of 12AU7) is the first tube section of the multivibrator and its output is coupled to the grid of the 6K6. The plate of the 6K6 vertical output tube is connected to the primary of the vertical output transformer, but a feedback network is also applied from the plate of the output tube to the grid of the 12AU7. This is the feedback network which sustains oscillations. The R-C constants of the networks between plates and grids are designed to reduce the effects of noise on oscillator stability.

Servicing procedures are similar to those detailed for other circuits. When instability occurs, tubes should be checked first and replaced if weak. Voltages and component part values should be also checked and replaced if off-value. Service notes for receivers also should be checked as well as the supplements thereto for any modifications of the circuit recommended by the manufacturer. In the circuits shown for Fig. 5, for instance, the resistor in series with the hold control was originally 820,000 ohms. In later productions this was changed to 1 megohm so that the hold control establishes sync near the center portion of its range. The 1,500-ohm resistor in series with the linearity control was originally 470 ohms in the earlier models. Late models also incorporate the 68-ohm resistor shown between the screen grid and the plate of the 6K6. This minimizes parasitic oscillations and reduces the tendency of such oscillations to create noise in the audio system during an occasional (and momentary) sync loss caused by program breaks.

Test equipment

Besides standard equipment such as the oscilloscope and vacuum-tube voltmeter, a linearity pattern generator is also useful. This unit is essential to correct for poor linearity in the absence of a station pattern. The linearity generator can be one producing vertical and horizontal bars, or the dots shown in the photograph at the head of this article. Poor vertical linearity in indicated here where the dot structure at the bottom is more closely spaced than at the top. Some defocusing at the sides is also indicated. When the linearity pattern generator is used, the lack of interlace cannot be ascertained because transmitted sync is not present. After linearity adjustments are made, interlace can be checked by turning to a station.

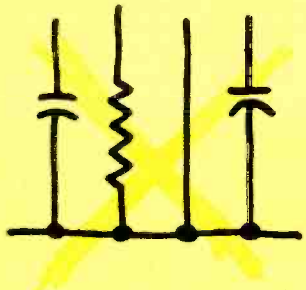
In some receivers (such as the Raytheon models C-2401A and C-2402A series) a printed circuit is used for the integrator. In such an instance the resistors can be checked, but the capacitors will have to be checked without being able to disconnect one end. It will be difficult to measure the capacitance values accurately without special equipment. When there is any doubt, a new integrator printed-circuit strip should be inserted. END

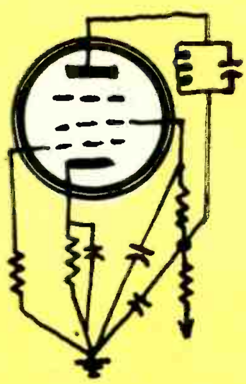


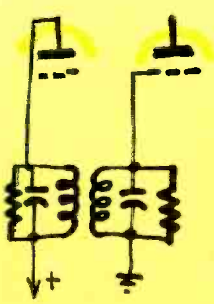
TELEVISION . . . it's a cinch

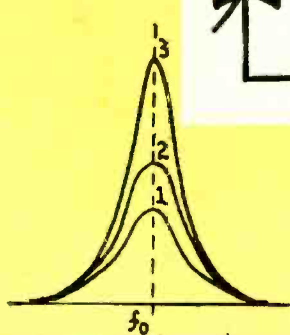
By E. AISBERG

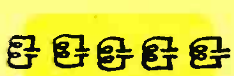
Twelfth conversation, second half: More r.f. problems, from the ground up; contrast controls, mixer methods.

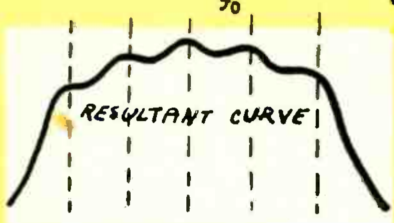


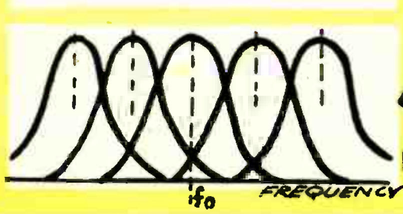


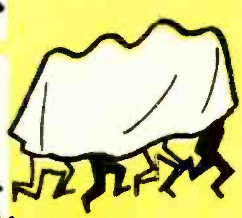












WILL—There's something new and different in your diagram. Usually all the lines in a schematic come together in neat right angles. But here you have a spray of lines coming from a single point on the chassis. Why?

KEN—You'll see more of that kind of hookup. It simply means that all the negative, or ground, connections are brought together at a single point on the chassis or ground bus. The old radio stunt of bringing ground leads to the most convenient point on the chassis is a sure way of producing oscillation (or sometimes heavy degeneration) when the frequencies begin to get high!

WILL—I see that the screen and plate are bypassed by capacitors that lead to the ground point on the chassis, and the cathode is bypassed by another capacitor across the cathode resistor. But aren't we trying to bypass plate and screen back to the cathode?

KEN—You're right. Decoupling might be a little better if the capacitors from the screen and the lower end of the plate coil were brought direct to the cathode. But it's easier to wire up a set with all these leads coming back to a common chassis point for each stage, and there doesn't seem to be much difference in practical results.

WILL—Are all televisers wired this way? I've seen plenty of TV schematics, but I don't remember ever seeing one that looked like this.

KEN—Once you understand the principle, it isn't necessary to show it in the diagram. For example, this drawing is in standard schematic style.

WILL—Yes, this looks normal. Here's the good old inductively coupled circuit with tuned primary and secondary. This kind of a circuit should help to bring up your selectivity quite a bit.

KEN—Poor Will! You still insist on thinking and talking like a good broadcast technician. But comparing TV to broadcast radio is like comparing radio to electric power circuits! You've got to change your whole outlook on life! "Bringing up the selectivity," as you put it so innocently, would be a calamity! And the worst of it is, increasing the number of tuned circuits does lead just toward that calamity. For example, look at this selectivity curve of one tuned circuit, then of two and of three in cascade. Every time you add another stage you narrow the passband, and our video signals have less and less chance to get by!

WILL—But they do get by! You're holding out on me—you have a cure for this trouble. What is it?

KEN—It's simple! You just tune each circuit to a slightly different frequency!

WILL—What? Do you mean you intentionally misalign the circuits—throw your i.f. amplifier out of adjustment?

KEN—Exactly. By selecting the frequencies of the various tuned circuits properly, you can get an over-all selectivity curve that approaches the ideal shape very closely. Of course, you pay for it in reduced gain—we still haven't found any way of getting something for nothing.

WILL—This curve of yours reminds me of the way we used to play camel when we were small kids. We'd get in a row and cover ourselves with a blanket. Our "camel" did have too many humps—I never saw anything just like it till you drew this flock of curves.

KEN—It's nice to know that a few of the experiences of your misspent youth are helping your understanding today!

Sensitivity and contrast

WILL—This may sound a little dopey—but is the gain of these TV amplifiers fixed, or do you have a gain control of some kind? I don't remember ever seeing any such controls—but I don't exactly know the meanings of all the terms on the screwdriver adjustments.

KEN—There is an adjustment all right, and it's right out on the panel—with a knob—where you can see it. It varies the gain the same way as gain controls work in radio—occasionally by varying the voltage on the screen grids, but mostly by varying the cathode bias.

WILL—And just what does a TV gain control do? Let's see—it would vary . . . Oh, of course! It's the brightness control! You said it was on the front panel . . .

KEN—But I didn't say it was the brightness control! The brightness is controlled by varying the picture tube's cathode bias, but we'll talk about that later. The gain control varies the amount of video modulation applied to the control element (grid or cathode) of that tube. When the video signals are weak . . .

WILL—. . . the brightness of the spot varies very little . . .

KEN—. . . and when the signals are strong, the spot goes through the whole gamut of brightness from dead black to intense white.

WILL—So—in the first case—you have a gray picture. In the second you have a picture with sharp blacks and whites. It's just like printing a photo negative on a soft type and then on a contrast type of photographic printing paper.

KEN—Exactly! And you have named the gain control without realizing it! It's the one you call "contrast" of course.

WILL—I guessed it! Now, does it control the r.f. tubes or the i.f. tubes?

KEN—It has been used on both—and even on the mixer tube—but now it generally controls the cathode bias of the video tubes, and the i.f. and r.f. stages have automatic gain control.

One or two tubes

WILL—You spoke of a mixer tube. I notice that TV circuits generally show an oscillator and a mixer, instead of the one converter tube we always have in radio. Why?

KEN—There are several advantages. You would get very much less gain with a converter tube at TV frequencies than on the broadcast band. It's better to use a pentode with a lot of gain and have a separate local oscillator. But both the converter tube and the pentode mixer have a bad fault—noise. The more elements you have in a tube, the noisier it is. So the majority of front ends now have a triode mixer and a triode oscillator—usually in the same tube—preceded by a cascode r.f. stage.

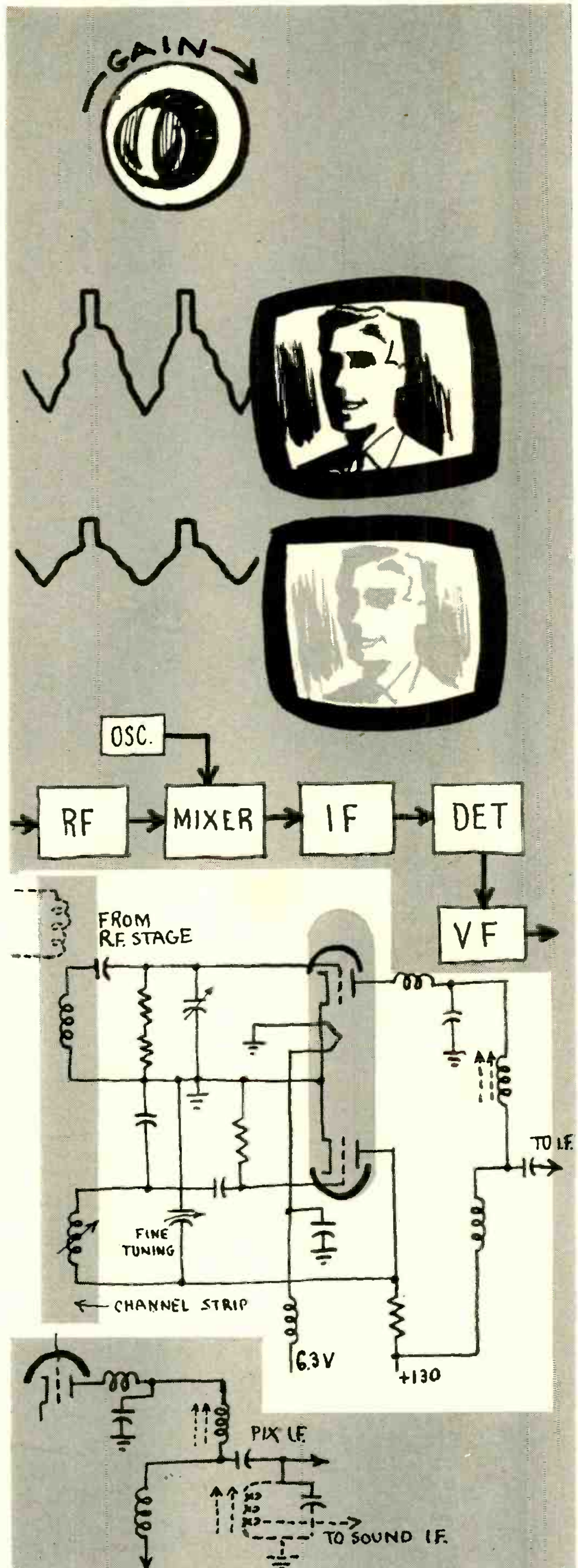
Sound without picture and picture without sound

WILL—But I see only one output lead here. We know there are two i.f.'s, sound and pix. Do they both go through the same i.f. amplifier?

KEN—In most cases, yes. That's what happens in all sets that use the *intercarrier* system. The *split-sound* receiver does have a separate sound i.f. amplifier, and another little coil tuned to the sound i.f. is placed in the output circuit of the tuner-converter to pick off the sound intermediate frequency. Perhaps I should have said "take off" the sound, because the coil is called a sound take-off. We'll draw it in dotted lines. Then there are a few sets that have one or two composite i.f. stages like an intercarrier receiver, then send the sound i.f. to a separate amplifier.

WILL—This begins to get complicated. Suppose we lay off for another day or so, till I get time to digest this.

(TO BE CONTINUED)



COLOR TV CIRCUITS

Part IV—Demodulators and matrix circuits. The authors begin with a simplified system which is not difficult to understand

By KEN KLEIDON and PHIL STEINBERG*

THE color oscillator and associated control circuits were covered in our previous article. We stated that the color burst signal and oscillator control circuits synchronize the color oscillator with the station, and the color oscillator applies two signals 90° out of phase to the demodulators. We also stated that the oscillator and control circuits were required in a color receiver regardless of the type of picture tube. The demodulators and matrix circuits fall into the same general category in that these circuits may be found in a color receiver using either the dot type of RCA or CBS, or the strip type (Lawrence) picture tube. However, due to the circuit simplifications possible using the Lawrence tube we will deal only with the demodulators and matrix circuits for the RCA or CBS dot type picture tube and cover the circuitry for the Lawrence strip type tube in a later article.

The oscillator buffer amplifier shown in Fig. 1 receives the signal **from** the color oscillator, amplifies this **signal** and, due to quadrature transformer T1 in the plate circuit, applies two signals —90° out of phase—to the demodulators. The quadrature transformer has a tuned primary and tuned secondary. When both primary and secondary are tuned to resonance the secondary output is 90° out of phase with respect to that of the primary. Therefore, the two signals applied to the demodulators will be 90° out of phase. Various methods may be employed in color receivers to couple the two oscillator signals to the demodulators, but in all methods there will be a 90° phase difference between the two signals. (The two oscillator signals are required for demodulation because the color information is contained in two signals modulated 90° out of phase at the transmitter.)

The two basic systems of demodulation in color receivers are the I–Q, and the B – Y R – Y or color-difference demodulation. One difference between the two systems involves the difference in phase between the two oscillator output signals and the incoming color-burst signal, the other concerns the color-signal frequency bandpass. The phase difference between the two systems is shown in Fig. 2. The I–Q system is merely rotated 33° with respect to the R – Y B – Y system. This rotation changes the relative amplitude of the two signals. However the *total* color signal consisting of the vector sum of either the R – Y and B – Y signals or the I plus the Q signal remains the same. Because of this the original red, blue, and green signals which were transmitted may be reconstructed by use of the proper matrix circuit. The relation between the two systems are embodied in the following two matrix equations:

1. $R - Y = 0.95I + 0.63Q$
2. $B - Y = -1.10I + 1.70Q$

The first equation states that an R – Y signal may be obtained by adding 95% of the output from an I demodulator and 63% of the output from a Q demodulator. The second equation states that a B – Y signal may be obtained by adding a negative 110% of an I demodulator output (180° out of phase with a positive Q signal) and 170% of the Q demodulator output.

The I and Q system has the advantage of providing extended color frequency response up to 1.2 mc, whereas the R – Y B – Y system is limited to 600 kc. However, the I–Q system requires a greater number of stages and may prove difficult to service due to its complexity. This article will deal only with R – Y B – Y demodulator system. We will cover the I–Q system in our next article.

As shown in Fig. 3, the color signal from the bandpass amplifier is applied to each demodulator control grid; and the two signals from the color oscillator, which are 90° out of phase, are

*Raytheon Manufacturing Company, Television and Radio Division

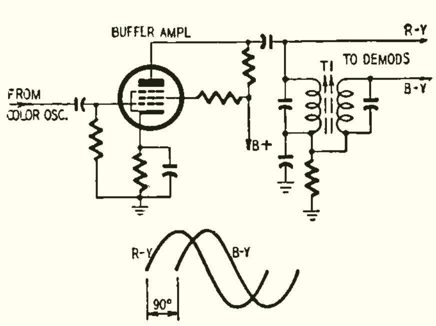


Fig. 1—Oscillator buffer amplifier.

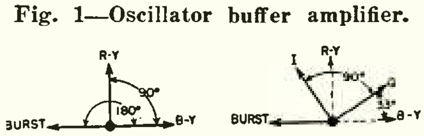


Fig. 2—Diagram shows demodulation systems—right I–Q, at left, B – Y R – Y.

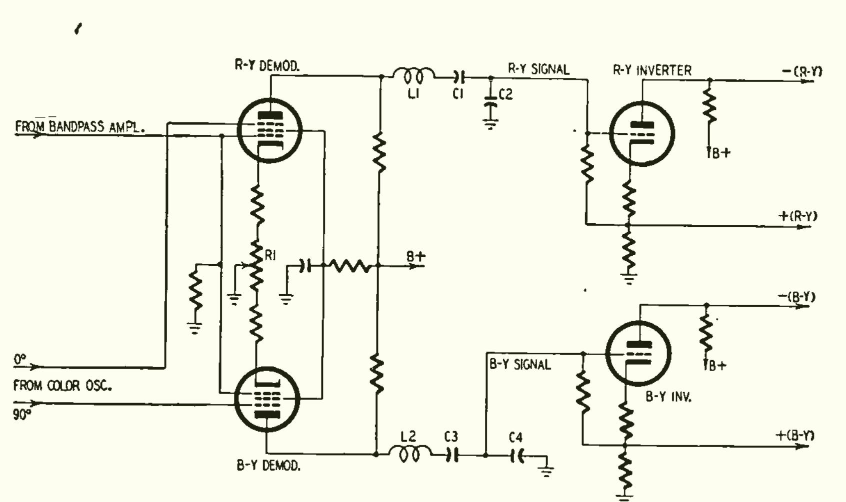


Fig. 3—Diagram shows signals fed to demodulator to obtain R – Y B – Y output.

applied to the suppressor grids. The R – Y and B – Y signals are obtained at the output.

A demodulator is similar in operation to the first detector in a superheterodyne radio receiver. The local-oscillator signal is beat or heterodyned with the incoming r.f. signal and the difference frequency is selected in the output.

Consider the color signal equivalent to the incoming r.f. signal, the color oscillator signal equivalent to the local oscillator, and the R – Y and B – Y signals equivalent to the video information amplitude-modulating a difference or intermediate frequency. Since the oscillator (3.58 mc) signal is exactly at the same frequency as the color subcarrier signal the difference or i.f. will be zero. Therefore, the two original video color-difference signals are recovered directly at a phase difference set by the reference 3.58 mc to the demodulator suppressors. This phase difference between the two signals is 90° if the quadrature transformer—or other phase-shifting circuit—is tuned properly.

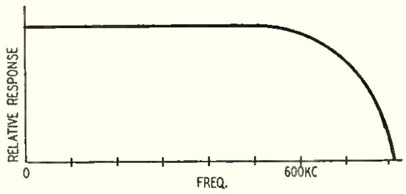


Fig. 4—Response of low-pass filters.

A low-pass filter consisting of L1-C1-C2 and L2-C3-C4 is placed in the plate circuit of the demodulators to prevent noise or any of the 3.58-mc oscillator and color subcarrier signal from appearing in the output and causing interference. The response of the low-pass filters is shown in Fig. 4.

Color-balance control R1 in the cathode circuit of the demodulators, is also shown in Fig. 3. This control compensates for the difference in gain of the two demodulator tubes and the different amplitudes of the R – Y and B – Y signals. The R – Y signal is transmitted at 1.78 times the amplitude of B – Y signal, and therefore the design of the demodulators must provide for greater amplification for the B – Y signal. The color balance control is adjusted for equal amplitudes of the signals in the output of the demodulators.

The demodulated color signals R – Y and B – Y may be passed through an inverter stage to provide the proper phase relationships for application to the matrix circuits. As in any phase inverter, there is a 180° phase difference between the cathode and plate, and therefore negative and positive R – Y and B – Y color signals are available for matrixing (Fig. 3). In some sets—by proper phasing of the 3.58-mc reference signal from the color oscillator—minus R – Y or minus B – Y signals are obtained directly from the demodulators, which are then designated as a minus R – Y demodulator or a minus B – Y demodulator.

A matrix circuit simply mixes two signals together to obtain a desired result. Fig. 5 shows the Y or luminance signal developed across R1 and R3, while the R – Y signal from the R – Y demodulator and inverter is developed across R2 and R3. Since both signals are developed across R3 the Y signal is canceled, leaving only the red signal. A plus Y and a negative Y signal result in zero Y signal, and the red signal, identical to the red signal from the red camera tube at the station, is obtained. The values of R1 and R2 are critical, and are therefore 5% in tolerance. The resistance ratios are predetermined from the color equations and signal levels available, as the proper amplitude of the plus Y signal must be developed across R3 to cancel the negative Y signal.

From the color equations, it can be shown that G – Y = –0.508 (R – Y) –0.187 (B – Y). This relationship is used in the green-signal matrix circuit, as shown in Fig. 5. Minus R – Y and minus B – Y signals are fed to the green-matrix resistors from their respective inverters. By attenuating the signals in accordance with the equation, the G – Y signal is formed across R4, which when added to the plus Y signal fed-in from the monochrome channel, gives G – Y + Y = G.

Another matrix system that may be used employs the equation, G = 1.7Y – 0.5R – 0.17B.

This matrix operates by taking the indicated proportions of the final *red* and *blue* color signals (*not* R – Y and B – Y) and adding 1.7 times the plus Y signal to give the green signal, as shown in Fig. 5 (broken lines).

The red, green, and blue signals from the output of the matrix circuit are equivalent to the signals from the color camera and are amplified and applied to the picture tube.

Other methods of matrixing may be employed in color receivers. However, the same principles apply. Vacuum tubes may be used in place of resistors —even the picture tube may be used. A three-gun color picture tube is shown in Fig. 6. Signals R – Y, G – Y, and B – Y are applied to the red, green, and blue cathodes, respectively. A negative Y signal is applied to the control grids which are tied together. Applying a negative Y signal to the grid is equivalent to applying a positive Y signal to the cathode. The G – Y signal is obtained, as before, by matrixing a ratio approximately –51% R – Y with –19% B – Y. The signals then add in the picture tube giving R – Y + Y = R, B – Y + Y = B and G – Y + Y = G.

In trouble-shooting a color-difference demodulation type of receiver, the face of the picture tube will usually give the quickest isolation of troubles. If red or blue detail is missing while a normal-looking black-and-white picture is obtained for monochrome transmission, the R – Y demodulator may be causing the loss of red detail while the B – Y demodulator may be at fault for lack of blue detail. If it is not possible to secure proper colors by replacing the demodulator tubes, it may be because a matrix resistor is open or shorted. This may be checked by resistance measurements.

We cannot too strongly emphasize that before checking the color circuits, reception should be first checked on black-and-white transmission so that all circuits common to the black-and-white and color channels may be eliminated.

The next article will deal with the I-Q system and with video output circuits. END

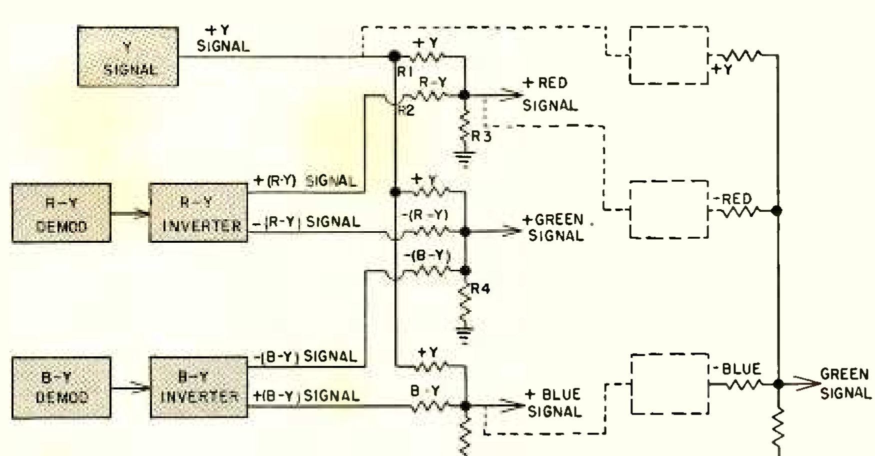


Fig. 5—Diagram shows two matrix systems—either can produce the green signal.

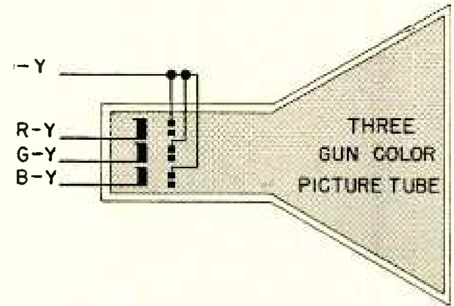


Fig. 6—A 3-gun color picture tube.

Tracking Down HORIZONTAL INSTABILITY

By CYRUS GLICKSTEIN

PART II—Tracing sync pulses; probable points of trouble

IN signal tracing, the manufacturer's service data is almost as important as the technician's test equipment. Compare the waveforms on the scope with those shown by the manufacturer. Important points to look for are:

1. Full-amplitude sync pulses above the video level in the video system output (video detector and amplifier) (Fig. 1-a): If the sync pulses are compressed at any check point in this part of the video system (Fig. 1-b) check for the cause in the preceding stage.

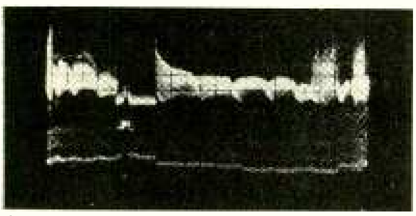


Fig. 1-a—Normal signal in video output.

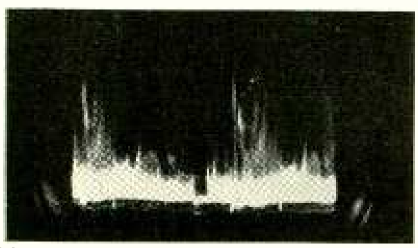


Fig. 1-b—Defective video signal. The sync pulses are extremely compressed.

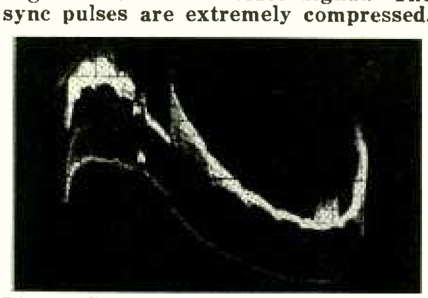


Fig. 2—Signal with 60-cycle hum pickup.

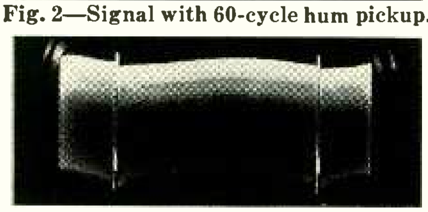
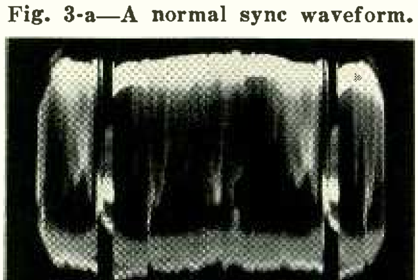


Fig. 3-a—A normal sync waveform.



Photos courtesy G-E Techni-talk

Fig. 3-b—Sync pulse output showing some video information remaining.

2. Sixty-cycle hum pickup in the signal: This will look on the scope like Fig. 2. Check for hum on the scope baseline (see that the baseline is straight) before connecting the leads to the TV receiver. When making waveform checks, the scope leads, *including the ground lead*, must be connected properly; a defective connection may result in a distorted waveform.

3. Ripple in the B plus line: If hum is visible in the signal, find out if it originates in the B supply. Only a small amount should be visible in the B plus line. A large ripple indicates a defect in the low-voltage supply.

4. Correct sync-circuit operation: The output from the sync section should consist of well-clipped sync pulses (Fig. 3-a). Sync-section output that contains video information (Fig. 3-b) makes synchronization unstable.

5. Trouble in the video dector, video amplifier, sync, a.f.c., and horizontal oscillator stages: These can be spotted by a lower-than-normal amplitude or a distorted waveform.

When servicing new or unfamiliar models, it is worth while to check the manufacturer's field service modifications, to find out whether the fault may be common in a given model. When manufacturers receive reports of recurrent troubles in a new model, they usually recommend circuit modifications to eliminate the fault. In receivers that have developed horizontal instability because of initial design values, the most common field modifications include: Additional filtering across the a.g.c. line to reduce ripple; change of resistor values in the a.g.c. voltage divider to increase a.g.c. output voltage; change of capacitor type in the horizontal lock circuit (to a silver mica or a zero temperature coefficient ceramic); change of component values in the video amplifier, sync circuit, horizontal a.f.c., or horizontal sweep circuit; and miscellaneous changes, such as relocation of parts, change in lead dress.

Causes of instability

The following list of some common causes of horizontal instability is based on various manufacturers' field service reports. The suggested modifications do not necessarily hold true for all models.

Video section

1. Distortion, horizontal bending, or tearing in strong signal areas; erratic horizontal hold: Weak or gassy r.f. or video i.f. tube; insufficient a.g.c. voltage.
2. Unstable horizontal or vertical sync: Some 6CB6 tubes do not have a great enough linear amplification range. This results in limiting, compressed sync signals, and poor vertical or horizontal sync operation. The most critical stage in this respect is the last video i.f. stage. Try several tubes. Unsatisfactory tubes should not be discarded, since they are usable in the r.f. or sound i.f. stages.
3. Horizontal jitter and smear caused by overload: Adjust a.g.c. control; connect attenuator network to antenna terminals to reduce signal input; change value of load resistor of first video amplifier from 2,200 ohms to 3,300 (1 watt) and cathode bypass capacitor of second video amplifier from 390 to 180 $\mu\mu$f.
4. Picture pulling due to hum pickup in a.g.c. bus or a.g.c amplifier tube: If a.g.c. tube change does not eliminate pulling, place 0.5-μf paper capacitor (if keyed a.g.c. is used, 4 μf) from a.g.c. bus to ground.

Sync section

1. Bend at top of picture at low contrast levels: Check value of plate load resistor in sync separator-clipper stage; replace if resistor has increased in value.
2. Hook at top of picture: Change .01-μf coupling capacitor to grid of first sync clipper to .05 or 0.1 μf.
3. Horizontal bend: Leakage between filament and other elements in 12AU7 sync separator tube.

Horizontal a.f.c. circuit

1. Horizontal jitter or touchy sync: Defective horizontal frequency coil; leaky .05-μf feedback coupling capacitor from one side of width coil to phase detector; change of value or defect in components.

Horizontal sweep section

1. Horizontal pulling to the left, top of picture only: Improper adjustment of horizontal hold or defective horizontal output tube.
2. Picture jumps, tears horizontally to the right: Defective horizontal output tube; defective 0.5-μf capacitor from damper tube to horizontal deflection coils.
3. Unstable sync: Check horizontal oscillator and sync amplifier tubes; check horizontal oscillator plate voltage.
4. Instability and oscillation in the horizontal sweep circuit: Insert parasitic resistor in grid circuit of horizontal output tube.
5. Horizontal sync instability and dark irregular patches on picture: Failure of capacitor across width coil in output circuit (2,000-volt rating). Internal arcing is difficult to detect. Replace mica with ceramic capacitor.
6. Intermittent horizontal hold: Check hold control, it may be worn. END

TV ANTENNA REPAIRS

By I. J. SOBEL

Fig. 1—Drilling in terminal block.

THERE is one link in the television receiver system about which very little has been written from the point of view of maintenance and repair—the antenna. TV antennas exposed to the elements for 3 months or more frequently develop difficulties that require a special trouble-shooting procedure. This is just as important as correct servicing of the chassis itself.

Symptoms of antenna trouble

Picture defects are often misinterpreted as receiver difficulties when in reality the trouble is in the antenna system. For example, if several channels are received perfectly while others are badly smeared, the tendency is to suspect the front end of the receiver. But the trouble in such cases may often be tracked down to a break in one side of the transmission line. Reflections from the break produce strong standing waves in the transmission line at the frequencies of the poorly received channels. In trouble-shooting such a job a simple d.c. continuity check of the transmission line can save a lot of time wasted on the chassis.

Any reception difficulties involving variation from channel to channel should immediately throw suspicion on the antenna system. To determine definitely whether the trouble lies in the antenna or in the receiver, connect another receiver—known to be in good condition—to the same antenna leads. Several service organizations keep portable receivers for this purpose. Such receivers may also be used as temporary replacements for customers' sets which have to be held in the shop.

Another test to isolate antenna system difficulties is to use a substitute roof antenna—a simple folded dipole, made of 300-ohm ribbon and cut to the wavelength of the troublesome channel.

Troubles in the antenna

Three main categories cover antenna troubles: First, we have poor or intermittent electrical connections to the dipole (stacked arrays have more connections and therefore bear more careful checking). Second, bent or broken active or parasitic elements may change the vertical and azimuth pickup patterns and cause weak signal pickup, ghosts, and a lowering of the signal-to-noise ratio. Third, changes in physical orientation may create symptoms similar to those associated with broken elements.

To replace the transmission line connections to the antenna terminal block, remove the antenna and mast from the mounting bracket and lay it down on a flat surface. Place the reflector on the ground or roof, and hold the mast firmly between the legs, with the mast base on the ground.

(If the antenna has forward-pointing elements as in double vees and some conicals, it may be better to remove or loosen the elements so the boom rests solidly on the roof or other flat surface. Some antennas would be damaged if bent as in Fig. 1.—*Editor*)

Using a No. 21 high-speed bit, cut a hole in each half of the terminal block which holds the active antenna rods in place (Fig. 1). Tap the holes with a 10-24 tap (Fig. 2). Then solder the newly cut and stripped lead-in wires to closed lugs, and connect the lugs to the antenna terminals with new 10-24 bolts. File clean any rust deposits around the holes and complete the job by taping the connections.

Bent parasitic elements can often be straightened by merely applying a little controlled pressure with the bare hands. Rods that have been snapped off due to wind or ice should be replaced with new elements.

A shift of antenna orientation is not too likely to occur, but it does happen with strong winds or poor installations. The pickup patterns of most broadband antennas have sharply defined lobes on some channels. This can cause an antenna which has been rotated only a few degrees to have very inferior pickup on one or two channels, although it operates very well on all others. The condition can be corrected by watching the receiver in operation on the offending channel, and turning the antenna mast in the mounting bracket until the strongest ghost-free reception is obtained. If the location is in a weak signal area a signal-strength meter may be needed to find the best orientation.

Transmission line troubles

Unstable input to the TV receiver, and poor reception on one or more channels, are the most common symptoms of transmission line trouble. They are both tackled by making a d.c. continuity check.

Remove the antenna leads from the receiver antenna terminals and connect the ohmmeter, set on low ohms, across the leads. If the antenna is of the folded dipole type a reading should appear. (This reading should be about five ohms for a moderately long run.) If the antenna is of the simple dipole type a shorting clip must first be connected across the antenna rods. Sometimes a resistor of 100,000 ohms or so is installed permanently across the terminals of a simple dipole antenna during the original installation to create a return path for just such a continuity check. This system is not foolproof, however, because a break in the transmission line can introduce a moderately high series resistance which will not be detected with the ohmmeter set to read 100,000 ohms. For example, a transmission line break which produces a series resistance of 2,000 ohms—a value which might result from dust and soot settling into the break and furnishing a poor conducting path across the broken ends—would not show up when measured in series with 100,000 ohms.

If no reading is obtained when checking with the ohmmeter, the break may be located by producing temporary shorts across the transmission line at various points. This is best accomplished by carefully skinning the line and connecting a clip lead across the bare wires. Insert the temporary shorts at points on the line progressively closer to the receiver until the ohmmeter shows continuity. It is then known that the break exists between the point of continuity and the point checked immediately before.

After the break is located a decision must be made as to just how much of the line to replace. In making this decision it is important to keep the number of splices to a minimum. It is better to replace a few more feet than to make an additional splice.

The following method of splicing ribbon line, which minimizes impedance discontinuities and the attendant reflections and standing waves, is recommended:

Fig. 2—Tapping the drilled hole.

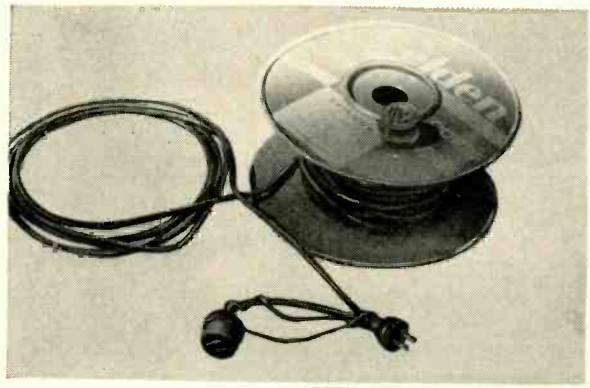
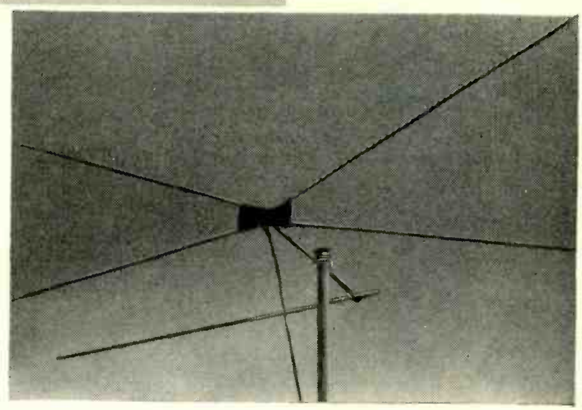


Fig. 4—Mounting a.c. cable on discarded reel makes a neat convenient tool.



Antenna with part of reflector missing.

1. Cut and skin the polyethelene insulation, leaving the edge wires bare.
2. Twist the wires so they protrude sideways, as shown in Fig. 3.
3. Solder the two twisted wires (rapidly so as not to melt the insulation). Cut off the excess wire, leaving about ¼ inch projecting on each side. Fold the wires back against the body of the line, in opposite directions from each other.
4. Tape securely for mechanical strength and weather protection. Install stand-off insulators on each side of the splice to take up mechanical strain.

Careful examination of the transmission line at critical points will indicate where the insulation is badly worn and where a new break is likely to occur. When the transmission lead passes obstructions such as TV antenna masts, beams, concrete ledges, window frames, etc., it should be taped for additional protection. Where the line makes sharp bends, it should be given plenty of slack. This is especially important near the antenna mast where slack is needed for antenna sway under strong winds.

A frequent cause of trouble is poor contact between the transmission line terminals and the antenna. In the course of checking the antenna installation it is a good idea to clean the contacts—soldering if necessary. This done, cover the connections with a plastic spray. In some areas where the soot in the air is found to be corrosive, the transmission line should be periodically wiped clean.

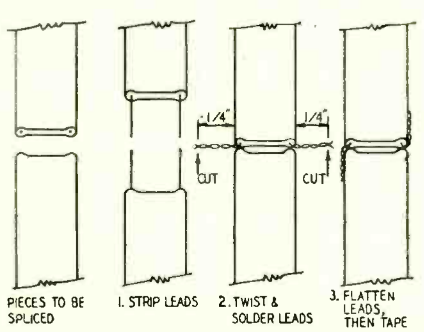


Fig. 3—Splicing 300-ohm transmission line for minimum change in impedance.

Mast work

Mechanical damage to the mast and mounting bracket is obvious on sight. The mast will probably be very rusty if it has been up any length of time. Rust is hardly a basis for replacement, however, because a new antenna will look about the same after it has been up several months in rainy weather. The antenna installation must be tested mechanically, by shaking it so as to simulate the effect of wind. While this is done the transmission line should be watched to see if it gets taut when the mast sways. Any movement of the bracket indicates that the masonry bolts need replacing. This should be done by drilling entirely new holes and inserting new bolts. Old holes have weak sides and are generally enlarged so that new bolts in the old holes will fare no better than the old bolts. In the case of chimney mounts, renewal is almost always in order since the comparatively thin material from which they are made rusts out easily.

Special tools and methods

During the course of several years' work in the field, I have devised certain tools which are especially adapted for simplifying the antenna repair job.

The first of these is a hundred-foot reel of heavy-duty rubber-covered a.c. wire for feeding a.c. power to the roof for soldering and drilling, for a roof-to-set telephone circuit, and for hoisting a tool box or parts to the roof.

Take a large empty reel, such as the one used for 1,000-foot Belden wire spools and cut a hole in its side for a female a.c. rubber receptacle to fit snugly. Connect the inside end of the spool's wire to this receptacle and hook up the free end to a male plug and a parallel female receptacle, as shown in Fig. 4.

The second "gadget" is a small battery box for supplying power to carbon telephones. A metal box 2 x 3 x 4 inches can be used. Mount a 4½-volt A bat-

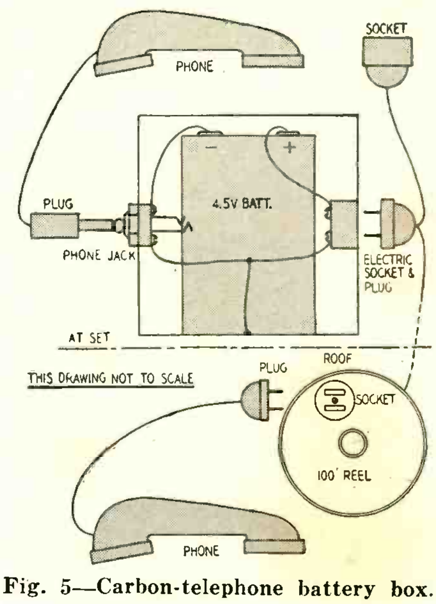


Fig. 5—Carbon-telephone battery box.

tery in the box with an open circuit phone jacks and female receptacle on opposite sides. The proper fittings are then mounted on the telephone hand sets, as shown in Fig. 5.

The service technician will find that the procedures outlined can save time and effort, and will create customer confidence and good will. END

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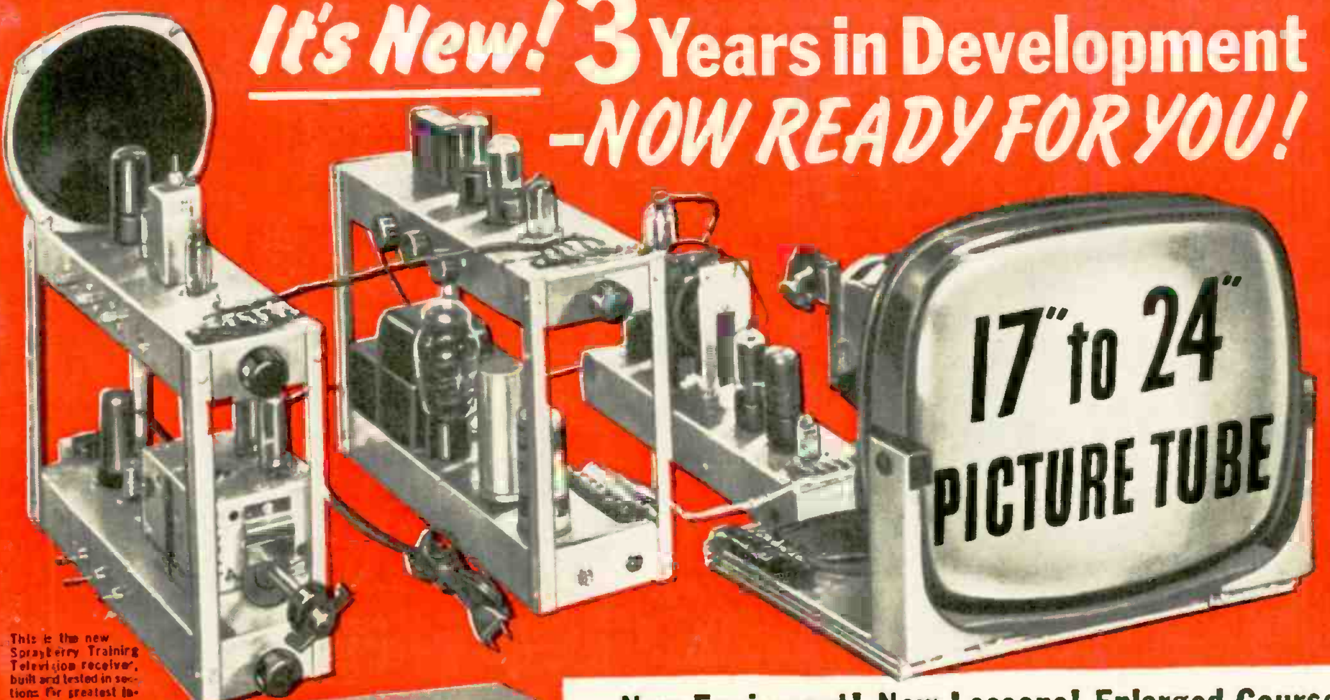

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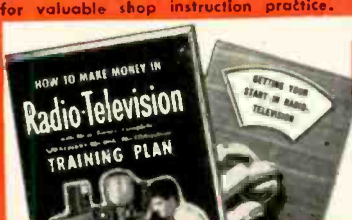

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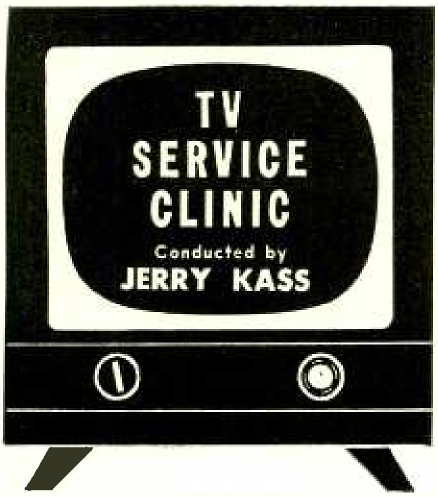


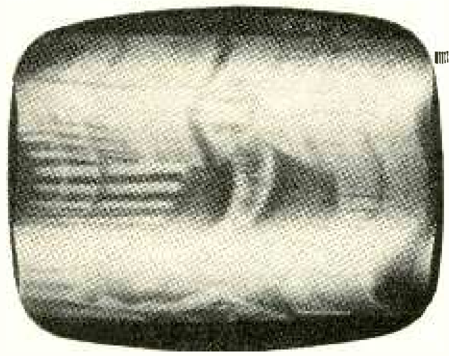


Fig. 1—Picture with 120-cycle hum.

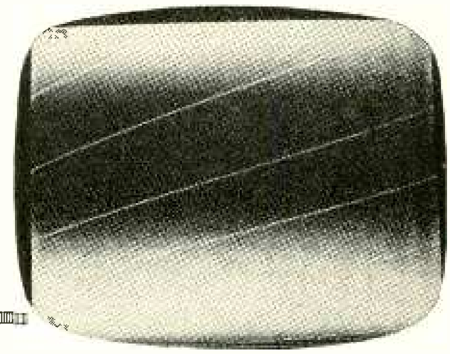


Fig. 2—A 60-cycle hum originating between sync take-off and C-R tube.

FEW defects in a TV receiver can be spotted as quickly as hum. Despite this, pin-pointing the faulty component or circuit is often very time-consuming. Because hum is not usually analyzed—most service technicians check one circuit after another at random—a great deal of effort is wasted. Fortunately, hum originating in different circuits has varying characteristics. In this discussion we will assume a TV receiver with the usual 60-cycle full-wave power supply.

Hum is the effect of either the 60-cycle heater supply or the 120-cycle low-voltage supply. Its effects appear on the screen by way of the deflection circuits, picture circuits, or both. When hum affects the raster, either as a horizontal bar (variation in brightness) or as a ripple along the edges, it will similarly affect the picture. However, it can appear in the picture without affecting the raster.

The first step in pin-pointing the source of hum is to determine whether it is 60 or 120 cycles. If there is one cycle of variation in brightness or edge curvature or a combination of both, it indicates 60-cycle hum — invariably caused by heater-to-cathode leakage. This effect can usually be obtained by connecting a resistor (100,000 ohms or larger) between the cathode of a tube and the ungrounded side of its filament supply.

Two cycles of variation in brightness or edge curvature or a combination of both indicates 120-cycle hum—invariably caused by a defective component, most often a capacitor, in the low-voltage power supply circuit.

120-cycle hum

The most common cause of 120-cycle hum is an open filter capacitor in the B plus or B minus supply, creating high 120-cycle fluctuations. If this occurs directly at the main power-supply filter, video and audio circuits could be affected. If it occurs only at one of the many B-supply paths, the ripple effect may be limited to some particular circuit.

If hum is caused by a defect in the B supply to the video amplifier, two hum bars will appear on the screen; they will appear on the raster, with or without a picture. See Fig. 1. If the hum is caused by a defect in the B supply to the r.f. or i.f. amplifiers, the bars will disappear when the last video i.f. amplifier tube is removed from its socket.

When the raster displays a 2-cycle change in width or height, appearing as modulation along the sides or top and bottom, it indicates the trouble lies in the B supply to the horizontal or vertical (rare) amplifiers. This affects the raster, and will appear with or without the picture.

Two cycles of horizontal S-shape variation—in the picture only—indicates trouble with the horizontal sync phasing. If the trouble is caused by the B supply to the horizontal a.f.c. or sync circuits, no bars will appear since hum will not usually reach the picture-tube grid. If hum is anywhere in the signal path, bars also will appear. (Fig. 1)

The best check for 120-cycle hum is to connect an electrolytic capacitor across each of the suspected capacitors and observe which one of them clears up the trouble.

60-cycle hum

Although there is a 60-cycle field around the power transformer and rectifier tube, it rarely causes any trouble. Virtually all 60-cycle hum can be traced to heater-cathode leakage in some tube where the 60-cycle current flows through the cathode resistor and modulates the signal. The greatest danger lies in high-impedance cathode circuits such as discriminators or second detectors. Thus, a tube with a slight heater-to-cathode leakage and causing hum may often be exchanged with a good tube from a low-impedance circuit. This will eliminate the hum, and the rejected tube will give no difficulty in many positions in the average TV receiver.

When one hum bar appears, remove the last i.f. amplifier tube. If the bar remains, it indicates a heater-cathode leakage in the video amplifier (Fig. 2). Since the video amplifier can pass a 60-cycle signal, heater-cathode leakage of any tube in the video amplifier will produce a hum bar regardless of whether or not the picture appears.

If the hum bar disappears when the last i.f. amplifier tube is removed, it indicates the faulty tube is in the i.f. amplifier or front end (r.f. amplifier, oscillator, or mixer).

Since the tuner and i.f. amplifier respond only to r.f. and i.f. signals, 60-cycle heater-to-cathode leakage cannot pass through to the video amplifier unless a signal which it can modulate is present.

A quick over-all check for heater-

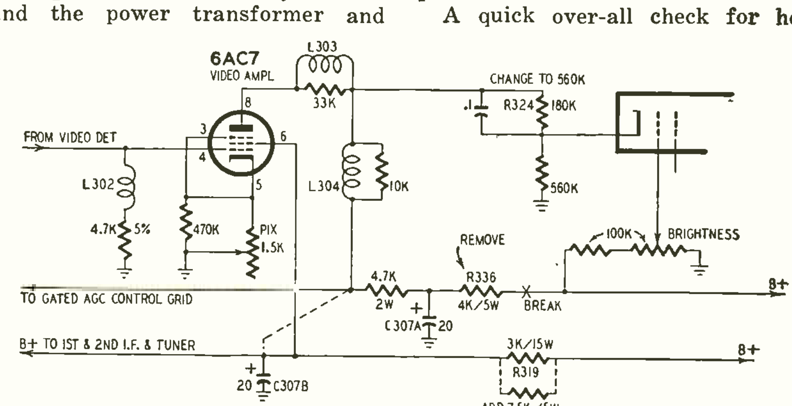


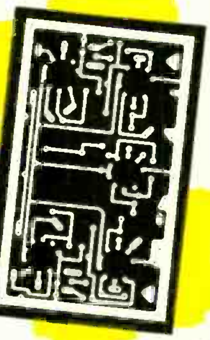
Fig. 3—Video amplifier of the 21F1 chassis. Some component values may vary with different production runs.

NEW 1955

Heathkit Engineering Features

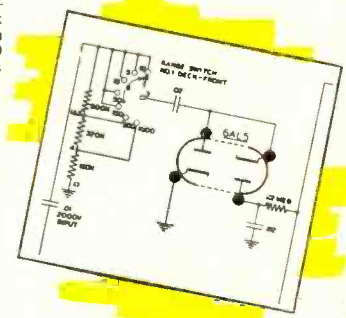
New PRINTED CIRCUITS

One of the many tremendous improvements in the new 1955 Heathkits is the use of an etched metal process printed circuit board. Printed circuits will be used in Heathkits whenever they will affect construction simplification, performance stabilization, and lend themselves to instrument design. Now for the *first* time a kit instrument company offers the advantages of modern printed circuit instrument construction technique. For the *first* time considerable attention has been given toward reducing kit assembly time. Also this is the *first* time that printed circuit boards have been hand soldered on a volume basis. Offered only by Heathkit, the pioneer and leader in kit instrument design.



New PEAK-TO-PEAK VTVM CIRCUIT

New 6AL5 full wave rectifier in AC input circuit permits full scale peak-to-peak measurements. Seven ranges — upper limits 4000 volts peak-to-peak. Just the thing you TV servicemen have needed in making TV circuit voltage checks. Precision resistor voltage divider limits AC RMS level to 150 volts. Prevents overloading the rectifier—extends upper limit AC RMS ranges to 1500 volts—further protects meter and circuitry against AC flash-over or arcing. Another definite example of continuing Heathkit design leadership in the kit instrument field.



New HIGH READABILITY PANELS

New 1955 Heathkits feature complete panel redesign. Sharp white lettering applied to the beautiful charcoal gray panels, provide a new high in readability. Lettering is easy-to-read open style and panel calibrations are vividly clear against the pleasing soft gray background. New knobs of exclusive Heathkit design.

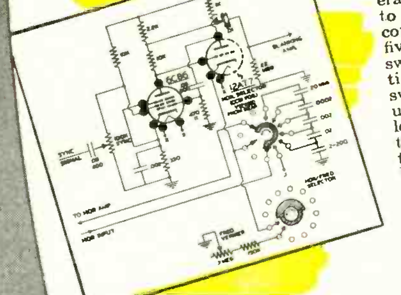
New 3" UTILITY SCOPE

The new 3" Scope is a "natural" for the well rounded line of Heathkit instruments. Small in size, 11¾" deep, 6½" wide, 9½" high, yet big in performance. Just think of the value, an Oscilloscope for $29.50. Brilliant intensity, sharp focusing, wide positioning range. An ideal portable Scope for the TV serviceman—a second shop scope—modulation monitor for you hams (deflection plate terminals in rear of cabinet). Performance to spare for all general scope applications. See specifications on following page.

New STYLING *New* COLOR

New styling and coloring is responsible for tremendous improvement in Heathkit appearance. The new instrument panel color combination is high definition white lettering in a soft charcoal gray panel. Cabinet color is a lighter feather gray. The satin gold baked enamel cabinet for the WA-P2 Preamplifier is further indicative of the modern pacesetting trend in Heathkit styling.

New SCOPE SWEEP CIRCUIT 10 CYCLES — 500 KC



New 1955 Heathkit Model O-10 Scope features a new wide frequency range sweep generator covering 10 cycles to 500,000 cycles. This coverage is available in five virtually decading sweep ranges and is five times greater than the sweep frequency range usually available. Excellent retrace time characteristics, actually less than 20% at 500 KC. Use of the free running Heath circuit provides a larger margin of stability and a new high in Heathkit Scope performance.

Continuing PROGRESS FUTURE LINE EXPANSION

The outstanding improvements featured in the 1955 Heathkit line are representative of the progress characterized by Heath Company operation. Long range planning will provide a continuing succession of new kit releases to further expand the Heathkit line which already represents the world's greatest selection of electronic kits. The innovations in the 1955 line, are representative of additional new models scheduled for release for the coming years.

SEE THE INSTRUMENTS ON THE FOLLOWING PAGES

HEATH COMPANY • • Benton Harbor 20, Mich.

cathode leakage would consist of shorting the cathodes of suspected tubes to ground temporarily; the hum will disappear when the faulty tube has been located.

A frequent hum problem is 60-cycle pulling of the picture without any hum bars on the screen. In such a situation, the trouble is probably in the sync separator or the horizontal a.f.c. circuit or oscillator. Heater-to-cathode leakage in these tubes causes changes in sync phasing which results in picture pulling. This effect will be present only with the signal, and can be checked by removing the picture (short the antenna terminals).

When the screen shows evidence of both 60-cycle hum bars and 60-cycle pulling, the indication is that the heater-to-cathode leakage is not in the deflection circuits but in the video signal path, prior to the sync take-off.

When pinning the trouble down to the video amplifier, include in your checking the video detector, d.c. restorer, the picture tube itself, and any other circuit that would respond to 60-cycle signals. Removing the last video amplifier tube provides a check on the C-R tube.

Very little has been said about hum in the vertical circuits. Since the hum and vertical scanning frequencies are the same, the usual effect of hum in these circuits is to distort the sweep into extreme nonlinearity that cannot be corrected by ordinary linearity adjustments.

Picture cutoff

I have in my shop an Admiral model 21F1. When no signal is coming in I have a good raster, but when I tune to a station, the picture goes dead. All the tubes check O.K. and all the resistance values seem to check. I have noticed that when the picture goes off there is too much negative bias in the video amplifier. Any information you could give me would be deeply appreciated. V. M., Franklin, N. Y.

Your trouble is due to blocking in the video amplifier. This condition is especially noticeable with strong signals which drive the video amplifier to cutoff. This set has direct coupling between the video amplifier and C-R tube. With the video amplifier cut off, B plus applied to the cathode of the picture tube will increase, making the grid voltage more negative with respect to cathode and driving the picture tube to cutoff.

Also since the gated a.g.c. tube is dependent upon voltage from the video amplifier for its operation, video amplifier blocking prevents a.g.c. voltage from being developed and the system remains blocked.

To correct this condition, the manufacturer suggests the following changes in the B plus circuit (see Fig. 3): Remove resistor R336 (4,000 ohms), isolating the brightness circuit from the plate supply of the video amplifier;

connect a 7,500-ohm, 5-watt resistor across R319; connect together the positive terminals of filter capacitors C307A and C307B (20 μf each); change resistor R324 in the video amplifier-to-picture tube circuit from 180,000 ohms to 560,000 ohms.

No raster

I have a Sentinel model 412 that has had an intermittent raster for some time. It has now gone off completely but the sound is normal. I have checked all tubes without success. What should I check for next? T. M., Bloomington, Ind.

This trouble is most likely caused by a defective component in the horizontal sweep circuit. First check the output-tube screen voltage for a possible open circuit. Also check the drive control capacitor for a possible short circuit.

Then check the horizontal lock coil in the horizontal oscillator circuit for a possible open circuit. The .001-μf coupling capacitor feeding the output tube grid is a frequent cause of trouble —it might be well worth while replacing it.

Next check the horizontal output transformer for open or partially shorted windings. When defective, the transformer will seriously distort the sawtooth wave. This can be quickly checked by observing the waveform across the linearity coil. A defective transformer will cause the waveform to appear as a ripple instead of a sawtooth.

Neck shadow

After converting a Video Products receiver, I ran into shadows at the edges of the picture that could not be eliminated. I have good vertical and horizontal sweep voltages. The ion-trap magnet and the focus coil are both properly adjusted on the 24AP4 picture tube. L. K., Chicago, Ill.

The condition you describe, neck shadow, can be caused by a number of things. Since you have checked the ion trap and focus coil adjustments, it will be necessary to locate the deflection yoke very carefully. Move the yoke as far forward along the neck of the tube as is physically possible. This is especially important in connection with the larger tubes.

Oftentimes the rubber bumpers on the front of the yoke holding bracket, or the difference between the yoke flare and that of the tube forces the yoke too far back along the neck of the tube. If this is the trouble, it will be necessary to obtain a better fitting yoke. This is not unusual since neck contours of various cathode-ray tubes may cause as much as ¼ inch difference in the forward movement of the yoke.

FM interference

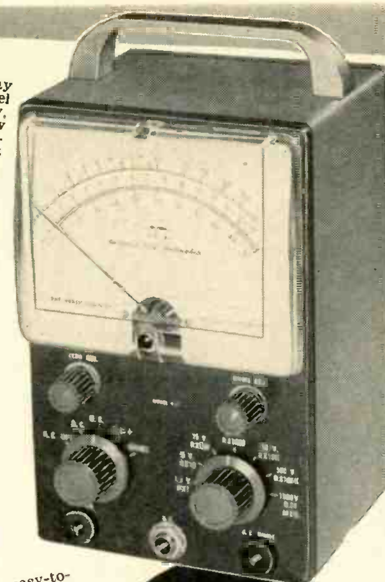
We are having considerable trouble on channel 9 which is 40 miles from us. A local FM station, WKJF, is located approximately 3 miles from us and causes a great deal of interference. We

NEW *Heathkit* VACUUM TUBE VOLTMETER KIT

PRINTED CIRCUIT DESIGN

New charcoal gray baked enamel panel with high readability, white lettering. New soft feather gray cabinet, subdued pilot light indicator.

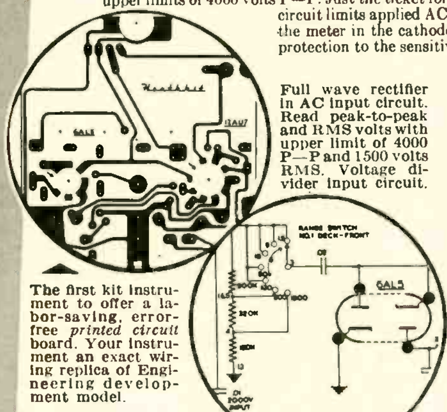
New printed circuit board for faster, easier construction—exact duplication of Lab development model



Another outstanding example of continuing Heath Company pioneering and leadership in the kit instrument field. A new **printed circuit** VTVM. New peak-to-peak circuit—new styling and new panel design. A prewired, prefabricated printed circuit board eliminates chassis wiring, cuts assembly time in half, assures duplication of Engineering pilot model specifications, and virtually eliminates possibility of construction error.

CIRCUIT:

A 6AL5 tube operated as a full wave AC input rectifier permits seven peak-to-peak voltage ranges with upper limits of 4000 volts P—P. Just the ticket for you TV servicemen. Voltage divider in the 6AL5 input circuit limits applied AC input to a safe level. This circuitry and the isolation of the meter in the cathode of the 12AU7 bridge circuit affords a high degree of protection to the sensitive 200 microampere meter.



Full wave rectifier in AC input circuit. Read peak-to-peak and RMS volts with upper limit of 4000 P—P and 1500 volts RMS. Voltage divider input circuit.

The first kit instrument to offer a labor-saving, error-free *printed circuit* board. Your instrument an exact wiring replica of Engineering development model.

RANGES:

Seven voltage ranges. 1.5, 5, 15, 50, 150, 500 and 1,500 volts DC and AC RMS. Peak-to-peak ranges 4, 14, 40, 140, 400, 1400, 4000. Ohmmeter ranges X1, X10, X100, X1000, X10K, X100K, X1 meg. Additional features are a db scale, a center scale zero position, and a polarity reversal switch.

New easy-to-read open panel layout. Off-on switch now incorporated in the selector switch.

MODEL V-7

$24.50

Shpg. Wt. 7 lbs.

IMPORTANT FEATURES:

High impedance 11 megohm input—transformer operated—1% precision resistors, 6AL5 and 12AU7 tube—selenium power rectifier— individual AC and DC calibrations—smoother improved zero adjust control action—new panel styling and color—new placement of pilot light—new positive contact battery mounting—new knobs—test leads included.

The new V-7 also sets the pace as a kit instrument style leader. Smart, good-looking charcoal gray panel and soft feather gray cabinet. High readability panel with sharply contrasting white calibrations. The pleasing, eye catching, modern styling is in harmonious balance with the outstanding circuit design improvements. Easily the best buy in kit instruments.

New peak-to-peak meter scale—new color harmony—new knobs.

Heathkit AC VACUUM TUBE VOLTMETER KIT

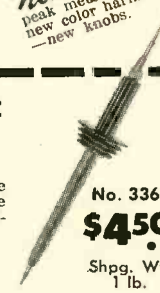
MODEL AV-2

$29.50 Shpg. Wt. 5 lbs.

Extreme sensitivity has been emphasized in the design of the Heathkit AC VTVM. Ten full scale RMS ranges are .01, .03, .1, .3, 1, 3, 10, 30, 100, and 300 volts. Frequency response is substantially flat from 10 cycles per second to 50 KC with input impedance of 1 megohm at 1 KC. Will accurately measure as low as 1 millivolt at high impedance. Total db range is —52 db to +52 db. An excellent kit for measuring the output of phono cartridges and the gain of amplifier stages. Use it also to check power supply ripple, as a sensitive null detector, and for compiling frequency response data. Features one knob operation, 200 microampere Simpson meter and precision resistors.

Heathkit 30,000 VOLTS DC PROBE KIT

Measure up to 30,000 volts DC with the Heathkit VTVM and the 336 high voltage Probe. Precision resistor provides multiplication factor of 100. Can be used with any 11 megohm input VTVM. Housed in a Polystyrene two color sleek plastic probe body for safety of operation.



No. 336

$4.50

Shpg. Wt. 1 lb.

Heathkit PEAK-TO-PEAK PROBE KIT

No. 338-C

$5.50

Shpg. Wt. 2 lbs.

Peak-to-peak values not exceeding 80 volts at a DC level of not more than 600 volts, can now be read directly by using 338-C Probe with previous model Heathkit VTVM's or any VTVM with 11 megohm input resistance. Probe construction features a modern printed circuit board for easy assembly. Frequency range 5 KC to 5 MC.

Heathkit RF PROBE KIT

The Heathkit RF Probe will permit the measurement of RF voltages up to 250 MC with an accuracy of ±10%. The limits are 30 volts AC and a DC level of 500 volts. Designed for any 11 megohm input VTVM. Modern styling, Polystyrene aluminum housing, Polystyrene insulation, and printed circuit board for easy assembly.

No. 309-C

$3.50 Shpg. Wt. 1 lb.

Heathkit AUDIO WATTMETER KIT

Read audio power output directly without using external load resistors with the new Heathkit Audio Wattmeter. Built-in non-inductive load resistors provide impedances of 4, 8, 16, and 600 ohms. Flat response from 10 CPS to 250 KC. Full scale power ranges are 0-5 MW, 0-50 MW, 0-500 MW, 0-5 W and 0-50 W. Model AW-1 will operate continuously at 25 watts and has a duty cycle of 3 minutes at 50 watts. Total db range in five positions is —50 db to +48 db, using the standard 1 milliwatt 600 ohms.

MODEL AW-1

$29.50

Shpg. Wt. 6 lbs.

HEATH company

BENTON HARBOR 20,
MICHIGAN

TELEVISION

have tried various stubs and traps but they have not been of any help. What do you suggest we do? J. M., Pittsburgh, Pa.

FM station WKJF broadcasts on 93.7 mc. The second harmonic of this would be 187.4 mc, which falls within the channel 9 band (186 to 192 mc). Thus the interference is that of second harmonic radiation of the FM station.

There is no way of separating the second harmonic of the FM signal from the fundamental of the TV signal. Both frequencies are the same and a tuned circuit or trap does not distinguish one from another. However you can correct the situation if the signals are coming from different directions. Try using a highly directional antenna such as the Yagi. If the interference is severe it may be necessary to use a separate antenna cut just for channel 9. Orient it for minimum interference.

Also check with other service technicians in your area. If this complaint is prevalent, you might check with the station as to whether they may be exceeding their permissible harmonic radiation.

Noise when picture appears

On a Motorola model VT107 the sound appears after the normal warm-up time (about 15 seconds). There is no high voltage and hence no raster for about 45 seconds, then there is a loud, piercing noise from the speaker and the raster and picture appear. This condition has prevailed for two months and does not seem to get worse. I have replaced all tubes in the horizontal sweep and high-voltage sections and all voltages test normal. The sawtooth voltage waveform appears at the grid of the 6BG6 prior to the noise. What can I do?—R. B., Lebanon, Pa.

This is caused by a defective component in the horizontal output or high-voltage system. The fact that you get a sawtooth voltage waveform at the grid of the 6BG6-G prior to the appearance of high voltage would confine the trouble to the horizontal amplifier tube or the transformer. The noise in the speaker when the high voltage appears would indicate that an arc closes a circuit to permit high voltage generation. First check the screen and cathode capacitors of the horizontal output tube. Also check for defective capacitors in the voltage-boost circuit in the cathode of the damper tube. These capacitors are connected to each side of the linearity-control coil.

It is also possible that you have an intermittent condition in the horizontal output transformer. Since high voltage appears only after warmup, check continuity quickly before the receiver has been on long enough to warm the transformer. Sometimes the heat generated in a receiver will expand the copper windings of a transformer enough to close a broken connection. Also make sure the 1B3-GT socket makes good contact with the tube pins and does not have a loose connection or cold-soldered joint. END

NEW *Heathkit*

TV ALIGNMENT GENERATOR KIT

MODEL TS-3

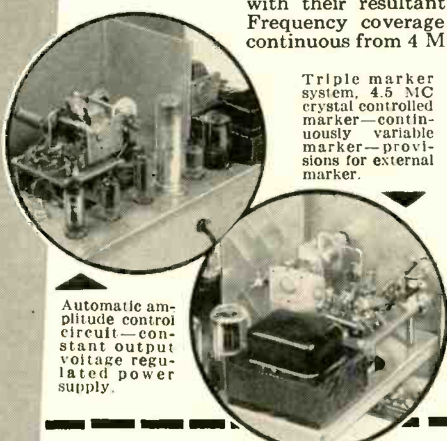
$44.50

Shpg. Wt. 18 lbs.

Here is the most radically improved Sweep Generator in the history of the TV service industry. The basic design follows latest high frequency techniques which result in a combination of performance features not found in any other sweep generator.

SWEEP:

Sweep action is obtained electronically through the use of a newly developed controllable inductor, thereby eliminating all moving parts with their resultant hum, vibration, fatigue, etc. Frequency coverage entirely on fundamentals, is continuous from 4 MC to 220 MC at an output level well over a measurable .1 volt.



MARKER:

The same instrument incorporates a triple marker system with a crystal controlled reference. A variable marker provides accurate coverage from 19 to 60 MC on fundamentals, and 57 to 180 MC on calibrated harmonics. A separate fixed crystal controlled 4.5 MC marker can be used for checking IF, bandpass, calibration, reference, etc. Provisions are also made for external marker use. A 4.5 MC crystal is supplied with the kit.

POWER SUPPLY:

The transformer operated Power Supply features voltage regulation for stable oscillator operation. Three sets of shielded cables are furnished with the kit. Sweep range is completely and smoothly controllable from zero up to a maximum of 50 MC, depending upon base frequency.

Here is a TV Sweep Generator that truly no serviceman can afford to be without for rapid, accurate, TV alignment work.

NEW *Heathkit*

SIGNAL GENERATOR KIT

MODEL SG-8

$19.50 Shpg. Wt. 8 lbs.

The new Heathkit service type Signal Generator, Model SG-8 incorporates many design features not usually found in this instrument price range. Frequency coverage is from 160 KC to 110 MC in five ranges, all on fundamentals, with useful calibrated harmonics up to 220 MC. The RF output level is well in excess of 100,000 microvolts throughout the frequency range. The oscillator circuit consists of a twin triode tube, one-half used as a Colpitts oscillator, and the other half as a cathode follower output which acts as a buffer between the oscillator and external load, thereby eliminating oscillator frequency shift usually caused by external loading.

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

Heathkit

LABORATORY GENERATOR KIT

MODEL LG-1

$39.50

Shpg. Wt. 16 lbs.

The new Heathkit Laboratory type Signal Generator definitely establishes a new performance standard for a kit instrument. An outstanding feature involves the use of a panel mounted 200 microampere meter calibrated both in microvolts and percent modulation, thereby providing a definite reference level for using the Signal Generator in design work, gain measurements, selectivity, frequency response checks.

DESIGN:

Additional design features are copper plated shield enclosure for oscillator and buffer stages resulting in effective double shielding. Fibre panel control shaft extensions in RF carrying circuits, thorough AC line filtering, careful shielding of the attenuator network, voltage regulated B plus supply, selenium rectifier, etc.

RANGES:

Frequency coverage from 150 KC to 30 MC all on fundamentals in five separate ranges. Output voltage .1 volt with provisions for metered external or internal modulation. Output impedance termination 50 ohms. Transformer operated power supply.

Investigate the many dollar stretching features offered by the LG-1 before investing in any generator for Laboratory or Service work.

NEW *Heathkit* BAR GENERATOR KIT

MODEL BG-1

$14.50 Shpg. Wt. 4 lbs.

The Heathkit BG-1 produces a series of horizontal or vertical bars on a TV screen. Since these bars are equally spaced, they will quickly indicate picture linearity of the receiver under test without waiting for transmitted test patterns. Panel switch provides "standby—horizontal and vertical position." The oscillator unit uses a 12AT7 twin triode for the RF oscillator and video carrier frequencies. A neon relaxation oscillator provides low frequency for vertical linearity tests. The instrument will also provide an indication of horizontal and vertical sync circuit stability as well as overall picture size. Operation is simple and merely requires connection to the TV receiver antenna terminal. Transformer operated for safety.

HEATH company

BENTON HARBOR 20, MICHIGAN

TELEVISION

A SUPERUNUSUAL CASE

By GEORGE R. ANGLADO

Of all the TV receivers that ever came into our shop, never have we run across as unusual a problem as happened on a Transvision A television chassis.

This chassis is sold as a kit, and makes a very good set. The manufacturer guarantees it to perform if put together according to instructions and if no tinkering is done to the preset alignment screws. We have seen one of these kit sets wired up and working fine, but when our customer finished his it just wouldn't work! The trouble was no sync and a very weak picture.

Checking the wiring against the schematic and parts list, we found the customer had done a good construction job. All voltages measured O.K. Our next step was to start replacing tubes one by one until the faulty one was found (that is, *if it was a tube*). Starting with the tuner, we replaced all the tubes in this section, all the video-i.f. tubes, the horizontal oscillator and amplifier tubes, vertical oscillator and amplifier tubes, and finally the horizontal phase-detector, all with no change. Also, we even tried replacing the high-voltage rectifier and the damper, with no success.

Finally we were down to one last tube—the 6SN7 second sync amplifier-phase inverter. When we pulled this one out of its socket the picture jumped out on the screen like a poor soul finding a doorway out of hell. This, we thought, was our culprit. All we had to do now was put in a new tube. But, even at that, why did the set work *with the tube out?* We plugged in a new 6SN7, and—you guessed it—the picture disappeared again!

Well, we were just about ready to give it up and write the manufacturer when we decided to try one thing more—replace every resistor and capacitor in the second sync amplifier-phase inverter circuit. This changed absolutely nothing at all as far as the trouble was concerned, and was a total waste of time (so we thought, and so you are probably thinking). *But* . . . in putting back the original parts, we accidentally soldered in a .05-μf capacitor instead of the .005-μf unit supplied by the manufacturer. (This is capacitor C in the schematic on page 79.) Instantly the picture jumped up again on the screen! This really had our heads spinning. We then removed the 6SN7 and the picture went out again!

Brother! After that we figured it was time to close up shop and go into some kind of legitimate business, like politics.

We would like to know (very, very much so) how the devil did the set play with the 6SN7 out of its socket—that is, *before* the .05-μf capacitor was put in by mistake? Why didn't this trouble happen on a previous set of

(*Continued on page* 79)

NEW *Heathkit* HIGH FIDELITY PREAMPLIFIER KIT

Here is the exciting new Heathkit Preamplifier with all of the features you Audiophiles have asked for and at a down-to-earth price level. Beautiful satin gold baked enamel finish, striking control knobs and arrangement, attractive custom appearance and entirely functional design.

DESIGN:

Uses three twin triode tubes in a shock mounted chassis, 2-12AX7 and 1-12AU7. Features tube shielding, plastic sealed color coded capacitors, smooth acting controls, good filtering, excellent decoupling, low hum and noise level, and all aluminum cabinet. Special balancing control for absolute minimum hum level. Cathode follower, low impedance output circuit for complete installation flexibility.

SPECIFICATIONS:

Provides five switch selected inputs, 3 high level, and two low level, each with individual level controls—4 position LP, RIAA, AES, and early 78 equalization switch—4 position roll-off switch, 8, 12, 16 with one flat position. Separate tone controls, bass 18 db boost and 12 db cut at 50 CPS, treble 15 db boost, and 20 db cut at 15,000 CPS. Power requirements from Heathkit Williamson Type Amplifier power supply 6.3 volts AC at 1 ampere, and 300 volts DC at 10 MA. Over-all dimensions 12 9/16" wide x 5 7/8" deep x 3 5/8" high.

APPLICATION:

The new Heathkit WA-P2 Preamplifier has been designed to operate with any of the Heathkit Williamson Type Amplifiers and is directly interchangeable with the previous Model WA-P1 Preamplifier unit. Order your kit today and enjoy completely smooth control over the operation of your Hi-Fi system. Obtain the exact tonal balance of bass and treble with the precise degree of equalization you want. Note that the design of the WA-P2 accommodates the newly established RIAA curve.

MODEL WA-P2
$19.75
Shpg. Wt. 7 lbs.

HAM EQUIPMENT

Heathkit AMATEUR TRANSMITTER KIT

The Heathkit AT-1 Transmitter has established a high reputation and has been enthusiastically accepted by hundreds of experienced operators as well as beginners. Power input up to 35 watts for the novice and suitable as a standby exciter for your higher powered rig later on.

Model AT-1 can be crystal or VFO excited and operates on 80, 40, 20, 15, 11 and 10 meters. The prewound coils with the oscillator and amplifier are switched simultaneously by the rugged band switch. Meter switch allows a reading of the final grid and plate current on the panel mounted meter. Modulator input and VFO power sockets are provided as well as a key jack for CW operation. Other features include a crystal socket, standby switch, key click filter, AC line filter, good shielding and a 52 ohm coaxial output. The 425 volt, 100 milliampere power supply and 5U4 rectifier are more than adequate for the 6AG7 oscillator multiplier and 6L6 amplifier doubler.

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

Brand NEW HEATHKIT VFO KIT

The new Heathkit VFO is the perfect companion to the Heathkit Model AT-1 Transmitter and it has sufficient output to drive any multi-stage transmitter of modern design. Good mechanical and electrical design insures operating stability. Coils are wound on stable, heavy duty, ceramic forms using Litz or double cellulose wire coated with Polystyrene cement and baked for humidity protection. Variable capacitor of differential type construction, especially designed for maximum bandspread. Kit is furnished with a carefully precalibrated scale which provides well over two feet of scale length. Smooth acting vernier reduction drive and illuminated dial provides easy tuning and zero beating.

Power requirements 6.3 volts AC at .45 amperes, and 250 volts DC at 15 mils. Just plug it into the power receptacle provided on the rear of the AT-1 Transmitter. Seven band coverage 160 through 10 meters with 10 volt average RF output. Uses 6AU6 electron coupled Clapp oscillator and OA2 voltage regulator.

MODEL VF-1
$19.50
Shpg. Wt. 7 lbs.

Heathkit GRID DIP METER KIT

The invaluable instrument for Hams, servicemen and experimenters. Useful in TV service work, for alignment of traps, filters, IF stages, peaking compensation networks, etc. Locates spurious oscillation, provides a relative indication of power in transmitter stages. Use it for neutralization, locating parasitics, correcting TVI, measuring CL and Q of components, and determining RF circuit resonant frequencies. The variable meter sensitivity control, headphone jack, 500 microampere Simpson meter, continuous frequency coverage from 2 MC to 250 MC. Prewound coil kit and rack included.

LOW FREQUENCY COILS:

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An excellent example of typical Heath Company ability to produce top quality kit merchandise at ridiculously low prices, is the AR-2 Communications Receiver. Here is a transformer operated all-wave receiver with all of the desired features and none of the disadvantages commonly encountered in so-called "economy sets."

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Uses 12BE6 mixer-oscillator, 12BA6 IF amplifier, 12AV6 detector-first audio, 12A6 beam power output, 12BA6 BFO oscillator, and 5Y3 rectifier. A lettered control plate is provided for the cabinet of your choice or you can order the optional Heathkit cabinet featuring the full size aluminum panel.

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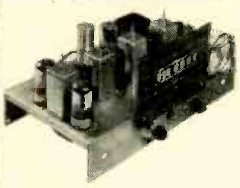

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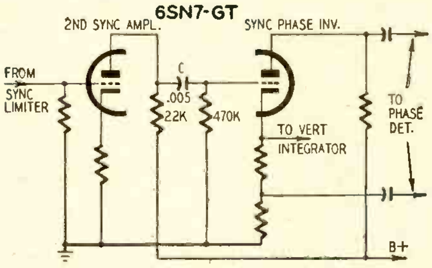
(*Continued from page* 74)
exactly the same type? And why, when a *new* .005-μf capacitor was installed, did the picture disappear again?



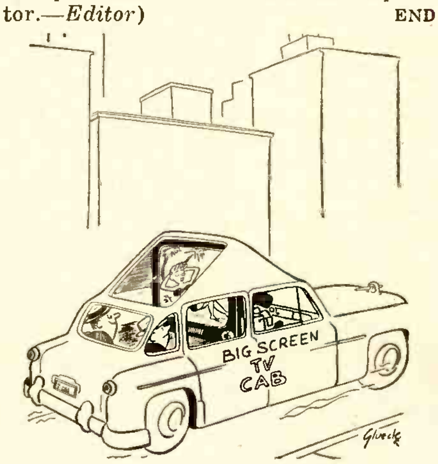
If you can answer these questions you deserve the $64!

(Mr. Anglado's problem was referred to Dave Gnessin of Transvision, Inc. Here, in substance, is Mr. Gnessin's analysis of the problem. Have you a better guess?

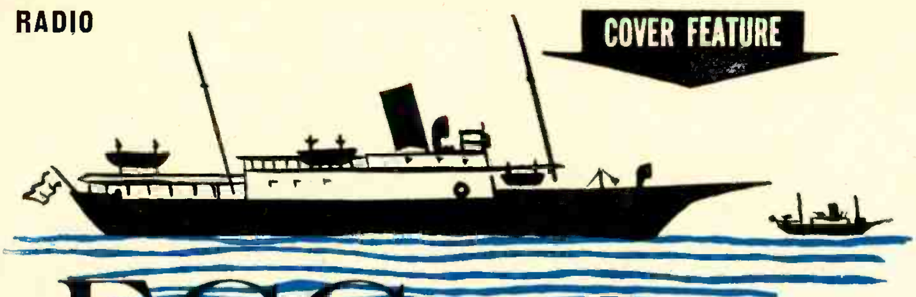
The .005-μf capacitor couples the plate of the second sync amplifier to the grid of the sync phase inverter. All sync signals pass through it. If this capacitor was shorted or leaky—this can happen in the best of sets—it would put B plus on the phase-inverter grid, blocking that section of the tube and removing sync action *while the tube was in its socket*. Removing the tube stops the blocking action, and cuts out *some* of the sync amplification.

But the Transvision model A chassis has an exceptionally high-gain sync system. There are two stages—the first sync amplifier and the sync limiter—ahead of the 6SN7 that caused the trouble here. Thus even with our problem 6SN7 out of its socket, enough high-level sync could leak across the socket and wiring capacitance to trigger the horizontal and vertical oscillators for normal action.

Now as to why the set wouldn't work after the .005-μf capacitor was replaced with a new one—presumably good: The grid of the original 6SN7 may have been contaminated with oxide pulled off the cathode by the positive grid voltage leaking through the defective capacitor, or the tube may have become gassy from the same cause. This would effectively short out the entire sync circuit at this point if the original tube was put back—even with a new capacitor.—*Editor*) END



COVER FEATURE



FCC BOOSTS MARINE RADIO

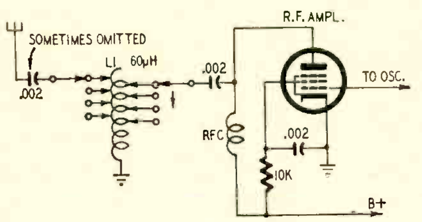
Government regulation supplies buffer for off-season slump

By ELBERT ROBBERSON

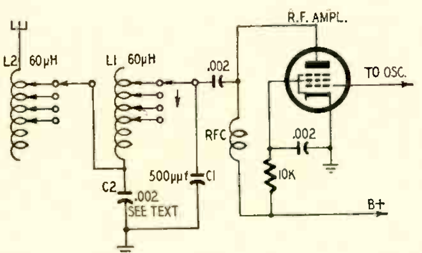
SERVICE technicians in the marine radio business have had extra business thrown their way by a couple of recent FCC rulings. Section 8.351 (d) of the Regulations now requires all small-boat radiotelephone licensees to certify that 2nd-harmonic radiation of the vessel's transmitter at the intership frequency of 2738 kc is 40 db below the unmodulated carrier level before being permitted to use that frequency. This is a technical requirement which other services have had to meet for years.

All that is needed is a fairly civilized transmitter circuit, proper adjusted. The "kicker" is that many phones (even from "name" manufacturers) use transmitter circuits that are definitely *un*civilized. Taming these transmitters makes a good slack-season project, and will put a lot of boats back on 2738 kc that the regulation has crowded onto the groaning 2638-kc intership channel. Here is how to do it:

The main design features necessary to keep low-order harmonic radiation at a minimum have long been known: a high-Q output tank circuit; an antenna coupling means, preferably low-pass, that permits optimum loading, and an antenna resonant at the fundamental frequency. Naturally, shielding and grounding are important, but it will be assumed that these features are adequate, since most of the interference is caused by current that gets out through the antenna wire. Let's see how the marine radiophones stack up.



a



b

Fig. 1-a—Basic r.f. output circuit.
Fig. 1-b—Output-circuit modification.

The one-coil transmitter

The main reason for excessive 2nd-harmonic interference from marine radiotelephones is the unbelievable popularity of the circuit shown in Fig. 1-a. Without going into the auxiliary wiring such as control relays, this diagram shows the basic r.f. output circuit of at least 10 of the most popular makes of radiotelephones afloat.

This circuit consists of a pentode or beam-power r.f. amplifier, with a dual bandswitch tapping the tube plate circuit and the antenna onto different points of the tank coil for different marine-band frequencies (2110 to 2738 kc).

One-quarter wave in this band is in the neighborhood of 100 feet, so the average marine antenna of from 18 to 50 feet acts like a capacitor. Tapping it onto different turns therefore changes the resonant frequency of the tank. The tube also acts as a capacitor, so it also has a tuning effect. Both adjustments are juggled to tune both circuits match impedances, and vary the coupling.

Fig. 1-a contains several very bad design features: The plate tank cannot help but have very low Q, with a total effective capacitance across it of from only 100 to 200 $\mu\mu$f, and with the antenna resistance directly connected. Antenna loading is usually a bad compromise between several possible adjustments: The antenna often must be tapped across a major portion of the coil for the plate circuit to approach resonance, and in this position, loading is so heavy that downward modulation often results. The antenna is usually connected through a capacitor, which naturally offers less impedance to the flow of harmonic currents than to the fundamental. Add to these the fact that the tank circuit is actually in the form of a high-pass filter, and that a short antenna favors harmonics, and it is no wonder a lot of messy signals exist.

At first glance, this type of transmitter may look like a hopeless case. But the owner may have an investment of from $250 to $1,500 in one of these clunkers, so even a piece of junk is worth salvaging. Fortunately, modifications necessary to bring the set up to modern standards are not too extensive or expensive.

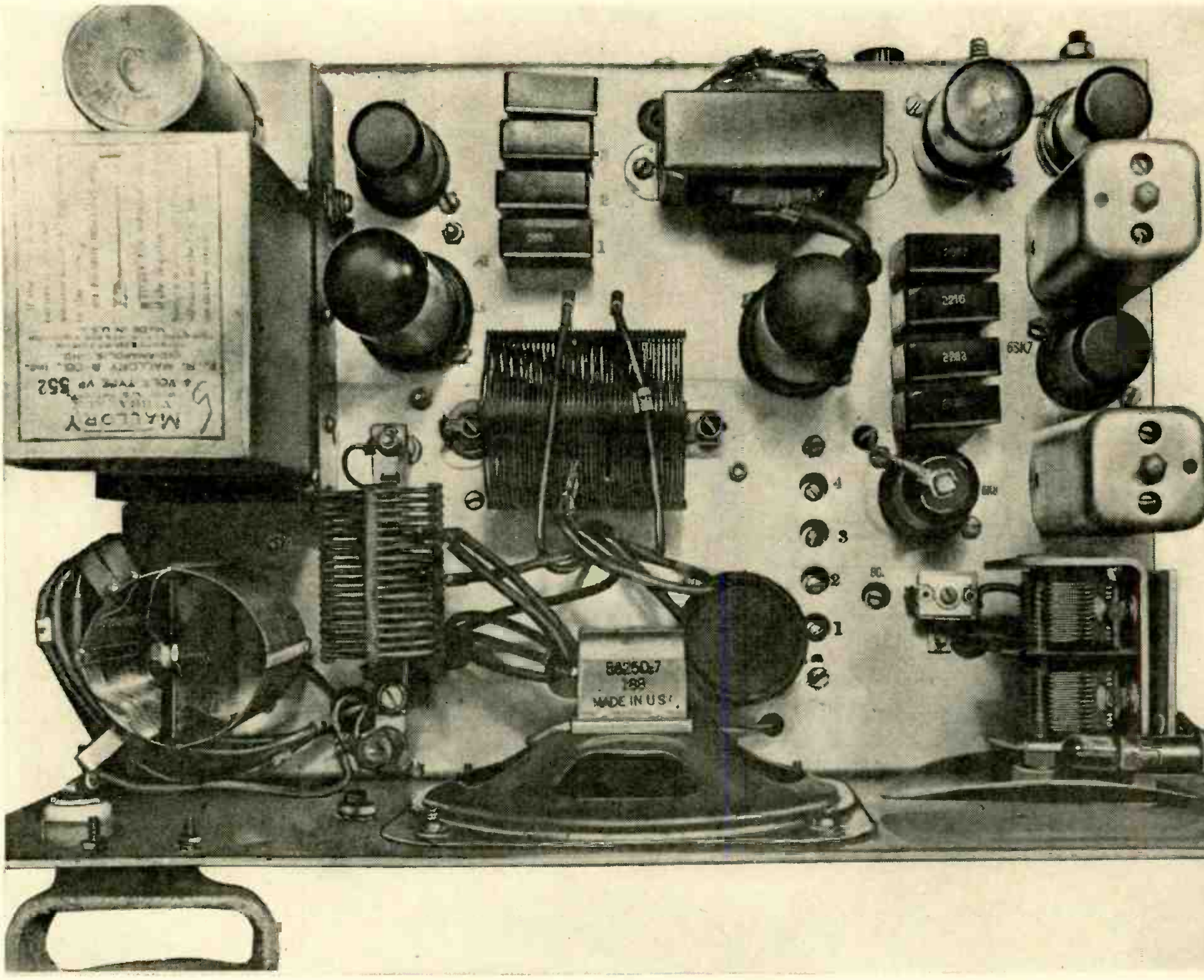
A modification that conforms to acceptable engineering practice in all respects and which should reduce harmonic radiation to the required amount is shown in Fig. 1-b.

Both diagrams show shunt plate feed. However, some of the offending transmitters use series feed, with the d.c. plate voltage fed directly through the tank coil. For safety, as well as to ease harmonic reduction, these outfits should be changed to use shunt feed.

Only three components must now be added: Tank-capacitor C1, antenna coupling capacitor C2, and antenna resonating coil L2. These will be discussed later.

A high-Q tank circuit is one of the most potent means of harmonic reduction in an r.f. amplifier. This calls for a fairly high tank capacitance. With the approximately 5,000-ohm plate resistance of the 6L6 and 807 tubes, commonly used in the marine telephone band, a capacitance of 500 $\mu\mu$f will give an operating Q of about 12, which approaches optimum. Although it is contrary to usual amateur, broadcasting, and up-to-date commercial practice, the tank capacitance can remain fixed at this value, with tank tuning adjustments made by the original plate-coil clips.

Output capacitor C2 provides a coupling means which by itself will attenuate harmonics. While the value on the diagram is .002 μf, the exact value for each installation (because of varying antenna resistance) must be determined on the job. Provision therefore should be made for varying this



Chassis of typical small-boat radiotelephone.

capacitance from .0015 to .0025. A variable capacitor or a set of fixed 100-$\mu\mu$f capacitors will serve this purpose.

Less capacitance increases antenna coupling and raises tube plate current at tank resonance; more capacitance decreases coupling and lowers operating plate current. A value of capacitance should be used for C2 which will load the tube to its proper plate current when both the tank and antenna are resonant. Once determined, this value will remain the same on all channels, so no further change will be required. Both capacitors should be high-grade mica or zero-coefficient ceramic rated for at least 2,500 volts, or peak plate voltage, if this is higher.

The tank circuit is now in the form of a low-pass filter.

If the antenna were ¼-wavelength long, it could be connected directly between L1 and C2. However, very few boats can carry the 85 to 111 feet of antenna required, so a loading coil is almost invariably used. The coil is tapped onto for the different channels by Johnson coil clips and flexible leads connected to the original antenna switching wafer in the band-switch.

The antenna loading coil should be chosen for high Q, consistent with reasonable dimensions, and should be mounted so there is no magnetic or capacitive coupling to the tank circuit.

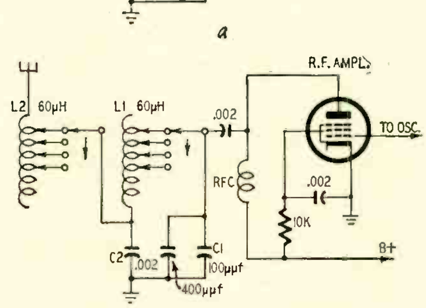


Fig. 2-a — An improved circuit design.
Fig. 2-b—Tank capacitance increased.

Six inches of B & W No. 3907-1 tinned coil stock should provide sufficient inductance to resonate the smallest antenna afloat. However, a heavier coil will give better antenna efficiency.

Two- and three-coil transmitters

Radiotelephones of later and better design have concentrated on the circuit form of Fig. 2-a. Sometimes the tank inductance is composed of one coil, with antenna coupling provided by tapping onto a few turns at the bottom of the coil, or by a link. The circuit shown, with a small 1-inch diameter coil, L3, of about 5 μh at the bottom of the main coil, permits a finer degree of coupling adjustment because of its lower inductance per turn.

Although this circuit looks almost like the improved system of Fig. 1-b, a couple of defects exist that in some instances may result in objectionable harmonic radiation.

The first defect is the small tank capacitance used in most equipment, a capacitance of around 100 $\mu\mu$f. This practice comes from competition between manufacturers, each trying to have the highest carrier output. With lower than the proper value of capacitance, tank-coil heat loss is low, resulting in slightly higher output. The trouble is that harmonic output is also higher.

The combination of too small a tank capacitor and close antenna coupling can increase harmonic radiation beyond the danger point, even though the same transmitter, properly adjusted, may pass inspection with a good safety margin.

Two safety measures are apparent: Increase the value of the tank capacitance to about 500 $\mu\mu$f and decouple the antenna to a point just below that which gives maximum output. Some marine transmitters may then overmodulate, but this can easily be eliminated by reducing mike sensitivity or a.f. gain.

To be absolutely safe, the extra coil, L3, can be removed. Then the same system can be used for coupling the antenna as was shown in the case of the one-coil transmitter. This is shown in Fig. 2-b, together with a 400-$\mu\mu$f auxiliary capacitor, required to bring tank capacitance to 500 $\mu\mu$f, which is not a bit too large.

Pi-network tank circuit

A telephone transmitter which has almost all of the characteristics for lawful operation—but not quite, in every instance—is the kind using a pi-network output circuit feeding an antenna directly. As mentioned previously, this arrangement will suffice for self-resonant antennas; or it would be perfectly satisfactory with a *flat* transmission line or other purely resistive load.

But the usual marine antenna is shorter than the resonant length and therefore highly reactive, as well as susceptible to harmonic currents. Using part of the tank coil to cancel antenna reactance (as is necessary in this case) has the effect of coupling the antenna directly into the tank, since the same turns of wire act to resonate both the tube circuit and the antenna. Thus a supposedly low-pass harmonic-suppressing circuit can give as much trouble as any other.

The solution is simply to add a separate antenna-resonating coil as shown in the previous examples. The network will then be working into the proper resistive load. Of course the tank capacitance must still be checked, to make sure it is large enough for reasonable operating Q.

Filters and traps

Besides the pi-network or low-pass filter shown in the previous circuits, there are other forms which under certain conditions may be used. Simplest examples are the parallel- and series-tuned wavetraps which have long been used to knock out receiver interference. However, it is extremely important not to look on traps as a cure-all. Marine-radio transmitting conditions are greatly different from those of broadcast or television. The kind of trap that will kill off spurious signals in a receiver may succeed *too* well in the marine radiophone—and kill off not only the harmonic but often the carrier as well.

In fact, the only advantage to the conventional wavetrap is that it can be connected in the transmitter antenna lead without digging into the equip-

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ment. But even a good antenna trap may reduce signal power.

The care with which filters must be applied to antenna circuits is governed by the fact that the radiation resistance of the average small-boat antenna is very low. For example, a typical 18-foot antenna has a radiation resistance of only 1 ohm. A wavetrap built according to receiver standards would have much more resistance, and even one carefully constructed of high-grade commercial small-coil stock cannot equal this figure. Thus, if there were no other losses, more than half of the transmitter power would be lost in the trap!

The forms of traps which might be used in antennas are shown in Fig. 3. All of them are tuned to the 2nd harmonic. First is the familiar parallel trap (Fig. 3-a), which is effective,

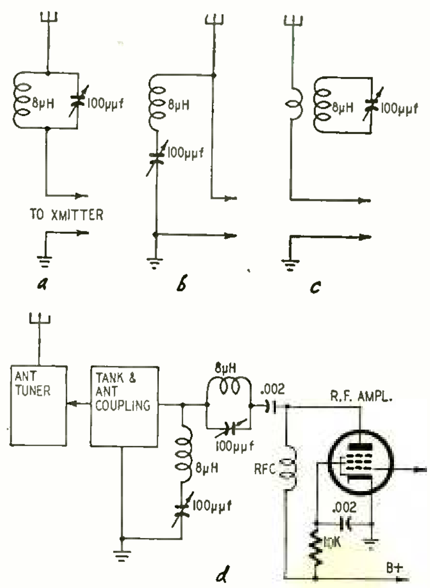

Fig. 3—Various types of antenna traps.

provided the antenna is long enough to have a radiation resistance much greater than the resistance of the trap. Fig. 3-b shows a series trap sometimes recommended, but which presents a shunt reactance to the antenna, which acts the same as a low-grade short circuit. Fig. 3-c shows a superior form of parallel-tuned trap which removes most of the harmful extra coil resistance from the antenna circuit.

Because all of them are likely to upset short-antenna performance, wavetraps should not be used indiscriminately. If they *must* be used, one or both of the connections shown in Fig. 3-d is recommended. Resistances in the tube plate circuit are not as critical as in the antenna, and the main effect plate traps will have is the introduction of a small reactance in the circuit which is easily canceled by the tank tuning control.

To be effective, traps must be physically small and preferably shielded, or located so their circulating currents cannot be coupled back into the antenna. For the 2nd harmonic of 2738 kc, a variable capacitor of 100 μμf and an inductor of 8 μh should be used. This amounts to about 1½ inches of a B & W No. 3015 Miniductor.

External circuits

A broadcast engineer can make sure that no outside wires or structures interfere with his antenna. However, his cousin installing radiophones on boats cannot. If there is one thing a boat has much of, it is yards and yards of wire hanging around. Some of these wires may be just the right length to resonate at a harmonic frequency. There have been cases where such wires, in the transmitter field, have radiated harmonics that would not have escaped via the regular antenna. They can get this harmful current either by induction or shock excitation. In installing equipment, keep this fact in mind so that offending circuits may be isolated, grounded, or broken with insulators. The resonant frequency of suspected wires can be measured with a grid-dip oscillator.

Another condition that may aggravate matters is supplying the grid of the r.f. output tube with too much grid drive. Not many marine radiophones suffer from this, but the possibility should be considered if other steps are not completely effective.

Measurements

Some phone transmitters are certified by their manufacturers to conform to the FCC rule. But in any event, it is necessary to make actual measurements of harmonic radiation as a final check, and a certification of this measurement is required by the FCC.

This work should be done with the equipment installed and tuned. It cannot safely be done on the bench, since both the transmitter adjustment and the antenna are important elements in forming the character of the output. The care which must be taken can be seen from the fact that a reduction of 40 db amounts to a harmonic power output of only *one ten-thousandth* of the carrier level.

A commercial field-strength meter would be ideal, but a communications receiver can be used. A check to determine the approximate level of the harmonic for preliminary job study can be made with the receiver's S meter. Each S point should amount to 6 db. However, for more accurate work leading to certification this calibration should be checked against a calibrated signal source, such as a laboratory-type signal generator.

By taking care of transmitter harmonic reducing modifications, and other radiotelephone refinements such as adding "deck-calling," and dual channel reception for the International Calling and Distress Frequency, 2182 kc, and by manufacturing antennas and other accessories (possible in any shop), service technicians in the marine radio business can make the otherwise quiet lay-up season very profitable. END

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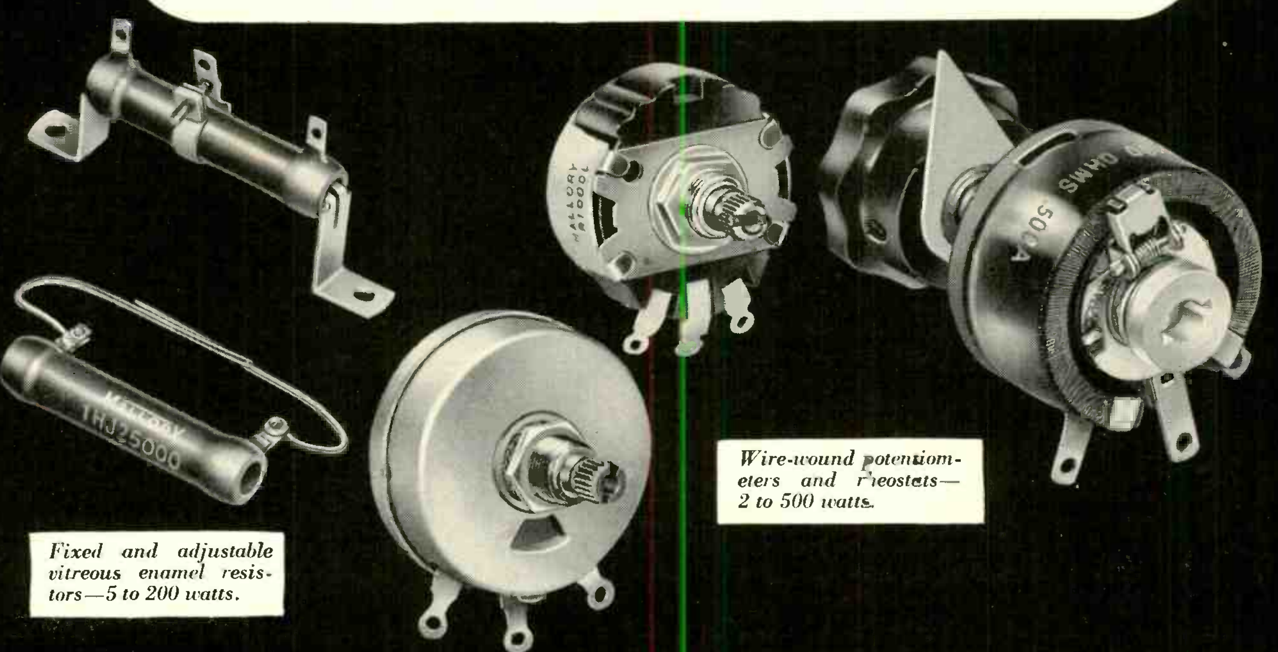

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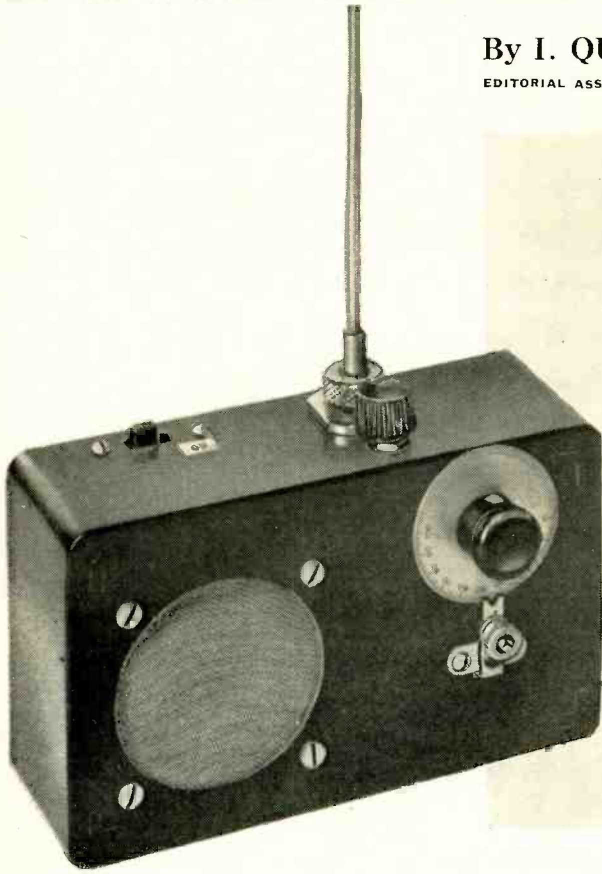
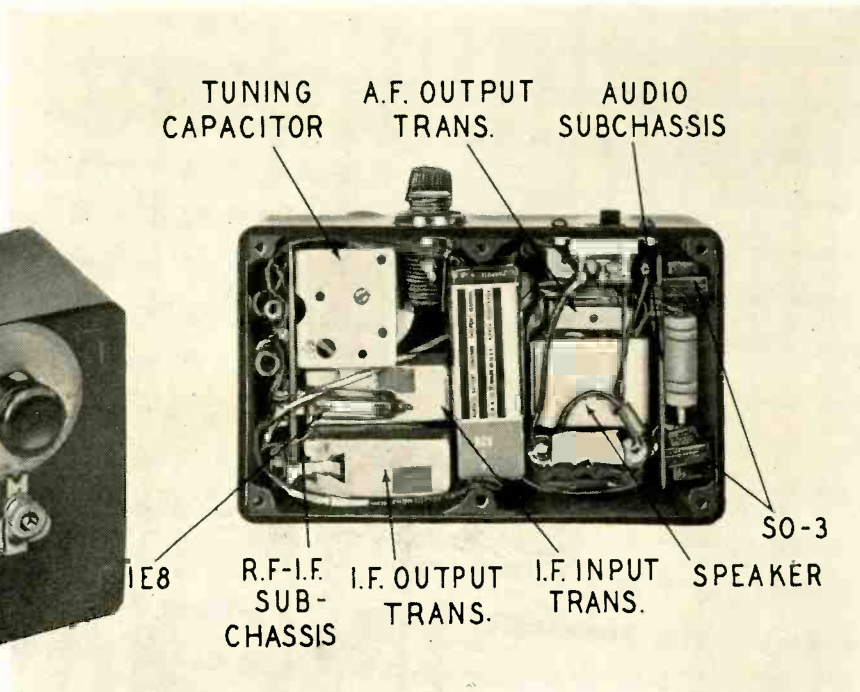
A MORE COMPACT BATTERY PORTABLE

By I. QUEEN
EDITORIAL ASSOCIATE





Left—The hybrid tube-transistor battery receiver. Fig 2, above—Rear view mentioned in Figs. 4 and 5.

LAST summer I constructed a superhet portable, described in the March, 1954, issue. In building it, the smallest parts available (at reasonable prices) were used. Since then I located smaller components which made it possible to reduce the set size by more than half. The circuit is essentially the same as before (Fig. 1).

The entire set is now housed in a plastic case only 6 x 2 x 3¾ inches. The rear of the box is removable (Fig. 2). The speaker is mounted within the box and faces the front, and the r.f. and i.f. circuits are mounted on a bakelite subchassis 3⅜ x 1½ inches (Fig. 3). This portion, including up to the crystal detector, is visible at the *left* in the Fig. 2 photo.

The variable capacitor used in this layout has a maximum dimension of 1¾ inches, and is considerably smaller than the one used in last year's set. It is made by the Variable Condenser Corp. (Brooklyn, N.Y.) All wiring and small components are beneath the subchassis, an area ½ inch deep. The antenna coil is a Vari-Loopstick. I changed the oscillator coil to Meissner No. 14-1074 which has an iron core completely within the winding—there is no protruding screw. Anything larger than this coil won't fit into the allotted space.

All audio components are mounted on a bakelite subchassis approximately 1 x 3 inches (Fig. 4), which also appears at the *right* of the Fig. 2 photo. This subchassis is mounted on the speaker. I had to drill the iron bracket surrounding the speaker magnet to do this. To hold the components in place I also drilled holes in the subchassis and drew the leads of all components through. The output transformer is visible just above the speaker bracket. It is sold under a "PeeWee" trade name and is only about 1 inch long. The on-off slide switch is located just above the transformer. I used a double-throw unit, but a single-throw is adequate.

To fit into the smaller space, I made a change in the battery supply. A K20 (30 volts) is used for the B source. This can be seen standing up near the center of the radio. Since the B voltage was reduced, I connected each tube's screen grid directly to B-plus, rather than through a dropping resistor. The A-battery is a Mallory type RM4000 which measures about 1½ inches in diameter and is only ⅝ inch high. In Fig. 2 it is just behind the on-off switch. To guard against a possible short circuit, it is covered completely with masking tape so that only the soldered leads come through. I now use 4 penlight cells for the transistor supply. They are taped together and rest beneath the speaker. The 20-ohm filament rheostat, LOCAL-DISTANT switch, 56,000-ohm biasing resistor, 15,000-ohm screen dropping resistor, and the phone and test jacks, which appeared in the original model, have been omitted from this model.

For improved reception I added a trimmer capacitor across the antenna

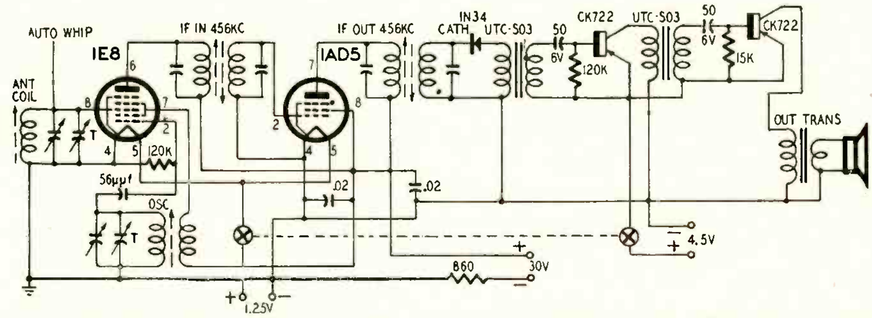
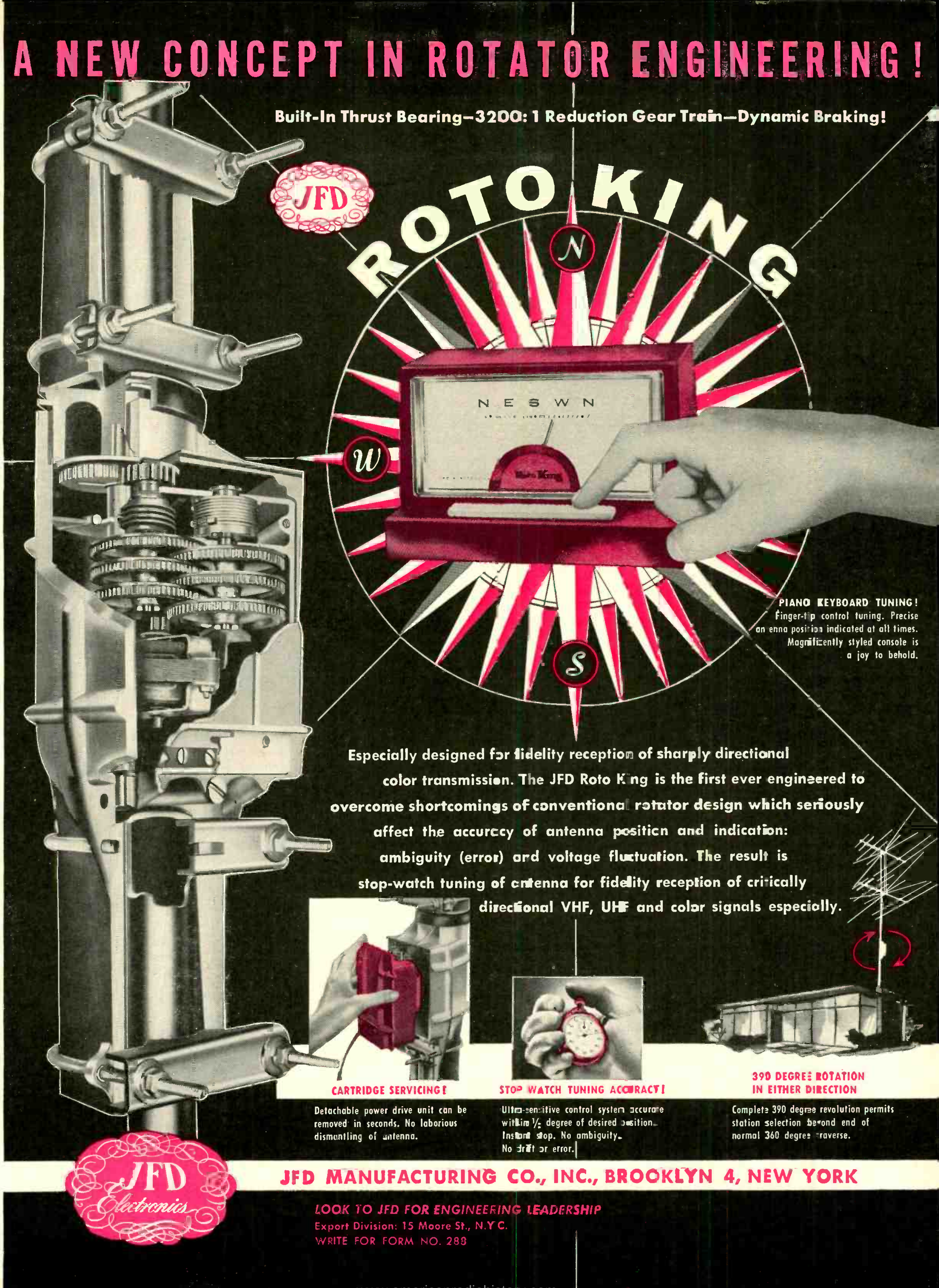


Fig. 1—Diagram of the March, 1954, receiver, modified as described in the text.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coil. Its knob can be seen near the antenna. The capacitor is a Johnson type 20M11, a very tiny unit. It tunes the antenna circuit to exact resonance and is especially helpful on weak stations. The antenna is a rod that tele-

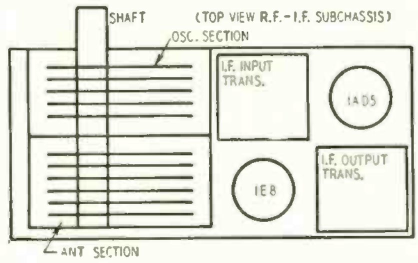


Fig. 3—Layout of r.f.-i.f. subchassis.

scopes within a ⅛-inch hollow length of brass tubing. Total length when extended is 19 inches.

The speaker measures only 2½ x 2½ inches, yet is rugged and provides good tone quality. It is made by Oxford.

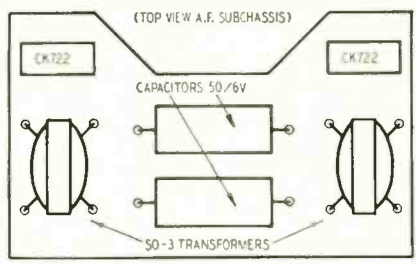
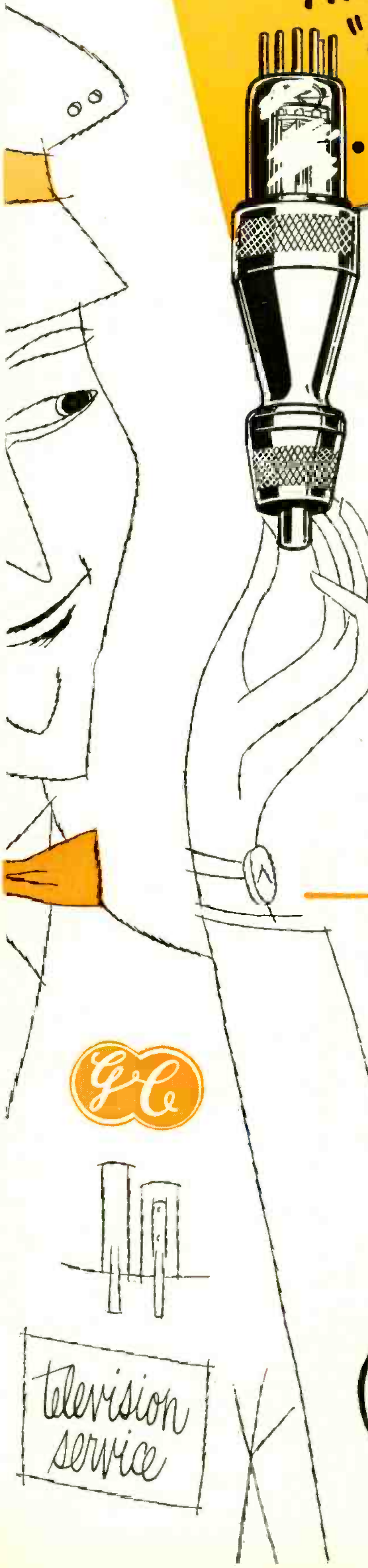


Fig. 4—Subchassis for audio components.

The radio, complete with rear cover, antenna and all parts and batteries, weighs only 2 pounds. It is a mere handful and can fit into an overcoat pocket. For carrying around, the antenna can be made removable as I have done.

The new, smaller version of the portable compares favorably with the original model. In a New York suburb it brings in all locals and dozens of out-of-town stations. I have picked up stations over 1,000 miles away with the 19-inch antenna, in the first floor of a building. The loudest stations (perhaps half a dozen) are audible and understandable 5 to 10 feet from the speaker. As with any portable, location has a considerable effect on performance. Within a steel skyscraper, results may be poorer than at street level outdoors. However, the receiver is so sensitive that it will pick up signals that have any reasonable strength. I heard stations even while riding the New York City subway, but the set must be held close to the ear, of course. (This little receiver was tried on the editor's desk at Plainfield, N.J.—roughly 20 miles west of New York City. Volume was low—the level was about right for comfortable listening at 2 feet from the speaker away in a quiet room. Pickup was surprising. With only its own short whip—on the second story of a wooden building—the first four stations heard were WBZ, Boston; WKBW, Buffalo; WINS, New York City, and WCAU, Philadelphia.) END



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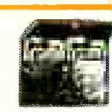

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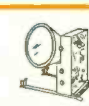

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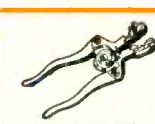

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Quick Check on 3-way Portable and Battery Radios

Short cuts and techniques for rapid servicing

By FAIRBANKS TRYON

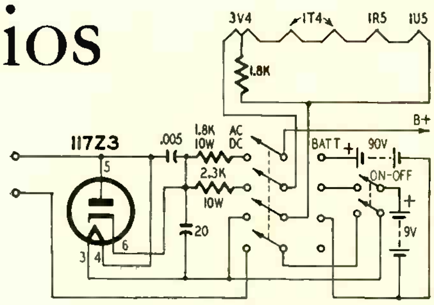
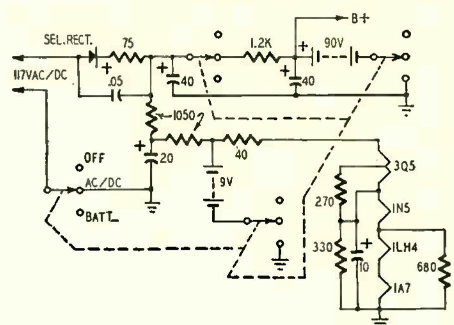
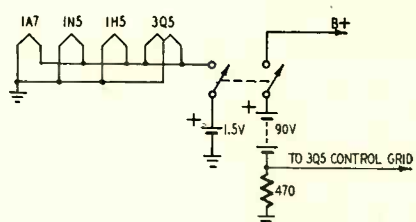


Plate and filament supply of 3-way portable using 117-volt rectifier.



Basic A- and B-battery supply circuit.



Schematic of an a.c.-d.c.-battery supply using a selenium rectifier.

THERE are three general classes of portables: Those having a rectifier tube, those having dry-disk rectifiers, and those using batteries only. Typical examples of each are shown in the diagrams on this page.

The 3-way sets having a rectifier tube with 1.5- and 3-volt tubes in series, when switched to a.c.-d.c., are very similar to conventional a.c.-d.c. receivers with the exception of the d.c. filament voltage for the 1.5- and 3-volt tubes. Because of this the method of quick check will be somewhat different from that outlined in my article, "Shortcut Service on Radios," appearing in this magazine October, 1953.

Rectifier-tube type

Do not plug set in—all readings indicated in this article will be misleading if tubes and capacitors are allowed to warm up before testing. Turn switch to a.c.-d.c. operation and remove batteries; leave switches in this position for all except filament tests. Most of these tests can be made without removing the chassis on larger sets.

Now start your tests across the line plug. Most sets will read between 125 and 300 ohms. Any reading over 300 ohms indicates intermittent filament in rectifier, high resistance in switch contacts, a bad line cord or plug, or increased series resistor. Should the first reading be 300 ohms or over and then fall back in a few seconds to 200 or less, the chances are the tube filament is intermittent. To save time try a new rectifier tube and repeat the test—if reading is normal, perhaps you have repaired the set.

Any reading under 125 ohms across the plug, on any a.c.-d.c. set, except when 110-volt pilot lamps are used (in this case, remove lamp), indicates leaks or shorts, usually found to be in the power-supply filter. In this condition plugging set in will only cause more damage. You can test the filter on most sets without removing chassis: simply remove the rectifier tube and read from cathode prong on socket to line plug (only one side of plug will work since removal of the tube will open the other lead). If you get any reading under 20,000 ohms, except a flash up scale which rapidly falls back to 20,000 (time required to drop back to 20,000 indicates condition of leakage), you have a defective filter capacitor. This test will not tell which filter is bad as the two are connected thru a resistor which in most cases is less than 20,000 ohms. When the chassis is out, if you remove the positive filter capacitor leads, you can tell which is bad. If both filters check O.K. try the same test at the points where the capacitors were connected. Readings at these points indicate leaking capacitors from plates or screens to B minus or ground. Checking along the B plus circuit to B minus, every resistor you go over from the rectifier cathode will increase the resistance reading unless you are getting nearer the leaky capacitor.

No reading across line plug indicates an open circuit. Hold prods on plug with one hand, grasp the line cord near the plug and bend the cord, also push in toward the plug. If needle flashes up and down scale the cord is broken at the plug. If no reading, bend the cord near the back of chassis. With needle points on prods pierce the cord near the plug; steady reading while bending cord will indicate cord broken at or in plug. No reading indicates an open switch, open series resistor, or open rectifier filament. Remove the rectifier tube and check all of its filament prongs (usually 3), an open between any two of them calls for a new tube. With the new tube in socket read across plug again. If the reading is normal you may have cleared up the defect. To check resistor or switches remove chassis and connect one prod to one prong of plug, with the other prod start at the line cord connection inside chassis which reads zero ohms. Check through all connections until you reach the other prong of the line plug (skip the switches if you like but check where it goes to the next tube or resistor).

To check the filament circuit of 1.5-volt tubes in series turn set on BATTERY and measure the resistance across the A battery prongs (removed from the battery of course). This reading should be about 7 ohms per A battery volt. In a 6-volt A-battery set the reading should be about 6 x 7 or 42 ohms. With a reading within 20% of that you can be assured all tube filaments and switches are O.K. Low readings indicate shorts and high readings or no readings indicate bad contacts, open circuits, etc. When shorts are indicated, look for stray strands and solder smears on battery plug, leaky or shorted filter capacitor from filament string to ground, and, where used, shorted resistors in filament string.

To check individual tube filaments, simply remove one tube at a time and check between its filament prongs. This is faster than the tube tester. A 1.5-volt tube will normally read about 10 ohms when first contacted, rising to about 20 ohms in a few seconds. If you have the diagram, check from each socket back to the A plug starting at either end of the string.

To check the filament A plus supply circuit when set is switched to AC-DC, remove the rectifier tube and check from cathode prong on socket to a filament prong on any one of the 1.5-volt tubes. A reading may not be obtainable on a low range; if not, try a higher range. The reading should be between 1,500 and 2,500 ohms when the hand stops drifting. The length of time required for the meter to slow to practically a stable condition is an indication of the quality of the A filter capacitor. Low readings indicate leaks or shorts, including cathode to filament shorts in rectifier tubes and changed value of resistors and B plus filter capacitors. The d.c. filament voltage for the battery tubes is taken from the B supply thru a series resistor (1,700 to 2,000 ohms) in most of these sets. High readings usually indicate altered resistors as this and filter-capacitor trouble are involved with most breakdowns in filament supply circuits.

All rules have exceptions. There are a great many if you include all of the prewar portables. The most common in recent models seems to be the power amplifier used on AC-DC on some sets, which switch it out and switch in the 3V4 or similar tube for battery use. On these sets the filament voltage for the other tubes is often obtained from the cathode of this power tube. This method places the filament string of 1½-volt tubes in parallel with the cathode resistor, which may be made up of 2 or 3 resistors. If a reading taken from this cathode to B minus is less than 30 ohms, check for leaks and shorts, especially cathode to filament in the power amplifier tube. The cathode of the rectifier tube supplies only B plus here and should be 20,000 ohms above B minus.

Dry disk rectifier type

This set is similar to the regular 3-way except for the power supply. Quick check with medium range of ohmmeter across line-cord plug (set turned on AC-DC, not plugged in). No reading is normal; reverse connections, and again no reading is normal. Any reading except a momentary flash indicates a shorted or leaky filter capacitor or dry disk. Go to the highest range on the meter and repeat the test, reversing connections as before. One of these readings should be at least 50 times the other. A dry disk rectifier having similar readings in both directions is bad. Compare the above tests with the readings across a new rectifier, where the difference will indicate condition of rectifier and filter capacitors.

Where the complaint on these sets is, "It works like it does with a weak battery; it comes on but fades away," suspect the rectifier. Even if it seems to check out, either take one lead off and attach a new rectifier to this lead and the other end of the old rectifier; or, if you prefer, read the voltage output. The voltage will be about the same d.c. reading as the a.c. input from a single rectifier; double it if 2 rectifiers are used. In either of these cases you may have to wait for the fading to take place. When you are busy, the quickest way is to put the new one on and turn the set on (plugged in) and let it run. If it does not fade out in an hour or so perhaps that fixes it. Check the filter capacitors before you let it run because a shorted capacitor will damage the new rectifier.

Check the filter capacitors as on the sets with the rectifier tube, taking the readings from the screen and plate of the output-tube socket (tube removed). Bad line cords, tubes, and capacitors, together with the line and filter resistors cause about 95% of the breakdowns on these sets.

Battery sets

These sets are of 2 general classes: those in which the tubes are all in parallel, working on a 1.5-volt A battery; and those having tubes in series and operating on an A battery whose voltage is equal to the sum of all the tube filament voltages.

All radios must have a bias voltage, a negative voltage applied to various grids. Originally, on battery sets and some early electric sets this was supplied by a separate C battery—some sets still use it. This voltage is now obtained on practically all battery sets by resistors from grid to chassis or filament and by a resistor between B minus and chassis. Some exceptions occur in sets having tubes in series where sufficient voltage can be obtained at certain points along the filament string. In the latter case A minus and B minus may both be grounded direct to chassis.

Except for the source of bias voltage and resistance readings at the battery plug, battery sets are very much alike. On series-filament sets the resistance reading will be about 7 ohms per volt of A battery, taken from A plus to A minus on the plug. The reading from A minus to chassis (or ground) will be zero. That from B minus to chassis may also be zero or it may be 300 to 1,000 ohms. From B plus to chassis the resistance should be 20,000 ohms or more unless you have leaks or shorts; but under 2 megohms unless the filter capacitor or B minus-to-chassis resistor is open.

On the so called "1,000-hour battery sets" and 1.5-volt portables the resistance reading across the A battery prongs will be small—2½ ohms or less, depending on the number of tubes (do not use meter delivering over 2 volts on this or any other test involving 1.5-volt tubes). The reading from A minus to chassis will be zero, and from A plus to chassis, 2½ ohms or less. B minus will be 300 to 1,000 ohms from chassis, and B plus will be over 20,000 ohms but under 2 megohms.

Readings far different from these will indicate troubles already covered. No reading, or over 1,000 ohms from B minus to chassis, would indicate the resistor from B minus to chassis is burned out (this will occur every time B plus is shorted to chassis, so use your voltmeter to check voltage and leave the screw driver for the screws). The switch on battery sets usually turns on both A and B supplies, therefore if one voltage is present and the other is not, don't forget to check both sides of the switch.

Practically all tests herein can be made without removing the chassis; however where leaks or shorts are indicated, or open circuits exist within the chassis it will have to be removed before repair would be possible. The main purpose of this article is to save time that many service technicians have been wasting in removing the chassis only to find that the line cord was loose from the plug or a tube burned out.

It is not usually necessary to pull the chassis if the battery wires are out of the plug (and you don't need a diagram to replace them, because, with the above readings you can replace the plug in less time than you can find the diagram).

Just be sure that after identifying the wires you get them in the proper prongs. If you are not sure, hold the plug over the battery socket, or drawing of it, on top of the battery with the prongs down like they enter the socket and check your readings again. After you plug the battery in and turn the switch it is too late to learn that you put the B plus wire in the A plus prong. Look before you leap! END

NEW METAL LOCATOR

A compact metal detector that will distinguish between metallic iron and other metals such as gold and silver has been developed by Gardiner Electronics Co., Phoenix, Arizona. The unit contains only one tube, a 1R5, and 2 cells. When iron is detected, the earphone signal becomes louder; when other metals are detected, the signal decreases.

ELECTRONIC *PHOTO-FLASH* SYSTEM

Portable unit provides "strobe" light for flash photography

By L. B. HEDGE

Camera, master lamp, and power unit.

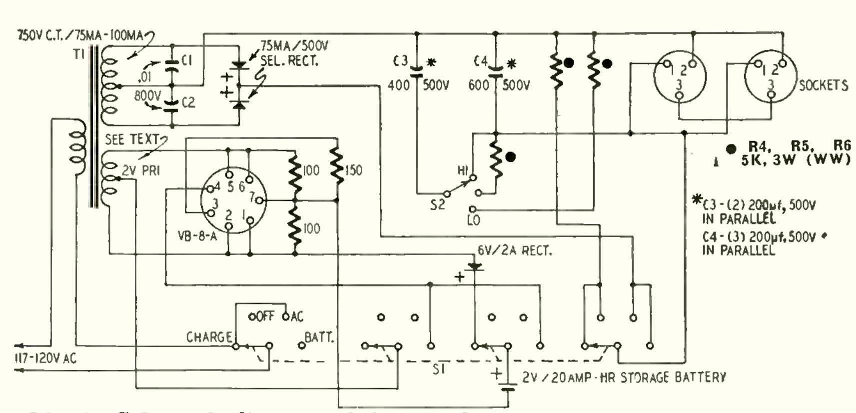
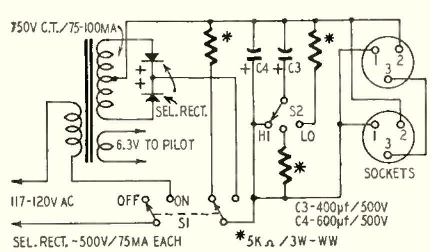


Fig. 1—Schematic diagram of the portable a.c.-battery power-supply unit.



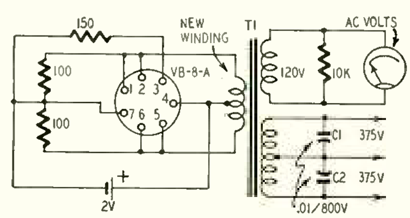


Fig. 2, left—A straight a.c. supply.
Fig. 4, above—New winding checker.

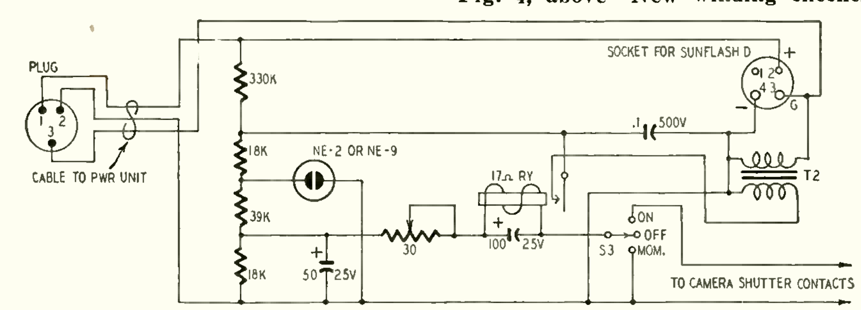


Fig. 3—Schematic of the master unit, used with the power supply of Fig. 1.

THE "electronic flash" or "strobe" light for flash photography has become in recent years the hallmark of the well-equipped photographer. The basic unit of this ultramodern lighting system is the gas discharge tube developed by Dr. Edgerton for the observation and photography of moving objects (U.S. patent 2,478,902 filed in 1933 and issued in 1949). Improvements in the original system which made it possible to parallel several lamps (Edgerton patent 2,351,603, filed in 1941 and issued in 1944) brought the electronic-flash system into serious competition with the conventional flash bulb. Its advantages of long life, high speed and intensity, rapid sequence use, and near daylight quality (color temperature) have made it extremely popular in the flash-photography field. Popularity has made the electronic flash tube available at a reasonable price in a variety of types, and the simplicity of its power supply and control equipment make construction of a high-quality photo-flash system a simple job. The system described here was built largely from odds and ends from the junk box—it is nevertheless a high-quality instrument of great versatility and durability.

An electronic-flash system consists of three basic parts: a power supply, a lamp (one or more flash lamps), and a triggering or timing unit. In general, the choice of the type and number of lamps to be used will determine the general form of the other units. Low-voltage (400–600 volts) tubes were selected for this unit for several reasons: 500-volt components are cheaper and more easily obtainable than the 2,000-or-more-volt components for a high-voltage system; the low voltage is safer, it requires less step-up in a battery-operated portable unit, and the flash time is longer with the low-voltage lamps—an advantage for most uses since the electronic flash crowds the lower exposure limit of most films and tends to reduce the margin of emulsion speed (ASA speed index) available at normal exposure times.

The quantity of light (light intensity integrated over the flash duration time) produced by an electronic flash tube is directly proportional to the power dissipated in the flash tube during the flash. It is fixed by the power available in the power supply, and is limited by the power-handling capabilities of the tube used. Low-voltage flash tubes are rated at from 100 to 300 watt-seconds maximum power dissipation, and will operate at 35 to 40% of this power with satisfactory efficiency. A 125-watt-second flash will give an exposure comparable to that of a *Press-40* flash bulb when used with *Plus-X* film. Two tubes flashed in parallel from the same power supply will each dissipate approximately 50% of the available power, and since only one will furnish the key light for the exposure, the guide number (*f*-stop × distance from lamp to subject) will be about 75% of the full power value.

Power supply

Power for the electronic-flash system is provided by a bank of capacitors—500-volt electrolytics serve well and are economical in cost, weight, and space occupied. A capacitor will store, when fully charged, power equal to $\frac{1}{2}CV^2$ in watt-seconds when C is in microfarads, and V is the voltage across the charged capacitor in kilovolts. Thus a 200-μf capacitor charged to 500 volts stores power of $\frac{1}{2} \times 200 \times (0.5)^2 = 25$ watt-seconds. The same capacitor charged to 447 volts stores only 20 watt-seconds, indicating the importance of keeping the supply voltage up; for a given capacitor and lamp setup the flash guide number is proportional to the voltage across the capacitor.

From these basic considerations it is possible to plan an electronic-flash system to provide the lighting you require. The system described here uses a power pack of five 200-μf-500-volt capacitors (125 watt-seconds maximum power, guide number for *Plus-X* about 155 with 1 lamp, 110 with 2 lamps), with a reduced-power-switching arrangement to permit use of three of these capacitors (75 watt-seconds, *Plus-X* guide number 115 for 1 lamp) for close-up shots where an open diaphragm for soft-focus background is required. A light storage battery vibrator power pack to charge the capacitors was decided on since the system was to be used afoot and afield as well as in civilization. The power supply can be used with a 117-volt a.c. supply as a charging source, and has a built-in circuit for recharging the battery from the power line (Fig. 1). In an emergency it can be recharged from a car storage battery with a 2- or 3- ohm current-limiting resistor in series. If such versatility is not required a much simpler, lighter, and cheaper power supply is possible, such as the a.c. unit in Fig. 2.

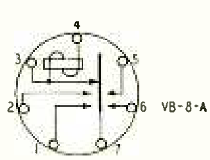


Fig. 5—Base connection of vibrator.

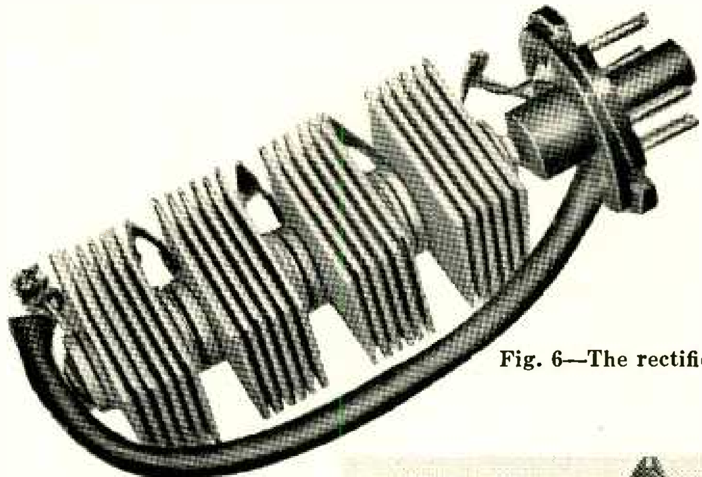


Fig. 6—The rectifier stack assembly.

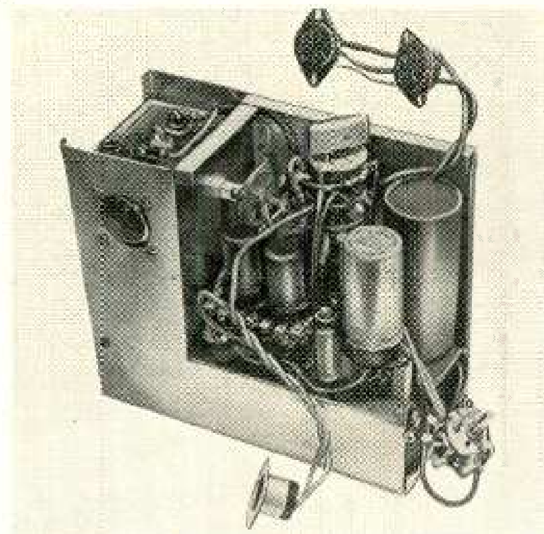


Fig. 7—Power unit using OZ4 tubes.

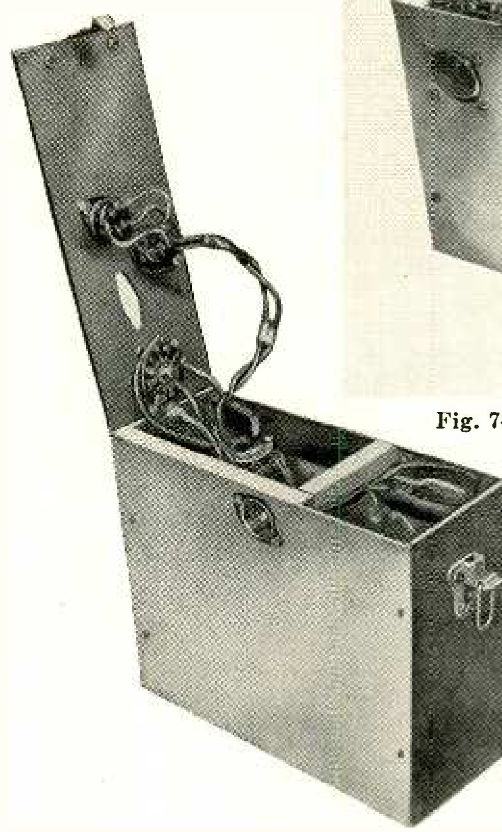


Fig. 8—Complete portable power unit.

The flash-lamp master unit (Fig. 3) with the lamp triggering unit included will be essentially the same for any low-voltage electronic flash system. It includes a socket and reflector for the flash lamp, a voltage divider, and series of small capacitors to supply the triggering power, a relay and transformer for starting the triggering pulse and raising its voltage (the triggering pulse to the tube must be about 1,200 volts), connections to the power pack and camera shutter contacts, and a neon ready-light which glows when the voltage on the power-supply capacitor bank reaches a satisfactorily high value (about 475 volts). This sounds more complicated than it is: the whole thing can be put into a battery-flash-light case if desired, or mounted in some equally small container of some other sort. The master units were built into surplus BC-366 jack boxes about 2¼ x 3¼ x 4¼ inches.

The one piece of "special" equipment used in my electronic-flash system is power transformer T1. It is rebuilt from a garden variety replacement power-supply unit with a 120-volt, 60-cycle primary, two filament secondary windings, and a 750-volt center-tapped high-voltage winding. The core was disassembled and the filament windings were removed (with turns carefully counted to determine the number of turns per volt used in the transformer

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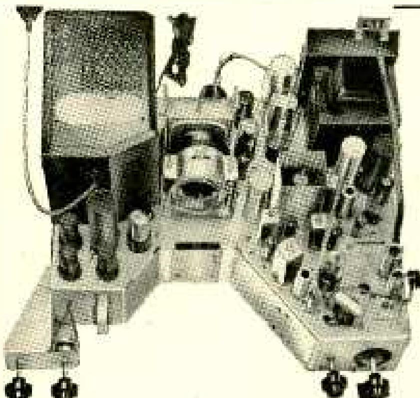

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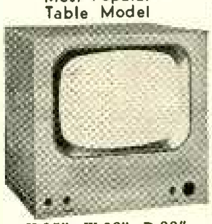

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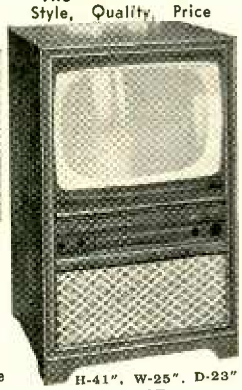

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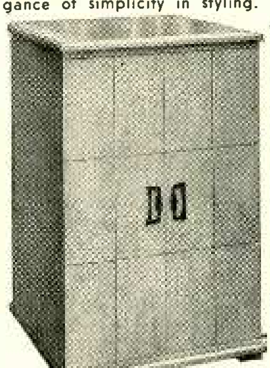

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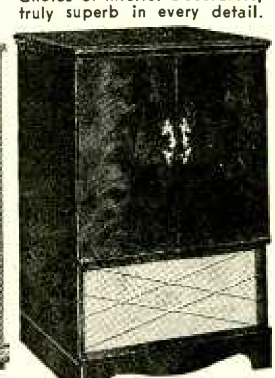

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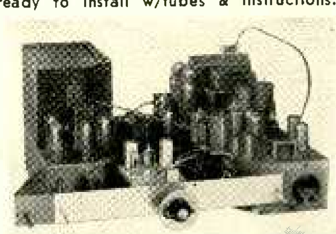

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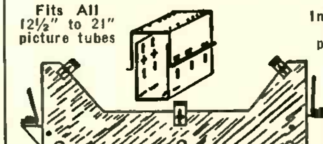

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design). A new low-voltage winding for a vibrator primary and battery-charging secondary was wound with No. 18 enameled wire in the space occupied by the original filament windings. This winding will require some cutting and trying, since it operates from a wave shape very different from the sine wave for which the transformer was designed. Start with a winding which will give 2 volts a.c. each side of the center-tap when 120 volts is applied to the primary. Be sure, in all testing, that the core is reassembled in the coils before power is applied! Check the operation with the battery and vibrator connected as shown in Fig. 4, measuring the voltage across the 120-volt winding with a 10,000-ohm resistor across it, and the .01-μf buffer capacitors (C1 and C2) across the high-voltage section. Insulate the high-voltage leads during this test. Due to the squarish wave input they will probably put out a considerably higher no-load peak voltage. Add to or reduce the number of turns on the new winding until the output on the line winding is 120 volts. Note that the synchronous vibrator (Fig. 5) has been connected as a nonsynchronous one by paralleling the two sets of fixed contacts—this is done to provide better current-handling capacity since the load at the start of the capacitor-charging cycle is high (10 to 15 amps for the first few seconds). When the special winding is adjusted to give 120 volts on the line winding, the transformer is ready for use.

High-voltage rectifier units are available for use in the capacitor-charging circuit, or four 120-volt units of the type used in a.c.-d.c. receivers can be wired in series for each half-wave section as shown in Fig. 6. These units were assembled on old tube bases to simplify removal, and were substituted for the pair of 0Z4's which were used initially (Fig. 7). The 0Z4's (with sections paralleled) will work satisfactorily with the power-line supply, but the excessive peaks in the vibrator output cause early tube failures in all the 0Z4's I have tried.

Two safety features which seem worth special attention are included in the power-unit design. First, the knob on the main function switch, S1, is used as a lock on the hinged cover of the power unit (Fig. 8), by mounting the switch in the case of the unit and cutting a hole through the case cover, so oriented that the cover can be opened only when the switch is in the off position. The off position of the main switch not only opens the power connections but also connects discharging resistor R5 across the power capacitor bank. This prevents opening the power unit with the capacitors charged or charging. Second, power-adjusting switch S2 is a 3-position unit, and makes possible switching from high to to low power, or vice-versa, without fireworks. Without buffer resistor R4 and supplementary discharging resistor

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"Fringe area" dealer-servicemen in every part of the country are reporting outstanding sales and service stories . . . *and, mounting TV consumer demand!* The new, revolutionary Super "KATYS" have now *convincingly proved* every quality and performance claim attributed to them.

Kay-Townes' original SUPER KATY design . . . *now amazingly improved* . . . will out-perform any other competitive antenna on the market today, *regardless of type or design principle!*

Manufactured and Distributed in CANADA By
DELHI METAL PRODUCTS, LTD., DELHI, ONTARIO

KAY-TOWNES ANTENNA CO.
ROME • GEORGIA

Originators of the **BIG-JACK**
the world's most Copied TV Antenna

R6 this switching would have to be done with the main switch in the off position to insure against throwing uncharged capacitor bank C3 across charged basic bank C4 with a resulting high current surge, or to switch C3 off without discharging it. This would leave it a hazard when the power unit is opened, or cause a heavy current surge when it is again switched into use.

Transformer T2 (Fig. 3) used to supply the striking pulse can be purchased, or a small, high-ratio iron-core transformer from the junk box can be used. The one I used is a surplus Ouncer microphone-to-grid unit. The high-voltage pulse is wired to the third conductor in the lamp cables (Fig. 9-a), and the corresponding terminals of

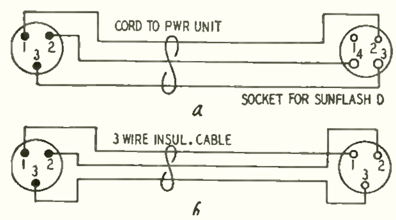


Fig. 9-a—Connection to slave lamp unit.
Fig. 9-b—Connection for extension cord.

the two receptacles are connected together, making either receptacle available for the master camera unit with the triggering pulse delivered to the other receptacle which can be used for the second slave lamp. An extension cord (Fig. 9-b) may be used in either lead, giving extra flexibility in the positioning of the power unit with respect to the lamps.

Parts for electronic photo-finish

Resistors: 2—100, 1—150, 2—18,000, 1—39,000, 1—330,000 ohms, 1/2 watt; 3—5,000, 3 watts; 1—30-ohm rheostat.

Capacitors: 2—.01 μf, 800 volts; 1—0.1 μf, 500 volts; 1—50 μf, 1—100 μf, 25 volts, electrolytic; 5—200 μf, 500 volts, electrolytic.

Miscellaneous: 3—3-contact female connectors; 3—3-contact male connectors; 1—relay, normally open, s.p.s.t., 17-ohm coil (Advance type 003); 2—selenium rectifiers, half-wave, 75 ma, 500 volts a.c.; 1—rectifier, 6 volts a.c. half-wave, 2 amps; 1—4-pole, 4-position switch, rotary; 1—1-pole, 3-position switch, rotary; 1—1-pole, 3-position (on-off-momentary) switch; 1—VB-8-A 2-volt synchronous vibrator (ATR 900 or Mallory T4003 may be used with wiring changes); 1—rewound power transformer, 750-volt secondary, center-tapped; 1—Ouncer, mike-to-grid transformer, (photo-flash ignition coil, GE 86G41); 2—4-pin ceramic tube sockets (for Sunflash D tube); 1—battery, 2 volts, 20 ampere-hour storage (Willard BB 54); 1—neon glow lamp, NE 2 or NE 9; photo-flash tubes (Sunflash D).

Switch S3 provides a convenient disconnect for the shutter connection, and on its "momentary" side is a manual-triggering connection for open-shutter flash shots. If the switch is not easily available, a s.p.d.t. switch may be used with a push-button in the lead to ground for manual triggering.

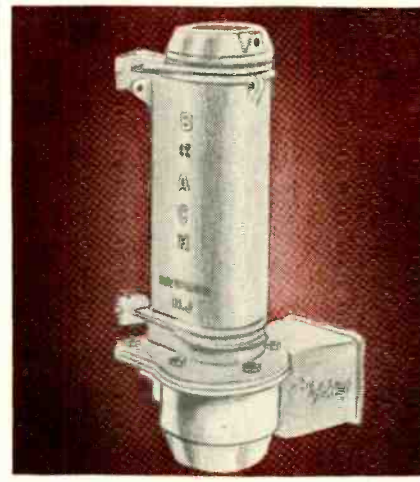
Neither the electrical nor the mechanical construction of the electronic-flash system is critical; arrangement of parts and wiring are matters of personal preference and individual design. My power unit was built into a case made from aluminum roofing sheet and 1/8-inch Masonite.

The New Brach Sky Chief ROTATOR

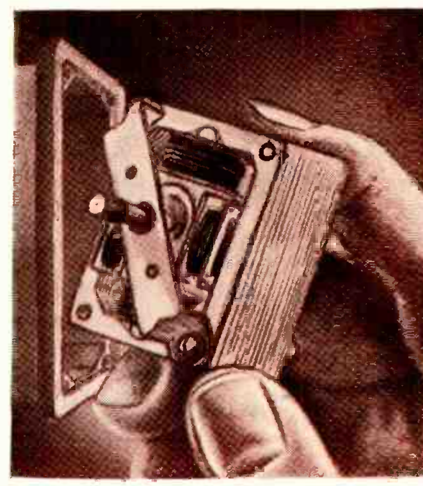
MODERN design combined with ruggedness, serviceability, the exclusive new "FLEXIBLE" WORM GEAR and a built-in thrust bearing are the main features of the new Brach SKY CHIEF Rotator. Below is the new control unit shown in *actual size*. It has a fine furniture finish and is styled to blend with the decor of all living rooms. Truly the Brach Rotator control unit is Designed for Modern Living. After two years of research and experimentation in the Brach laboratories, we now claim the following features for the Brach SKY CHIEF.

Designed for Modern Living

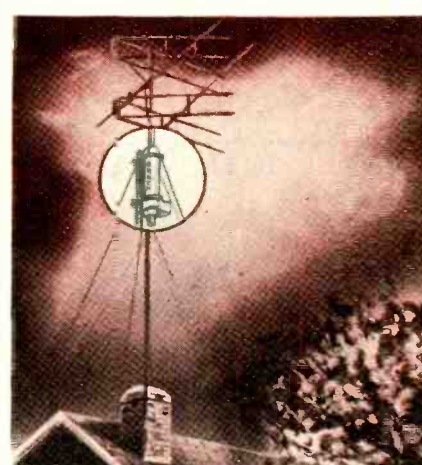
- Exclusive flexible worm gear assures operation in high winds, with ice loadings, and massive antenna arrays.
- Super-strength precision cut bull gear.
- Greatest starting and operating torque.
- Easily replaceable motor.
- No drift-dynamic stop control.
- Designed for all chimney and mast mounts.



Weatherproof design – built in guy mounting adaptable for chimney or high mast installations



Motor easily replaceable—just plug-in.



Super-strength construction assures safety against high winds, ice loading and massive antenna arrays.

Designed For Modern Living

THIS IS THE ACTUAL SIZE OF THE CONTROL BOX   **Model No. 54 M**

BRACH MANUFACTURING CORP. • Div. of General Bronze • 200 CENTRAL AVE., NEWARK 3, N. J.

ELECTRONICS

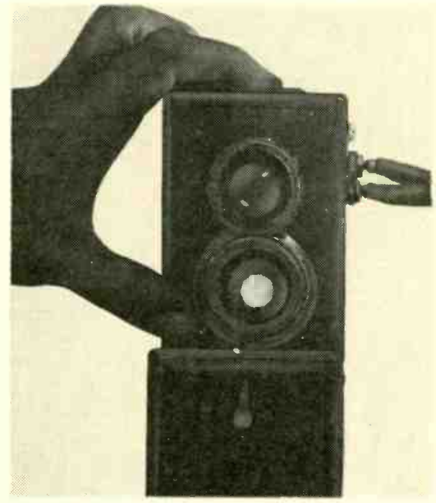


Fig. 10—Shutter at its largest opening.

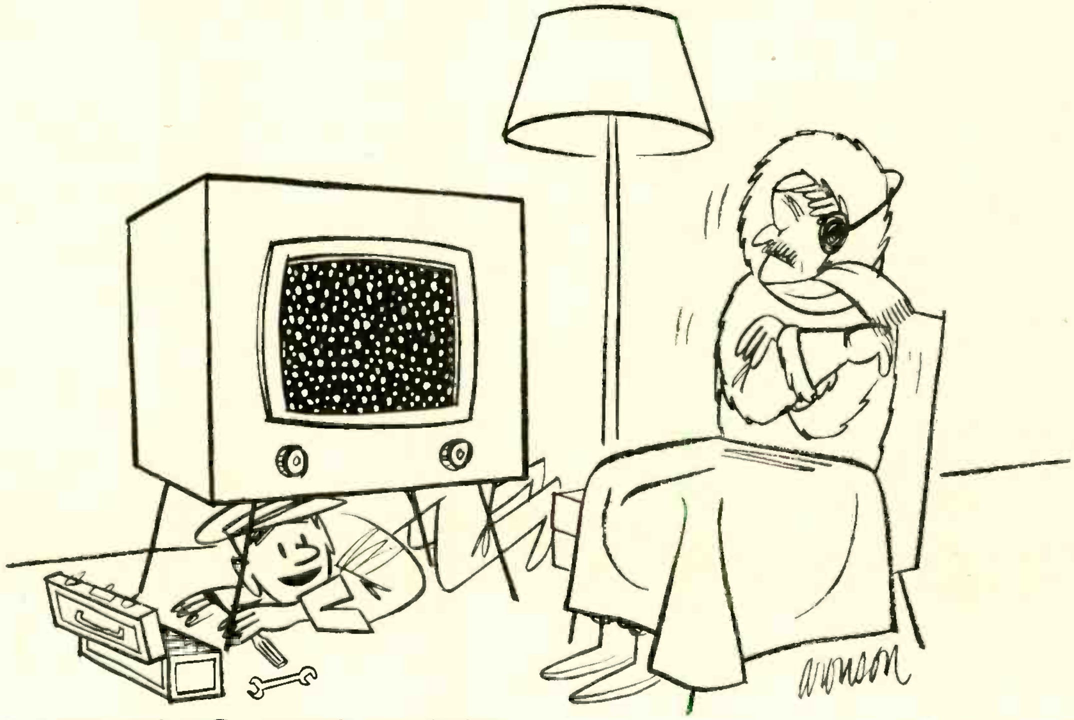
APPROXIMATE GUIDE NUMBERS

Watt-second output	50	75	100	125	150
Daylight Color Film: Kodachrome, Ektachrome, Ansco Color	20	24	29	34	40
Verichrome, Plenachrome, Plus-X	80	95	115	135	160
Plus-X, Super XX, Supreme, Super-Pan Press	100	115	135	155	180

A slave lamp unit is often helpful in properly lighting a flash shot. A three-wire cord with a plug on one end, a socket and reflector on the other, and some clamping arrangement for holding the reflector—and the job is done. The system works with or without the slave lamp—it can be added at any time.

After the system is completely assembled, synchronization can be adjusted by opening the back of the camera (Fig. 10) and looking through the lens while the shutter is operated at its largest opening (smallest f number). The flash will be fast enough to stop the shutter action so that the lens opening, if the flash is not properly synchronized, will have an irregular and smaller opening than its full-open image. Adjust the 30-ohm rheostat (Fig. 3) to a position where the flash shows a full opening of the shutter to complete synchronization, and the system is ready to operate. The table will serve as a guide to exposure with this system, but reflectors, backgrounds, film processing, and other factors introduce variations that make a firm specification impracticable—a roll or two of each type of film you plan to use, shot at a variety of subjects will permit you to establish the right guide numbers for your own films and the processing you prefer.

The experience gained in this exploratory work will repay itself many times when it saves you from just missing some prized shot for want of the proper guide number. END



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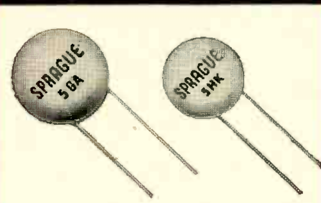

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Tiny, tough, dependable . . . in every application . . . whether discs, plates, buttons, or door knobs. And there's a Sprague ceramic capacitor to meet every service need. You give your customers dependable service, guard yourself against costly call-backs, when you use only Sprague Ceramic capacitors.

Insist on Sprague TWIST-LOK☆ 'LYTICS

Sprague TVL's fill the top performance bill in the toughest TV circuits. High temperatures, surge voltages, ripple currents won't faze them. Like all Sprague capacitors, Twist-Lok 'Lytics are your first line of defense against expensive call-backs.

Insist on Sprague BLACK BEAUTY® TELECAPS®

The most imitated capacitor Sprague ever introduced. But you get Sprague *performance* only when you insist on Sprague Telecaps. Hundreds of millions are in use today as first choice of quality conscious manufacturers and servicemen. It's the *premium* molded tubular *at no extra cost.*

Accept no substitutes. There is a Sprague Distributor in every sales area in the United States. Write for the name of your nearest source of supply today.

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**Distributors' Division of Sprague Electric Company*

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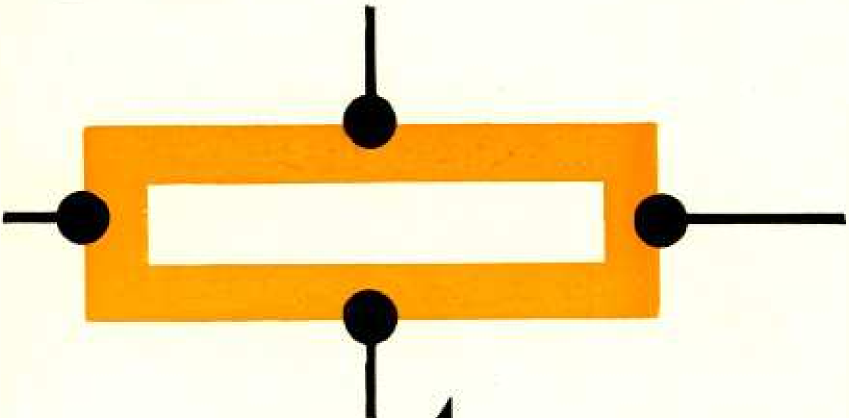
WORLD'S LARGEST CAPACITOR MANUFACTURER



Adding an element widens transistor applications and possibilities

4-TERMINAL TRANSISTORS

by NATHANIEL RHITA

THE transistor is basically a 3-element device like a vacuum tube. It needs emitting, controlling, and collecting elements. Again like a tube, an amplifying crystal can often show improved results if a fourth element is added. Several types of 4-terminal transistors have been developed and tests show that remarkable results may be expected from them. Gain, saturation current, frequency range, and internal impedance are among the characteristics that can be improved by a fourth element or electrode.

Fig. 1-a shows a 4-zone semiconductor invented by Jewell J. Ebers of Whippany, N. J. His patent (No. 2,655,610) has been assigned to Bell Telephone Laboratories. The zones are identified by P or N to indicate positive or negative type conductivity. The semiconductor can be prepared from a single crystal. It may have a cross-section area .03 inch on each side, with the outer zones .05 inch thick, and the inner ones .002 inch. Metal is plated at the ends of P1 and N2 for connecting leads.

Fig. 1-a shows typical voltages and a suitable hookup for the new transistor. P1, N1, and N2 function as emitter, base and collector, respectively. P2 is tied through R2 to the output circuit. This extra zone is a control element under the influence of R2. Emitter bias is varied by R1.

Fig. 1-b shows some of the remarkable results provided by this transistor. The graphs show how alpha (current gain factor) varies as R2 and the emitter current are changed. When R2 is zero, we have the case of an ordinary p-n-p transistor since N2 is shorted out. Therefore we find the usual constant alpha of almost unity. When R2 has a low resistance, for example several hundred ohms, there is a steep rise in alpha with emitter bias. In other words, R1 is a very effective gain control for this transistor. With a high R2 we find amazingly high alpha. With 10,000 ohms, for example, alpha is actually higher than 50. It remains nearly constant as emitter current varies.

The 4-zone transistor may also be connected as in Fig. 1-c. This requires a single battery supply and only two resistors. Due to interaction between zones, this circuit is excellent for triggering or switching work. Ordinarily we need a point-contact transistor for these purposes. The new 4-zone transistor, although a junction type, is just as effective. Thus we can take advantage of the junction features: high efficiency, low cost, and ruggedness.

The graph tells the story. If I is increased from zero, E rises sharply. This indicates a region of high positive resistance. After the peak value is reached, further bias causes E to drop. This, of course, signifies negative resistance and instability, just what we need for a trigger. After point E_s, another positive resistance region appears. If I is increased past I_p, the transistor is flipped from a low current (open switch) condition to one of high current (closed switch). It is triggered back to its original state by any pulse that lowers I below its critical value.

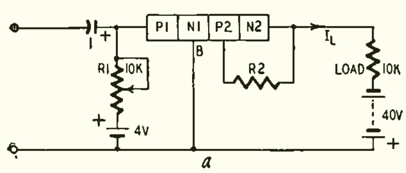
In Fig. 1-c, I is controlled by either or both resistors.

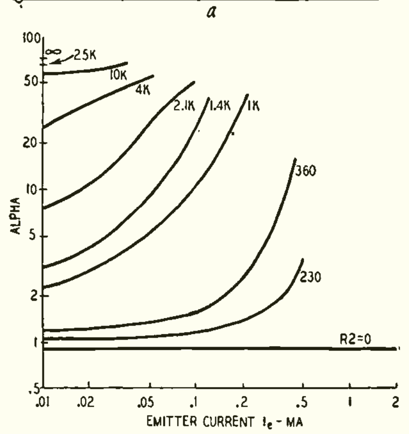
Fig. 2-a shows a different type of transistor. There are only 3 elements here as in a conventional n-p-n junction type, but the base has two separate terminals. A voltage is applied between these two points, and the performance is improved remarkably. The current that flows between the two points in the base can reduce the resistance of this zone—down to zero if desired. In turn this extends the frequency range and increases transistor gain.

The simplest application of this new transistor is as a modulator. In this case we take advantage of the two inputs: one to the emitter, the other to the auxiliary base terminal. It is important to remember, however, the phase difference between them. In Fig. 2-a a more negative bias will *increase* output current. A greater bias at point A will *decrease* it.

Fig. 2-a is a modulator circuit. A carrier is fed to the emitter element. The d.c. bias flows through R1. The audio voltage modulates the carrier. Point A is biased by the same emitter battery but through a separate resistor (R2). These resistors permit individual adjustment of bias to the two control elements, and also isolate one from the other. The bias at A has the same polarity as that of the emitter. Modulated output flows through a transformer to a load (L).

Fig. 2-b shows the transistor as a frequency converter. T1 feeds energy back from the collector to the auxiliary terminal at the base. Polarity of the windings must be observed, so that





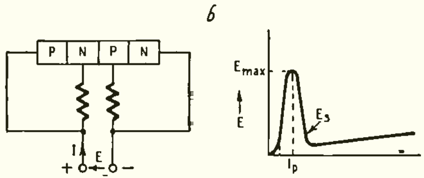
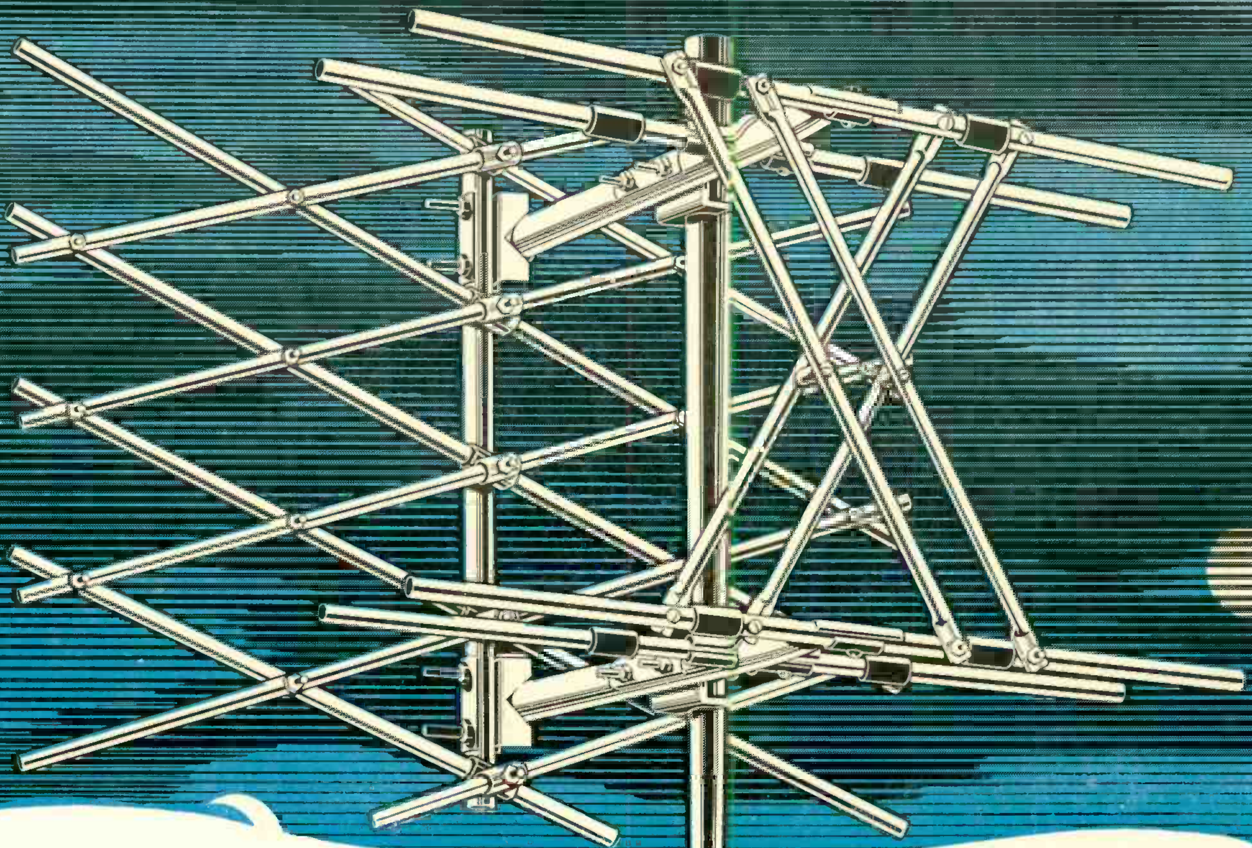


Fig. 1-a—The 4-zone semiconductor.
Fig. 1-b—Alpha-emitter bias curves.
Fig. 1-c—Circuit variation of Fig. 1-a.



Here's the ideal "all-channel" antenna for fringe and far fringe reception

THE NEW RADELCO

DRAGNET*

MODEL DN2 FOR VHF • UHF

with the Sensational Diamond-Back Reflector

★ Completely rejects interference from both back and sides.

★ Eliminates co-channel interference.

★ Front to back ratio far surpasses any other antenna on the market.

★ Superior all-channel gain.

★ Completely pre-assembled.

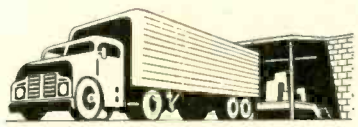
$34.95 LIST

*Trade Mark Registered Pat. Pending

The Dragnet Has Been Thoroughly Field Tested

After several years of development and field testing in all sections of the country, Radelco now gives you an antenna that definitely solves the reception problem in areas where reception has been found most difficult.

RADELCO MANUFACTURING CO.
CLEVELAND 25, OHIO



Dragnets are now being shipped to distributors throughout the nation. Place your order now with your favorite parts jobber.

load gain is even better. At last scientists seem to have the answer to an efficient junction transistor that will amplify and oscillate at high frequencies.

This transistor was invented by Robert L. Wallace, Jr. of Plainfield, N.J. His patent (No. 2,657,360) is also assigned to Bell Telephone Laboratories.

The internal impedance of the transistor elements are greatly influenced by the flow of base current, I_b. We show here only the effects on base resistance, which is probably as important as any. The resistance is drastically lowered and can even be made negative by a flow of less than 200 microamperes.

One or more types of multielement transistors are nearly ready for commercial distribution. The information contained here should help you to understand and make the best use of these new types, when they do make their appearance. END

SWIFTEM ELECTRIC CLINICAL THERMOMETER

Here is the electrical thermometer described on page 6 of last month's RADIO-ELECTRONICS. The thermistor is the enlargement at the tip of the probe. It reacts so quickly to heat variation that a patient's temperature reading can be made in less than 5 seconds.

The meter portion of the instrument is calibrated directly in degrees, so that it can be read like a standard clinical thermometer. It is powered by a mercury-cell battery guaranteed for 750 hours of intermittent operation.

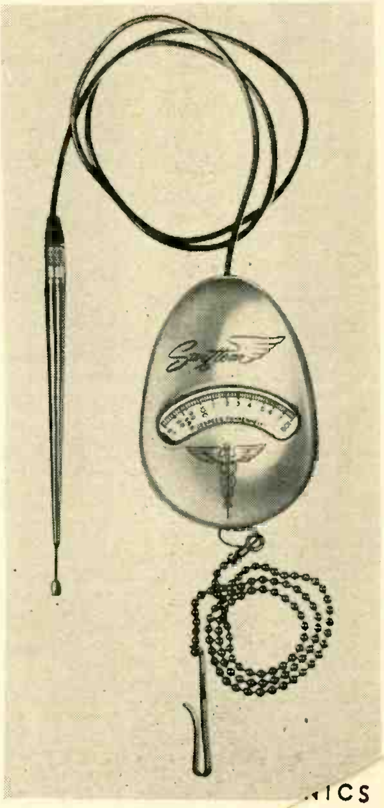
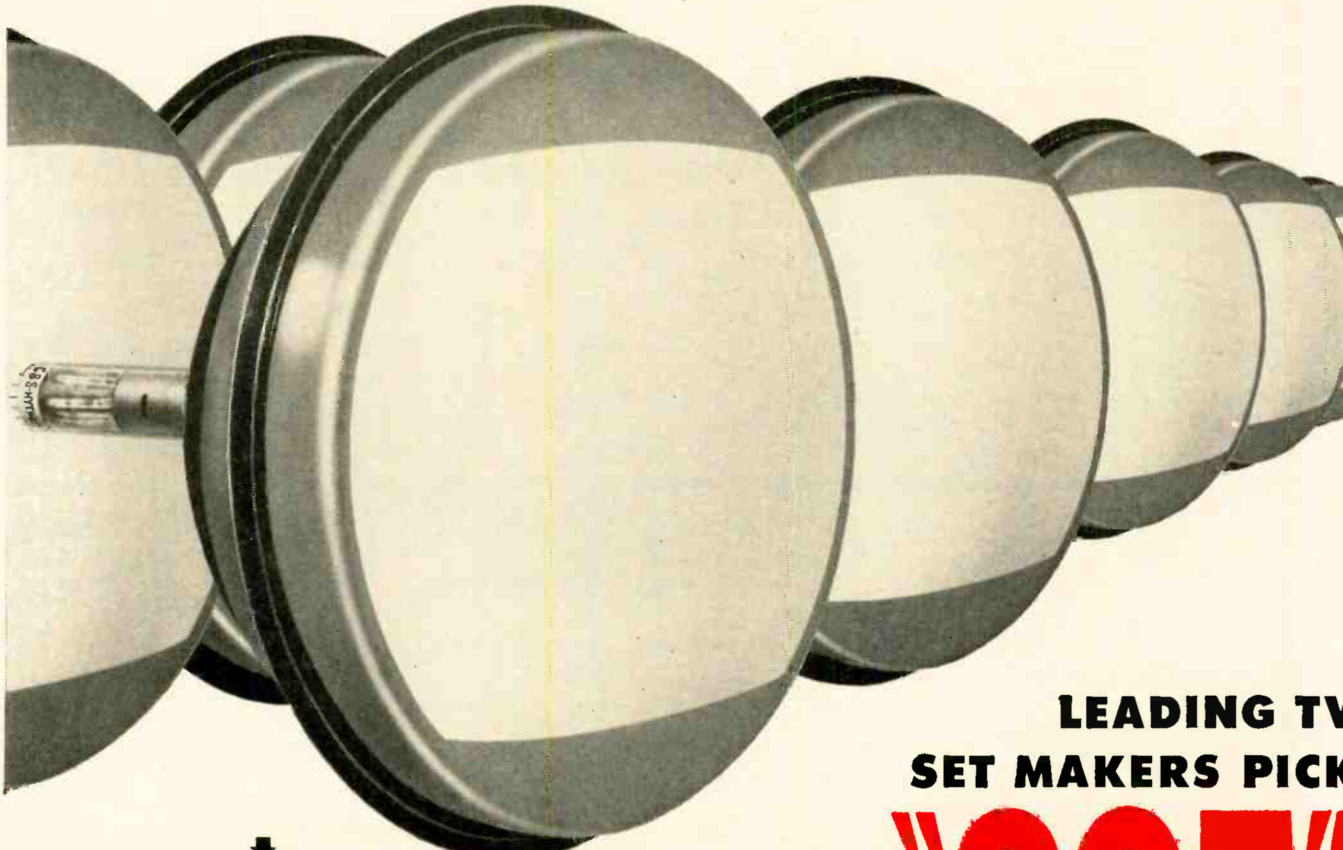


Photo Burlington



LEADING TV SET MAKERS PICK

CBS-COLORTRON "205"

LEADING BIG-SCREEN COLOR TUBE

. . . for Biggest Picture

. . . for Superior Performance

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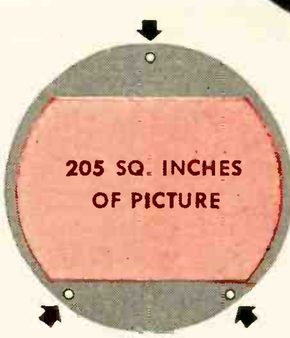


HOW "205" ACHIEVES BIGGEST PICTURE

As its name implies, picture area of "205" is a big 205 square inches. The "205" achieves this maximum utilization of screen area: 1. By photographic printing of tricolor screen directly on inside of curved face. 2. By using a simple, light-weight shadow mask. 3. By positioning the three mask supports above and below the desired screen area . . . where the screen is masked off anyway by the set maker to obtain the desired 4 x 3 aspect ratio. This permits full lateral use of screen.

The CBS-Colortron "205" is *today* traveling in freight cars and trucks to the nation's leading TV set manufacturers. It was chosen by them, because of: The "205's" larger 205-square-inch screen. The "205's" over-all superior performance. The "205's" easier circuit adjustments. The "205's" absence of "pincushioning" and other distortion. And the "205's" availability in production quantities now!

BIG-SCREEN COLOR TV IS HERE . . . today . . . at CBS-Hytron. Original . . . simple . . . functional . . . advanced design of the "205" made this possible: 1. With its curved screen-mask construction. 2. With its maximum use of the screen area. 3. With its electromagnetically converged three-beam electron-gun assembly. And CBS-Hytron's huge, new Kalamazoo plant stands ready to step up the "205's" availability when needed. Yes, you can look to CBS-Hytron as the leader . . . and major producer of big-screen color picture tubes.

IT'S CBS-HYTRON FOR NEW COLOR RECEIVING TUBES TOO

TYPE	DESCRIPTION
CBS-Hytron 3A3	Half-wave, high-voltage rectifier
CBS-Hytron 6AM8	Diode, sharp-cutoff pentode
CBS-Hytron 6AN8	Medium-mu triode, sharp-cutoff pentode
CBS-Hytron 6BD4A	Sharp-cutoff beam triode, high-voltage regulator
CBS-Hytron 6BD6	Sharp-cutoff r-f pentode color demodulator
CBS-Hytron 6BJ7	Triple-diode d-c restorer

NEW . . . FREE "205" DATA

Keep abreast of big-screen color TV. Four-page sheet on CBS-Colortron "205," RETMA type 19VP22, contains complete data on: Construction . . . operation . . . application . . . installation . . . adjustment . . . electrical and mechanical characteristics. Write for Bulletin E-227 today!

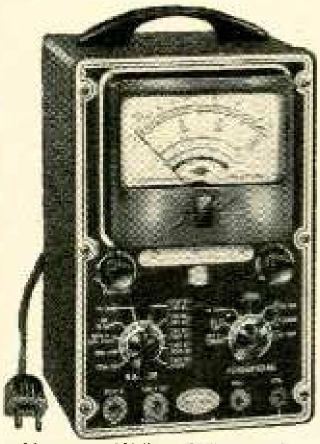
CBS HYTRON

CBS-HYTRON Main Office: Danvers, Massachusetts

A Division of Columbia Broadcasting System, Inc.

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

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



Measures 6¼" x 9½" x 4½"

Superior's new Model 670-A

SUPER METER

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

SPECIFICATIONS:

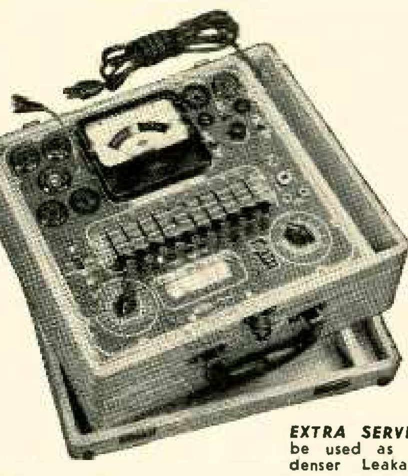
D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Quality test for electrolytics)
REACTANCE: 50 to 2,500 Ohms 2,500 Ohms to 2.5 Megohms
INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries
DECIBELS: −6 to +18 +14 to +38 +34 to +58

ADDED FEATURE:

The Model 670-A includes a special GOOD-BAD scale for checking the quality of electrolytic condensers at a test potential of 150 Volts.

The Model 670-A comes housed, in a rugged crackle-finished steel cabinet complete with test leads and operating instructions.

$28.40 NET



Superior's new Model TV-11

TUBE TESTER

SPECIFICATIONS:

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

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

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

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

★ Newly designed Line Voltage Control compensates for variation of any Line Voltage between 105 Volts and 130 Volts.

★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRA SERVICE — The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

The model TV-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover

$47.50 NET

SUPERIOR'S NEW MODEL TV-40

C.R.T. TUBE TESTER

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

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

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

EASY TO USE:

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

SPECIFICATIONS:

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

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

$15.85 NET

SHIPPED ON APPROVAL

NO MONEY WITH ORDER—NO C.O.D.

Try any of the above instruments for 10 days before you buy. If completely satisfied *then* send down payment and pay balance as indicated on coupon. **No Interest or Carrying Charges Added!** If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. D-62, 3849 Tenth Ave., New York 34, N.Y.

Please send me the units checked. I agree to pay down payment within 10 days and to pay the monthly balance as shown. It is understood there will be no carrying, interest or any other charges, provided I send my monthly payments when due. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

Name ....

Address ....

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

☐ Model 670-A..............Total Price $28.40 $7.40 within 10 days. Balance $3.50 monthly for 6 months.

☐ Model TV-11..............Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.

☐ Model TV-40..............Total Price $15.85 $3.85 within 10 days. Balance $4.00 monthly for 3 months.

NEW PATENTS

FREQUENCY-SHIFT MEASUREMENT

Patent No. 2,677,015

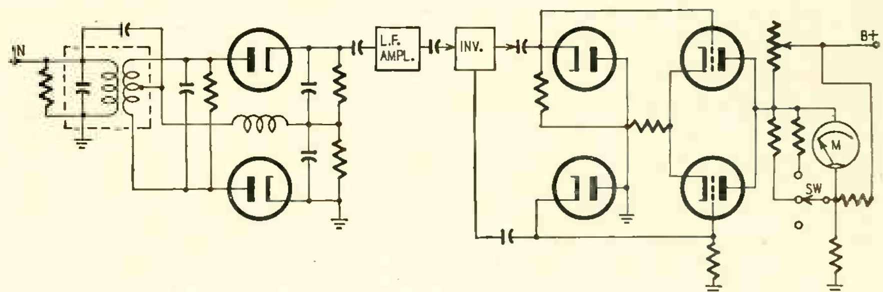
Arthur H. Hausman, Alexandria, Va.

(Assigned to the United States of America as represented by the Secretary of the Navy)

Certain types of radiotelegraph systems use the frequency-shift method. The transmitter output is constant, but its frequency shifts from one value (mark) to another (space). This invention measures the shift, that is—the difference between mark and space frequencies.

The diagram shows a Foster-Seeley discriminator followed by an amplifier, phase-inverter, and a pair of limiters. The diodes are fed in push-pull, and their outputs are always positive. For example, in the upper diode electron flow can occur only from ground to cathode, so this element can never go negative. The output triodes are connected in push-push. Their grids are fed out of phase and their anodes are tied together. A push-push stage acts as a doubler, for no matter which triode conducts, anode current flows.

As in any FM receiver, the discriminator converts frequency changes into amplitude changes. As the carrier shifts from space to mark (and vice versa) a.c. is generated. Frequency depends upon the rate of shift and may be as low as one cycle. Thus all coupling capacitors must be extra large to pass the low frequency. The amplitude of the a.c. depends upon the amount of shift, that is, the difference between space and mark frequencies.



The a.c. voltage is delivered to the meter, calibrated in terms of frequency shift. Zero adjustment of the meter is controlled by the potentiometer, and the switch controls the sensitivity. Since a very low frequency might produce irregular meter readings, the doubler stage is included to increase frequency to a point where readings will be reliable.

The potentiometer controls the input to the upper diode. It should be adjusted so equal and opposite voltages are impressed across the diodes.

ARTIFICIAL REVERBERATION

Patent No. 2,674,660

James R. Ambrose, Indianapolis, Ind.

(Assigned to Radio Corp. of America)

Echoes and reverberations are among the special sound effects needed in dramatic shows and for commercial announcements. This invention, simpler than most previous ones of this type, reproduces multiple sounds from tape.

The tape passes over an erase head (Fig. 1) as in conventional machines. Two record heads are next in line. Each of these covers only a single channel, that is, half the tape width. The five reproduce heads cover the entire tape width so they are affected by both channels.

The desired sound from an input circuit is recorded by each record head at different points along the tape (Fig. 2). Thus as each reproduce head passes these points, the sounds become audible. The original sound is heard 10 different times since there are five reproduce heads and two record heads.

Each reproduce head has its own preamplifier and attenuator. This makes it possible to adjust the volume controls so that each reverberation is weaker than the previous one. Furthermore, note that one record head is fed with the full input while the other receives a fraction of this voltage. Therefore the first five reverberations heard (from the upper channel) will sound louder than the next series, which are recorded on the lower channel.

Another feature is that the output of one or more reproduce heads may be fed back through an amplifier for re-recording. Thus, if desired, an echo can be sustained indefinitely.

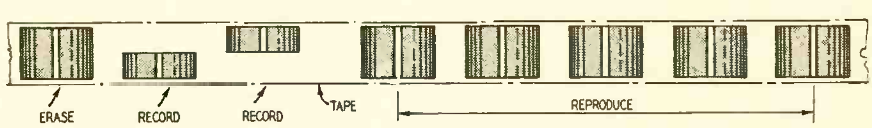


Fig. 1—Diagram showing arrangement of erase, record and reproduce heads. Record heads cover one track (channel) only; reproduce heads cover whole tape.

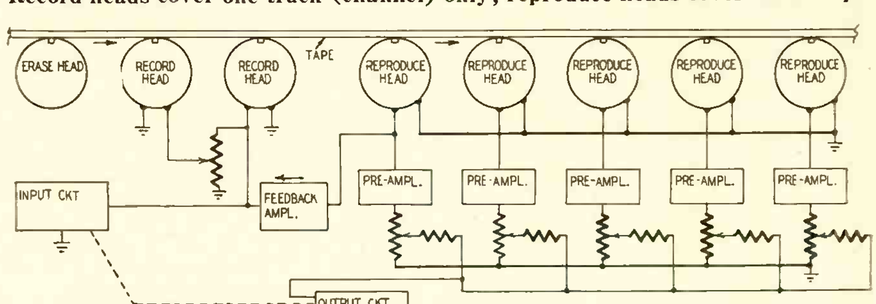


Fig. 2—Sound from input circuit is recorded at two different points. Separate preamplifier volume controls permit a gradual decay of sound.

NEW PATENTS

TWO-WAY AMPLIFIER

Patent No. 2,662,122
Robert M. Ryder, Summit, N.J.
(Assigned to Bell Telephone Laboratories, Inc.)

A tube can transmit and amplify in only one direction. If communication is to be carried on in both directions (forward and reverse) we must use at least two tubes or use a send-receive switching device. On the other hand, a transistor transmits and amplifies in both directions at the same time, if its gain is greater than 1. A point-contact transistor has this characteristic.

Either base or emitter may be used as the

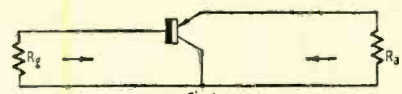


Fig. 1—Diagram shows collector as common element.

input element of a transistor. The collector is the common or *grounded* element. Fig. 1 shows a basic hookup. When signals are transmitted from left to right, R_g is the source and R_a the

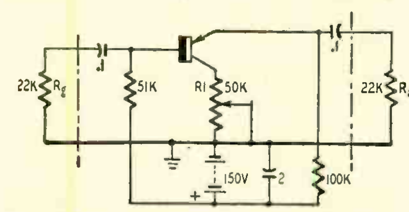


Fig. 2—Practical circuit—transistor is R-C coupled.

load. For reverse transmission, R_a is the source and R_g is the load.

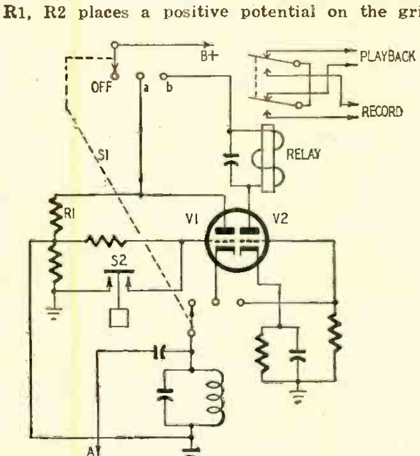
Fig. 2 is a practical circuit. Although the transistor is R-C coupled to source and load, matching transformers may be used instead. A single battery supplies all input power. R1 varies the current gain and determines the ratio of forward to reverse amplification. For equal transmission in both directions, it may be adjusted for a gain of 2.

RE-RECORDING DEVICE

Patent No. 2,675,430
Kenneth K. Clarke,
Chromepet, Madras, India.

Erasability is an important feature of magnetic recording. If any portion of a tape recording is found to contain an error, it is easy to erase that portion and substitute a corrected version. The problem is to fit the re-recording into its exact place, without overlap or delay. This invention controls the re-recording so that it starts and ends at precisely the correct spots. It operates automatically.

When S1 is thrown to position *a*, divider R1, R2 places a positive potential on the grid



NEW PATENTS

of V1 and this triode conducts. If S2 is closed momentarily, the grid is grounded and the triode is blocked. S2 is a dashpot-type switch that remains closed for only a short interval. Thus for a moment after depressing S2, V1 is cut off. This shocks LC into oscillation at its natural frequency, about 15 kc. The high frequency appears at terminal A which leads to the record-playback head, and a super-audible beep or marker is recorded on the magnetic tape.

If errors are discovered in a recording, the tape is played back and a marker is recorded before and after each error by operating S2 at the proper times.

To re-record the selection, it is played again into the recorder mike with the ganged switch in position *b*. In this position, VI is out of the circuit and V2 is connected. The normal position of the relay armature is as shown, so the original recording is heard. When the first marker pulse is reached, the high frequency is impressed (through terminal A) at the grid of V2 and is amplified. It energizes the relay so that the armature is snapped to "record." At this instant the re-recording begins and replaces the original sound. When the next marker is reached, there is another pulse and the relay armature is snapped back to "playback," ending the re-recording. All this is done automatically and without need for attention of the recordist.

The V2 plate relay is any locking type whose armature alternates between its positions each time it is energized.

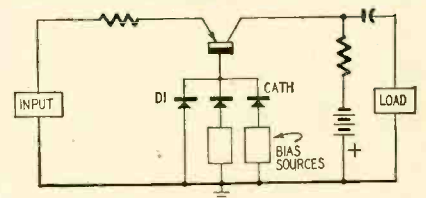
D.C. GAIN CONTROL

Patent No. 2,676,271

Edwin G. Baldwin, E. Orange, N.J. (Assigned to Bell Telephone Labs., Inc.)

This circuit uses an n type point contact transistor. Control is governed by a d.c. voltage applied to the transistor. The signal may be a.f. or r.f.

The base circuit includes three crystal rec-



tifiers. Two of them are biased by d.c. potentials, normally negative. Thus D1 is the only conducting diode, and the positive charges can pass through it from ground to the base. Its low resistance generates a small amount of positive bias for the emitter.

If either d.c. bias voltage is reversed (that is, made positive) the corresponding diode begins to conduct. Then the positive voltage is applied directly to the base and the transistor gain is reduced. Using a pair of control potentials and diodes permits either one to control gain. Alternatively, one control potential may be larger than the other, providing for different gain levels through the transistor.

This circuit may be controlled by push-buttons, if desired. END

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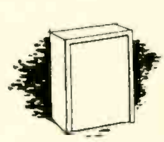

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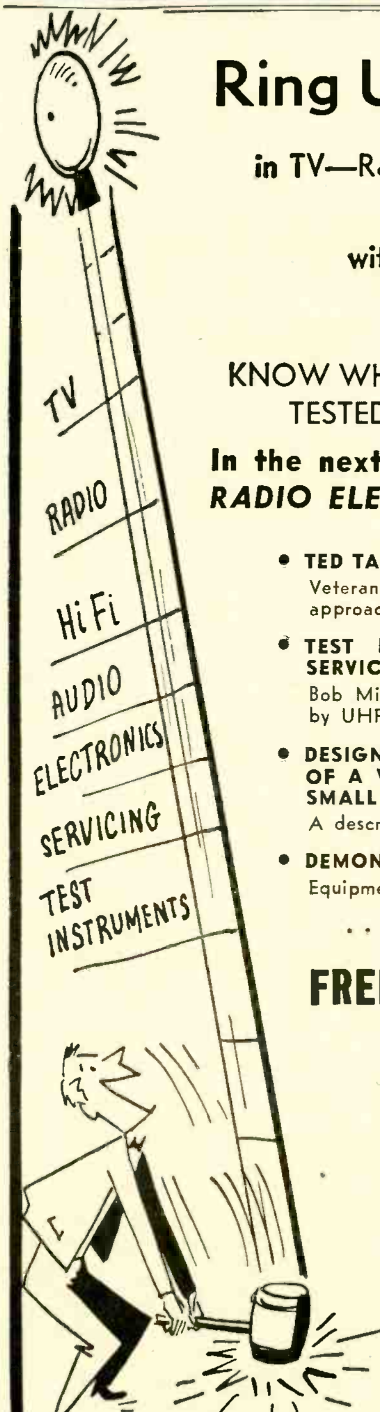

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TECHNICIANS' NEWS

UTAH WANTS LICENSES

In reply to a recent questionnaire circulated by the Utah Association of Radio and Television Servicemen (see RADIO-ELECTRONICS, August, page 90), service technicians of the Salt Lake City area have expressed a majority preference for State licensing.

The association is now working with city officials and representatives of the local business men's association to draw up a bill which they expect to present to the Legislature next January.

HOW TO ORGANIZE

Telling radio technicians how to organize a local TV-radio-electronics service association, the National Alliance of Television and Electronic Service Associations has issued what may be to the servicing fraternity the most important document of the year.

Called "Here's How" the booklet is a collection of mimeographed sheets stapled into a 4-page folder which serves both as a cover for the book, and to carry a plea for affiliation with NATESA. Three pages then carry a step-by-step plan—in 12 steps—on the actual work of organizing a local association.

Sheets showing a suggested constitution and by-laws, samples of promotional material, questionnaires, and membership applications follow. These are based on forms used by NATESA or TISA (the Television Installation Service Association of Chicago). There is also a short history of TISA, showing what a service organization can do for its membership and the community.

TECHNICIANS KNOW LAW

The San Antonio Radio and Television Association reports that members participated in a discussion "Law and How It Affects Your Business" by a local attorney at the June 22 meeting.

The discussion took place as a part of the General Electric business course now being conducted by the San Antonio association. The course is being handled in a slightly unconventional manner. Texts are used in class. Meetings discuss the subjects covered by the course—which the members study at home. Each meeting is led by a local authority on the subject discussed that evening and members put their home study to use in the discussion and question period.

An interesting by-product of the course is that some of the wives of members—who in San Antonio attend meetings regularly with their husbands—are said to be using the G-E business methods to set up household budgets and accounting systems.

LOOSE TALK

Technician to customer:

Yes, ma'am, you were perfectly right. It *was* only a loose wire—in the 27MP4!

—Long Island Guild News

TECHNICIANS' NEWS

GUILD HAS NEW EDITOR

The Editor-in-Chief of the Long Island *Guild News*, Murray Barlowe, has resigned his position to enable him to concentrate on his duties as Director of Lecturing and chairman of the Technical Committee. Ralph Milne is the new Editor. The post of corresponding secretary, formerly also held by Barlowe, is now being held by Chris Stratigos

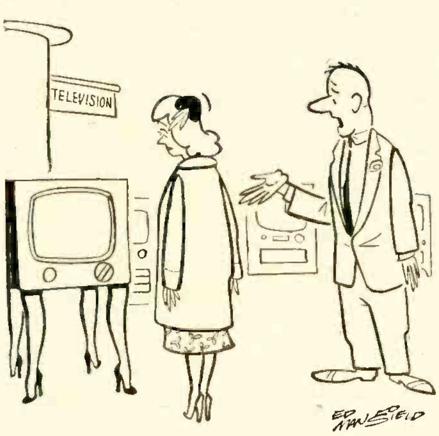
Guild business included reports on the color television lectures being held in Queens, cooperation with the government's plan for selenium salvage by turning scrap rectifiers in to Sarkes Tarzian, and extension of the president's and vice-president's powers to meet the requirements of the Guild's rapid expansion. A committee which had visited a local distributor reported on his company's policy with respect to strict wholesale selling.

TRIPLETT HONORED

A plaque reading: "Very best wishes to Ray L. Triplett on completing his 50th anniversary as president of the Triplett Electrical Instrument Co. of Bluffton, Ohio. His outstanding leadership and direction of the company during this long period has been characterized by wisdom, understanding and a cooperative attitude, reflecting the

finest traditions of the electrical industry", was presented to him recently by NATESA. President Frank Moch made the presentation.

Shown in the photograph, left to right, are Ray Braun, president of the Associated Service Companies of Cincinnati, Mr. Moch, Mr. Triplett, and John W. Hemak of Minneapolis, NATESA treasurer. END



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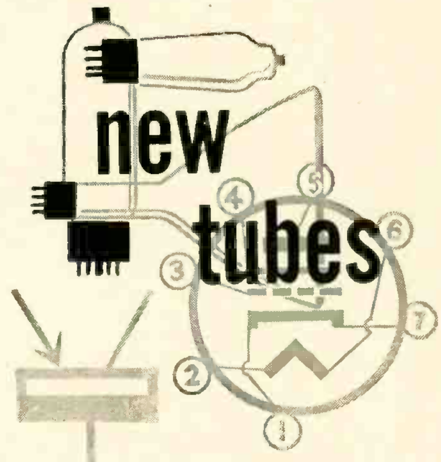


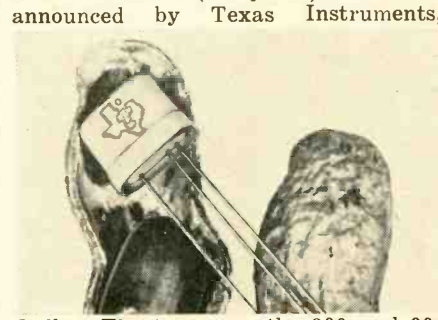
and Transistors

An important advance in the development of color TV picture tubes has been announced by CBS-Hytron. The CBS-Colortron 205 is a 19-inch, aluminized, round glass-envelope unit. It has been given the RETMA designation 19VP22.

Using the CBS method of screen processing, the tri-color, phosphor-dot screen is placed directly on the inside surface of the spherical face plate, providing a large useful screen area of 205 square inches. The length is 26 7/16 inches.

The tube's three matched electron guns are each tilted toward the tube axis, for better convergence, which is also aided by three pairs of pole pieces mounted 120° apart above the anode, forming part of the dynamic convergence magnetic circuit. The tube operates with an anode voltage of 25,000.

The first commercially available silicon transistors (see photo) have been announced by Texas Instruments,



Dallas. The types are the 900 and 901 general purpose units designed for high-gain low-level audio applications, and the X-15, for medium-power use.

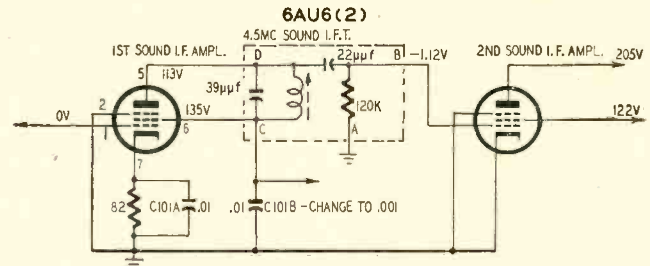
Raytheon and RCA have announced the 17-AVP4, a monochrome picture tube using low-voltage electrostatic focusing and magnetic deflection. The 17AVP4 has a screen area of 145 square inches and a deflection angle of 90°.

The 21ALP4-A direct-view, rectangular glass picture tube has been announced by Raytheon and RCA. The tube has a 90° deflection angle and uses low-voltage electrostatic focus and magnetic deflection. It has a metal-backed screen and a screen area of 263 square inches. END

RCA KCS-83 SERIES CHASSIS

Oscillations in the sound i.f. circuits of these chassis may be caused by a change in the value of the .01-μf screen bypass capacitor (C101-b) in the first sound i.f. stage. A defective capacitor at this point allows the first sound i.f. to oscillate within the range of 2 to 3 mc and cause raspy sound and a beat pattern in the picture.

Two replacement capacitors are recommended for dual capacitor C101-a and C101-b. Replace C101-a with a .01-μf positive temperature-coefficient type (RCA stock number 73960) and C101-b with a .001-μf positive temperature-coefficient type (RCA stock number 78623). Note that the replacement for C101-b is a .001-μf type where the original value was .01 μf. Keep the bypass capacitor leads short and make the connection to the same points as the original parts.—*RCA Service*

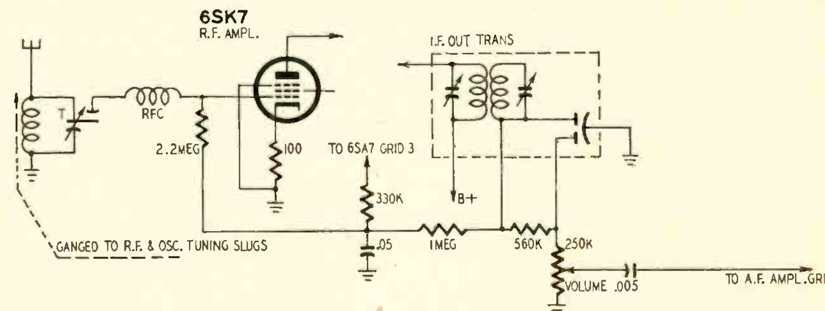


CHEVROLET 985793 AUTO SET

The set played normally on distant stations. On strong local stations the signal was distorted with an intermittent rasping noise. Using a signal tracer and a strong unmodulated signal from a signal generator, we localized the trouble in the r.f. stage. A resistance check from the grid of this stage to ground showed 100,000 ohms. The normal resistance is 3.7 to 4 megohms as indicated by the values on the partial schematic.

A further check showed that the mica insulation in the antenna-to-grid coupling capacitor (a part of the antenna trimmer) had shattered and was partially shorted.

The set was restored to normal operation by replacing the mica insulation. —*Floyd Holton.*



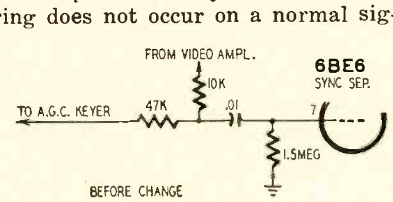
INTERMITTENT 12SA7'S IN A.C.-D.C. SETS

Check heater voltages when tubes test good in intermittent a.c.-d.c. sets. In two cases, I traced intermittents to "good" 12SA7's drawing only 7–9 heater volts. New tubes cured the ills. —*Alfred Hollinden*

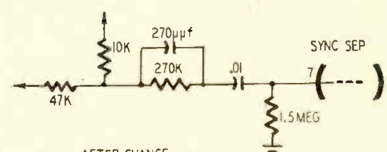
ARVIN SERIES 9200 TV SETS

Horizontal wavering in the top one-third of the picture on these sets (chassis TE-355, -358, -359, -362, -364, and TE-357) may be caused by intermittent partial loss of horizontal sync pulses when the set receives piped-in r.f. signals from a faulty multiple-dwelling or community antenna system. This wavering does not occur on a normal signal into a separate antenna.

When this condition prevails the trouble can be cleared up by inserting a parallel R-C network consisting of a 270-$\mu\mu$f mica capacitor and a 270,000-ohm, ½-watt resistor in the line to the sync separator. The diagrams show the original and modified circuits.—*Arvin Service Bulletin.*



BEFORE CHANGE

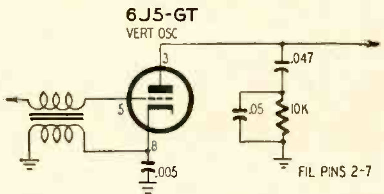


AFTER CHANGE

MOTOROLA 17K5E

The set worked normally for about an hour and then began losing height, intermittently with the picture shrinking to a line about one-quarter inch high. All components in the vertical oscillator and output checked normal.

The set was turned on again. After



about an hour of normal operation, a faint ticking sound was heard coming from the .047-μf, 400-volt vertical discharge capacitor connected to the plate of the 6J5-GT vertical oscillator as shown in the diagram.

This capacitor was normal when the set was cold but began to break down when it warmed up. Replacement with a 600-volt unit of the same capacitance cured the trouble.—*Michael L. Tortariello*

ZENITH CHASSIS 5537

When this 3-way portable is dead and all voltages and parts check O.K., the trouble may be a high-resistance short between the chassis and the metal-clad wirewound resistor on top of the chassis. This resistor supplies 6 volts to the four 1.4-volt tubes. The short to chassis increases the current drain and drops the voltage to less than 4.

Replace the defective unit or insulate it from the chassis.—*Geo. R. Anglado*

POWER LINE ARCING?

In the "TV Service Clinic" of last November, a reader described TVI in the form of two dark horizontal bands across the screen on channels 2, 4, and 5. The reader believed, and Mr. Mandl agreed, that the trouble was probably caused by corona discharge from nearby high-tension power lines.

I have experienced at least three cases of TVI with exactly the same symptoms. The cause of this trouble turned out to be an oscillating 117-volt light bulb. In two cases the bothersome lamp was located in the same building with the TV receiver.

I'll bet that reader J. M. has the same trouble.—*A. F. Popelarski*

A.C.-D.C. MOTORBOATING

Although motorboating is comparatively uncommon in modern 5- and 6-tube a.c.-d.c. radios, we do run across a set with this complaint from time to time. In every case so far, the trouble has been caused by common coupling through the power supply circuit and has been eliminated by installing a 4,700-ohm decoupling resistor and a .05-μf bypass capacitor in the B plus lead to the primary of the second i.f. transformer.—*Wayne Miller* END

MISCELLANY

THE FUND REACHES $11,445.11

HELP-FREDDIE-WALK FUND

We here at RADIO-ELECTRONICS have had some wonderful reports about little Freddie Thomason, six year old, armless and legless son of radio technician Herschel Thomason, of Magnolia, Ark., and we are more than happy to bring them in turn to you. His father writes:

"I have the best news that I have been able to write you in a long time. *Freddie is now walking* and is doing a real nice job of it. He can walk all over the house, so his Mother puts a football helmet on him almost every morning and lets him go. He usually walks for about three hours before he gets tired. I will be writing you more about his progress later."

Freddie and his friends watch TV

As most of our readers know, for many years Freddie will be dependent upon special devices to get the exercise and education he needs to prepare him for a self-reliant adulthood. All contributions to the Help-Freddie-Walk Fund have been sent on to Herschel Thomason, who then turns them over to a General Fund. $15,000 of this fund has been set aside on a time deposit and is drawing interest. A smaller fund has been set up to be used for immediate expenses.

Recently, we received the welcome news that a special room has been added to the Thomason house for Freddie's personal use, using these "immediate" funds. Mr. Thomason writes:

"Please express to your readers our appreciation for their part in helping to build the room. The addition, built at a cost of about $2,300, was badly needed for Freddie's present and future convenience. We hope in the future to equip it with special devices for exercise and education."

RADIO-ELECTRONICS readers will be proud of the part they have had in making Freddie's progress to date possible. The bulk of the money in his General Fund has come from you, in contributions ranging from $.50 to several hundred dollars. BUT—the job is only beginning—and the end isn't even in sight. Freddie is an otherwise healthy and normal boy. As he continues to grow and develop, all the special devices he needs will have to "grow" with him, and this will take money, thousands and thousands of dollars over the span of some fifteen or more years before Freddie will have reached his full growth.

We therefore ask that you continue sending in your contributions as often as you can. No amount is too small to receive our sincere thanks and appreciation, as well as the thanks and appreciation of the entire Thomason family. *Make all money orders, checks, etc., payable to Herschel Thomason.* Address all letters to:

Help-Freddie-Walk Fund
c/o RADIO ELECTRONICS Magazine
25 West Broadway
New York 7, N. Y.

FAMILY CIRCLE Contributions	$ 602.50
RADIO-ELECTRONICS Contributions as of April 8, 1954	10,809.59
Anonymous, Northampton, Mass.	1.00
Anonymous, Roseville, Mich.	1.00
Anonymous, New York, N.Y.	.50
Anonymous, Toledo, Ohio	1.00
Anonymous, Portland, Oregon	5.00
Fred M. Brenner, Dayton, Ohio	1.00
J. Salvador Donaire, Honduras, C.A.	7.02
Dorn, Murrysville, Pa.	1.00
Van H. Ferguson, Tallahassee, Fla.	3.50
E. F. Long, General Electric Co., Schenectady, N.Y.	1.00
Shirley Pinner, Hamilton, Ontario, Canada	1.00
Albert Steinberg & Co., Philadelphia, Pa.	10.00
TOTAL CONTRIBUTIONS as of July 2, 1954	$11,445.11

Radio Thirty-Five Years Ago

In Gernsback Publications

HUGO GERNSBACK
Founder

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

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

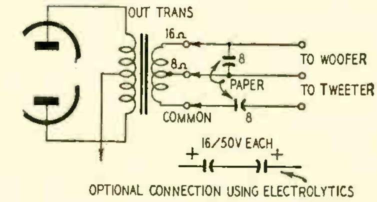
In September, 1920 *Science and Invention (formerly Electrical Experimenter)*

A Giant Radio Central Station
New de Forest Buzzer Radiophone
A Direct-Reading Microfaradmeter
How to Become a Professional Radio Man, by Pierre H. Boucheron
Sea Plane Flies by Radio Compass

TRY THIS ONE

CROSSOVER NETWORK

The diagram shows a simple method of isolating an 8-ohm woofer and tweeter without chokes when the output transformer has 8- and 16-ohm taps. The tweeter connects to the common and 8-ohm taps through an 8-μf capacitor. The woofer and an 8-μf capacitor are paralleled between the 8-



and 16-ohm taps as shown. Paper capacitors are recommended but you can replace each 8-μf unit with a pair of 16-μf electrolytics connected back-to-back.

The crossover point will be about 2,500 cycles with this arrangement.—*John Carlson.*

IMPROVISED SCREWDRIVER

Ever have a tough time trying to get the cover off the back of an auto radio in a tight place? Did you skin your knuckles trying to get a small wrench in the tight place to get the self-tapping screws out of the cabinet? You could have saved those knuckles if you had used a dime. A dime fits in the slot of most of the screws in the newer car radios and is easier to get into many tight places than even a short-handled screwdriver. — *B. W. Welz*

INSTALLING CABLE CONNECTORS

When terminating shielded cables with connectors that have cable clamps, it is desirable to connect the braided shield to the connector shell. This is usually done by removing the outer insulation and tightening the clamp over the braid. This method weakens the cable by eliminating the outer insulation at the point where it enters the connector. The insulation provides a large part of the cable's resistance to bending so its removal may allow the conductors to be damaged by excessive flexing almost bound to occur at the connector.

Weakening of the cable at the connector can be avoided by folding the shield braid back over the outer insulation and then clamping to it. In this way the original cable strength is retained while a good electrical contact is made between the shield and connector shell. —*Charles Erwin Cohn*

A HINT FOR BATTERY SETS

Before installing fresh batteries in portable radios, we wrap them in aluminum foil to protect the set from damage should the batteries corrode or become leaky.

Make sure that the foil doesn't short-circuit any connections.—*Harry J. Miller*

TRY THIS ONE

USEFUL DESIGN HINT

When designing electronic equipment I always keep a set of colored pencils handy for noting corrections and changes in the diagram and chassis layout. I use the crayons in increasing order according to the RETMA color code. For example, I prepare the original drawings in black lead pencil. The first change is made in red, the second in orange, and so on. When making the final drawings I follow the colored lines having the highest value in the color code.—*Ron Alexander*

IRON-CORED I.F.'S

In permeability-tuned i.f. transformers, the bottom slug is usually held by a sheet-metal nut in the middle of the fiber terminal board. When a metal screwdriver is used to tune this slug the circuit alignment may change as the screwdriver is applied and removed from it.

The slug is ungrounded so the metal tool changes its capacitance to ground, thus upsetting the tuning. The obvious cure is to solder a short jumper from the sheet-metal nut to a convenient point.—*J. Sareda*

(An equally obvious cure is, of course, to use a non-metallic aligning tool to set the slugs.—*Editor*)

TINTED TV SCREEN

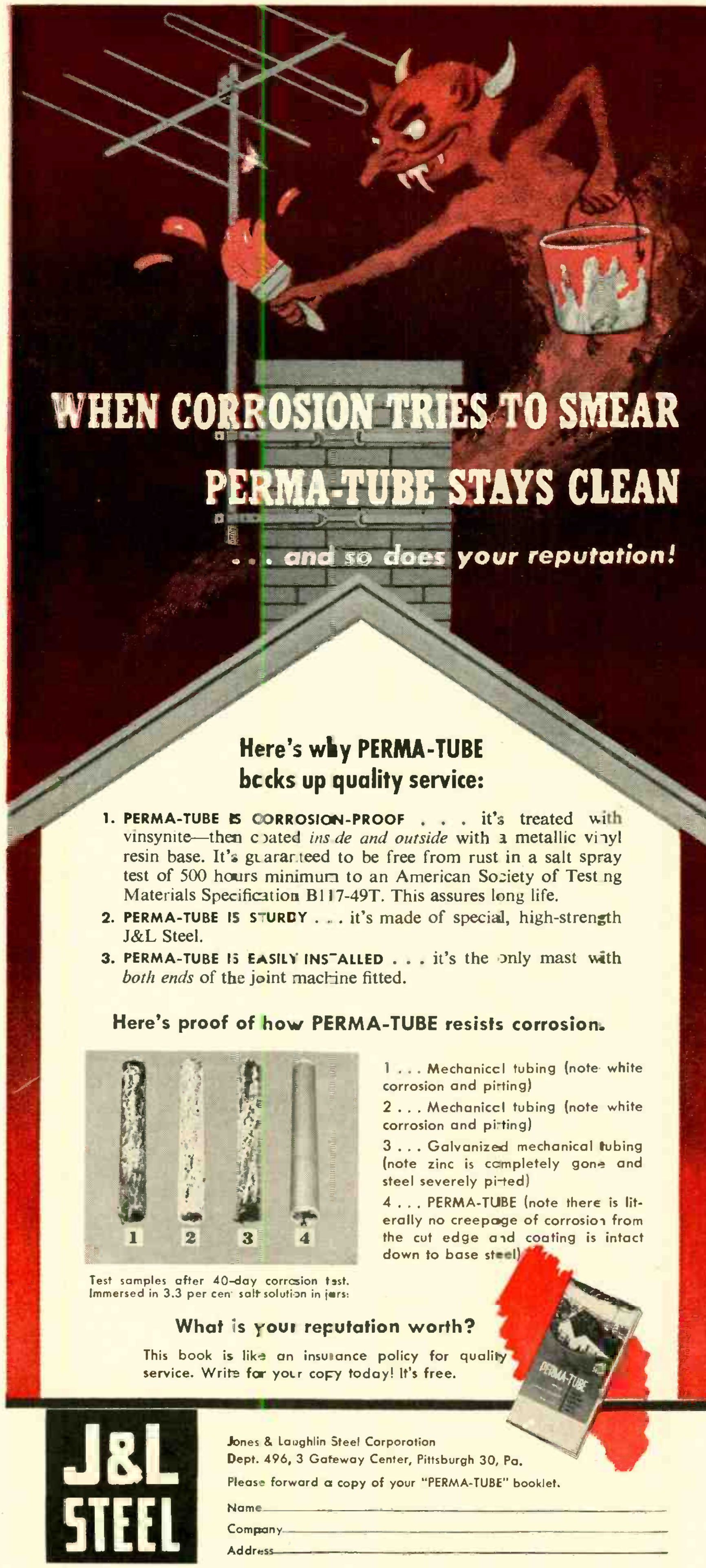
If you like the filter screen TV sets and are not ready to trade your old one in, try this idea. I have used it for some time.

Go to a garage or a company dealing in automobile glass and have them cut a piece of a tinted windshield the size of the safety glass in your set. Many times a cracked windshield may be found with enough unbroken glass in it to satisfy your needs. Sometimes you can get it for just the cost of cutting and dressing the edges. Do not destroy the original glass, some people do not like it and when the time comes to trade your set you will have either one the dealer or new purchaser wants.—*Bruce C. Vaughan, Jr.*

SPLICING SHORT LEADS

Some salvaged resistors and capacitors have leads that are so short—only about one-half inch in some cases—that they cannot be used in some applications. I use a method of splicing which enables me to lengthen the leads without bulky joints.

I use either a No. 58 wire drill or a sewing needle about .045 inch in diameter as a mandrel in a pin vise and wind a tight spring-like spiral of No. 23–26 tinned wire around it. I then cut the spring into pieces of about 8 turns each. The leads to be joined are pushed into opposite ends of the spring so their ends butt in the middle. Flowing solder over the spring connector and leads completes the joint and makes it electrically and mechanically sound.—*Charles B. Carlson*



TRY THIS ONE

CIRCUIT ANALYZER

The construction of some TV sets and small radios often makes it difficult to take voltage and resistance readings at the tube sockets. I solved this problem by mounting a number of wafer sockets—one for each type of tube base—on standoffs on a small wooden panel or board. Multiconductor cables connect each set of socket terminals to corresponding pins on male plugs or salvaged tube bases.

The analyzer test panel is handy when you don't want to pull a heavy TV or radio chassis or when the socket terminals of a set are not readily accessible because of parts mounted over them. Remove the tube from the stage to be checked and insert the test plug in its place. Plug the tube into the panel and take the measurements.—*Martin Bolton*

(When checking high-gain and high-frequency circuits, the long analyzer leads may cause oscillations or circuit detuning which affects the circuit performance and voltage readings.—*Editor*)

SOCKET FOR C-R TUBE

While constructing a scope I found that I did not have a socket for the C-R tube. I looked around for a temporary substitute to keep the project going until one could be ordered. I removed the contacts from a few wafer sockets, soldered appropriate leads to them and then slipped them over the base pins on the C-R tube. The resulting setup was neater than alligator clips and produced better contacts.

This arrangement worked so well that I have since used socket contacts and matching pins from old tube bases in numerous applications where simple connectors can be employed.—*Wm. B. Rasmussen*

(It is advisable to color-code the leads or tag them with the numbers of the matching pins to facilitate replacing the tube and to eliminate error. A plastic cup can be fitted over the exposed pins to avoid shock.—*Editor*)

DRY-BATTERY STORAGE

Spoilage and deterioration are problems when a large supply of dry batteries is held in stock. This can be solved by placing the batteries in a deep freezer or refrigerator that will hold the temperature below freezing. Freezing the batteries slows up chemical action and greatly increases their shelf life.—*J. Sareda*

PLUG CONNECTIONS

When preparing cables for soldering to male plugs or tube bases, it is a good idea to dip the bared wire into some soldering paste before inserting it into the prong. This makes the solder run more easily into the prong, thus simplifying the job.—*C. Cohn* END

NEW DEVICES

NEW ANTENNA

Walsco Electronics Corp., 3602 Crenshaw Blvd., Los Angeles, Calif., has introduced their new low-price *Scotty* antenna which is designed for metropolitan and suburban areas, and is capable of producing a strong signal 20 to 30 miles from the transmitter.

It is not a fringe antenna, but can be readily stacked for semi-fringe reception. The antenna has an unbreakable polystyrene insulator with outstanding electric properties. This insulator is silicone-treated to prevent the formation of dust, soot, moisture, etc.

TUBE TESTER

Radio City Products Co., Inc., Easton, Pa., has introduced a new portable tube tester, model 327P, which contains a large 4½-inch rectangular meter. It is compact in size and weighs only 9½ pounds, making it convenient to take out on the job or to use in the shop or store.

Cathode-ray picture tubes, including color picture tubes, can be tested with adapter cables that are available, and can be housed in the cover of the tester. Rather than the conventional roller chart, a tab index tube chart gives quick reference. This permits immediate setup in the tube chart for new tube test data as the tubes are brought out.

MIKE AND STAND

Turner Co., Cedar Rapids, Iowa, has announced that the 50D *Aristocrat* microphone is now available in a satin black finish with a matching desk stand for TV use.

The TV version is called the 50D-TP. The stand has a built-in shock mount to minimize disturbance from vibration, jars, and knocks. The microphone mounting is designed for fast conversion from desk to hand or floor stand use.

It is essentially nondirectional in operation and has an ultra-wide range. The response is listed as 50 to 15,000 c.p.s.

An advanced circuit design with a high output dynamic generator requires no closely associated auxiliary equipment. The low-impedance model with a 4-pin Cannon connector may be used for either 50-ohm or 200-ohm output. A high-impedance model also is available.

OSCILLOSCOPE

Sylvania Electric Products, Inc., Great Arrow Drive, Buffalo, N.Y., has announced the type 404 wide-band all-purpose oscilloscope for designing and servicing television receivers. It utilizes a seven-inch cathode-ray tube for extra large patterns.

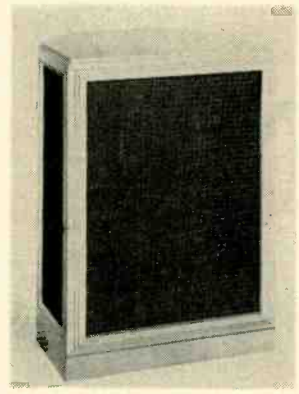
Sensitivities are: vertical—10 millivolts per inch; horizontal—150 millivolts per inch. The vertical plates are 24 volts per inch, and the horizontal plates are 26 volts per inch. The input impedances are: vertical amplifiers—5 meg, 26 μμf; horizontal amplifiers—5 meg., 31 μμf; vertical and horizontal plates (direct)—4.7 meg. 16 μμf; accelerating potential—2,200 volts. Sweep rates are from 25 cycles to 50 kilocycles.

SPEAKER CABINETS

Jensen Manufacturing Co., 329 S. Wood St., Chicago, Ill., has introduced two new back-loading cabinets for 12-inch and 15-inch speakers. They can be used with coaxial or Triaxial speakers, mid-channel and high-frequency units, and woofers. All units are mounted from the rear of the cabinet and are concealed behind the acoustic-type plastic grill cloth. The pre-cut openings in the front baffle are blocked by an adapter baffle. The cabinets are designed to fit into a corner or they may be placed against a

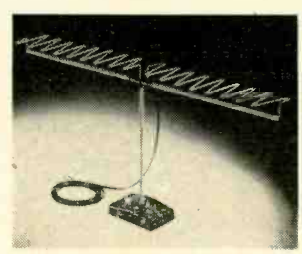
NEW DEVICES

side wall. Low-frequency radiation is augmented by acoustic passages opening into the sides of the cabinet. Model BL-250 is for 12-inch speakers, and model BL-121 is for 15-inch speakers.



INDOOR ANTENNA

Peerless Products Industries, 812 N. Pulaski Rd., Chicago 51, Ill., has announced its new *Diron Golden Wand* TV indoor antenna, model DV11G. It has been pretuned to receive all v.h.f. channels and FM. The broad-band characteristics of

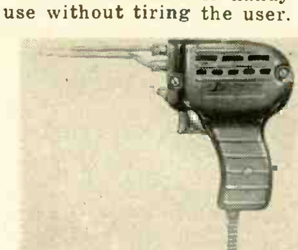


the *Diron* permit black and white and color transmission. Directly coupled elements provide high gain.

Twelve feet of 300-ohm twin lead permits location behind a bookcase or even in a closet. It is available in gold and in black.

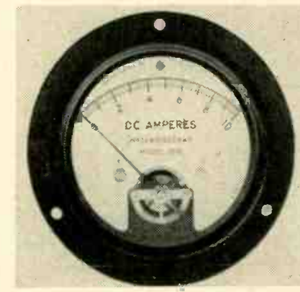
SOLDERING GUN

Wen Products, Inc., 5808 Northwest Highway, Chicago 31, Ill., has announced the new *Quick-Hot* soldering gun, model 199. It weighs only 1½ pounds. It is ready to work 2½ seconds after power is applied. It is designed for extra-long reach. Its balance makes it handy to use without tiring the user.



PANEL INSTRUMENTS

Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill., has announced an addition to its panel instrument line. These sealed ruggedized panel meters will be made with d.c. ranges showing any practical scale from 300 μa to 800 ma. The



meters will be available in two sizes—2½ inches and 3½ inches.

REPLACEMENT TRANSFORMERS

Merit Coil & Transformer Corp., 4427 N. Clark St., Chicago 40, Ill., has put on the market three new horizontal output transformers which are designed as exact replacements for similar Admiral units. The

models HVO-22, HVO-23, and HVO-24 all have mounting brackets, mounting centers, terminal boards, and terminal locations exactly comparable to the Admiral television transformers they are designed to replace.

SOLDER DISPENSER

CBS-Hytron, Danvers, Mass., has announced the development of a solder dispenser and refills for it. It is a one-hand tool and does away with haywire coils of solder. The operator's thumb

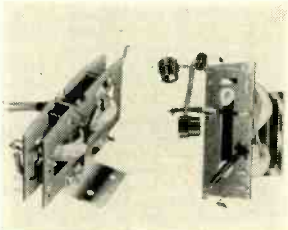
on the knurled wheel of the solder dispenser feeds solder and retracts it when the job is done. It holds 72 inches of solder. The dispenser is light and pencil-like with a pocket-clip; it comes ready to use—loaded with 20 refills.

REPLACEMENT FLYBACKS

Stancor Division of the Chicago Standard Transformer Corp., Addison & Elston, Chicago 18, Ill., has announced the addition of exact replacement flyback transformers for Motorola and Muntz, both physically and electrically, which do not require chassis or circuit alterations.

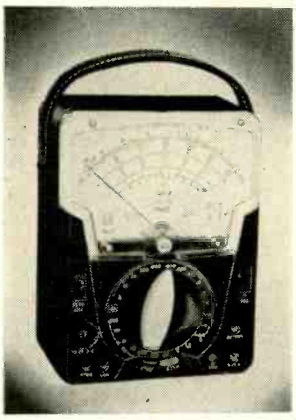
Stancor flyback A-8239 is an

exact replacement for Motorola parts Nos. 24K792753 and 24K-701099. A-8239 has application in over 100 Motorola models and chassis. A-8240 is an exact replacement for the Muntz part No. TO-0036.



NEW TESTER

Triplett Electrical Instrument Co., Bluffton, Ohio, has introduced a new tester, model 631,



that combines a volt-ohm milliammeter and a vacuum-tube volt-meter in a single unit.

Its characteristics include: 34 ranges, v.o.m. 10 a.c.-d.c. volts; six direct current; resistances from 0.1 ohm to 150 megohms; decibel and output readings. V.t.v.m: four, including 1.2-volt range for grid voltage and accurate discriminator alignment.

Sensitivity: V.o.m. 20,000 ohms per volt on d.c.; 500 ohms per volt on a.c.; V.t.v.m.: 11 megohms.

One switch on the unit selects all ranges and minimizes chance of incorrect settings and burnouts. The knob is large and flush with the panel.

The model 631 has a large 5½-inch meter with an exceptionally legible scale.

NEW LOUDSPEAKERS

RCA Victor Division, Radio Corporation of America, Harrison, N. J., has announced the availability of two new loudspeakers which feature larger-than-usual Alnico V magnets.

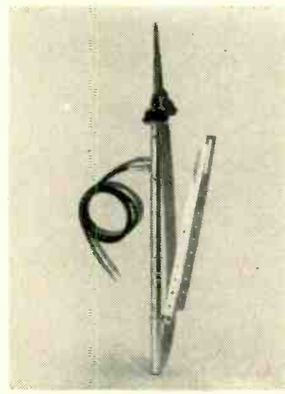
The speakers are a 6½-inch permanent-magnet type 220S1, for replacement service in table model radio and television receivers, and in centralized sound systems; and a 6 x 9-inch permanent-magnet type 218S1, for use in automobile radios and home music systems.

The 220S1 type incorporates a 2.15-ounce Alnico V magnet, a 3.2-ohm voice coil, and a special universal flange for mounting a wide range of transformer sizes.

The 218S1 speaker has a 3.2-ohm voice coil and an Alnico V magnet weighing only 2.9 ounces; yet it has the performance capabilities of a speaker designed with a 3.16-ounce magnet.

AUTO AERIALS

Brach Manufacturing Corp., 20 Central Ave., Newark 3, N. J., is delivering to the replacement market two new universal auto aerials, models 473, *Speedmount,* and model 501, the *Fendermount.*



Each unit has a three-section triple chrome-plated brass mast, automatic ground connection, and an adjustable (0–32°) insulator.

INVERTER

American Television & Radio Co., 300 E. 4th Street, St. Paul, Minn., has announced an ATR inverter which can be used in any auto for operating standard tape recorders, wire recorders, or any other type of dictation machine.

The ATR tape recorder inverter operates from the 6- or 12-volt d.c. automotive storage-battery system and provides 110 volts a.c. household electricity for operating the recorder.

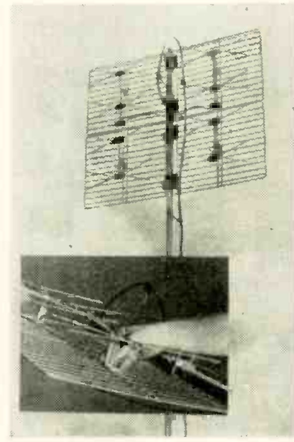
The inverter is available with mounting brackets for under-dash or trunk mounting. A remote-control unit is available for use with inverter, when inverter is mounted in trunk compartment.

8-BOW ANTENNA

JFD Manufacturing Co., Inc., 6101 16th Avenue, Brooklyn 4, N. Y., has announced a new 8-bow antenna with a calibrator. This precision calibrator

NEW DEVICES

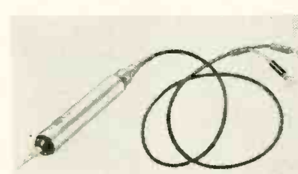
is a custom-built graduated slide. It connects the bow to the screen element, and is easy to peak for any u.h.f. channel or group of channels. It adjusts the spacing between bows and grids. This provides high signal-to-noise ratio.



In addition to the adjustable dipole mounting bracket, there is side-by-side stacking of two 4-bay bows. The antenna has a sharp horizontal pattern which indicates a narrow beam width, and side lobes are negligible. The beam pattern of the major lobe width is 15° at the half power points, and average back rejection is 18 db.

DUAL PURPOSE PROBE

Scala Radio Co., 2814—19th St., San Francisco, Calif., has announced a dual-purpose probe which can be used as both a direct probe and an alignment probe.



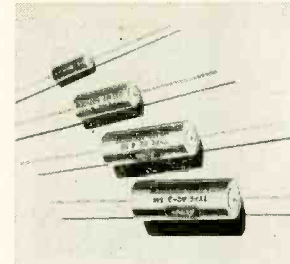
A switch governs use. As a direct probe, the BZ-5 is designed for general trouble-shooting. Shielding guards against pickup of stray fields near the chassis, with a minimum of circuit loading.

In visual alignment work, where a filter characteristic is required and the direct probe should not be used, a flip of the switch converts the BZ-5 into a resistive isolating probe. Thus used it provides the optimum filter characteristics essential for visual alignment. The arrangement is basically that of a low-pass filter which sharpens up the alignment markers and also cleans up noisy response curves.

The new probe will work efficiently with any oscilloscope. It is furnished complete with calibrated low-capacitance co-axial cable which can be used with all Scala probes.

X-250

Astron Corp., 255 Grant Ave., East Newark, N. J., has developed impregnant X-250 which is being used in the construc-

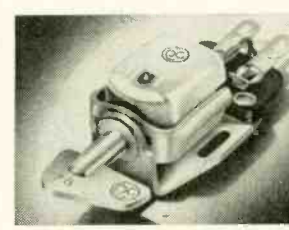


tion of Astron *Meteor* line of capacitors. X-250 provides high capacitance stability, low power factor, low resonance loss, and high test voltage. The capacitance versus temperature curve of *Meteor* capacitors is practically flat from —40°C to +125°C, and at −65°C the capacitance decrease with temperature is less than 5%.

Type AQ and TQ capacitors are hermetically sealed metal-tubular subminiature units designed for operation over a wide temperature range of −65°C to +125°C without derating. They are available also in a variety of MIL-C-25A case styles and higher capacitance values for broader application in electronic designs.

NEW STYLUS

Pickering & Company, Inc., Oceanside, Long Island, N. Y., announces that its model 260 turnover magnetic pickup cartridge is now available with a diamond stylus for long-playing recordings and a sapphire stylus for standard 78 record-



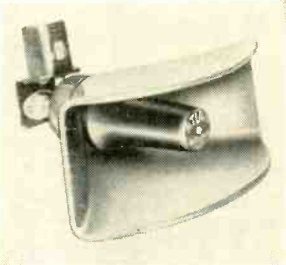
ings. The diamond stylus is of .001 inch radius for long-playing records and the sapphire stylus is of .0027 inch radius for standard groove 78-r.p.m records.

Except for the sapphire stylus, this unit is identical in all respects to the Pickering model 260 double-diamond turnover pickup which features low over-all distortion, high compliance, low-moving mass, minimum tracking force and high output.

NEW PROJECTOR

Atlas Sound Corp., 1449 39th St., Brooklyn 18, N. Y., has announced a new wide-angle, all-purpose projector called the *Cobra-jector*, model CJ-30. It features a polyester fiber-glass projector, Alnico-V-Plus magnetic assembly, 100% phenolic diaphragm and voice coil assembly, and universal bracket.

It is excellent for applications such as paging and talk-back, intercommunication, and marine and industrial installations. It reproduces with a crisp, penetrating characteristic giving coverage of wide areas and under difficult conditions such as high noise, adverse winds, etc.

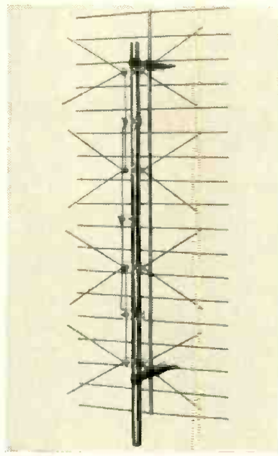


Electrical connections can be made either to the extending plastic-covered leads or directly to the driver unit terminals. The universal mounting bracket permits adjustment in both a vertical or horizontal position without the need to change the bracket position on the wall or mounting surface.

The specifications are: input power (continuous), 15 watts; input impedance, 8 ohms; response 250 to 9,000 c.p.s.; and dispersion, 120° x 60°. Shipping weight is 6 lbs.

U.H.F. ANTENNAS

Trio Mfg. Co., Griggsville, Ill., now has an improved version of their UBT series of u.h.f. antennas. The new antennas are of the bowtie and reflector type with all elements and phasing bars constructed of hard-drawn aluminum rod for extreme rigidity, low wind resistance, and light weight. They are made in three models: UBT-1, a single bowtie with reflector; UBT-2, a two-stack model; and UBT-4, a four-stack model especially designed for ultra-fringe areas.



The manufacturer claims high gains, excellent front-to-back ratios, and unusually good match to the standard 300-ohm line.

NEW TESTER

Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y., has announced the new model 120 multirange test set which operates on 20,000 ohms per volt d.c. and 5,000 ohms per volt a.c.

It has 44 self-contained ranges which start low and go high, low resistance range with a 2-ohm center scale; low-voltage range provides 1.2 volts full scale, both a.c. and d.c.; an extended low d.c. current range starts at 0-160 microamperes.

Range selection with the model 120 is achieved through a 36-range, 18-position, positive-detenting, master range selector with low resistance, silver-plated contacts.

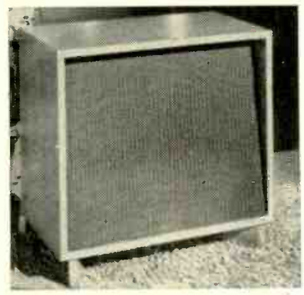
The ranges are: 8 d.c. voltage, 0-1.2-3-12-60-300-600-1200-6000 volts; 8 a.c. voltage and output; 0-1.2-3-12-60-300-600-1200-6000; 7 current (d.c.) 0-1.2-120-600 ma, 0 to 12 amperes; 5 resistance, 0-200-2000-200,000 ohms, 0-2-20 megohms; 8 decibel, from −20 to + 77 db (0 db taken as 1 milliwatt across 600 ohms).

SPEAKER SYSTEM

Permoflux Corp., 4900 W. Grand Ave., Chicago 39, Ill., has introduced its new *Largo* speaker system which utilizes the new Permoflux model 8V81 *Super Royal* speaker (8-inch) and 32KTR super-tweeter model in an enclosure.

The compact speaker system's enclosure is a horn-loaded non-resonant baffle with the horn loading of the speaker back-wave taking place in the cabinet base. Baffle and speaker characteristics provide undistorted reproduction of all frequencies from 35 cycles to 16,000 cycles.

The *Largo* speaker system features a high-frequency balance control and a special connector to receive a headset extension cord for private listening and hard-of-hearing music lovers. It is constructed of mahogany and Korina veneers. END

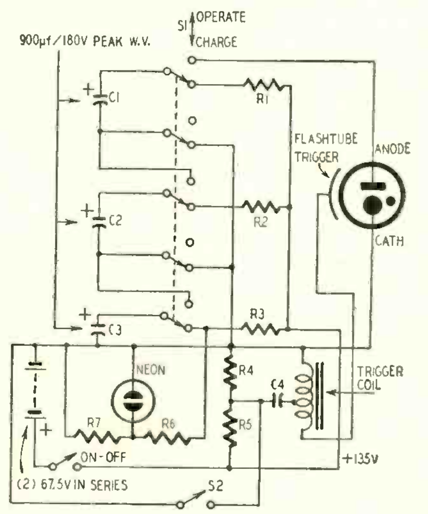


All specifications given on these pages are from manufacturers' data.

RADIO-ELECTRONIC CIRCUITS

POWER FOR PHOTOFLASH

For years, lightweight power supplies for electronic photoflash units have been designed and constructed by engineers and experimenters alike. Most modern photoflash tubes operate with about 900 volts between plate and cathode; earlier types require 2,000 volts or more. There are several general approaches to the design of the power pack. Some are a.c. operated with oscilloscope-type high-voltage supplies, some have storage batteries with vibrator-type supplies, while others use small 300-volt B-batteries in series to develop the required voltage for the photoflash tube.



An article in *The Radio Constructor*, a British publication, describes an electronic photoflash unit using two 67.5-volt portable radio batteries in a novel arrangement to supply operating voltage for a flash tube requiring 400–450 volts.

When switch S1 is in the CHARGE position as in the diagram, C1, C2, and C3 are connected in parallel across the 135-volt battery supply so they charge through R1, R2, and R3, respectively. Throwing S1 to OPERATE connects C1, C2, and C3 in series to apply 405 volts between plate and cathode of the photoflash tube. The neon indicator lamp is across a section of a 135-volt voltage divider consisting of R3, R6, and R7. The values of R6 and R7 are proportioned so the neon lamp lights when the charge on the capacitors reaches about 110 volts. The combined values of R3, R6, and R7 should be comparatively high to minimize the load on the batteries.

The trigger coil may be a G-E type 86G41 or a model airplane spark coil. C4 is a 400–600-volt paper capacitor of about 0.25 μf. The combined resistance of R4 and R5 should be high enough to limit the current drain to 5–8 ma. Adjust their values so the coil supplies a trigger pulse of sufficient amplitude for reliable operation.

The time-constant of R5-C4 should not be longer than the time required for C1, C2, and C3 to reach full charge.

R1, R2, and R3 are current limiting resistors to equalize the charge on the capacitors and prevent arcing across the contacts of S1 when it is thrown to OPERATE. Consult the photoflash capacitor manufacturer's data for recommended resistor values at the specified charging voltage.

S2 is the firing switch which may be on the synchronizer solenoid or a contact on the camera shutter. S1 must be rated to handle the voltages in this circuit.

This same type of supply can be adapted so that a single 300-volt B battery can be used to supply a G-M tube or a photoflash tube requiring 900 volts.

VARIABLE BANDWIDTH

When a wide-band AM signal is tuned in on a receiver which has a narrow peaked i.f. response or a flat topped band-pass response substantially narrower than the transmitted band of frequencies, the higher modulation frequencies are greatly attenuated. The more common methods of broadening i.f. amplifier response are well known to readers of this magazine. Patent No. 2,514,443, issued to Murray G. Crosby, describes two radically new methods of

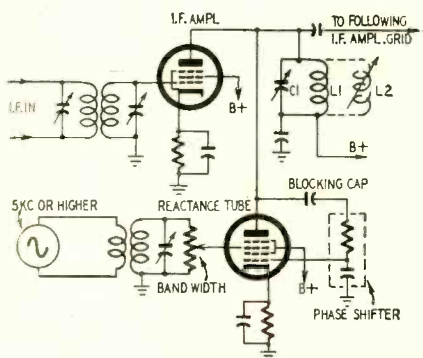


Fig. 1

controlling the apparent bandwidth of i.f. amplifier circuits. The circuit in Fig. 1 is for controlling the response of a conventional single-peaked response curve.

Here we have an i.f. stage with a single-tuned circuit L1-C1 as its plate load. A reactance tube is connected to the i.f. amplifier circuit so its plate-cathode impedance shunts the tuned circuit and appears as an inductive shunt (L2) in parallel with L1. The effective inductive reactance of L2 is determined by the gain of the reactance tube and the voltage on grid 3. The inductive reactance increases when the voltage on grid 3 is varied in one direction and decreases when the voltage is shifted in the opposite direction.

Grid 3 of the reactance tube is fed with a superaudible signal of about 5 kc or higher. This causes the reactance of L2 to vary and change the instantaneous frequency of the i.f. amplifier plate circuit. The speed of the frequency shift is determined by the frequency of the signal fed to the reactance tube, and the amount of reactance variation is determined by the amplitude of the applied a.c. voltage.

The solid curve in Fig. 2 illustrates the typical peaked response of a conventional i.f. amplifier circuit. The dashed lines show how the peaked response of the tuned circuit is shifted periodically by equal amounts above and below the normal resonant frequency. The effect of this periodic detuning of the i.f. circuit is an apparent flat-topped band-pass curve.

The inventor also describes how the effective width of a narrow flat-topped i.f. response curve may be increased

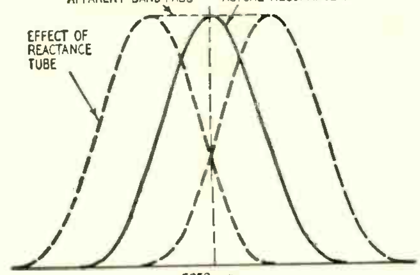


Fig. 2

by using the reactance tube to modulate the receiver's local oscillator. Frequency-modulation of the local oscillator results in rapid shifting of the intermediate frequency so the upper and lower side-bands are alternately passed through the relatively narrow i.f. circuits.

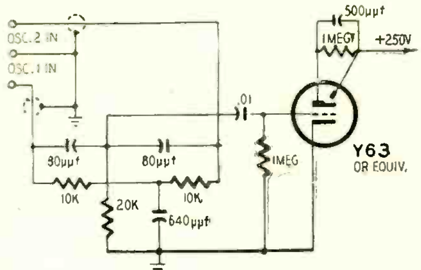
The inventor also describes a method of using carrier strength to control the sweep width produced by the reactance tube. Thus, the bandwidth can be automatically increased on strong signals and decreased to reduce background noise on weak ones.

NOVEL PARALLEL-T USE

Some form of simple mixer circuit is often used to compare the frequency of a variable oscillator with a frequency standard. In many instances, the less stable of the two oscillators tends to lock in with the other when the frequency difference is small. This makes it difficult, if not impossible, to get an exact zero beat between the reference oscillator and the one whose frequency is to be measured.

In *Electronic Engineering* (London, England), J. S. Nisbet shows a parallel-T network as a linear mixer for two signal sources in a frequency meter. One oscillator connects to the input end of the parallel-T and the other to the output end. Output for the detector can be tapped off of either T—from the junction of the series resistors or from the series capacitors. At the null or resonance frequency of the network, the transfer impedance between the ends of the circuit is zero, so no voltage is fed from one oscillator to the other. With the circuit shown, coupling and pulling between oscillators are avoided to a point where the frequency difference is less than a cycle at 50 kc. A

British type Y63 electron-ray indicator tube is used as a detector and zero-beat indicator. A 6E5 or similar type may be used instead.

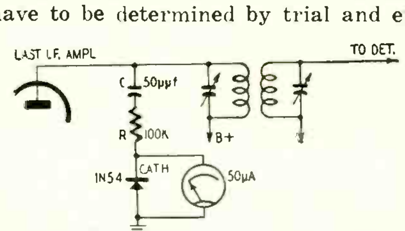


In the usual parallel-T designed as a filter or for the feedback circuit of an oscillator, the constants are selected for maximum possible attenuation at the null frequency and minimum losses elsewhere in the spectrum. In this aplication, the attenuation must be high through the comparatively wide band of frequencies where pulling may occur, so the values are slightly different from those in normal filter and null circuits.

S-METER CIRCUIT

Many receivers used by amateurs and SWL's lack S-meters for measuring relative signal strength. Instructions for installing an S-meter usually require several components and some circuit alterations. This circuit, described by G2HR in *The Short Wave Magazine* (London, England), does not require any alteration of the original circuit and uses only four components including the meter.

In this circuit, a diode and microammeter are used as a high-resistance r.f. voltmeter. The meter is shunted by a germanium diode and is in series with a resistor and capacitor between ground and the plate of the last i.f. amplifier. The values for R and C may have to be determined by trial and er-



ror. C should not be much larger than about 50 μμf and R should be about 100,000 ohms. The type of diode was not specified in the article. A 1N54 or equivalent should work satisfactorily.

Different values of R and C may be required with meters less sensitive than the 50-μa unit shown.

The sensitivity of most all-wave receivers varies from band to band. If you calibrate the S-meter with a laboratory-type signal generator, you can select sets of R-C constants to give the same S reading for equal signal inputs on each band. The R-C combinations can be connected into the circuit as needed with a multipurpose switch ganged to the band switch in the receiver. END

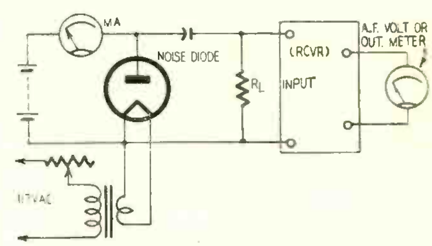
QUESTION BOX

NOISE-FIGURE MEANING

What is noise-figure, how is it measured, and how is it used to compare receivers? I see the term used very often, but have never yet met anyone who can tell me just what it really means.—M.B.B., Denver, Colo.

Noise-figure is a factor used to indicate the quality of an actual receiver compared to a theoretically perfect set with the same bandwidth and absolutely no internal noise. The noise-figure is the signal-to-noise power ratio of the ideal receiver divided by the signal-to-noise power ratio of the actual receiver. The ability to read weak signals increases as the noise-figure of the receiver decreases. The diagram shows a basic noise generator used in measuring noise-figure.

The circuit is designed around a *temperature-limited* diode—a diode operated with enough plate voltage to attract to the plate all the electrons emitted by the filament. Under these conditions, the diode produces a wide-band r.f. hiss or noise with amplitude directly proportional to the plate current. Plate current and amplitude of the r.f. output are controlled by varying the filament voltage.



The noise voltage is produced across R_L (a noninductive resistor) with resistance equal to the antenna or lead-in impedance. Connect the generator and output meter to the receiver as shown. With the receiver operating at maximum sensitivity and the noise generator turned off, advance the set's volume control to obtain an arbitrary reading on the output meter. Then turn the generator on and increase the filament voltage until the output meter reading increases 3 db.

The noise-figure (F) of the receiver is equal to $20 \times I \times R_L$, where I is diode plate current in amperes. In decibels, F is 10 times the logarithm of the figure obtained with the equation above.

The physical construction of a tube largely determines the noise it introduces. Thus, a triode amplifier will produce less noise than the very best of mixer tubes.

Bibliography:

F. E. Terman, *Radio Engineering*, 3rd Edition, pp. 770-773.

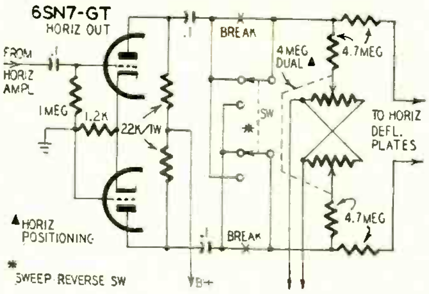
Byron Goodman, "How Sensitive Is Your Receiver?" *QST*, Vol. 31, No. 9, September, 1947, pp. 13-21.

William Orr, "The Silicon Crystal Noise Generator," *CQ*, Vol. 8, No. 6, June, 1952, pp. 25-27.

Edward F. Tilton, "Noise-Generator Techniques for the V.H.F. Man," *QST*, Vol. 33, No. 8, August, 1949, pp. 20-21, 90-92.

SCOPE SWEEP REVERSAL

I have an Eico 5-inch scope. I want to install a switch to reverse the sweep direction so response patterns will have the same time-versus-frequency direction as in set manufacturers' service manuals. Please show how this is done.—R. D., Springfield, Mo.



The diagram shows the horizontal output circuit of the Eico 425 scope with the sweep reversal switch added. The signals on the plates of the push-pull horizontal amplifier are 180° out of phase so the sweep changes direction when the plate output leads are reversed by throwing the switch.

TV TRANSMITTER DATA

I want to construct an amateur TV station and a closed-circuit TV camera chain for experimental purposes. Can you supply practical circuits of simple sync generators, timing circuits, flying-spot scanners, r.f. amplifiers, and modulators? I have lots of theoretical material from magazines and textbooks but no practical circuits. I need practical circuits with typical values. Can you supply circuits or references that will be useful to me?—J. McN., Wyandanch, N. Y.

The article "Experimental TV Relay," RADIO-ELECTRONICS, May, 1949, describes a 10-watt transmitter with line amplifier, and modulator. Additional references are given in the following bibliography:

G. Zaharis, "Television Synchronizing Generator," *Electronics*, Vol. 23, No. 5. May, 1950, pp. 92-93.

L. E. Flory, W. S. Pike, J. E. Dilley, and J. M. Morgan. "Pack-Carried Television Station," *Electronics*, Vol. 25, No. 6, June, 1952, pp. 92-95.

S. R. Patremio. "The Du-Mitter," Radio & Television News (*Radio-Electronic Engineering Section*) Vol. 49, No. 2, February, 1952, pp. 3-5.

J. R. Popkin-Clurman. "Simplified Ham TV Station," *Radio & Television News*, Vol. 43, Nos. 5-6, Vol. 44, No. 1, May, June and July, 1950.

END

Interest in the Question Box, as indicated by letters received, is not high, and the question has arisen as to whether the space might not be better devoted to other subjects. What do our readers think? Should we: (1) continue the Question Box as is; (2) discontinue it; or (3) substitute some other material, and if so, what? Please mail your vote to Question Box, Radio-Electronics, 25 West Broadway, New York 7, N.Y.

RADIO BUSINESS

Merchandising and Promotion

Cornell-Dubilier Electric Corp., South Plainfield, N. J., and **Radiart Corp.,** Cleveland, developed a new animated

display for the complete line of CDR rotors which they manufacture. The illuminated display turns to show the rotating action of these rotors.

Pyramid Electric Co., North Bergen, N. J., introduced a new type of pack-

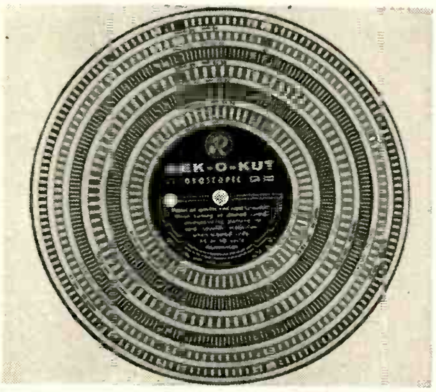
aging which aids distributors in the stocking of and displaying of the company's line of tubular electrolytic capacitors.

Hallicrafters Co., Chicago, has built new point-of-sale material for com-

munications dealers around its recently sponsored expedition to Clipperton Island. A group of five hams set out for this Pacific atoll with the idea of establishing a "new country" which world-wide hams could add to their scores of countries worked.

Sprague Products Co., North Adams, Mass., is reprinting its "Beware the Service Bargain" flyer which originally appeared as an advertisement in **Radio-Electronics** and other trade magazines. It is available from the company in quantities at a nominal cost.

Rek-O-Kut Co., Long Island City, N. Y., designed a new stroboscopic speed test disc for checking turntable speeds. It is available free upon request.



Shure Brothers, Inc., Chicago, developed a new plastic cartridge replacement kit housing three cartridges which will replace 192 of the cartridges most likely to need replacement.

General Electric Tube Department, Schenectady, N. Y., produced a new

one-minute movie for TV showings, illustrating for the public what it takes to fix a TV set. It is part of the G-E campaign to promote better public understanding of the TV service technician's function. The film is available to G-E tube distributors for local TV showings. A pamphlet illustrated by stills from the film also is available from either the company or its distributors.

Allen B. Du Mont Laboratories, Television Receiver Division, Clifton, N. J., is offering purchasers of new Du Mont

RADIO BUSINESS

TV receivers a toy television service truck for the kiddies. The same truck will be sold nationally in retail toy stores.

CBS-Hytron, Danvers, Mass., developed another in its series of service aids, a new service coat, available from its distributors.

RCA Tube Division, Harrison, N. J., announced the winners in its recent $50,000 "Tell and Sell" tube contest in which distributor salesmen who aided the winning service technicians were awarded duplicate prizes. G. Lee Hurlburt, Lakewood, N. J., service technician won the first prize, a 1954 De Soto hard-top convertible. E. Frank Roberts, Cleveland, Ohio, won second prize, a $1,000 U.S. Savings Bond. Allan J. Holmes, Orange, N. J., won third prize, a deluxe RCA Victor TV-radio-phonograph console combination. Duplicate distributor prizes went to Robert Bursley, Krich-New Jersey, Newark, N. J., first prize; L. Fromwiller, Maine Line Cleveland, Inc., Cleveland, Ohio, second prize; and Bruce Douglas, Krich-New Jersey, Newark, N. J., third prize.

Calendar of Events

A Symposium on Propagation, Standards, and Problems of the Ionosphere, September 8-11 at the new Boulder (Colorado) Laboratories of the National Bureau of Standards.

Fifth Annual Fall NATESA Convention, September 24-26, Morrison Hotel, Chicago.

High-Fidelity Show, September 30-October 2—Palmer House, Chicago.

Second National Conference on Tube Techniques, October 26-28, Western Union Auditorium, 60 Hudson Street, New York, N. Y.

Fourth Annual Eastern Joint Computer Conference and Exhibition, December 8-10, Bellevue-Stratford Hotel, Philadelphia, Pa.

Production and Sales

RETMA reported the production of 2,301,005 TV sets and 4,048,904 radios during the first 21 weeks of 1954. This compares with 3,309,757 TV sets and 6,102,711 radios produced in the same 1953 period. The association noted that during the first five months of this year 7,713 color TV sets were manufactured.

RETMA reported the manufacturers' sale of 3,275,301 cathode-ray tubes for the first five months of this year compared with 3,633,288 for the 1953 period.

New Plants and Expansions

Cornell-Dubilier Electric Corp., South Plainfield, N. J., formally opened its new plant in Sanford, N. C., last June. Leslie A. Johnson, newly appointed vice-president of the corporation, is plant manager.

Howard W. Sams & Co. formally dedicated its new plant at Sams Park, 34th and Sutherland Ave., Indianapolis, recently. The Sams operations will be centered in the new building and the plant at 2201 East 46th St.

Allen B. Du Mont Cathode-ray Tube Division, Clifton, N. J., opens permanent headquarters for its West Coast sales and sevice depot in Los Angeles this September.

Granco Products, Long Island City, N. Y., opened a new annex adjoining its present plant.

Pioneer Electronics Corp., Los Angeles, completed a 5,000 square foot addition to its present plant. The added space will be used for warehousing picture tubes.

Wheatland Tube Co. has begun production of electric-welded steel tubing in its new mill in Delair, N. J. The company's home plant is located in Wheatland, Pa., with executive offices in Philadelphia.

National Cash Register Co., Hawthorne, Calif., established its subsidiary, Computer Research Corp. of California, as the Electronics Division of NCR. The new division will manufacture electronic computors for business application in addition to its present line of computers.

Elco Corp. moved to larger quarters at M Street, south of Erie Ave., Philadelphia.

Business Briefs

... **Paramount Pictures'** Barney Balaban predicted the sale of 21- and 24-inch color TV sets for about $500 before the end of next year. Paramount owns 50% of Chromatic Television Laboratories which developed the Lawrence color TV tube.

... **Technical Appliance Corp.**, Sherburne, N. Y., awarded its 1954 Taco Scholarship, worth $2,500, to Wayne F. Wales, a graduate of Sherburne High School. The company awards the scholarship annually to foster an interest in technical education among local high school students.

... **RETMA** announced that the admission of seven new members to the association had brought total membership to a new high of 387. New members include: Allied Research & Engineering, Inc., Hollywood, Calif.; Crescent Industries, Inc., Chicago, Ill.; D & M Products, Detroit, Mich.; International Electronic Industries, Inc., Nashville, Tenn.; Morhan Exporting Corp., New York; Pan-Electronics Corp., Atlanta, Ga.; Sylvan Ginsbury, New York.

Pyramid Electric Co., North Bergen, N. J., announced that its recent offer of 92,000 shares of common stock had been completely sold out.

... **RCA Tube Division**, Harrison, N. J., is now producing and marketing commercial ferrite cores for use in standard components and to manufacturers' specifications.

... **Radion Corp.**, Chicago, recently won a decision in the U.S. District Court of the Southern District of California which upheld the patent covering its "Bullseye" antenna. Defendants in the case were Pacific Bolt Corp. and Central Industries Corp.

... **Radio Receptor Co.**, New York City, changed the name of its Seletron and Germanium Division to Semi-conductor Division to better identify products manufactured by the division under its recent expansion program. END

PEOPLE

S. A. Loeb, former chairman of the Board of Webster Electric Co., Racine, Wis., was elected to chairman of the Executive Committee. **Arthur C. Kleckner**, formerly president, succeeds him as chairman of the Board. **Preston Crewe**, formerly executive vice-president and treasurer, was elected president and treasurer. **David J. Munroe**, former vice-president, Manufacturing and Engineering, is now executive vice-president. The following officers were re-elected: Frederic A. Fishel, vice-president and secretary; B. T. Wiechers, vice-president in charge of industrial sales; P. A. Karll, vice-president in charge of purchasing; Joseph O. Mithus, assistant treasurer, and Elliott M. Ray, assistant secretary.

P. Crewe

A. C. Kleckner

Leslie A. Johnson was recently elected vice-president of Cornell-Dubilier and appointed as manager of the new Sanford, N. C., plant. He has been with Cornell-Dubilier since 1939.

L. A. Johnson

G. L. Werner

G. Leonard Werner joined Astatic Corp., Conneaut, Ohio, as general sales manager. Werner was formerly sales manager of Mark Simpson Manufacturing Co.

Dr. Rodolfe M. Soria was promoted to director of engineering of American Phenolic Corp., Chicago. He was formerly head of the Development Division of the company. In his new position he succeeds Richard M. Purinton, who recently resigned as vice-president of American Phenolic and is now representing it in the New England area.

Dr. R. M. Soria

James O. Burke

James O. Burke was elected executive vice-president of Standard Coil Products, Chicago. **Jere H. Cavanaugh** joined Standard Coil as financial administrator. James Burke, one

PEOPLE

of the founders of Standard Coil, is also treasurer and director of the company.

Albert Brand, secretary-treasurer of Radio Merchandise Sales Corp., New York City, now also assumes the responsibilities of sales manager for the company. Mr. Brand together with Sidney Pariser are the founders of the company.

Albert Brand

S. John La Puma joined JFD Manufacturing Co., Brooklyn, N. Y., as publicity director for all the firm's divisions. He has had wide public relations experience with the U. S. Army overseas and was formerly a copywriter with a New York advertising agency.

S. J. La Puma

Jerry Kirshbaum of Precision Apparatus Co., was re-elected president of the Eastern Division of the Sales Managers' Club. **Robert Ferree**, International Resistance Co., was re-elected vice-president. **Walter Jablon**, of Freed-Eisemann Radio Co., was elected to the Board of Directors of the Show Corporation for a period of two years.

J. Kirshbaum

Obituary

David Turner, chairman of the Board, and one of the founders of the Turner Company, Cedar Rapids, Iowa, died recently of a heart ailment.

Quintin G. Noblitt, co-founder and chairman of the Board of Arvin Industries, Columbus, Ind., died in the Bartholomew County Hospital at the age of 71.

Personnel Notes

. . . **Max F. Balcom**, director-consultant of Sylvania Electric Products, was elected chairman of the RETMA Board of Directors. **Glen McDaniel** was re-elected president and general counsel.

. . . **David H. Newton** was appointed advertising manager of Telex, Inc., St. Paul, Minn., for both its electro-acoustic and its hearing aid divisions.

. . . **Ray L. Triplett**, founder of Triplett Electrical Instrument Co., Bluffton, Ohio, was honored by local citizens and sales representatives from 24 states and 6 foreign countries at a community celebration of his 50th anniversary in the industry.

. . . **Don Larson**, advertising director of Hoffman Radio Corp., was appointed general manager of the West Coast Electronic Manufacturers' Association.

PEOPLE

. . . **Frank M. Folsom**, president of RCA, presented President's Cup awards to five branch managers of the RCA Service Company who were winners in a recent campaign to promote efficiency and customer satisfaction in TV servicing. Winners were Orval H. Bowers, Flushing, N. Y.; William L. Davis, Indianapolis; James K. Stewart, Salt Lake City; Lawrence E. Traeger, Spokane; Acie C. Criss, Montgomery, Ala.

. . . **Harry L. Chaney** joined Kay-Townes Antenna Company, Rome, Ga., as chief engineer. He was formerly with Tele-King and Electronic Devices Company.

. . . **Edward C. Tudor**, president of I.D.E.A., Inc., was named chairman of the RETMA Credit Committee.

. . . **Earl F. Larson** was named sales application engineer for the Westinghouse Electric Corporations' South Pacific District with headquarters in Los Angeles. **Robert E. Thomas** was promoted to sales application engineer for the Central Pacific District with headquarters in San Francisco. **Maurice Birt** was named manager of customer service and tube warehousing. The new appointments are in line with a company move to expand its Western sales, service, and warehouse facilities for tubes. Westinghouse also established a new regional headquarters office in Los Angeles.

. . . **John L. Franke** was appointed chief engineer of the RCA Victor Radio and Victrola Engineering Department, Camden, N. J. **Alexander D. Burt** was promoted to manager of record changer engineering and **Paul R. Bennett** to manager of radio and phonograph engineering. All three were formerly staff engineers of the RCA Home Instrument Division.

. . . **Frank W. Edmonds** joined Burnell & Co. as president of the newly formed Pacific Division in South Pasadena, Calif. He was formerly with Langevin Manufacturing Company.

. . . **Arthur C. Bryan** was appointed vice-president and general manager of Consumer Products, and **William H. Feathers** was appointed vice-president and general manager of Industrial Products of National Carbon Company, a division of Union Carbide and Carbon, New York City. **Walter A. Steiner** was appointed vice-president in charge of development. All have been with the company for some time.

. . . **Joseph P. Gavron**, a 22-year veteran with Mycalex Corp., New York City, was named assistant to the president, Jerome Taishoff.

. . . **Edward F. Morgan** and **Vernon L. Brown, Jr.**, were named service managers of the New York and Chicago districts, respectively, of Magnavox Corp., Fort Wayne, Ind. Both are veterans in servicing work. Morgan replaces R. J. Guilfoyle who was named district manager of the Harrisburg territory, and Brown takes the place of R. J. Weber who was promoted to the company's Advertising Division as sales training manager. END

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. All literature offers void after six months.

PRINTED CIRCUITS

Photocircuits Corp. has issued an 8-page engineering brochure on printed circuits describing their function, fabrication, and application. Information on methods of application, materials, electrical characteristics and components. Assembly with dip soldering and plate-through holes is described.

Available gratis from Photocircuits Corp., Glen Cove, N. Y.

SOUND EQUIPMENT

David Bogen Co., Inc., has issued a 20-page catalog, No. PA554, on public address amplifiers, sound systems, and sound accessories. One section of the catalog, entitled "Hints for Selecting the Proper Sound System," discusses the important factors involved in determining what equipment to use.

Characteristics for the new Bogen J series of PA amplifiers are given. The catalog lists sound systems for permanent installations, both inside and outdoors, as well as portable systems. It also lists the following accessories: microphones, stands, cone speakers, trumpet speakers, wall baffles, line-to-speaker matching transformers, recessed baffles, rack mountings, and vibration isolating bases. Also included are portable phonograph units, transcription players, high-power paging systems and a music-instrument amplifier.

Available from Bogen distributors and from David Bogen Co., Inc., 29 Ninth Ave., New York 14, N. Y.

APPLICATION GUIDE

Yardney Electric has issued a *Silvercel* application guide which gives complete electrical data and physical dimensions of more than 24 batteries. The device serves as a handy indicator for the selection of the most suitable battery for any requirement.

Gratis from Yardney Electric Corp., 105 Chambers St., New York, N.Y.

RESISTORS

Tru-Ohm Products has issued a 20-page catalog on resistors and power rheostats. All pertinent information on fixed, adjustable, axial lead, heavy duty, and other resistors is given. Special size resistors are illustrated, as are resistor mountings.

A section of the catalog is devoted to power rheostats—25, 50, 75, 100, and 150 watts. The information also includes data on special rheostat shaft and bushing assemblies, taper wound rheostats, tandem rheostat assemblies, etc., and ceramic welding nozzles.

Gratis from Tru-Ohm Products, 2800 N. Milwaukee Ave., Chicago 18, Ill.

RESISTORS

IRC has issued an 8-page catalog data bulletin, G-1, on the type MV high-voltage resistors. Forty-five different types of resistors are described, giving their characteristics, construction, individual specifications, applications, and installation. The catalog is well illustrated with charts, graphs, and photographs.

Available upon writing to International Resistance Co., 401 N. Broad St., Philadelphia 8, Pennsylvania.

CRYSTAL CATALOG

Standard Crystal Co., has issued a 12-page catalog, No. 354 on crystals. It features their complete line from subminiature hermetically-sealed plated units to crystal ovens. A military chart is included as an aid in selecting proper crystal types for particular requirements.

Available by writing Standard Crystal Co., 1714 Locust, Kansas City, Missouri.

ALIGNMENT TOOLS

General Cement Manufacturing Co. has issued a 4-page color brochure, No. 3545 which features 36 TV alignment tools plus five tool kits containing matched sets of tools, suitable for a wide range of receivers.

Available gratis from General Cement Manufacturing Co., 919 Taylor Avenue, Rockford, Illinois.

TEST EQUIPMENT

EICO has issued a 6-page brochure, form DMC-554, which gives the specifications of 38 kits, as well as 42 factory-wired instruments.

Available gratis from EICO distributors or direct from the Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y.

SKETCHBOOK

G. H. Leland, Inc., has issued the *Engineering Ledex Sketchbook* bulletins which will be put out approximately once a month. Application notes, specifications, typical circuits, and other pertinent data on the Ledex line of rotary solenoids, circuit selectors and relays are given in the various issues of the *Sketchbook.*

Available to engineers from G. H. Leland, Inc., Dayton 2, Ohio.

REFERENCE CAVITIES

General Electric has issued a 12-page booklet which describes types GL-1Q26-A, GL-6301, and GL-6452 reference cavities for frequency determination in micro wave circuits.

Available to interested parties from the Tube Department, General Electric, Schenectady 5, N. Y.

TV FUSE LIST

Bussmann Manufacturing has issued a 1954 TV fuse list. Information on fuses used in past and present TV sets are given. Pictures and dimensions of various types of fuses are listed.

Available from Bussmann Manufacturing Co., University at Jefferson, St. Louis 7, Missouri. END

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5Z3	.29	6U8	.69	35Z5	.29
6AB4	.39	6V6	.49	35/51	.29
6AG5	.49	6W4GT	.39	36	.29
6AJ5	.69	6X4	.29	37	.29
6AK5	.69	6X5	.29	39/44	.29
6AL5	.39	7A4/XXL	.39	49	.29
6AQ5	.49	7A6	.49	50B5	.49
6AS5	.49	7A7	.49	50C5	.49
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THE OSCILLOSCOPE. By George Zwick. Gernsback Library Book No. 52. 192 Pages. Over 100 illustrations. **Only $2.25.**

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CHAPTER 4—TYPICAL OSCILLOSCOPES Circuit analysis of the Du Mont 208B and the RCA WO-56A.

CHAPTER 5—ALIGNMENT Meaning of Bandpass • Alignment of peak-tuned i.f. system • Broad-band alignment • The FM discriminator • The ratio detector • Video i.f. channels • I.f. alignment procedure • Quick alignment check • TV sound i.f. channels • Front-end alignment • Oscillator alignment using stations • Video-output response.

CHAPTER 6—OSCILLOSCOPE TECHNIQUES Matching pad balanced to ground • Scope probes • The r.f. probe • Isolation of instrument from equipment under test • Coupling to the front end • Measuring low input voltages • A.g.c. bias substitute • Calibration of scope as a voltmeter • Plotting curves • Scope precautions.

CHAPTER 7—TESTS AND MEASUREMENTS Audio-gain measurements • Audio response • Phase shift • Hum • Video flutter • Measurement of current waveshapes • Auto-radio vibrator supplies • Selenium rectifiers • Checking filter operation • Measuring ripple.

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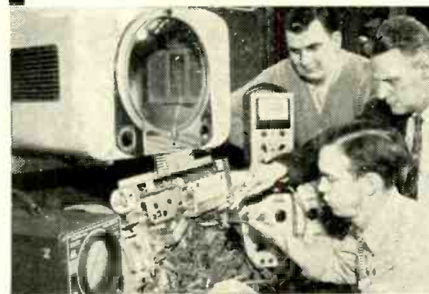

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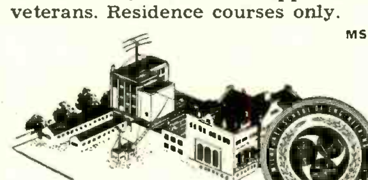

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BOOK REVIEWS

TELEVISION SIMPLIFIED, Fourth Edition, by Milton S. Kiver. Published by D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. 6 x 9 inches, 533 pages. Price $6.75.

Now in its fourth edition, *Television Simplified* remains an outstanding text on the basic principles of television. Containing many new illustrations and schematic diagrams in addition to new and expanded chapters on up-to-date developments, the text is never complicated, yet is remarkably complete.

Two new chapters cover u.h.f. and color television, with the chapter on u.h.f. including a thorough discussion of u.h.f. antennas, transmission lines, and converters.

Added material consists of information on TV tuners, video and cascode amplifiers, and an explanation of various keyed a.g.c. systems. A great deal of space is devoted to the intercarrier receiver, and there is a complete analysis of two television receivers. The new 40-mc i.f. system is discussed and compared with the older 20-mc system.—*JK*

HOW TO LOCATE AND ELIMINATE RADIO AND TV INTERFERENCE, by Fred D. Rowe. Published by John F. Rider Publisher, Inc., 480 Canal St., New York, N. Y. 5 x 8½ inches, 122 pages (including 20-page appendix and index). Price $1.80.

The location and elimination of interference to broadcast and communications services has always plagued engineers and service technicians. Comparatively little practical information has been published on this subject in the past, so many technicians are at a loss as to how to attack the problem. This has often led to erroneous or false diagnosis (usually with an amateur radio operator getting the blame for interference produced by a heater thermostat, electric sign, etc.).

Many cases of interference still in existence would have been cleared up long ago if this book had been published earlier and its contents digested by the technician receiving the complaint.

The book borders on the nontechnical and can be understood readily by readers with the minimum knowledge of electric or electronic circuits and devices. It opens with discussions of the general interference problem including types and sources and the methods for locating them. The author begins the section on prevention and elimination of TVI and BCI with discussions on the use of power-line filters and proper installation techniques for effective reduction of noise from neon signs, fluorescent lamps, thermostats, vibrators, motors, and other electrical apparatus, and concludes with discussions on suppressing TVI at the transmitter and eliminating it at the receiver.

There are two appendices. The first consists of 67 questions and answers based on the material covered in the text. The second is a typical radio-interference ordinance of the type enacted in many localities.—*RFS*

BOOK REVIEWS

CRYSTAL HANDBOOK, compiled by the Research Division, James Knights Co., Sandwich, Ill., 35 pages, $1.00.

A short treatise dealing with piezoelectric effects, crystal cuts, crystal oscillators and applications. A large number of circuit drawings and a short bibliography.

THEORY AND DESIGN OF ELECTRON BEAMS, by J. R. Pierce. D. Van Nostrand, New York. 222 pages, $4.50.

A work on electron optics written by the Research Director of Bell Telephone Laboratories. The author has gathered together "the minimum amount of theoretical material necessary for a good understanding of electron flow and electron focusing in devices other than electron microscopes and image tubes."

SCIENCE AND THE COMMON UNDERSTANDING, by J. Robert Oppenheimer. Simon and Schuster, New York. 120 pages, $2.75.

This work by the controversial Director of the Institute for Advanced Study at Princeton and wartime director of the laboratory at Los Alamos permits the reader to discover just what the author's actual beliefs and opinions are.

RADIO RECEIVER DESIGN (second edition), by K. R. Sturley. Part I—Radio Frequency Amplification and Detection. John Wiley & Sons Inc., New York. 667 pages, $10.00.

This standard work is considerably enlarged in the second edition. It now has 667 pages as against the first edition's 435. Shows evidence of considerable modernization.

PROCEEDINGS OF THE NATIONAL ELECTRONICS CONFERENCE, Volume X. Compiled and published by the National Electronics Conference, Chicago. 831 pages, $5.00.

A collection of 101 papers covering all subjects in the realm of electronics. Constitutes an important source of authoritative information.

ELECTRONIC ORGANS, by Robert L. Eby. Van Kampen Press, Wheaton, Ill. 213 pages. $5.00.

Non-technical descriptions of organs made by the six leading manufacturers, with shorter descriptions of a few others. Registration of various models given fully. Little maintenance information and no complete schematics, although a number of partial diagrams are presented. END

CORRECTION

In the "Book Reviews" column of the August issue, we inadvertently located Supreme Publications, publishers of *Television Servicing Course*, at an incorrect address. The correct address of the publisher is 1760 Balsam Road, Highland Park, Illinois.

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RADIO SCHOOL DIRECTORY PAGE 153

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Barry Electronics sells first quality, fully guaranteed, individually boxed, STANDARD-BRAND Tubes. Our Tubes do not have to be "set or meter checked" . . . They are from original, sealed cartons from the five leading Tube manufacturers.

Cheap imitations such as seconds, rewashed bargains, and off-brands result in unnecessary callbacks, expenses, and loss of customer good-will.

YOU CAN PLACE YOUR CONFIDENCE IN OUR NEW, FIRST QUALITY, FULLY-GUARANTEED STANDARD-BRAND TUBES.

Ask for FREE News Bulletin and Handy Order Form

Tube Orders Over $25.00, with full remittance, PREPAID to you in U.S.A.

STANDARD BRAND RECEIVING TUBES

—NO REBRANDS • NO SECONDS—

Type	Net	Type	Net	Type	Net
OA2	.95	6AX5GT	.85	7E5	.39
OB2	.85	6B8	.75	7F7	.89
OB3/VR90	.82	6BA6	.70	7F8G	1.25
OC3/VR105	.91	6BC5	.74	7H7	.70
OD3/VR150	.89	6BE6	.72	7N7	.95
OZ4	.55	6BF5	.94	7Q7	.98
1A7GT	.77	6BG6G	1.89	7X7	.90
1B3GT	.90	6BH6	.85	12AT6	.55
1H5GT	.77	6BJ6	.85	12AT7	1.05
1L4	.60	6BK5	.95	12AU6	.65
1L6	.95	6BK7A	1.15	12AU7	.84
1LA6	1.10	6BL7GT	1.20	12AV6	.55
1LB4	1.10	6BN6	1.20	12AV7	1.00
1LN5	1.10	6BQ6GT	1.27	12AW6	.88
1N5GT	.95	6BQ7A	1.23	12AX4	.90
IN34A	.55	6BX7GT	1.25	12AX7	.80
IN38A	.85	6BY5G	1.75	12AY7	1.75
1R4	.65	6BZ7	1.28	12AZ7	.92
IR5	.75	6C4	.56	12B4	.98
1S5	.75	6C6	.50	12BA6	.70
IT4	.70	6CB6	.75	12BD6	.75
1U4	.75	6CD6G	1.80	12BE6	.72
1U5	.70	6CL6	1.10	12BH7	1.00
1V	1.03	6CU6	2.10	12BY7	1.05
1V2	.90	6Q6	.75	12BZ7	1.10
1X2B	.90	6F4	3.50	12SA7	.69
1Z2	3.25	6F5	.68	12SF5	.70
2X2	.35	6F5GT	.68	12SG7	.80
3A4	.59	6F6	.70	12SH7	.63
3B7	.39	6F6G	.80	12SJ7	.55
3Q4	.89	6F8G	.85	12SK7	.69
3Q5GT	.90	6G6G	.85	12SL7GT	.65
3S4	.75	6H6	.52	12SN7GT	.85
3L4	.90	6J4(RCA)	4.95	12SQ7GT	.63
3V4	.75	6J5	.55	12SR7	.69
5AW4	1.50	6J6	.80	12SX7GT	1.10
5R4GY	1.50	6J7	.75	14F7	.75
5U4G	.59	6K6GT	.65	19BG6G	2.05
5V4G	.97	6K7	.60	19T8	1.10
5W4G	.80	6L6G	1.10	25BQ6GT	1.35
5X4G	.75	6L6GA	1.10	25L6GT	.70
5Y3GT	.48	6L6M	1.45	25W4GT	.70
5Z3	.75	6L7	.80	25Z5	.75
6A8GT	1.10	6N7M	.70	25Z6GT	.64
6AB4	.70	6Q7GT	.80	26A6	1.75
6AB7	.95	6S4	.63	26A7GT	4.50
6AC7	1.14	6S7M	.98	26C6	1.25
6AQ7G	1.85	6SA7	.69	26D6	1.75
6AF4	1.39	6SC7	.88	28D7	1.55
6AG5	.78	6SD7GT	.80	35A5	.72
6AG7	1.10	6SG7	.66	35B5	.70
6AH4GT	.89	6SH7	.98	35C5	.72
6AH5GT	.89	6SJ7	.65	35L6GT	.70
6AH6	.93	6SK7	.69	35W4	.45
6AJ5	1.30	6SL7GT	.65	35Z3	.70
6AK5	.80	6SN7GT	.79	35Z5GT	.50
6AK5-W	1.50	6SQ7	.63	50A5	.75
6AK6	.98	6T4	1.35	50B5	.70
6AL5	.60	6T8	.99	50C5	.72
6AN4	1.60	6U8	1.05	50L6GT	.70
6AN5	3.65	6V3A	1.30	80	.66
6AQ5	.72	6V6GT	.67	81	.75
6AQ6	.73	6W4GT	.65	83V	1.15
6AS5	.75	6W6GT	.82	84/6Z4	.65
6AS6	2.65	6X5GT	.52	117Z3	.75
6AS7G	3.75	6X8	1.00	117Z6	1.00
6AT6	.58	7A7	.75	1620	4.50
6AU4GT	1.00	7A8	.69	5642	1.00
6AU5GT	1.15	7B6	.75	5654	1.75
6AU6	.65	7B7	.76	6096	1.85
6AV5GT	1.10	7B8	.78	and others	
6AV6	.57	7C4	.29		
6AX4GT	.84	7C5	.69		

SPECIAL-PURPOSE TUBES

Write for our complete listing of XMTG, Industrial, Special-Purpose and Crystal Diodes. We stock over 2,000 types at excellent prices.

Above is only a partial listing of our huge stock. Types not listed may be ordered at approx. the same savings. Many new special purpose types in stock. We specialize in hard-to-get, obsolete types, which are no longer in production.

AUTHORIZED DISTRIBUTORS
CBS-HYTRON EIMAC WESTINGHOUSE

ORIGINAL JOBBERS' BOXED TUBES
IN STOCK—LATE DATES, at WHOLESALE PRICE LEVELS!

TWO-COLORED TUBE CARTONS, with new Safety Partitions. Prevents Tube Breakage. This Super-Gloss Red and Black Carton is the Most Distinctive Box Available Today! Minimum: 100 any one size. Quantity prices on request.

SIZE		EACH
Miniature	(6AU6, 6AL5, etc.)	$.01
GT	(6SN7, 6W4, etc.)	.0125
LARGE GT	(1B3, 6BQ6GT, etc.)	015
LARGE G	(5U4G, 6BG6G, etc.)	.02

Terms: 25% with order, balance C.O.D.
All merchandise guaranteed. F.O.B., N.Y.C.

PHONE: REctor 2-2562

BARRY ELECTRONICS CORP.
136-B LIBERTY ST. N. Y. 6, N. Y.

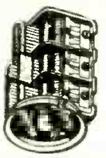
RAD-TEL Full Year Guaranteed TUBES

70% TO 90% OFF . . . RAD-TEL TUBES FOR QUALITY, PERFORMANCE, AND DEPENDABILITY

COMPARE! Save More At RAD-TEL On All Parts!

VARIABLE CONDENSERS

Manufactured by Philco, Radio Condenser, etc. 2 Gang AM and FM: No. 9 Each 89c. Lots of 3 79c.

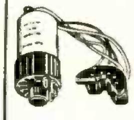


Contains 2 separate sections for AM and 2 for FM with padder condensers. With attached slug tuned high frequency coil whose plunger is geared to condenser shaft. Pulley type drive wheel.

2 Gang AM, 3 Gang FM No. 10, equipped with drum pulley and padders. Each 89c. Lots of 3 79c.

3 Gang AM Superhet No. 12, complete with padders and pulley type drive wheel. Each 89c. Lots of 3 79c.

NO. 132—CATHODE RAY TUBE REJUVENATOR



Fits all makes of picture tubes. Completely automatic. Easy to install, no tools needed. For AC parallel circuits. Your Old Picture Tubes Are Still Useful. List price—$5.95.

Lots of 10 $1.09 **Each $1.29**

NO. 75—ARMY-NAVY HEADSETS

Individually boxed. Very sensitive. Meet both Army and Navy specifications. List Price $16.00.

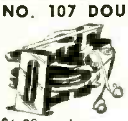
$2.95 each per set
Lots of 3 $2.83 each

WAFER ROTARY SWITCH KITS

A choice combination of single, double, etc., from 2 to 8 positions.

Special Kit of 10 $1.39
Lots of 3 Kits $1.29

NO. 107 DOUBLE FLYBACK TTR-172

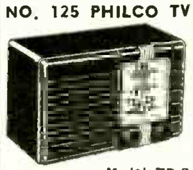


Up to 13.5KV output. RCA type horizontal deflection transformer with two filament windings for voltage doubler operation. First time at this low price.

$1.89 each. **Lots of 3 $1.79**

RCA TYPE FLYBACK TRANSFORMER
$1.45 each. **Lots of 3 $1.35**

NO. 125 PHILCO TV BOOSTER



Completely self-contained, including 2 6J6 tubes . . . 1 for high channels and 1 for low channels and selenium rectifier. Plastic cabinet. In factory-sealed cartons, complete with instructions.

Model TB-3 $9.95

NO. 46—HI-VOLTAGE R.F. COIL 4500 VOLTS RF TRANSFORMER

Ideal for TV and Oscilloscope power supplies, using 5" to 7" tubes. This buy is too BIG to be beaten!
List price—$7.50

79c Each
Lots of 3 69c Each

NO. 97—WEN SOLDERING GUN

3 seconds on 120 Volt AC readies it for any soldering requirement. 250 Watt size. Also cuts plastic tile (with special tip). Multi-useful! UL Approved. Built-in spot light.

Each $9.71
List price—$12.95
Lots of 3, $8.64 Each

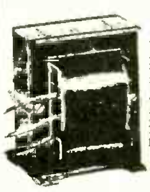
TIPS
Feraloy Long Life.................35c each
Standard Tip.................11c each
No. 100 WEN POLISHER $9.00 each
Lots of 3 $8.75 each

All New Parts At Old Fashioned SAVINGS!

SPEAKERS All Standard Brands Dynamic + PM

Size	Ohms	Price	Lots of 5
5"x7"	1000	99c	+89c
5"x7"	1800	99c	89c
5"x7"	2750	99c	89c
6"	90	1.49	1.29
(with 6K6 output transformer)			
8"	680	1.95	1.70
(with 6V6 push-pull transformer)			
6.5"	38	1.49	1.29
5"	1.47 oz.	1.95	1.70
(with 50L6 output transformer)			
4"	.68 oz.	1.89	1.64
(with 50L6 output transformer)			
8"	2.15 oz.	2.95	2.65
10"	2.15 oz.	3.95	3.60

NO. 3—VERTICAL OUTPUT TRANSFORMER



Very popular, used in most TV sets. Well-known manufacturer. Matches vertical output tube to the deflection yoke. 10 to 1 ratio. A terrific buy on a top performer. List Price—$4.50.

95c each

Lots of 5 90c each

NO. 133. Electrolytic Condensers

Assorted condensers, consists of single, double, triple and quadruple. All popular voltages and capacities. All standard popular brands.

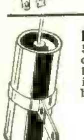
Kit of 10
$2.39

NO. 81. ANODE CAPS

Fits all TV sets. Phosphor bronze metal plug with rubber insulator and high voltage lead. Seize this buy NOW!

List price—75c
19c each
Lots of 10 18c each

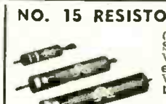
NO. 53 BIAS CONDENSERS



500 MFD 12 V. Mfd. by leading companies.
List price—$2.00. Maximum value in minimum space. A buy you've been looking for!

35c each
Kit of 10
$2.95 each

NO. 15 RESISTORS

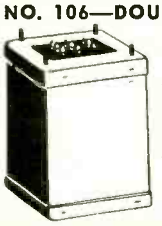


(ASSORTMENT OF 200 Standard RTMA Coded or Value printed. Uninsulated. ½ Watt, 1 Watt, 2 Watt and some 10 Watt. List Price: $10.00—

$1.39

Lots of 10 Kits 99c each

NO. 106—DOUBLE SHELL TYPE POWER TRANSFORMER



No. J184 PRI. 117V. Sec. 266V. 300 ma; 5v, 6 AMPS; 6.3V, 1.5 AMPS; 6.4V, 4.4 AMPS.

$3.50 each

JAN TUBES

Nos. 1619, 1626, 1629, 615, 7193, 954 and 45 special.

Asst. Pkg. of 10

$2.70

Some tubes easily worth $2. each

Additional Tube Buys!

1E7	.29	6U5	.57
1LB4	.89	12B4	.60
1P5GT	.57	12C8M	.34
2W3	.38	12SC7M	.63
3B7	.27	35	.58
3D6	.27	36	.39
6AS6	1.49	58	.60
6AU5GT	.32	1274	.30

Type	Price
OA2	.74
OA4	.68
OB2	.81
OC3	.72
OD3	.70
OZ4M	**.65**
1A5	.49
1A7GT	**.47**
1AX2	**.62**
1B3GT	**.73**
1C5	.43
1G6	.24
1H4	.30
1H5GT	**.49**
1L4	**.46**
1LA4	.59
1LA6	**.69**
1LC5	.59
1LC6	.79
1LD5	.59
1LE3	.59
1LG5	.69
1LH4	**.69**
1LN5	**.59**
1N5GT	**.67**
1Q5GT	.58
1R5	**.62**
1S4	.59
1S5	**.51**
1T4	**.58**
1T5	.59
1U4	**.57**
1U5	**.50**
1V	.43
1X2A	**.63**
2A3	.30
2X2	.49
3A4	.45
3E5	.46
3LF4	.69
3Q4	**.48**
3Q5GT	**.69**
3S4	**.58**
3V4	**.58**
5AZ4	.59
5T4	.79
5U4G	**.55**
5W4GT	.50
5Y3GT	**.37**
5Y4	.51
5Z3	**.45**
6A6	.51
6A7	.69
6AB4	**.44**
6AC5	.69
6AC7M	**.86**
6AF4	**.90**
6AG5	**.56**
6AG7M	**.99**
6AH4	**.57**
6AH6	**.73**
6AJ5	.65
6AK5	**.55**
6AK6	**.59**
6AL5	**.42**
6AM8	.78
6AQ5	**.50**
6AQ6	**.37**
6AQ7	**.70**
6AR5	**.45**
6AS5	**.50**
6AT6	**.41**
6AU4GT	**.68**

Type	Price
6AU6	**.46**
6AV5GT	.83
6AV6	**.40**
6AX4GT	**.65**
6B4	.54
6BA6	**.49**
6BA7	**.57**
6BC5	**.54**
6BD5	.59
6BD6	**.45**
6BE6	**.51**
6BF5	.41
6BF6	.37
6BG6G	**1.25**
6BH6	**.53**
6BJ6	**.49**
6BK5	**.80**
6BK7	**.80**
6BL7GT	**.83**
6BN6	**.59**
6BQ6GT	**.98**
6BQ7	**.90**
6BZ7	**.90**
6C4	**.40**
6C5	**.39**
6C6	.58
6CB6	**.54**
6CD6	**1.11**
6CF6	.64
6CS6	.51
6D6	.59
6E5	**.48**
6F5GT	.39
6F6	**.59**
6G6	.42
6H6GT	**.41**
6J5GT	**.43**
6J6	**.52**
6J7	**.43**
6K5	.47
6K6GT	**.45**
6K7	**.44**
6L6	**.64**
6L7M	.68
6N7M	.63
6Q7	**.45**
6R7	.69
6S4	**.48**
6S78	1.69
6S7M	.79
6S8GT	.53
6SA7GT	**.55**
6SD7GT	.41
6SF5GT	.46
6SG7GT	.41
6SH7GT	.49
6SJ7GT	.41
6SK7GT	**.53**
6SL7GT	**.48**
6SN7GT	**.59**
6SQ7GT	**.46**
6SR7GT	.45
6SS7GT	.42
6T4	.99
6T8	**.80**
6U6	.59
6U8	**.78**
6V6GT	**.50**
6W4GT	**.47**
6W6GT	**.57**
6X4	**.37**
6X5GT	**.37**
6X8	**.75**
6Y6G	**.48**

Type	Price
7A4	.47
7A5	.59
7A6	.69
7A7	**.69**
7A8	**.68**
7AD7	.79
7AF7	.53
7AG7	.69
7AH7	.79
7B4	.44
7B5	.45
7B6	.69
7B7	**.49**
7C4	.59
7C5	**.69**
7C6	**.59**
7E5	.59
7E6	.30
7E7	.59
7F7	**.79**
7F8	.79
7G7	.89
7H7	**.59**
7J7	.79
7K7	.69
7L7	.59
7N7	**.69**
7Q7	**.66**
7R7	.89
7S7	.79
7V7	.89
7X6	.54
7X7	.70
7Y4	**.69**
7Z4	.59
12A6	.54
12A8GT	.61
12AL5	**.37**
12AQ5	.52
12AT6	**.41**
12AT7	**.72**
12AU6	**.46**
12AU7	**.60**
12AV6	**.39**
12AV7	**.73**
12AX4	.67
12AX7	**.63**
12AY7	.69
12AZ7	.59
12BA6	**.49**
12BA7	**.60**
12BD6	.45
12BE6	**.51**
12BF6	.39
12BH7	**.63**
12BY7	**.65**
12BZ7	.65
12H6	.56
12J5	.42
12J7	.49
12K8	.59
12Q7	.59
12S8GT	.62
12SA7GT	**.65**
12SF5	.50
12SG7	.51
12SJ7M	.67
12SK7GT	**.63**
12SL7GT	**.57**
12SN7GT	**.52**
12SQ7GT	**.56**
12SR7M	.49
12V6GT	**.46**
12X4	**.38**

Type	Price
14A4	.69
14A5	.59
14A7	**.63**
14AF7	.59
14B6	**.63**
14B8	.63
14C5	.79
14C7	.79
14E6	.75
14E7	.88
14F7	.65
14F8	.69
14H7	.59
14J7	.30
14N7	.84
14R7	**.79**
14S7	.89
14W7	.30
14X7	.69
14Y7	.62
19BG6	1.39
19T8	**.69**
19V8	.79
24A	.39
25AV5GT	**.83**
25BQ6GT	**.98**
25L6GT	**.51**
25W4GT	.59
25Z5	**.66**
25Z6	.49
26	.45
27	.39
32L7	.89
35A5	.58
35B5	**.52**
35C5	**.51**
35L6GT	**.51**
35W4	**.47**
35Y4	**.54**
35Z3	**.59**
35Z4	.47
35Z5GT	**.47**
45	.55
45Z5	.49
46	.69
50A5	**.55**
50B5	**.52**
50C5	**.51**
50L6GT	**.61**
50X6	.49
50Y6	.49
50Y7	.50
55	.49
56	.49
57	.58
70L7	.97
75	.49
76	.44
77	.57
78	.47
80	.43
83V	.68
84/6Z4	.46
85	.59
117L7	.99
117P7	.99
117Z3	**.37**
117Z6	.69
807	.99
866A	1.39
Hi-Po #567	1.39

RAD-TEL TUBE CO.

Dept. RE-9

115 Coit St., Irvington 11, N. J.

"Integrity Is Our Chief Asset"

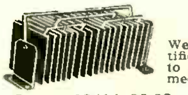
TERMS: A 25% deposit must accompany all orders—balance C.O.D. All shipments F.O.B. Irvington warehouse. ORDERS UNDER $10—$1.00 HANDLING CHARGE. Subject to prior sale.

PLEASE: Send full remittance . . . allow for postage and save C.O.D. charges! We refund all unused money!

Phone: Essex 5.2947

Tubes in Bold Type Cover 90% of Demand

SELENIUM RECTIFIERS



We specialize in Rectifiers, Power supplies to specifications. Immediate delivery.

Curr. Cont.	18/14 Volts	36.28 Volts	130/100 Volts	266/217 Volts
1AMP	1.40	2.40	8.50	22.25
2AMP	2.10	3.00	10.50	28.25
4AMP	3.75	7.50	25.25	38 85
6AMP	4.50	9.00	33.00	54 85
10AMP	6.60	12.75	42.50	84.85
12AMP	8.20	16.25	46.00	99.85
20AMP	13.25	25.50	79.50	160.85
24AMP	16.25	32.50	86.50	190.85
30AMP	20.00	38.00	121.50	235.85
36AMP	25.00	48.50	158.50	295.85
50AMP	32.00	62.50	189.75	405.85
100AMP	60.00	120.00	380.75	795.85

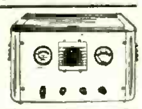
Rectifier & Transformer

115V/60 cy inputs.

up to 14VDC at 12 Amps ....$ 19.98
up to 28VDC at 4 amps 14.98
up to 28VDC at 12 amps 29.98
up to 28VDC at 24 amps 63.98
up to 28VDC at 50 amps 127.00

WRITE FOR POWER RECTIFIER CATALOG

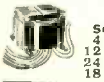
HIGH CURRENT PWR SUPPLIES



Variable 0-28VDC. Completely Built, Ready to Go. Full Wave Selenium Rectifier, Transformer, Variac, Volt & Amp Meters, Switch, Terminals & Fuse. In Hvy Dty Steel Cabinet. Standard 115V 60 Cy Input. 220V or to order. Write!

Stock Number		Continuous Rating	With Meters
T28V5A	0-28VDC	at 5 Amp.	....$47.75
T28V12A	0-28VDC	at 12 Amp	...... 89.00
T28V24A	0-28VDC	at 24 Amp	......129.50
T28V50A	0-28VDC	at 50 Amp	......239.50

RECTIFIER XFMRS



Primary 115V 60 Cyc
Secondary 0-9-12-18-24-36V
4 Amp ....$ 8.75; 2/$15.75
12 Amp ....$16.75; 2/$29.95
24 Amp ....$35.75; 2/$69.95
18 Volt. 2 Amps $2.25; 2/$4.

RECTIFIER CHOKES

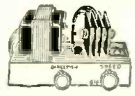
CH07/4AMP/.07HY/.6R/10# $7.95
CH01/12AMP/.01HY/.1R/12# $14.95
CH004/24A/.004HY/.025R/20# $29.95

"TAB" THAT'S A BUY

BARGAINS—BARGAINS

Just off the press. "TAB" Scoop Sheet. Tools, Portable Radios, Phonos, Audio Equip, Radio Parts & Equipment. All items way below usual bargain prices. Write for the "TAB" Scoop Sheet.

VARIABLE DC POWER SUPPLY

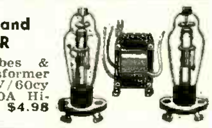


Full Wave rectification, 6000Mfd filter Condenser, fused. 6.3V or 12.6V at 2 amp. operates 115V/60cy.
Model 2DCF......$12.98
As above except 4 amp.
Model 4DCF.......$20.98

BATTERY CHARGER RECTIFIER

13-0-13V (CT) 100 Amp., fan cooled or 34AMP air cooled. For 6V Booster Chgrs. New Selenium $11.98
EXPORTERS WRITE FOR QTY PRICE

866A KIT and XFORMER

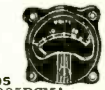


(2) 866A Tubes & Sockets. Transformer Rated. PRI 115V/60cy Sec 2.5VCT/10A Hi-Volt Insulation $4.98

TOGGLE SWITCHES

SPDT 15A/125V Center Off—AN3022-1B ....69c;5/$2.50
SPST 5A/125V used LN 4/$1
SPDT 15A/125V Center Off Mom. ....79c; 3/$2; 20/$10
SPDT 15A/125V AN3022-3B ......59c; 3/$1.25; 30/$10.00
DPST 20A/125V AN3027-2B ......69c; 5/$2.50; 25/$10.00
DPST 5A/125V BKLT CSD....49c; 3/$1.20
3PDT 22A/125V C'Hammer $1.49; 2/$1.98
4PDT 10A/125V......$1.98; 3/$5; 20/$30

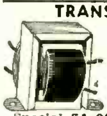
METER SALE



50% OFF REG. RESALE PRICE

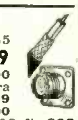
0-1MADC/3½"RND/MR35W001DCMA/$8.33 Reg. "TAB" Special.....$3.95
0-5MADC/3½"RND/MR35W005DCMA/$8.33 Reg. $3.95
0-100MADC/3½"RND/MR35W100DCMA/$8.33 Reg. $3.95
0-30VDC/2½"RND/Aircraft "AN"....$2.98
0-800VDC/Weston 301/3½"SQ/1000 OHMS-Per-Volt/$25.00 List...........$9.95
0-1500VDC/3½"RND/$12.95 Reg.....$5.95
0-150VAC/WSTGH3"SQ $4.95
120-0-120ADC/with-shunt/"AN" $4.98

TRANSFORMER SPECIAL 6.3 VOLT 3¾ AMP



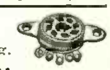
CONTINUOUS DTY, 115VAC Input
SIZE 2 5/16H/2L/1⅛"W. MTG CNTR 2⅜. MFGRS, Jobbers, DLRS ORDER NOW THIS $1.98 VALUE
Special $1.00; 12 for $10; 100 for $75

TV & COAX CABLE



300 Ohm Twinex. Heavy duty 65 mil copper TV lead in. per ft. 2c; 100 ft.......... $1.39
1000 Ft. $11.95; 5000 Ft. $50.00
300 Ohm Twinex. 100 Mil Extra heavy duty 100 ft...........$3.29
1000 Ft. $24.00
RG8U 52 Ohm 100 ft. $11; 1000 ft. $98
RG11U 75 Ohm 100 ft. $11; 1000 ft. $98
RG59U 73 Ohm 100 ft. $ 5; 500 ft. $22
HiVolts 15KV Anode Wire 50 ft. $1.50

TUBE SOCKETS



CINCH—JOHNSON—AMPH

Octal (low-loss mica) ring mtg. each 12c; 10 for $1.00
Octal (mica) ring mtg...12/$1
Octal (steatite) ring mtg..........12 for 2.00
Octal (bakelite) saddle mtg..........15 for 1.00
Octal (bakelite)saddle mtg..........15 for 1.00
Octal (mica) saddle mtg..........12 for 1.00
Octal (steatite) saddle mtg..........12 for 2.00
Loktal (mica) saddle mtg..........12 for 1.00
7 pin min (mica) base shld 20c; 12 for 2.00
7 pin min (mica) bottom mtg....12c; 10/$1
7 pin min (bklt) rubber shock mtg. 12/$2
7 pin min wafer ....9c; 15 for 1.00
9 pin min (mica) bottom mtg....20c; 12/$2
9 pin min (bklt) bottom mtg. 18c; 7/$1
9 pin min (bklt) base shld......28c 5 for 1.00

TRANSFORMERS

All 115 V 60 Cyc Input TV, & CR pwr Xmfr up to 20" tubes. Hi VOLTS to 20KV (w/quadrupler ckt.) ALL tubes. PL & FIL wndgs.
300 VDC/275 Ma Full-Wave; 6.4V/10.3A,5.4V/8A.2.5V/3A Hypersil Core, Oil Fill $4.98; 2 for $8.50; 6 for $22.00
2500V/20MA, 6.3V/.6A. 2.5V/1.75A for BC412 Scope Replmt.........................$7.98
1600VCT/5MA, 6.3VCT/3A, 6.3VCT/10A, 2.5VCT/5A SPECIAL $7.95; 2 for $14.00
950VCT/100MA, 5V/5A, 5V/2.5A, 45V/1A, 10V/1.5A. Western Elect..................$4.98
900V/35MA 2X2.5V/2A. XCLENT 1800V DRIER TWO 2X2 FIL WNDGS..........$2.25
778VCT/200MA, 5V/3A, 6.3VCT/5A $4.98
770V/2.5MA, 2.5V/3A, HVINS HMSLD includes FILTER PARTS. 4/scope..........$3.69
700VCT/70MA, 5VCT/3A.6.3VCT/2.5A. $4
550VCT/250MA, 5V/2A, 6.3VCT/2.5A. 12.6V/3.5A. CSD RCA........$4.50; 2/$8.00
500VCT/60MA, 6.3V/4A Hmsld. $2.98
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6, 12. 24 115VDC 115 & 230 VAC @ $1.49
2X330VCT/10MA, EACH WNDG........$3.49

230 TO 115V AUTOFORMERS

For 220-240V/50-60 cy input. To 110-120V or step-up. With cord, Plug & Receptacle.
TPA050/50W $2.55; TPA075/75W $3.65
TPA100/100W $4.00; TPA200/200W 5.75
TPA250/250W $6.75; TPA300/300W 7.25
TPA500/500W $8.25; TPA750/750W 11.75
Model TPA1000/1000 Watts/1KW.... 16.95
Model TPA1500/1500W/1.5KW 22.50
Model TPA2000/2000W/2KW......... 28.95
Model TPA3000/3000 Watts/3KW.... 49.95
WRITE FOR QTY. PRICES—EXPORTERS

FILTER CHOKES

6HY/175MA.....$1.49; 2/$2.49
10HY/125MA/UTC(CASED/H'sld/1Kvins $1.98
50Hy/125ma. CSD. H'sld..$2.89
20Hy/300ma or 15Hy/400ma 12Kvins $8.95
13.5Hy 1 amp 17 Kvins Raytheon....$35.00
3Hy/40ma HI-Q CSD 69c; 2 for.......98c
Dual 2Hy/300ma Cased.........95c; 2/$1.49
12Hy/65ma HMSLD............$1.25; 2/$2.00

FILAMENT TRANS.

2.5VCT/10A 12.5KVINS.....$5.50; 3 for $14
2.5VCT/10A 5KVINS.............................$3.59
7.5VCT/12A 15 KVINS $10.95; 2 for $17.50
24V/1.25A CSD ....$1.98; 2 for $3.49
42.5V/2A Sel Rect Xmfr..........$4.98; 2/$8
64V/1Amp HMSLD...........$3.49; 2 for $5.00
2X12.6V 2A or 25.2V/2A or 12.6V/4A CSD...........$3.59; 3/$10.00; 12/$36.00
PRI 110 & 220V Sec 16.6V/1.25A. 12.6 VCT/3.5A ....$4.98; 2 for $8.00

TUBES

*From This Special List We Ship $10.00 and Up Tube Orders At Our Expense (Postpaid) Within Continental Limits of U.S.A.
90 Day Gtd. When ordering mention 9RE

0A2	.88
0A3/VR75	1.04
0B2	1.37
0B3/VR90	.96
0C3/VR105	.92
0D3/VR150	.92
1B3/8016	.80
1L4	.48
1L6	1.35
1LD5	.98
1LN5	.78
1P5	.78
1T4	.79
1R4	1.29
1R5	.59
1U4	.52
1U5	.54
2A4G	1.18
2X2	.42
5R4GY	1.20
5R4GYW	1.75
5T4	1.48
5U4G	.55
5X4G	.79
6AC7	.80
6AG5	.71
6AG7	1.14
6AH6	1.21
6AJ5	1.40
6AK5	.87
6AK6	.92
6AL5	.48
6AL7GT	.98
6AN5	3.27
6AQ5	.52
6AQ6	.81
6AQ7GT	1.29
6AR6	3.27
6AS5	.79
6AS6	2.22
6AS7G	3.48
6AT6	.54
6AU5GT	1.10
6AU6	.56
6AV5GT	.98
6AV6	.49
6AX4/6U4	.74
6B4G	1.18
6BA6	.54
6BA7	1.09
6BC5	.63
6BC7	1.23
6BD6	.83
6BE6	.54
6BF5	.98
6BG6G	1.58
6BH6	.53
6BJ6	.69
6BK7	1.58
6BL7GT	1.19
6BN7	2.69
6BQ6GT	1.20
6BQ7	1.65
6C4	.52
6C5	.68
6CB6	.59
6D4	2.70
6F6GT	.79
6H6	.60
6J4	6.66
6J5	.54
6J6	.58
6J7	.72
6K6	.54
6K7	.58
6K4A	3.68
6K8GT	1.08
6L6	1.48
6L6G	1.08
6L6GA	1.08
6L6GAY	1.98
6SA7GT	.66
6SC7	.90
6SF5	.78
6SF7	.73
6SG7	.64
6SH7	.61
6SJ7	.58
6SK7GT	.56
6SL7GT	.64
6SN7GT	.68
6SQ7GT	.62
6SR7	.62
6SS7	.88
6T8	.96
6U4	.74
6U8	.99
6V6	1.39
6V6GT	.59
6W4GT	.52
6X4	.49
6X5	.54
6Y6G	.88
7A8	.68
7C7	.76
7F7	.82
7F8	1.24
7H7	.72
7N7	.72
7V7	1.06
7Y4	.68
12A6	.48
12AH7GT	1.45
12AL5	.54
12AT6	.54
12AT7	.89
12AU6	.72
12AU7	.69
12AV6	.52
12AV7	.98
12AW6	1.18
12AX7	.98
12AY7	1.69
12BA6	.59
12BA7	.94
12BD6	.59
12BE6	.59
12BF6	.85
12BH7	1.29
12C8	.62
12H6	.64
12J5	.52
12K8	.68
12Q7GT	.55
12SA7GT	.68
12SC7	1.08
12SF7GT	.84
12SG7	.80
12SH7	.63
12SJ7GT	.54
12SK7	.66
12SL7GT	.62
12SN7GT	.68
12SQ7GT	.54
19BG6	1.98
19V8	1.98
25BQ6GT	.98
25L6GT	.67
25Z5	.78
25Z6GT	.58
28D7	1.94
35B5	.52
35L6	.67
35Z5GT	.54
35Y4	.68
45Z3	.88
50A5	.76
50B5	.54
50C5	.54
50L6GT	.62
RK61/XFG1	2.65
80	.58
81	1.38
83	1.12
83V	1.22
84/6Z4	.62
117L/M7GT	1.98
117Z6GT	.96
CK502AX	1.49
CK503AX	1.49
CK505AX	1.79
CK512AX	1.45
CK531DX	1.89
CK532DX	1.89
CK533AX	1.29
CK536AX	.99
CK538DX	.98
CK539DX	2.19
CK543DX	.99
CK544DX	.99
CK546DX	1.99
CK571AX	2.49
CK1005	.68
2050	1.48
CK5672	1.20
CK5678	1.28
5687	3.74
CK5702	2.90
CK5703	1.29
Xtal Diodes	
1N21A	1.55
1N21B	2.10
1N22	1.22
1N23	1.35
1N23A	1.89
1N23B	2.00
1N25	4.98
1N26	8.75
1N27	1.55
1N34	.64
1N34A	.88
1N35	1.65
1N38A	1.29
1N41	8.95
1N42	16.95
1N45	1.45
1N46	.69
1N47	4.00
1N48	.47
1N51	.45
1N54	.78
1N60	.60
1N63/K63	2.49
1N69	.98

YOU PICK THEM 39c WHILE THEY LAST

LOTS OF 10

Your selection of 10 at 39c each or smaller quantity at indicated prices.

ELECTROLYTIC CONDENSER *FRESH STOCK*

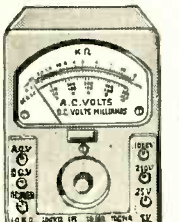
2X 20MFD/450VDC....69c; 3 for $1.95
3X 15MFD/450VDC....98c; 3 for 2.50
3X 20MFD/400VDC....79c; 2 for 1.29
25MFD/450VDC...........69c; 3 for 1.95
30MF/450V&20MF/25V .....3 for 1.95
50 mf/350vdc FP ....5 for 1.00
30-15-10 mf/250vdc ....5 for 1.00
16MFD/450V ....55c; 3 for 1.20
Dual 8MFD/450V..........75c; 3 for 1.50
Dual 16MFD/450V....85c; 3 for 2.00

SOCKET ASSEMBLIES

½" JEWEL BAYONET SOCKET W/Shutter (Dimmer) 33c ea. Lots of 5

Ordered in smaller quantity. Ea.............39c
DIALCO-31101 Pilot Light 1" Jewel 115V Reg $1.03 "TAB" Special 85c;3/$2; 10/$5
DIALCO-95408 Neon Panel Light, Red, Amber & Clear, Reg. 98c Spec. 79c; 12 for $6

NEW POCKET AC-DC VOM Model 727c MULTITESTER



$9.99 Plus 25c Ship in U.S.A.

1000-OHM Per/V Reads AC & DC Volts: 0 to 5. 25. 250 & 1000 Volts. DCMA: 0 to 1, 10, 100MA OHMS: 0 to 10K & 100K HI-accuracy—1% wire wound resistors & HV deposited resistors. Rugged jeweled D'Arsonval micro-amp meter movement, excellent damping. extra long meter scales. with vivid red & black calibrations. The size of 2 packs of King cigarettes. 1¼"D, 4⅝"L, 3¼"W. A must for every TV serviceman, ham, experimenter or beginner. Built ready to work (no kit) complete with test leads. Model 552 smallest precision built Hi-accuracy Pocket Multitester 1% deposited carbon resistors. jeweled D'Arsonval micro-amp meter movement. Extra long meter scale AC & DC volts; 0-10-250 & 500V. DCMA: 0-1 & 250 MA. OHMS: 0-100K. Miniature size 1½"D. 4"L. 3⅛"W. With test leads $6.99. plus 25c for shipping U.S.A.

OIL CONDENSER SPECIAL 2MFD 600VDC

Aerovox Type Po9 Steatite Insulators. Adjustable Mounting Clamp. Case 2" dia. x 2¾" high. BRAND NEW ....49c; 10 for $3.50

TELEVISION ANTENNA

VEE CONICAL Broad response, all channel, powerful for fringe areas....$8.95
FOLDED DIPOLE Hi & low antennas, all channel, sturdy construction $4.95
TV CONICAL ANTENNA All Channel, Sturdy 8 elements cross bar & clamp............$3.95
DOUBLE-V Ant. All Channel. Sturdy Cons. w/Mtg Clamps & 100 ft. Twinex........$4.49
WINDOW CONICAL All Channel............$3.95
5 FOOT Interlocking Mast Sections. Hvy Duty, rustproof........2 for $1.49; 10 for $7

106 WATT SEC PHOTOFLASH KIT—AC

Includes transf condensers two/525MFD/450V/Total 103W/Secds. Resistors, capacitors, rectifier, flash tube in indicating flash gun, guide # 40 on Kodachrome. Special $39.98

BATTERY 106 WATT/SCDS PHOTOFLASH KIT

Same specs. only batteries...............$36.98
525MFD/450V/53w'scds condensers. low leakage (2MA)...........Spec $9.00; 2/$17.00.
16MFD/1.8 to 2.8KV/60WS cndsr....$5.95
CK5517 mini (no-fil) gas rectifier.....$2.88
1600VDC selenium rectifier.................$2.98
Electronic Flash Handbook ckt data 50c.

"TAB" PHOTOFLASH LAMPS

"Tab" No.	Replaces	W-Sec. Max.	Each
TLW	FA104/FT118	150	$5.98
THI	AMGLO 5804X	100	10.98
23ST	GE FT 210	200	9.98
THVA	SYLV. 4330	200	9.98
V4X4	X400	200	10.98
TLX	FA100/DX	150	9.00
353GTQ	FT 503	2000	49.98
FT105	FT 105	150	4.29

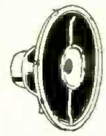
TRIGGER COIL FOR GE 86G41 .... 1.47
WRITE FOR "TAB" FLASH TUBE DATA 50c

OIL CONDENSERS

NEW WAREHOUSE LIST

.00025MFD/25KV $4.00; 2 for $7.00
.0016MFD/15KV $7.00; 2 for $12.00
2X.1MFD/2000V ....$1.39; 2 for $2.00
.5MFD/600V ....25c; 6 for $1.00
.5MFD/1500V ....85c; 3 for $2.00
1MFD/500V ....33c; 4 for $1.00
1MFD/600V ....39c; 3 for $1.00
1MFD/1000V ....39c; 3 for $1.00
2MFD/600V ....59c; 5 for $2.00
4MFD/3000V ....$7.98; 2 for $14.00
4MFD/5000V ....$19.95; 2 for $35.00
5MFD/600V ....$1.50; 3 for $4.00
16MFD/600VAC/1800VDC....$5.95; 2/$10
10MFD/600V(2.5-2.5-5MFD) oil 12 for $18

HI-FI SPEAKERS

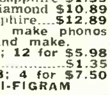


All 8 ohm. V.C., Alnico V Magnets, Inbuilt Network. 2 wires needed for HF & LF Response Famous Hi-Fi Speakers Mfgrs.
15" Coaxial Pm & 5" Tweeter. 25 watt/20-17500 cy. Model P25CO $23.75
12" Coaxial PM & 3¼" Tweeter. 12 watt/45-15KC Spec. $12.75; 3 for $35
8" Coaxial PM & 2½" Tweeter. 8 watt/70-15000 cy Model P8CO ....$7.98; 2/$15
12" HI-FI PM 10 watt/35-14kc $9.95
8" HI-FI PM 7 watt 45-14kc...............$7.25

AUDIO COMPONENTS

Electrovoice triplay cart. $1.98
GE RPX040/78 Goldtone $5.25
GE RPX041/MG Goldtone $5.25
RPX050/GE Orig Box.......$6.69
GE RPX052/Dual (D&S) $17.75
GE RPX053/.001 & .003 diamonds $25.98
"TAB" GTD Phono Needle Replacements
RPJ010 Dual .001 & .003 sapphire..$1.95
RPJ012 Dual .001 & .003 diamonds $20.89
RPJ001/78 or RPJ005 .001 sapphire $1.35
RPJ003/78 or RPJ004/LP diamond $10.89
RPJ013 Dual diamond & sapphire.....$12.89
Replacement needles for all make phonos Please specify model and make.
MGor78 single osmium.....59c; 12 for $5.98
MGor78 single sapphire styli..............$1.35
MGor78 Dual sapphire $1.98; 4 for $7.50
WRITE FOR "TAB" HI-FIGRAM

CIRCUIT BREAKER FUSES



PUSH TO RESET
Amps 3—5—7—10—15—20
Ea. 27c; 5 for $1.00.
Asst (U-Select) ....100/$15
Circuit Breaker Fuse W/2 Mounting Clips 39c
3 for $1.00; 20 for $5.98; 100 for $20
Fuse is 3AG Size. Operates up to 24 Volts
Please State Current (Amps) Desired
Heinmann Magn Bkrs. Amps: 0.22, 3, 7, 9, 12, 15, 30, 35, 40, 80, 180.......Ea. $1.98; 12/$20; 50/$75
Sq. D & CH Toggle Sw Brkrs, Amps; 5, 10, 15, 20, 25 98c; 10/$8.98; 50/$39
Klixon Thermal Push Button Bkrs Amps; 5, 10, 15, 20, 25, 30 89c.....10 for $7.98

PRECISION RESISTORS FOUR MILLION IN STOCK

All 1% Accuracy Gtd

ORDER ANY VALUE WE HAVE IT: REGULARLY SOLD FOR 69c AND UP "TAB" SPECIAL 35c EACH; 10 OF ONE VALUE.............. 25c ea.
100 OF ONE VALUE..........................$20.00
10 ASSORTED VALUES (U-SELECT)...$3.00
INDICATE SECOND RANGE. NO MFGRS CHOICE, WE SHIP TYPES IN STOCK
NOTE: 1 MEG & UP ADD 25c EA RESISTOR

SPEEDWAY ELECTRIC DRILL ¼" MODEL 200J

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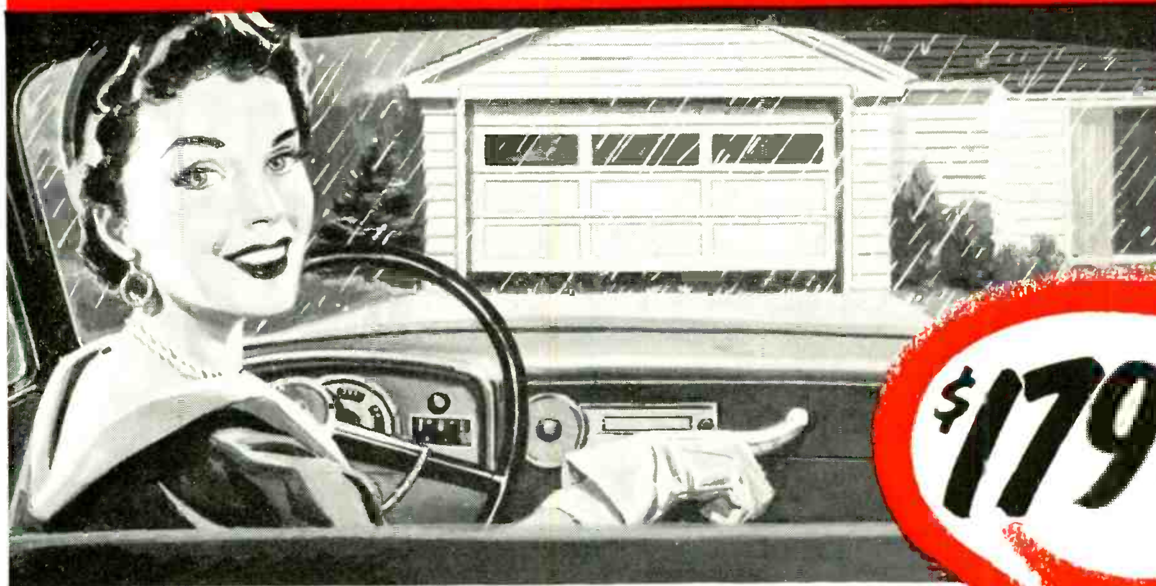

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