IN THIS ISSUE

BUYING A HI-FI AMPLIFIER?

STEREOPHONIC SOUND FOR THE HOME

FM MULTIPLEXING

ADAPTING THE "ULTRA-LINEAR" WILLIAMSON TO 6550 OPERATION

A 100-WATT POWER AMPLIFIER

A MUSICIAN LOOKS AT HI-FI

A PORTABLE TRANSMITTER-RECEIVER FOR 148 MC.

EVOLUTION OF THE PHONOGRAPH

REMOTE CONTROL FOR TV

OUR COVER
(See Page 95)
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November, 1955

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A Glossary of Musical Terms
TOLL TV AND THE SERVICE TECHNICIAN

ARGUMENTS pro and con on the question of toll TV are waxing hotter and hotter, and at this writing it appears that the FCC is no closer to a decision than when the case was first presented to it. In fact, it is very likely that at least some aspects of the problem will have to be submitted to Congress, with a clear-cut decision perhaps years away.

A new factor was injected recently with a proposal by Jerrold Electronics that toll TV be set up on a closed-circuit basis, somewhat like the present Community TV antenna systems. Such a basis would have obvious advantages from the standpoint of control, distribution, and billing, but might not be as advantageous from the economic standpoint as the three presently proposed systems (Zenith, Skatron, and Telemeter). Jerrold has published a detailed cost analysis in which it claims that with 30% saturation, costs will be equivalent to any of the proposed three systems, and furthermore, that the cost per subscriber will decrease rapidly as saturation increases.

Service technicians everywhere have a definite stake in the final outcome of these arguments. If one of the scrambled systems is approved, someone will obviously have to install the unscrambler equipment at the receiver. This will require making some connections and perhaps some alterations within the receiver itself. It appears that this work would have to be done by factory-trained men rather than existing service organizations. Furthermore, once the set has been disturbed in this manner, the customer would be more apt to call on the toll TV company for future service than his regular service technician. This is logical, since in most cases the set would have been working properly before installation of the toll TV equipment, and the customer would assume that any future difficulty resulted directly from such installation. Thus, widespread use of any of the three scrambled toll TV systems could result in a big decrease in available jobs for presently existing service organizations.

No such problem exists with the proposed wired system. No equipment is installed in the receiver, and no alterations are necessary. The signal is brought into the home by means of a coaxial cable and terminates in a box with terminals for connection to the receiver antenna terminals. Responsibility of the cable company is clear-cut. It must provide a suitable signal at the box terminals. If such a signal is present, any fault obviously lies in the receiver itself and the regular service technician will be called in for set repairs. Thus, this system does not pose any threat to existing service organizations.

Jerrold claims that its proposed system does not require FCC approval, and so it is going ahead with tests in four of its existing community TV systems, and in addition is completely wiring two large communities which already have adequate TV coverage. These tests will determine the economic feasibility of closed-circuit toll TV.

Another interesting aspect of the whole problem is the claim by Jerrold that it can break any of the scrambling codes used by the three other proponents of toll TV. If this claim can be proved, and if such code-breaking can be carried out easily on a large scale, the proposed systems would have to be discarded for lack of a means of effectively collecting tolls. Jerrold has challenged the three proponents and has asked the FCC to arrange for a test in the near future, whereby Jerrold engineers can prove their claim.

One proponent’s answer to this claim is that, given sufficient time and money, any code can probably be broken. However, with a shift in the code every month or oftener, such a procedure would be highly impractical, and the dissemination of such information for pay would be illegal.

Two of the major considerations in setting up a code are to determine how much scrambling is necessary in the picture and sound and how complex the code must be to prevent unauthorized large-scale “pirating.” These matters have been carefully considered by the proponents of scrambling, and they feel that they have arrived at satisfactory answers.

All of the parties involved have heavy financial interests at stake, with millions of dollars having already been spent in engineering and testing the various systems. Many others will be directly affected in one way or another by the ultimate outcome. With such big stakes, claims and counter-claims will be fired back and forth, and it may be a big difficult to delive beyond the surface and determine what decision is in the best interest of the American public as a whole. The final decision will be awaited with a great deal of anticipation.

O.R.

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November, 1955
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**JFD SUPER-STAR HELIX**

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**JFD FIRE-BALL**

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<tr>
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<td>96&quot; wide stacked</td>
<td>$38.60</td>
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I’ll Prove It Is Easy And Practical To Learn At Home. Sample Lesson FREE.

Practice Broadcasting with Equipment I Send

It’s practical to train at home for good Radio-TV jobs and a brighter future. 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 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. Get FREE sample lesson.

Practice Servicing with Equipment I Send

Self-confidence, security, earning power come from knowing-how and from experience. Nothing takes the place of PRACTICAL EXPERIENCE. That’s why NRI training is based on LEARNING BY DOING. You use parts I furnish to build many circuits common to Radio and Television. With my Servicing Course you build a modern Radio (shown at right). You build a Multimeter, use it in conducting experiments, 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. Judge for yourself whether you can learn at home in your spare time.

Get My SAMPLE LESSON and
64-Page Illustrated 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!

Television Is Growing Fast
Making New Jobs, Prosperity

More than 30 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 and to operate hundreds of Television stations. 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. Over 40 years’ experience training men at home.

Available to VETERANS
Under G.I. Bill

Good Jobs Good Pay See Other Side

Cut out and mail card NOW!

How to Be a Success in RADIO-TELEVISION

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

K L M O P R

No stamp needed! We pay postage.
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 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. Television Broadcast Stations extend from coast to coast now with over 30 million Television Sets already in use. Over 400 Television stations are on the air and there are channels for hundreds more.

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

SEE OTHER SIDE

J. E. Smith, President
National Radio Institute

I TRAINED THESE MEN

Lots of Spare-Time Jobs

"I do a lot of spare-time Radio and TV servicing. It was fun learning and I don’t know how to thank the Institute, Plain View, Idaho.

Engineer with WHBF

"I trained to NRI and operated a successful Radio repair firm. Then I got a job with WHBF and now am an engineer for WHBF. V. W. Womanhod, High Point, N. C.

Quit Job for Own Business

"I decided to quit my job this full time. I love my work, which is all right financially. I live with my wife and do not need diversions. John, Tacoma, Wash.

Extra Money in Spare Time

"I am a police captain and have good extra-time service and make extra money in spare time. It is better than anything else. True, Evergreen, Wash.

My Training Leads to Jobs Like These


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 Travins, 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."
Auto-Radio Technicians:

DELCO RADIO

TRAINING COURSES MEAN MORE BUSINESS FOR YOU

Week-long courses for experienced service technicians provide latest radio and repair information—enable you to do the job faster and more efficiently.

Quick, accurate auto radio diagnosis and repair to factory specifications boosts your profits. That's why so many qualified auto radio-technicians attend these Delco Radio training courses at no cost for tuition, school supplies, or equipment.

Factory-trained instructors, using latest equipment and instruction methods, conduct these intensified week-long courses, designed to familiarize repairmen with modern auto radio developments and factory-approved repair techniques.

The Delco Radio diploma, awarded only to those who successfully complete the course, is proof that you're equipped to give more and better service to more people—and that means more business.

If you're an auto radio service dealer, come yourself, or send your technicians. There's one of 30 GM Training Centers near you. Apply through your local Delco Electronic Parts Distributor or write Delco Radio Division of General Motors, Kokomo, Indiana.

Here's the course of study —
**SPOT RADIO NEWS**

*Presenting latest information on the Radio Industry.*

By RADIO & TELEVISION NEWS' WASHINGTON EDITOR

ANOTHER DELUGE of boiling briefs on pay—see TV flooded the Commission's offices, as the final round in the paper hearings came to a close, shortly after the Labor Day holiday. Once again the networks scored the toll idea, calling it impractical and an imposition on the public, while the trio of code proponents and a few others called the idea the salvation of TV.

In the flurry of closing statements, toll opponents also warned the FCC that it had no authority to decide the issue under the present laws, and urged that the matter be referred to Congress to determine once and for all whether the subscription plan should be considered a common carrier, as the telephone companies, or broadcasting, or whether pay programs should be sent over leased wires.

Thus, with so muddled a situation facing them, plus over seventy volumes of pounding verbage to sift, the Commission has quite a chore ahead of it. A number in industry and on the Hill has indicated that the best way to handle the affair from now on would be to issue a call for public hearings and listen to oral testimony. Such sessions, which would feature cross examinations, could resolve a number of the basic pro and con arguments, and also clarify the picture for any possible Congressional action.

One of the most caustic rebuttals came from CBS, which said that the claims of pay-TV proponents were so vague and general, that they should be disregarded. The American system of telecasting, noted Columbia, is by universal admission the best in the world. And that is why those who foster the cause of toll television, they added, have just... "polished the glitter..." and simply glorified the gamut of presentations possible under coin TV, when actually, such programs are now

---

**NEW TV STATIONS ON THE AIR**

(As of October 25, 1955)

The following new stations bring the lists published in previous issues up to date.

<table>
<thead>
<tr>
<th>STATE, CITY</th>
<th>STATION</th>
<th>CHANNEL</th>
<th>FREQUENCY RANGE (IN MC.)</th>
<th>VIDEO WAVELENGTH (IN FT.)</th>
<th>VIDEO POWER (IN KW.)</th>
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</thead>
<tbody>
<tr>
<td>California</td>
<td>KCRX-TV</td>
<td>3</td>
<td>50-66</td>
<td>18.08</td>
<td>50</td>
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<tr>
<td>Sacramento</td>
<td>KNTV</td>
<td>11</td>
<td>198-204</td>
<td>17.8</td>
<td>25</td>
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<tr>
<td>Florida</td>
<td>WESH-TV</td>
<td>2</td>
<td>84-60</td>
<td>11.8</td>
<td>100</td>
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<tr>
<td>Daytona Beach, Georgia</td>
<td>WCTV</td>
<td>6</td>
<td>62-88</td>
<td>16.06</td>
<td>100</td>
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<tr>
<td>Thomasville, Illinois</td>
<td>WTVW</td>
<td>3</td>
<td>60-66</td>
<td>16.06</td>
<td>56.2</td>
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<tr>
<td>Kansas</td>
<td>KARD-TV</td>
<td>3</td>
<td>60-66</td>
<td>16.06</td>
<td>100</td>
</tr>
<tr>
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<td>KTBS-TV</td>
<td>3</td>
<td>60-66</td>
<td>16.06</td>
<td>100</td>
</tr>
<tr>
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<td>KTVO</td>
<td>3</td>
<td>60-66</td>
<td>16.06</td>
<td>100</td>
</tr>
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<tr>
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<tr>
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<td>WFFA</td>
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<td>174-180</td>
<td>5.61</td>
<td>316</td>
</tr>
<tr>
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<td>2</td>
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<td>4.65</td>
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<tr>
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<tr>
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<td>KFWX</td>
<td>7</td>
<td>215-216</td>
<td>4.65</td>
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<tr>
<td>Fort Worth</td>
<td>KTRV</td>
<td>9</td>
<td>198-204</td>
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<tr>
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<td>WREJ</td>
<td>11</td>
<td>198-204</td>
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<tr>
<td>Virginias</td>
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<td>174-180</td>
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<td>316</td>
</tr>
<tr>
<td>Roanoke</td>
<td>WYOR</td>
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<tr>
<td>West Virginia</td>
<td>WBYN</td>
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<td>210-216</td>
<td>4.65</td>
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<td>Huntington</td>
<td>WORL</td>
<td>5</td>
<td>56-62</td>
<td>12.74</td>
<td>1.46</td>
</tr>
<tr>
<td>Territories</td>
<td>WORL</td>
<td>5</td>
<td>56-62</td>
<td>12.74</td>
<td>1.46</td>
</tr>
</tbody>
</table>

*The frequency of the video carrier = 1.25 + channel lower freq. limit. Total number of TV stations now on the air in U.S.: 496 (116 of which are U. S. F.).*
Learn PRACTICAL RADIO-TV with 25 BIG KITS

Prepare for a Good Paying Job — Or Your Own Business

"I Will Train You at Home in RADIO-TELEVISION On Liberal No Obligation Plan!"

New Equipment! New Lessons! Enlarged Course! The true facts are yours in my big new catalog . . . YOURS FREE . . .

JUST MAIL COUPON!

I can train and prepare you in as little as 10 months to step into the big opportunity Radio-Television service field. Train without signing a binding contract . . . without obligating yourself to pay any regular monthly amounts. You train entirely at home in spare hours . . . you train as fast or as slowly as you wish. You'll have your choice of 2 SPRAYBERRY TRAINING PLANS . . . planned for both beginners as well as the more experienced man. Get the true facts about the finest most modern Radio-Training available today . . . just mail the coupon for my big new 56 page fact-filled catalog plus sample lesson—both FREE.

Train the Practical Way — with Actual Radio-Television Equipment

My students do better because I train both the mind and the hands. Sprayberry Training is offered in 25 individual training units, each includes a practice giving kit of parts and equipment . . . all yours to keep. You will gain priceless practical experience building the specially engineered Sprayberry Television Training Receiver, Two-Band Radio Set, Signal Generator, Audio Tester and the new Sprayberry 18 Range Multi-Tester, plus other test units. You will have a complete set of Radio-TV test equipment to start your own shop. My lessons are regularly revised and every important new development is covered. My students are completely trained Radio-Television Service Technicians.

See for Yourself . . . Make Your Own Decision . . . Mail Coupon Today!

The coupon below brings you my big new catalog plus an actual sample Sprayberry Lesson. I invite you to read the facts . . . to see that I actually illustrate every item I include in my training. With the facts in your hands, you will be able to decide. No salesman will call upon you. The coupon places you under no obligation. Mail it now, today, and get ready for your place in Radio-Television.

SPRAYBERRY ACADEMY OF RADIO
111 North Canal Street, Dept. 25-E, Chicago 6, Illinois

Mail This Coupon For Free Facts and Sample Lesson

SPRAYBERRY ACADEMY OF RADIO
Dept. 25-E, 111 N. Canal St., Chicago 6, Ill.

Please rush all information on your ALL-NEW Radio-Television Training Plan. I understand this does not obligate me and that no salesman will call upon me. Include New Catalog and Sample Lesson FREE.

Name _____________________________ Age ______

Address ____________________________

City ___________________ Zone ______ State ___
Hit The BIG Multiple TV Market

...Sell the JERROLD TV Multi-Outlet SYSTEM

The Jerrold TV Multi-Outlet System is not only the easiest, most profitable distribution system to sell ... it is also your key to large TV set orders.

For the Multi-Outlet System distributes snow-free pictures to 5, 10, 20 or more receivers from a single antenna—with an increase in signal strength and with highest possible signal-to-noise ratios.

Best of all, Jerrold supplies you with complete sales aids—brochures, cost estimating data ... plus instructions that make installation a breeze for any TV service technician.

Find out how you can capture the growing multiple-set market. Write to Jerrold for complete information.

more db per Dollar Bill

JERROLD ELECTRONICS CORP.
2214 CHESTNUT ST., PHILADELPHIA 3, PA.

available and coming ... "to the American people in improved quality and from more diversified sources every day that goes by."

The network viewed the pay program as one which would subvert the present system and subject viewers to a ... "system of charges more onerous than any system of Government tax ... ever contemplated ..."

The idea that the toll plan should be given a trial was also hit, for such a move, said Columbia, would only prove, at best, that there is a minority who could afford to and would pay for programs. All that this test would prove, added CBS, is that if someone received the right to ... "charge admission to what hitherto had been a public picnic grounds, enough hungry people might need a place to eat badly enough to make the enterprise ... an extremely profitable one."

This would be true even though fewer people could use the picnic grounds, and even though the people who were excluded from it might be those who needed its facilities the most ..." One brief, filed by a Philadelphia manufacturer of community-TV equipment, re-emphasized an earlier stand that all toll codes could be broken and therefore all of the proposals were senseless. All systems, it was noted, feature basic decoder designs that are common, even though some principles of circuitry and their mechanical complexities vary.

According to this manufacturer, the three decoders were similar in the following respects:

Video information from the receiver must be obtained in order to operate the decoding devices. This requirement necessitates the use of a switch to break into the video portion of the teletext, when the decoding mechanism is in operation, or if normal programs are to be observed, a switch in the decoder is necessary in order to complete the drive circuit, thereby restoring the receiver for normal operations. In addition, audio information is necessary for the operation of the decoders. Such signals are obtained either from the output of the FM discriminator, or, if the receiver has insufficient audio fidelity, it then becomes necessary to obtain an audio intermediate-frequency drive signal from a stage prior to the FM detector. The audio, after decoding, is re-routed back to the receiver to a point in the audio amplifier section. Also, information is necessary from the horizontal output circuitry, as well as from the vertical output stage.

To obtain video information requires two connections; an encoded video input to the decoding device, and a decoded video output from the decoding device. Two connections were also said to be required to obtain audio information; an audio or an audio intermediate-frequency input to the decoding device, and a decoded audio output from the decoder. This quartet of connections, plus the vertical and horizontal connections, add up to a

(Continued on page 140)
Now, while demand for trained men is rising, you can prepare for a top-pay, lifetime career as an electronic technician, television repairman, or studio technician... or set up your own profitable business. You don't need any experience whatsoever to add your name to my list of hundreds of successful graduates.

**LEARN BY DOING**

As part of your training I give you the equipment you need to set up your own home laboratory and prepare for a BETTER-PAY TV JOB. You build and keep an Electromagnetic TV RECEIVER designed and engineered to take any size picture tube up to 21-inch, (10-inch tube furnished. Slight extra cost for larger sizes)... also a Super-Het Radio Receiver, AF-RF Signal Generator, Combination Voltmeter-Ammeter-Ohmmeter, C-W Telephone Transmitter, Public Address System, AC-DC Power Supply. Everything supplied, including all tubes.

**STUDY NEWEST DEVELOPMENTS**

My training covers all the latest developments in the fast-growing Television-Radio-Electronics industry. You learn about FM — RADAR — COLOR TV — TRANSISTORS — PRINTED CIRCUITS, etc.

**CHOOSE FROM THREE COMPLETE COURSES**

1. Radio, FM and Television Technician Course — no previous experience needed.
2. FM-TV Technician Course — previous training or experience in radio required.
3. TV Cameraman and Studio Technician Course — advanced training for men with Radio or TV training or experience.

**EXTRA TRAINING IN NEW YORK CITY AT NO EXTRA COST!**

After you finish your home study training in Course 1 or 2 you can have two weeks, 50 hours, of intensive Lab work on modern electronic equipment at our associate resident school, Pierce School of Radio and Television. THIS EXTRA TRAINING IS YOURS AT NO EXTRA COST WHATSOEVER!

**FCC COACHING COURSE**

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

**EARN WHILE YOU LEARN**

Almost from the very start of your course you can earn extra money by repairing sets for friends and neighbors. Many of my students earn up to $25 a week... pay for their entire training with spare time earnings... start their own profitable service business.

**MAIL THIS COUPON TODAY!**

Mr. Leonard C. Lane, President
Radio-Television Training Association
Dept. T-T1C, 52 East 19th Street, New York 3, N. Y.
Dear Mr. Lane: Mail me your NEW 60-page book, "How to Make Money in Television — Radio — Electronics," a Free sample lesson, and other literature showing how and where you can get a top-pay job in Television.

Name ____________________________
Address __________________________
City ____________________________ Zone ______ State ________

I AM INTERESTED IN:☐ Radio-Fi TV Technician Course
☐ FM-TV Technician Course
☐ TV Cameraman & Studio Technician Course

(please print plainly)

NO SALESMAN WILL CALL!
Telephone science produces an important new rectifier

At Bell Laboratories one line of research is often fruitful in many fields. Latest example is the silicon power rectifier shown above.

Product of original work with semiconductors—which earlier created the transistor and the Bell Solar Battery—the new rectifier greatly reduces the size of equipment needed to produce large direct currents. It is much smaller than a tube rectifier of equal performance and it does not require the bulky cooling equipment of other metallic rectifiers.

In the Bell System the new rectifier will supply direct current more economically for telephone calls. It can also be adapted to important uses in television, computers, industrial machines, and military equipment. Thus, Bell Telephone Laboratories research continues to improve telephony—while it helps other fields vital to the nation.

Bell Telephone Laboratories

Improving telephone service for America provides careers for creative men in scientific and technical fields.
Six months from today
Which Will You Hold?

Add Technical Training To Your Practical Experience-
GET YOUR FCC LICENSE IN A HURRY!

Then use our Amazingly Effective
JOB-FINDING SERVICE

• 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.

• TELLS HOW-

Employers make JOB OFFERS Like These to Our Graduates Every Month

Letter from nationally-known Airlines, "Radio Operators and Radio Mechanics are needed for our company. Pecuniary rewards increase with opportunities for advancement. Both positions include many community benefits such as paid vacations, free flight mileage allowance and group insurance."

Letter from nationally-known Manufacturer, "We have a very great need at the present time for radio-electronic technicians and would appreciate any helpful suggestions that you may be able to offer."

These are just a few examples of the job offers that come to our office periodically. Some licensed technician 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
A. F. Ronald H. Petersen  1st  18 weeks
Carl Verboom  1st  18 weeks
Marvin F. Kimball  2nd  21 weeks
L. M. Bannor  2nd  21 weeks
H. W. Talbot  1st  27 weeks
John E. Richards  1st  27 weeks
Carl E. Smith, E.E., Consulting Engineer, President
CLEVELAND INSTITUTE OF RADIO ELECTRONICS DESK RN-82, 4700 Euclid Bldg., Cleveland 3, Ohio

November, 1955

Money-Making FCC Commercial Radio Operator LICENSE Information

Get This Valuable Booklet FREE!

REGRET TO ADVISE YOU FAILED YOUR FCC EXAMINATIONS-

1st CLASS RADIO TELEPHONE OPERATOR'S LICENSE

TV ENGINEERING INCLUDED IN OUR TRAINING & COACHING

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Cleveland Institute of Radio Electronics
Desk RN-82, 4700 Euclid Blvd., Cleveland 3, Ohio (Addressto Desk No. to Avoid Delay)

NAME

AGE

ADDRESS

CITY

ZONE

STATE

PHONE

For prompt results, send air mail.

Special tuition rates to members of the U.S. Armed Forces

Effective Job-Finding Results:

Here are just a few recent examples of job-finding results:

BROADCASTING
Your 'Chief Engineer's Bulletin' is a great way of obtaining employment for your graduates who have obtained their first licenses. Since this bulletin has been on the list I have received calls or letters from five airlines in the southern states and am now employed as Transmitter Engineer at WMTX.

Kinner Frost, Box 274, Summer, Tenn.

CIVIL SERVICE
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 job to do with your training this desirable position.

Charles E. Lemire, 4150 Geneva Ave., Dayton 6, Ohio

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

Harry Holmes, 1231 E. Normandy Dr., Chicago, Ill.

Your FCC license is recognized by employers as proof of your technical ability.

www.americanradiohistory.com
Now... easier more versatile operation for...

THORENS
THE ONLY HI-FI CHANGER

New...

SIMPLIFIED SPEED CONTROL
Dial-selection of any of three speeds plus a fine-tuning knob to permit exact pitch adjustments above and below all standard speeds.

New...

CONTROL FOR MANUAL OPERATION
Allows you to disengage the automatic trip mechanism to enjoy flexible operation.

Plus an improved direct-drive motor with separate gear for each speed... for absolute speed constancy and silence.

$93.75 net

See Your Dealer or... for more about new improved Thorens Record Changers, Players and Turntables write:

THORENS
NEW YORK

Within the Industry

JOHN E. GRAY, for many years a member of the technical staff of Hughes Aircraft Company, has been named chief engineer of Berlant Instruments of Los Angeles, manufacturer of "Berlant" and "Concertone" tape recorders.

The new appointment was announced by American Electronics, Inc. of which Berlant is a wholly-owned subsidiary.

Mr. Gray was formerly assistant project engineer for Sperry Gyroscope Company. He served in the Navy for 3 years as an officer and is a member of the Naval Reserve. He is a graduate of the Stevens Institute of Technology, a senior member of the IRE, a charter member of AES, and a member of the Acoustical Society of America.

WILFRED L. LARSON, president of Switchcraft, Inc., Chicago, was recently elected chairman of the Association of Electronic Parts and Equipment Manufacturers, trade group composed of 120 Midwest electronics firms.

J. Wayne Cargile, sales manager of Perma, Inc., was elected vice-chairman and Helen Staniland Quam of Quan-Nichols Company, Chicago, was re-elected for her eighteenth annual term as treasurer.

MICHAEL P. FUMAROLA has been named publicity director for all of the divisions of JPD Manufacturing Co., Inc. of Brooklyn.

He will coordinate all promotional and publicity programs for the antenna, rotator, and capacitor divisions and work in close association with Ed Finkel, sales manager, on marketing problems from the public relations standpoint. He will prepare information on the company’s technical and merchandising developments as well as plan public service operations for parts jobbers, dealers, TV stations, and consumer publications.

LAWRENCE C. FULLER, JR. has established a new manufacturers’ representative firm at 32 Rittenhouse Place in Ardmore, Pa. to service the Middle Atlantic area.

ARROW SALES, INC. of North Hollywood and Chicago has merged with G. L. ELECTRONICS, INC. of Los Angeles. This merger now offers buyers two sources from which to order by mail and three locations where in-person purchases can be made. Mail orders are handled at P.O. Box 3878, North Hollywood, California and 2441 S. Michigan Avenue, Chicago 16, Illinois while stores are maintained in Chicago at 2005 Empire Ave., Burbank, California; and 1632 Venice Blvd., Los Angeles 6, California.

MILTON J. SHAPP has been re-elected president and chairman of the board of Jerrol Electronics Corp., Philadelphia manufacturer of equipment for master television antenna systems.

Also re-named vice-president by the board was Henry J. Arbeiter who has served as chief engineer since 1948. Two new vice-presidents were elected; Donald Kirk, Jr. to be vice-president in charge of research and development, and Caywood C. Cooley who will direct the field service organization of the firm. Simon Pomerantz, controller of the company was elected treasurer while James J. Fuld was named secretary.

ELGIN NATIONAL WATCH COMPANY has established warehouse and distribution facilities in Elgin, Illinois for two of its West Coast electronics plants, AMERICAN MICROPHONE CO. and ADVANCE RELAY CO. A large stock of parts will be carried at the new warehouse... A Mid-America regional marketing office has been opened at 7001 W. North Avenue, Oak Park, Illinois by TEXAS INSTRUMENTS INCORPORATED. The company’s line of semiconductor products and electronic components will be marketed from the new facility... BERLANT-CONCERTONE has named ELECTRONIC CORPORATION OF AMERICA, 104 Somerset St., New Brunswick, N.J. as its factory parts exchange warehouse on the east coast... Production of electrical devices, plastic products, and electronic components is now under way in the new SIERRA ELECTRIC CORPORATION plant at Gardena, California. Five separate locations in the Los Angeles area have been consolidated at the new site... EASTERN PRECISION RESISTOR CORP. has moved to a new and enlarged plant at 675 Barby Street, Brooklyn, N.Y. The firm was formerly located at Richmond Hill, N.Y. L. L. CONSTANTIN & CO., manufacturer of glass-to-metal vacuum seals and other electronic components, has opened a second plant at 187 Sargent Ave. in Clifton, N.J. MICRO SWITCH of Freeport, Illinois has purchased a multi-story factory.
NOW... RCA trains you at home to be an expert technician in...

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November, 1955
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building which provides 300,000 square feet of manufacturing space. The company has been operating from this location on a lease basis for a number of years. . . . BENDIX AVIATION CORPORATION is building a 85,000 square foot building in the Detroit area to house its research laboratories division. . . . XCELITE, INCORPORATED of Orchard Park, N. Y., has added a new building which will increase the firm's output of hand tools by about 25 per cent.

ARTHUR J. RICHARDS has been appointed chief radio engineer of the electronics division of Arvin Industries, Inc. of Columbus, Indiana. He has been service manager of the radio division for the past six years having joined the company in 1949 after a three year tenure as radio design engineer for Capehart-Parnsworth Corporation of Ft. Wayne.

His new duties will include supervision of the design, engineering, and pre-production planning of the firm's radio line.

W. D. JENKINS of the Radio Supply Co., Richmond, Va. has been elected president of the Electronic Parts Distributors Show for 1956. Theodore Rossman of Pentron Corp. was chosen vice-president; W. Walter Jablon of Presto Recording Corp. was named secretary while Herbert W. Clough of Belden Mfg. Co. was elected treasurer.

The board of directors also made preliminary plans for the 1956 Show which will be held in Chicago the third week in May. Mr. Jenkins appointed committees to deal with the budget, entertainment, housing, publicity, credentials, and the educational program of the sessions.

PAT J. MORRISKEY is the new industrial sales manager for Gramer-Halldorson Transformer Corporation of Chicago.

He will manage sales of the firm's complete line of electrical and electronic products for industrial applications.

Mr. Morriskey has been identified with the electronics industry for over seventeen years having been associated with a leading manufacturer of electrical components prior to his present affiliation.

LLOYD E. SWEDLUND has been named manager of monochrome tube product engineering at the General Electric Cathode-Ray Tube Sub-Department in Syracuse . . . . JEFF D. MONTGOMERY, former sales engineer for Andrew Corporation, has been named West Coast engineering manager of Andrew California Corporation of Claremont, California. (Continued on page 136)
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100% inspected
accurate replacement
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the most complete line
of twist mount
dry electrolytic capacitors

Better than any claims we could make is the unqualified and enthusiastic acceptance by engineers and servicemen alike. These are some of the features on which this acceptance is based:

- Aluminum containers provide maximum protection against moisture.
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Up to now, your local credit facilities may have been inadequate to handle installment buying. So... G.E. makes available special financing aid in order to help you get all the TV service business you can profitably undertake.

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Ask your G-E tube distributor for complete information on this new way to get more service business—at no sacrifice of your working capital! Instructions...contract forms...advertising-promotion helps are ready for you. Tube Department, General Electric Company, Schenectady 5, N.Y.

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- Your TV service customers now can afford to replace worn-out picture tubes immediately. They no longer feel obliged to wait.
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- TV owners now can afford to buy the best from you. That means G-E Aluminized Tubes—G-E Service-Designed Tubes—other high-quality components.
- You can successfully compete for the local consumer's retail dollar. You are offering the same up-to-the-minute credit-purchase terms as other progressive merchants in your neighborhood.
The new Telrex "THUNDERBIRD" multi-element wide-band Beamed Power arrays are engineered for fringe and "sub-fringe" area reception, and for all receiving conditions requiring exceptionally good directivity and high sensitivity.

Super Thunderbird Model T-120 is the finest wide-band, multi-element array ever developed. A system of variable impedance phasing loops permit precision tuning and the duplexing of element functions to provide the equivalent of 8 operating elements on the LO channels; 13 elements on the HI channels. Elements for element, they develop greater gain and directivity than many single channel arrays. Model T-120 is accurately matched to 200-300 ohm transmission line for both HI and LO channels. "Trombone" sections to yield exceptionally high gain and optimum signal transfer efficiency. LO band gain averages better than 5.5 db; HI band gains exceed 12 db, while front-to-back ratios range to 25 db.

For brilliant, interference-free signals under toughest reception conditions choose the Telrex Super Thunderbird T-120. Available also in 2 bay units—Model T-122, 1/4-wave stacked for gain increases averaging 3 db on all channels: and Model T-123, 1/2-wave stacked to provide gain increases up to 4.5 db on LO channels, over single-bay units.

Thunderbird Model T-110 incorporates all the high-performance features of the Super Thunderbird T-120, including variable impedance loop phasing, compensated "trombone" matching sections and in-line, low wind resistance configuration plus high strength, all aluminum, quick-rig construction for dependable, high performance, low cost, long lasting installations. Dupeled elements are equivalent to 5 effective elements on LO channels for average gains exceeding 5 db; and 11 operating elements on the HI channels for gains exceeding 10 db. Front-to-back and front-to-side ratios of better than 22 db minimize interference. Available stacked 1/4-wave. Model T-112, for all channel gain increases of 3 db, and 1/2-wave stacked, Model T-115S, for increased gains to 4.5 db on LO channels.

Thunderbird T-130 employs Conical Dipole and 1/4 Beam quadrature phased driven elements to achieve virtually flat, stepless gain characteristics on all VHF channels with minimum number of elements. Model T-130 also employs variable impedance phasing loops, duplexed elements and Telrex compensated "trombone" matching sections. Four effective LO channel elements; 9 operating elements on HI channels, produce gains to 3 db on 5-6, and up to 11 db on channels 7-13. Special trap circuitry used in all Thunderbirds, attenuates interference arising outside the assigned TV bands to assure crisp, smear-free picture quality and full sound response.

Model T-132, stacked 1/4-wave gives average gain increase of 3 db on all channels. 1/2-wave stacked Model T-132S provides up to 4.5 db gain on LO channels over single bay. Web-
HERE IS THE TAPE RECORDER THAT "COULDN'T BE MADE"...

What a serious high-fidelity enthusiast wants in a tape recorder has never been a mystery. He wants a recorder which, at ¾ ips will equal or exceed professional performance at 15 ips — and at a price comparable to the price of the usual garden variety of "home recorder"! In other words, he wants flat response over the entire audio range, undetectable noise, hum, wow and flutter and professional NARTEB equalization — at ¾ ips (to give up to 90 minutes of playing time on a 7" reel at a cost lower than one good LP record) — and all for less than $300.

Now, DeJUR, a great name in high-quality precision cameras, answers the demands of the HiFi enthusiast in every particular. For the first time in America, he can have a tape recorder meeting his most exacting performance requirements for a fraction of the price he would normally expect to pay.

Compare it in an A-B test with the most expensive professional recorder your high-fidelity outlet carries. We're sure you won't be able to tell the difference.

Now, let's get down to specifications. They have been checked by an independent engineering firm and confirmed by the testing laboratories of America's largest high-fidelity distributors.

FREQUENCY RESPONSE
At ¾ ips, the frequency response is 40 cps to 16,000 cps ± 2 db (the closest comparable machine is 1,000 cps less and $100 more!) Even at 3¾ ips, the DeJUR Dual Professional is flat from 50 cps to 10,000 cps ± 2 db.

SIGNAL-TO-NOISE RATIO
Noise is down 55 db (that equals or exceeds the figure for recorders priced at $600 and up!)

FLUTTER AND WOW
The DeJUR Dual Professional uses a heavy-duty genuine hysteresis dual-speed synchronous motor, the same type of motor used in $1,000 studio recorders (even the better "home recorders" use only 4-pole motors!) A hysteresis motor is independent of line voltage fluctuations, thus eliminating a major source of wow and flutter. Both are less than 0.1‰ at ¾ ips, 0.2‰ at 3¼ ips (the competitive recorder closest in performance has 0.25‰ at ¾ ips and costs $100 more!)

EQUALIZATION
Professional NARTEB equalization is used throughout the DeJUR Dual Professional. This means, that not only can you make and play back tapes of perfect fidelity, but you can also play commercial pre-recorded tapes the way they were meant to be played.

INSTANT TRACK SWITCHING
Four separate heads are employed in the Dual Professional — an erase head and a record-playback head for each track. When you reach the end of a reel on the first track, you simply press a button and the tape reverses its motion recording or playing back the second track! Anyone who has fussed and fumed as he tried to change reels in the middle of a symphony will greet this feature with cheers!

ELECTROMAGNETIC DYNAMIC BRAKING
In the DeJUR Dual Professional, there are no mechanical clutches, belts and pulleys to get out of order. The dual speed hysteresis motor is reversible and electromagnetic dynamic braking is employed for instantaneous stops and starts without tape strain or stress.

ILLUMINATED TAPE COUNTER
An illuminated, clock-like dial indicates elapsed footage so accurately that the tape can be indexed to a single note!

AUTOMATIC STOP
Inexpensive DeJUR aluminum foil feeders are available which automatically stop tape motion in either direction! There's no need to re-thread — no flopping tape ends.

PUSH-BUTTON KEYBOARD
A piano key switchboard controls all recording and playback functions through relays. Even your wife can operate the Dual Professional without an instruction manual!

OTHER EXCEPTIONAL FEATURES
Instantaneous stopping in record or playback, less than ¾" in fast wind; 2 high impedance and 1 low impedance inputs controlled by selector switch; rewind time of 90 seconds for 1200-foot reel in either direction, foam rubber pressure rollers, relay operated and triple-fused for protection against improper operation, 100-220 volt, 60 cycle AC operation.

And the price? That's the biggest surprise of all! The DeJUR Dual Professional Tapedeck is only $299.50 audiophile net!

Also available in a handsome, scuff-proof carrying case complete with built-in 6-watt power amplifier, 2 electrostatic speakers, 3 FM speakers and wide-range cardioid dynamic microphone for only $379.50 audiophile net.

AVAILABLE ACCESSORIES
Remote control foot switch $19.50. Wide-range cardioid microphone $29.50.

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November, 1955
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Buying a Hi-Fi Amplifier?

Before you buy—make sure you know what features in a power amplifier are most important.

E EVERY industry has its phases, one of which is the condition where individual manufacturers feel compelled to include some features that do not contribute anything useful to the operation of their products. Because his competitors are advertising these features and the public is insufficiently enlightened as to their value, the individual manufacturer decides to include them in his line to maintain his competitive position. Eventually the public is educated to the true value or worthlessness of such features. This may be started, either by a truly courageous manufacturer who is prepared to stake his livelihood on introducing the simplified version to the public and at the same time persuading them that they do not require all the extra features, or by some individual, with somewhat less at stake.

The audio amplifier industry seems to be in somewhat this position at present. For some time manufacturers have been producing amplifiers to better and better specifications. Individual manufacturers, when discussing their policies for the design of next year’s products, are faced with the problem of not only making their amplifiers perform well, but also of being able to quote truthful figures that compare favorably with those quoted by competitors.

The newcomer to audio thus encounters real confusion when he decides to choose an audio amplifier. Naturally enough, as in selecting any other commodity, he starts by consulting catalogs, with the idea of sorting out a short list of the best from which to make a final choice at demonstrations. Right here he encounters his first problem. What do these specifications mean? How much power do I really need? How good does the frequency response really have to be? How little distortion must I have, if I’m really going to have clean-sounding reproduction?

These are the “how good?” problems. In addition to these, he has to make sure that the amplifier will fit in with the loudspeaker system he proposes to use, and also work satisfactorily from his pickup, tuner, or whatever he wishes to play through the amplifier. So let’s take some of these questions in order.

How Much Power?

The kind of answer to this question that one will get by asking different people varies widely. This is largely due to the wide interpretation of what is loud or what is quiet.

If you look at a table of loudness figures you will find that the range covers 130 decibels from the threshold of audibility to the threshold of pain. This represents a power ratio of 10,000,000,000,000! A comfortable listening level, corresponding to average conversation or a program heard in an average auditorium, is about 50 decibels above the threshold of hearing. In the average living room, with a loudspeaker system of average efficiency, this can be achieved with an average power of about 300 milliwatts.

The average intensity of a sound is considerably below the maximum peaks, which occur occasionally in the same program material, whether we are considering speech or music reproduction. An amplifier must have sufficient margin to cover the peaks without going into distortion. Allowing a good margin for peak overshoot, 10 watts should be ample to cover an average power of 300 milliwatts, with the highest possible transient peaks likely to be encountered.

However, the interesting point is that the loudness scale covers such a tremendous power range. The difference between what
some people would call average conversation and the way others normally converse—which might more accurately be called shouting—can be at least 10 db. An increase in power level of 10 db represents 10 times as much power. This means that, to produce a consistent level, with head-room for peaks, equivalent to some people’s “loud conversation,” we should need a 100-watt amplifier instead of a 10-watt unit.

The difference between the two is that the 10-watt amplifier, turned up to a point where it would never over-load or the highest peak, will provide us with a comfortable listening level in our own living room, while the 100-watt amplifier will provide the neighbors two doors away with a comfortable listening level, as well as ourselves, that is if the loudspeakers will handle that much. So, assuming that our definition of “being neighborly” means we allow our neighbor to select his own program on his own equipment, and not rely on listening to ours, we should not need more than about 10 watts to get the kind of level we need.

Popular amplifiers have outputs extending up to about 50 watts, but the reader is cautioned against a common mistake of thinking that a 50-watt amplifier turned up to give full output will sound 5 times as loud as a 10-watt amplifier turned up to full output. When we consider that 50 watts is only 7 db louder than 10 watts, and that 3 db is generally recognized as the smallest detectable change in loudness, we realize that a change from 10 watts to 50 watts represents a little over twice the smallest change in loudness that can be definitely noticed. The important thing to realize is that, although this change may not be very noticeable in our own house, it can represent the difference between intelligibility and quite an annoying audibility in our neighbor’s house. Keep this in mind when planning a system.

If you are one of those fortunate people who live where you can use 50 watts without annoying the neighbors, and if you also like to have your orchestral music so the crescendos really sound like crescendos, then by all means get a 50-watt amplifier. But if you live in an apartment, or some place where it is good to consider the neighbors, then you are advised to buy a smaller amplifier, and automatically safeguard yourself against giving un-witting annoyance. You will be surprised to find that 10 watts doesn’t really sound very much quieter than 50 watts in your own room.

Frequency Response

The next question is, how good does the frequency response have to be? We already have a hint at the answer to this question from the fact that 3 db is the smallest change in loudness that can readily be heard. This statement applies to general program material. On the loudness of a single tone 1 db is just noticeable. This being the case, it is fairly obvious that anything less than 1 db deviation from flat in overall frequency response is going to be impossible to detect audibly. So from the listening standpoint it is pointless to have an amplifier with a response of better than ± 3 db over the audio band.

This is one of those cases where the fact that other manufacturers are giving specifications to fractions of a db, such as .1, 2 or 5, has encouraged competitors to design amplifiers whose specifications do not look unfavorable compared with the best.

Frequency responses are usually given within tolerances of db from flat, and also between frequency limits at which it is assumed the amplifier ceases to be flat. A popular range is from 20 cycles to 20,000 cycles. This is certainly as wide a frequency response as you will ever need. From a practical viewpoint, musical tones of any kind seldom, if ever, get below 40 cycles, so a response down to 40 cycles is all that is necessary to reproduce any kind of program material you are likely to encounter. At the high end, few people can hear above 17 kc, and they have to listen hard to hear that. Quite commonly hearing ceases above 12 or 13 kc, so again it is obvious that 20 kc is an absolute limit to satisfy even the most critical ears.

Some amplifiers, however, specify a frequency response from less than 20 cycles to over 20 kc. Various reasons are given for doing this, associated with the performance of the amplifier, but it is obvious from the foregoing that this cannot contribute to listening enjoyment.

It has been pointed out that one can detect the difference in sound reproduced through amplifiers whose response goes beyond 20 cps to 20 kc. Limits and those whose response rolls off at these limits. This is perfectly possible, but the difference is not necessarily an improvement in quality of reproduction. A more critical examination of the facts shows that the extended frequency range tends to increase the background noise level, which is audible in the form of hiss, so there is a somewhat higher hiss level in the wider range amplifier. Some people seem to have picked up the erroneous impression that the presence of noise indicates good high-frequency response.

Surely it is obvious that realism in high-frequency response requires the absence of artificial hiss, while maintaining a faithful reproduction of the high frequencies in the program material. This is better achieved by having an amplifier with a response flat between the audible limits and then rolling off gradually at both ends.

Power Response

Another aspect of power output and frequency response relationships is given by some manufacturers under the term “power response.” An amplifier may give its rated output, of say 50 watts, over a band of frequencies in the middle range, but may not be capable of giving its full 50 watts over the entire frequency range specified. Frequency response may comply with the specification at a level of, say, 10 watts, but it will not give 50 watts at the ends of the specified frequency range. Some take the view that such an amplifier does not conform to its specification, or that the specification is misleading.

If the output is given as 50 watts and the frequency range is specified as 20 cycles to 20,000 cycles, then some argue this should mean the amplifier will give 50 watts all the way from 20 cycles to 20,000 cycles. However, few amplifiers listed as having a frequency response of 20 cps to 20 kc, and a power output of 50 watts will give the full 50 watts at 20 cycles or at 20,000 cycles.

This is the reason why some manufacturers specify power response, which is a curve giving the maximum output, or the output with a given amount of distortion against frequency. Fig. 1 illustrates power response plotted against the frequency response of the same amplifier.

To design an amplifier that gives the full rated output at the extreme ends of the specified frequency range requires the use of a much more expensive output transformer. So
the question will arise, is this extra cost worth it in terms of improved performance?

This is a subject about which there has been some controversy. But the fact remains that any audio program material possesses nowhere near the full energy at either the low end or the high end. Consequently the full power is not necessary at the two ends of the frequency response to reproduce any acceptable program material. It may be desirable in a special-purpose laboratory amplifier, the purpose of which is to make measurements over the whole range of frequencies, but this is an application not considered in this article.

An additional aspect would seem to argue against favor of not having the full output available at the end of the frequency response. Full rated output at the high end accounts for burn-out of a number of tweeter units, which can occur if there is any instability giving rise to either high-frequency oscillation or excessive over-oscillation of the high frequencies. If these oscillations or over-oscillation occur, say, at 20 kc. where they are not audible, but the high-frequency unit has to take the power, then the voice coil of the high-frequency unit, which is usually not very large, has to absorb the entire power output of the amplifier, and will burn out if this continues for any period of time.

At the low end of the frequency response, 50 watts at 20 cycles represents a very large movement of a lot of air, because a considerable volume movement has to take place to transmit the necessary energy they were designed to handle. This means one of two alternatives must be chosen. Either the low frequencies must be provided by a number of large low-frequency loudspeaker units, so the 50 watts can be pushed into the room with a reasonable diaphragm excursion, or else the power must be limited, down in this range, so the unit used does not have its diaphragm pushed clean out of the gap, if it must. So 50 watts at 20 cycles is a job that manages to get through the amplifier.

Distortion

Next we are asked, what do the distortion figures mean? Picking up current catalogues, one finds distortion figures quoted from .05% and even lower, up to 2 or 3%, yet all the units are billed as high-quality amplifiers. So the question naturally arises, what figure can be considered acceptable?

Of the two methods of specifying distortion, harmonic and intermodulation, the former, giving the total harmonic present in a reproduced waveform from a pure sine wave, remains slight, for a popular. Some years ago, the fact was noticed that less than 5% of a second harmonic was difficult to detect audibly, while other forms of distortion produced by the same amplifier (getting only 5% second harmonic distortion) were quite noticeable. This led to a search for alterna-

tive methods of specifying distortion, based principally upon intermodulation checks. Intermodulation products are more readily noticeable on the reproduction of program material, because they introduce completely spurious tones rather than simple harmonic products which modify the timbre of a tone. But this does not necessarily mean that the method of measuring and specifying distortion is any more indicative of the auditory performance than was the simple harmonic method of measuring distortion.

Last year Mr. C. J. LeBel presented the results of some experiments in a paper before the Audio Engineering Society, in which he also discussed various theoretical relationships between the harmonic method of measuring distortion and the various methods of measuring intermodulation distortion. The specification of intermodulation distortion is further complicated by the fact that there are various ways of making the measurements. An interesting result of Mr. LeBel's experiments was that, while the theoretical relationship seems to hold fairly well with comparatively simple, non-feedback type amplifiers, the feedback amplifiers, low-distortion amplifiers did not seem to give such consistent results.

This leads us to ask the question, "Supposing I take two amplifiers, in which identical methods of measuring distortion are used, and identical results are obtained from each measurement, will both amplifiers give me the same apparent distortion on a listening test?" The answer is that they may give widely differing results.

To understand how this can be, we need to know a little bit more about the character of distortion. Taking first the older method of measuring distortion, by checking the total harmonics, the reason for a difference can be seen fairly readily. Experiment has shown that the second harmonic is the most easily tolerated, and is practically unnoticeable up to about 5% on a single pure sine wave. The third harmonic, however, becomes noticeable at a considerably lower level, somewhere around 1½ to 2%, and higher order harmonics become progressively more noticeable.

Suppose we take an amplifier, well designed but without feedback, which gives 3% harmonic distortion, all of which is of the second variety. Now suppose we put in some extra gain and add 40 db of feedback around this amplifier. According to feedback theory we could knock the second harmonic from 3% down to .03%. But we have overlooked something.

The input to our new amplifier, inside the feedback loop, (which has 40 db more gain than the original amplifier) is now 99% feedback balanced against 100% of the original signal. The resultant signal put in the remaining 1% will contain 3% second harmonic—or very nearly that much—just as feedback has knocked our original amplifier 3% down to .03%.

This 3% is second harmonic at the input to the amplifier, will generate 3% second harmonic of itself on the way through the amplifier, as well as offsetting the original second, resulting in a component at the output, 3% of 3% fourth harmonic, or .09% fourth harmonic. This is illustrated, with voltage figures, in Fig. 2A.

So our 40 db feedback has knocked our original second harmonic down to .03% and has won us .09% fourth harmonic which we didn't have at all at the beginning. Multiloop amplifiers can do a good job of multiplying the order of residual harmonic that gets left!

Suppose now that the original design was not too good, so that, without any feedback, there is still 20% distortion, the order of residual harmonic might be 20%. It is quite easy to knock this 20% down to 1%, merely by using 26 db of feedback. Assume that the third harmonic this time. So 26 db of feedback will reduce 20% third down to 1% third. But at the same time 1/5th of the resultant input to the amplifier, inside the feedback loop, will be third
harmonic, and this will produce 1/5th third harmonic of itself on the way through the amplifier—maybe not quite as high as this because the level is lower than the fundamental. Assume perhaps that the fed back third generates 1/10th of itself, ninth harmonic. This still means that we have 2% of 9th harmonic, although we have reduced the third harmonic to 1%. Fig. 2B illustrates this case.

By dividing the feedback loops up into sections we may keep the resultant harmonic at any one point below 20% and hence avoid producing a high-order harmonic as high as 2%. But the principle is evident. Working in this manner, unless we design the amplifier to have low distortion without feedback, we have high-order harmonics, instead of the low-order harmonics that the old fashioned type of amplifier more commonly had.

Turning now to intermodulation products: most of the theory concerning intermodulation products is based on components caused by the same curvatures in the amplifier that produce low order harmonic products. The commonest intermodulation test consists of applying a combination of 60 cycles and 2000 cycles, in amplitude ratio 4 to 1, and then applying a filter system to the output which eliminates the two original signals and measures the residual intermodulation product. The intermodulation we are looking for is a modulation of the 2000-cycle signal by the high amplitude 60-cycle wave. To measure this, first the 60-cycle component is filtered off by a high-pass filter. Then the residual 2000-cycle component is passed through a демодулятор, similar to that used in a receiver, which will detect whether there is any modulation of the 2000-cycle signal. This entails filtering out the residual component of 2000 cycles, and getting left with a modulation consisting of 60 cycles and upward. If only low order components are produced, 60 cycles and 120 cycles may be the only spurious modulation components present, after this process. This procedure is shown in Fig. 3. But if high-order intermodulation products are generated, frequencies as high as 900 cycles may easily be present, and a filter network intended to eliminate a carrier of 2000 cycles will also practically eliminate components as high as 900 cycles at this point.

High-order intermodulation products, like high-order harmonic products, are much more noticeable. High-order intermodulation products cause a general "muddiness" in the reproduction. In addition to having a greater "annoyance factor," the high-order products are apt to be inaccurately measured, for the reason just described.

Hum and Noise

This is one more performance figure given in amplifier specifications which can be indicative of how the amplifier will sound. Sometimes hum and noise figures are given separately and sometimes a combined figure is given. Let's take them separately to see what each method of specification can tell us. First suppose we are given a figure of hum level. Will two amplifiers both specified as giving, say, 90 db below rated output sound the same when fed into the same loudspeaker system? (Assuming of course that the two amplifiers have the same rated output.) Again the answer is not necessarily.

A look at the loudness contours near the threshold of audibility—which is where we hope to find the hum level—shows that the ear becomes increasingly sensitive at the rate of about 18 db-per-octave as frequency goes down. The frequencies present in amplifier hum range from 60 cycles upwards. The fact just mentioned means that —90 db hum level, in which the only component is 120 cycles, is no better than a hum level of —72 db, composed entirely of 60 cycles. A 60-cycle hum is usually due to "break-through" from tube heaters, fed by 60 cycles from the line transformer. A 120-cycle hum is usually caused by residual ripple on the "B+" supply, which is full-wave rectified. Sometimes 180-cycle hum may be present, due to a radiated field from the power line transformer. This will be even more perceptible to the ear. For example, a —90 db hum level, in which the principal component is 180 cycles, will not be better than a 61 db hum level at 60 cycles.

Even this is not the worst possible disparity. Another variety of hum is the ticky, static kind, that can be due either to charging pulses on the storage capacitor of the system or, if choke filtering is used, to current switchover between the two halves of the rectifier. Either way, the resultant is a short duration pulse, of which the hum meter will measure an r.m.s. value, integrated over a 60- or 120-cycle waveform on which it appears. Thus its instantaneous amplitude may be as much as 10 times its r.m.s. reading.

Assuming that the pulse duration is 1/20th of the 60-cycle period, and the amplitude is 10 times its r.m.s. reading, such a ticky hum level can readily fall within a specification of —90 db and yet be noticeable against most program material.

Noise level, which is generally interpreted to mean tube hiss and kindred noises, although sometimes the figure given includes hum, can also have a variety of interpretations according to the precision nature of the noise. In general, a good flat "white" noise is not too noticeable. Even if it is noticeable during quiet periods of the program, it cannot be considered objectionable. But if the amplifier has a sharp roll-off or a tendency to peak at an ultrasonic frequency, this can give marked coloration to the noise, making it sound like a definite hiss instead of just a background. Differences of this nature can be equivalent to a deviation in measured value of between 10 and 20 db.

This, it is true, is not such a drastic deviation as can occur in specification of hum level, but when the two are given as a combined figure the value does not really convey much. A level specified as —90 db relative to full rated output, is usually practically inaudible in the average living room, unless you put your ear fairly close to the loudspeaker. The writer has one observation to make here however: a little while ago, measuring a number of audio amplifiers, he found that the impedance of the unit at a mid-range frequency was considerably below the rated impedance.

Matching

There are still some more things specified about audio amplifiers that we need to check before making our purchase.

The output impedance must provide for the particular loudspeaker system we have in mind. If the loudspeaker system operates at 16 ohms, then we need an audio amplifier with an output impedance rated at 16 ohms. The writer has one observation to make here however: although a little while ago, measuring a number of audio amplifiers, he found that the impedance of the unit at a mid-range frequency was considerably below the rated impedance. (Continued on page 146)
IN THESE days of such extreme specialization it is not surprising that the source of musical sound has been overshadowed by scientific progress in the recording field. The musician's work is judged by a vast audience on the basis of an intricate array of knobs, tweeters, woofers, tubes, resonators, etc. To the artist-performer, orchestral player, and teacher the aim and ideal is the attainment of the "highest fidelity" in interpreting the composer's written instructions. While the musician's life is primarily directed toward the achievement of this goal, no realistic outlook on our present day musical scene can overlook what is commonly referred to as "hi-fi."

The estimate of retail sales of components for high-fidelity equipment for 1954 is $50,000,000. The significance of this figure can not be brushed aside by even the most "non-commercial" musician. Any movement directed towards bringing finer musical reproduction and ultimately finer music into the American home, deserves wholehearted support on the part of the musician, providing it is based on the critical appraisal of the listening audience. At the same time, however, it must be understood that a considerable difference exists between a live performance and a recording session.

Aspects of a Recording Session

The limitations of the recording session are the first of many obstacles to be overcome in the reproduction of the concert hall sound by mechanical means. There are the unavoidable physical restrictions, preventing coughs, the squeaking of chairs, sneezes, hitting buttons, and the noise of turning pages. There is the psychological tension of aiming for technical perfection in view of the permanency of one's musical creation. The musician also seeks to maintain freshness and enthusiasm despite the repetition of the same passages or movements. With the use of tape and the possibility for splicing, great improvement has been made in this direction.

As far as the technical aspects of recording are concerned, at least in the author's experience, there is often a desire from the technical personnel that the performer do a minimum of modifying dynamically and balance-wise. The recording engineer's technical and musical understanding is then trusted to achieve the proper dynamic range, without destroying musical logic or stylistic traditions.

Fortunately in the recording of classical music there is no evidence that the method of recording is like that of recording crooners, where the singer uses no dynamic range and the expression is supplied entirely by the men who turn the knobs.

For the best playing results, the musician likes acoustical conditions which will give him freedom, ease, and power in tone production. He will favor, rather, the longer reverberation time of a good concert hall (about 1.7—2 seconds) than the comparatively dead studio with shorter reverberation time, to avoid the forcing of the string sound and overblowing of the brasses. A recent experience of the Cleveland Orchestra illustrates these problems. Columbia's engineers have had to adjust to the acoustics of the hall by moving the orchestra out and in front of the shell as far as possible. They supplemented the sound by reproducing and picking up live sound from the marble-lined foyer. Eventually much more "live" recording sound was obtained.

Four factors would constitute a musician's recording paradise:
1. Absorbers (appropriate types of wall coverings) adjustable in relation to the reverberation time for various musical performances, such as orchestra, chamber music, and solo recital;
2. Air-conditioning controlling the moisture content of the air, which has such a vital effect on intonation;
3. Physical conditions which would enable players to hear each other well enough to achieve perfect ensemble.
4. Conditions under which perform... (Continued on page 164)
LIKE the proverbial snowball, the popularity of stereophonic sound is growing steadily as more and more audiophiles are "exposed" to the advantages of this type of sound reproduction. Basically, stereophonic sound provides the realism of "in-person" listening since the sound source is divided into two parts—the one part that would normally be heard by the audi- tor's left ear and the second part which the right ear would normally capture, with the sound "mixing" taking place within the listener's head.

Those persons whose musical experience has been limited to recorded works will undoubtedly find their first taste of stereophonic reproduction a unique experience while those who are lucky enough to live near urban centers where concerts are offered regularly will find this form of reproduction more closely akin to their concert hall experiences than monaural recordings, whether on disc or tape.

Those who have never heard stereophonic sound could perhaps visualize the effect more clearly if a simple example were given. Picture yourself in the country near a railroad crossing. In the distance and to your left you hear the whistle and sounds of an approaching train. Although some of the sound will reach your right ear, your instinct and experience will tell you that the train is approaching from your left. The sound increases in intensity in your left ear until the train moves directly in front of you. At this point, both ears (assuming normal hearing) will be receiving the sound with equal intensity. As the train moves past your vantage point, the sound will be received by the right ear with the left ear hearing only the attenuated sound.

If a recording were made with a single sound channel and a single loudspeaker were used to reproduce the sound, you would get an impression of the train coming closer as it nears you and then the sound would attenuate as the train moves past. Although with the monaural recording you get the feeling of the train approaching and leaving, you in no way obtain the "directional" effect. With stereo you would obtain the illusion of the train coming from, say, the left and leaving toward the right. Additional speakers on a single channel system would not change the over-all effect other than providing sound re-enforcement.

The example of the train is a good illustration of the illusion to be obtained with stereophonic equipment. Although it is unlikely that one would enjoy a steady diet of train whistles, it does demonstrate the type of reproduction that is obtainable with this type of equipment. With stereo tapes of musical selections the third dimensional effect is not as exaggerated as in the case of the train but the effect is definitely noticeable and adds depth and realism to the recording.

In making such stereo recordings, microphones are normally placed on each side of the orchestra. With this arrangement, sound originating on the left side of the orchestra will go through its own sound channel and emanate from the left-hand speaker in the home. Similarly, the music from the right side of the orchestra goes through a second, separate sound channel and comes out through the right-hand speaker in the reproducing system.

Thus the output of the complete orchestra is obtained in such a manner that the feeling of "10th row center" is imparted to the listener. The millions who saw and heard Walt Disney's "Fantasia" were thrilled by this early demonstration of three-dimensional sound but naturally assumed that it was a "gimmick" whose practicality was limited to elaborate installations in just a few of the larger theaters.

Today, however, the audiophile can enjoy such reproduction in his own home thanks to the variety of stereophonic equipment, tapes, and discs now being offered by manufacturers and recording firms.

Stereo equipment, to date, is not cheap but for the serious music lover who can afford quality equipment, it offers the ultimate in sound reproduction. For the technically minded hi-fi enthusiast who enjoys building his equipment, the over-all cost can be reduced considerably. The only equipment that he would need to buy is the stereo tape or record player. The balance of the equipment could all be
One of the two amplifier-speaker cabinets used in Model 612 system. Your own amplifiers and speakers can also be used.

home-constructed. Actually, the rest of the equipment required consists of a two-channel amplifier with dual speaker systems.

While the stereophonic tape and record catalogue is still relatively small and choices are that your favorite selection has not been recorded in this medium, there is a representative group of numbers on the market, both classical and popular, as well as "demonstration" tapes and records of various types. Companies offering stereophonic tapes and disks are listed in the directory appearing on page 194 of this issue, along with manufacturers of various stereophonic equipment items.

Another "shot-in-the-arm" for stereo reproduction was the recent FCC ruling which will permit the multiplexing of FM program material. With this system, all FM stations are permitted to put out two channels. These could be used for stereo reproduction of live material. Further details on multiplexing FM are given on page 55 of this issue.

Ampex Tape Phonograph

One moderately priced stereo system for the home is the Ampex 612 tape phonograph and its twin amplifier-speaker units. The tape reproducer will play either in-line stereophonic tapes, half-track tapes, or full track tapes which have been recorded at 7½ ips. Frequency response is 40 to 15,000 cps within ±2 db when playing back the Ampex "Standard Tape No. 5563." Signal-to-noise is 50 db below a signal recorded at 3% distortion level. Flutter and wow is .25 per cent. The output is 1.25 volts into a load of 10,000 ohms or more at the program level which is sufficient to operate any standard power amplifier input.

The equipment incorporates three operating modes: "play," "fast forward," and "rewind." There are five controls on the 612. The "power" switch turns the equipment "on" and "off" while the "play" switch sets the tape in motion at normal speed. The "fast-fast forward" switch is used to transport the tape rapidly in the forward or reverse directions. The "selector" switch has two positions, "stereo" and "single." When stereo tapes are played, the switch is placed in the "stereo" position and each of the two tracks on the recorded tape is connected to a different amplifier and loudspeaker. The "volume" control is used to adjust the volume of both channels simultaneously. In the "single" position, the 612 acts as a conventional tape reproducer. Only one track on the tape is reproduced and it is fed to one preamplifier in the 612 system and the preamp output is fed to both output receptacles. This permits the enhancement of the recorded material although the result is not stereophonic sound.

The complete 612 system consists of the stereophonic tape reproducer and two matched amplifier-speaker systems. Currently the entire system is available housed in matching mahogany furniture cabinets or as portable units encased in handsome Samsonite luggage-type carrying cases.

In order that audiophiles can utilize their existing equipment, the "system" can be purchased as separate components if desired. The tape phonograph alone is available in a blonde mahogany finish at $395.00 with the blonde mahogany finish $10.00 extra. The portable unit is priced the same. The amplifier-speaker cabinets are $169.50 each for the blonde walnut type with $10.00 extra for the blonde finish while the portable unit in the Samsonite case is priced at $149.50.

Purchased as a complete system, the dark walnut version is $699.00, the blonde unit is $69.00 extra, and the Samsonite-housed system is $694.00 complete.

Now that there is commercially-built stereophonic equipment readily available on the market, audiophiles will undoubtedly want to take advantage of this newer and better method of reproducing their choice musical selections. Three-dimensional sound is here to stay!
A New Master Audio Control

Engineering details on a hi-fi unit which provides many "professional" features for owners of home music systems.

When the Fisher Model 50-C "Master Audio Control" was introduced, approximately three years ago, it won immediate public acceptance. Inspired by this public acceptance and the desire to anticipate future high-fidelity trends, a research program was initiated for the development of a new "Master Audio Control." As a result of this program, it was found possible to do the following: improve the signal-to-noise ratio; reduce distortion to a new low; provide more accurate phonograph equalization settings, more effective bass and treble tone control circuits, and a higher degree of ease and flexibility in switching.

In addition to improvements in circuitry, it was foreseen that complete mixing facilities should be incorporated as a result of the increased acceptance of tape recorders in the home. Also, with the major record manufacturers producing recorded tapes on a large scale, it became evident that it should be possible to treat this new medium with the same simplicity as one treats the record. That is, preamplification and equalization should be provided so that only a basic tape transport mechanism will be needed to reproduce these tapes. Such a mechanism therefore parallels the role of the record changer in function and in comparably low price.

In addition, since an audio control unit will become a decorative element in thousands of homes, it is imperative that it be well styled, so that it will be a welcome addition to living-room decor.

This article describes the new "Master Audio Control" which, with the aid of a number of new and unique circuits, meets all these requirements. The unit is intended to satisfy the most exacting and complex needs in top-quality home systems, with something to spare.

Seven inputs are included, designed to match the needs of every type of signal source which may be used in home systems, as follows: (1) magnetic tape playback head; (2) magnetic pickup; (3) crystal pickup (or any constant-amplitude pickup); (4) low-level microphone; (5) radio tuner; (6) and (7) two high-level auxiliary inputs.

Up to five sources can be switched in simultaneously and mixed in any proportion, with the ease and lack of interaction that characterizes the best professional consoles. The pickup inputs are on a "phone" channel. The tape-head input is switched onto the phone channel when the lever switches for record compensation are depressed.

Fig. 1. Equalization characteristics of the 50-C "Master Audio Control." It covers all present and some past recording curves.

Fig. 2. Tape-head playback equalization in effect when two lever switches for the record compensators are in 5th position.
The five mixer-level controls are all controlled by knobs on the front panel. Channels are selected by push-buttons, which are in a row beneath the mixer-level controls. The operator merely pushes one button, or two or more simultaneously, to connect the channels he wants. A pilot light under each button indicates which are in use at any time.

The tuner input and the two auxiliary inputs are fed directly to the first of two pairs of direct-coupled triodes which form the main amplification line of the unit. The microphone input, with an input impedance of 18 megohms, includes a triode preamplifier which gives enough additional gain so that high-quality dynamic or crystal microphones, with their low signal levels, can be used. The gain of this stage is over 32 db.

The two pickup inputs and the tape-head input feed through a separate two-stage amplifier, which incorporates the pickup and tape equalization and the record compensation circuits. These equalization circuits are of the selective feedback type, which not only provides the equalization but also keeps the distortion and noise produced in the two stages at a low level. The gain of this stage, when used on phonograph, is 32 db at 1000 cycles. In the tape position it is 37 db at 1000 cycles.

There are four bass turnover points and four treble roll-off curves, to make 16 different record compensation curves. As shown in Fig. 1, these cover all the presently used recording curves, as well as those of recent years.

A fifth position on the two lever switches for the record compensators, as already mentioned, provides the proper gain and equalization for a signal taken directly from a tape playback head. Fig. 2 shows the equalization curve which is in effect in this position of the compensator. This equalizes the position and tape-head input, giving the music lover who wants to add tape playback facilities a convenient and economical way to do so.

A tape "deck" which includes just the playback head and the transport mechanism—no electronics—will put the buyer "into tape," at a cost for the tape equipment comparable to that of disc playing equipment of similar quality. Tape decks of this description are available on the market at various price levels.

If the user, however, already has or prefers to buy a tape machine which includes equalization and preamplification, he can, of course, connect it to his system through one of the high-level auxiliary inputs.

Two of the channel selector buttons, those for the radio tuner and for Auxiliary No. 1, each automatically connects the a.c. power to a separate a.c. output circuit on the back of the chassis. Thus a radio tuner or other program source which requires a supply of a.c. power will draw power only when it is actually in use, being turned on automatically when the channel button is pushed in. A third a.c. outlet on the back of the chassis is for the power amplifier and supplies power when the master switch of the unit is turned on.

A new circuit device eliminates the signal loss which usually occurs in conventional mixing circuits and, together with the resistors in series with each grid, keeps interaction between channels at a negligible level—less than ½ db. This is important in maintaining the high signal-to-noise ratio built into the individual channels. All channels come together at the grid of Vₐ, the first triode of the first direct-coupled pair. The feedback voltage around this pair comes off a voltage divider consisting of resistor Rₛ, plus the total grid-to-ground resistance in the first triode circuit. Since additional channels, as they are switched in, add the channel resistance in parallel with that already in the circuit, the feedback (Continued on page 173)

Fig. 3, Effect of the loudness balance control. At the high settings of the master volume control, accentuation is lessened.

Fig. 4. Bass and treble control range of the 80-C. In the listings of positions, bass settings are Nos. 1-7, treble Nos. 8-14.
Remote Control for TV

By WALTER H. BUCHSBAUM
Television Consultant
RADIO & TELEVISION NEWS

In many cases these units are furnished with the set, but, they can be installed by any service technician.

NOW that TV receivers have become more standardized in circuitry and over-all design, some manufacturers are stressing special accessories for their sets as sales features. One of these is a remote-control attachment to permit the viewer to change channels and make other adjustments without leaving his seat. Quite a few receivers in the luxury class are delivered with remote control and this feature is optional on many medium-priced receivers. Adding remote control to older sets should prove an added income source for the alert service technician. Such installations are especially useful in homes where older persons or shut-ins find their major diversion in TV viewing.

Servewise, the wired remote devices are subject to wire damage and mechanical failure of switches and relays. The photoelectric type of remote control invites defects in both the electronic and mechanical portions. This article presents a short survey of some of the most popular remote-control devices and gives troubleshooting and service data for most common defects.

Early remote-control TV systems used a separate r.f. tuner and i.f. system, feeding a video signal to the receiver itself. This system required a coaxial cable, "B+" and heater wiring, and a fairly large remote tuning cabinet. None of the more recent systems are of this type. Instead, use is made of a small motor to turn the r.f. tuner shaft while the remote unit itself usually contains only potentiometers and switches. This means that the voltages required over the cable are either 117-volt a.c., 6-volt a.c., or simple audio or bias signals. As a result, most of the control units comprise little more than can be held in the palm of one's hand.

Perhaps the most elaborate system from the technician's point of view is the Zenith photoelectric tuning system. For the viewer it is the simplest. He merely shines the beam of a flashlight on one of four photocells to get the control actions he desires. This wireless system is described in more detail later and is quite spectacular in its operation, although fairly expensive.

Most of the other remote control systems use a wire between the set and the viewer. In some instances this is a simple two-wire line, while in others a more complex cable is used. One type of remote control system, the Sentinel unit, includes a remote speaker located right in the control unit. This permits the viewer to look at his set from quite a distance and keep the volume low enough for comfortable listening.

Typical Remote Systems

The new Zenith "Flash-Matic" system is illustrated in Figs. 2 and 4. A total of four photocells is used. Each of these cells controls a relay through an amplifier tube. The upper two cells initiate counterclockwise or clockwise rotation of the tuner shaft by means of a small motor for channel selection. The lower-left cell turns the receiver on and off, while the lower-right photocell shorts out the sound. Since the photocell characteristics will vary with age and since ambient and incident light may further vary their operation, a manual sensitivity control is provided at the upper-left corner. There is also a reset and manual volume control and power switch.

Remote control of contrast or volume is not provided in this system. Fig. 4 shows the mechanical arrangement inside the cabinet. Note that there is a separate remote control chassis containing three tubes, relays, and additional sensitivity controls for the service technician's use. It is apparent from...
The panel lar model PC remote circuits stopped trol tunerlems eliminates mechanical alignment out. Brightness parallel with the front The volume other, tuning, and channel switching.

In the automatic positioning, the remote control chassis will draw a small amount of power even if the receiver has been turned off.

A more complicated remote tuning unit is the Emerson model 1158 shown in Fig. 1. This unit makes use of two potentiometers and permits remote adjustment of volume, brightness, fine tuning, and channel switching. How this is done is shown in the circuit diagram of Fig. 5.

Note that there are two switches; one, $S_v$, the a.c. power switch, and the other, $S_m$, the motor actuating switch. The volume control is connected in parallel with the front panel volume control and uses shielded wire throughout. Brightness is varied by the usual d.c. voltage. The fine tuning control is accomplished by varying the “$B^{-1}$” voltage on the r.f. oscillator. This eliminates mechanical alignment problems at the fine tuning control on the tuner itself and accomplishes the control smoothly, electronically.

The channel tuning motor itself is stopped automatically by a conventional detent limit switch relay arrangement. Once the remote cord is unplugged from the chassis, the receiver operates in the conventional manner through the front panel controls.

When adjusting the front-end tuning circuits of a remotely-controlled set it is necessary to check the local oscillator “$B^{-1}$” voltage and set it to the correct median value before adjusting the individual channel tuning slugs of the local oscillator.

A completely different channel switching arrangement is used in the remote-control system of the Walsco model PC-9 TV receiver. The palm-sized remote control shown in Fig. 3 contains a channel selector knob similar to the one found on the front panel of a TV receiver. In this system, the cable must carry about 17 wires to the TV receiver, but once the channel is selected, the tuner will automatically keep turning until the correct channel is reached, and then the tuner motor stops.

A circuit of the entire system is shown in Fig. 7 and indicates that the motor operates a commutator-type switch. It keeps turning the commutator and the tuner shaft until the relay receives power through the remote switch ground return. Then the 6-volt relay opens its contacts and the motor power is interrupted.

In addition to the tuner selector, there is a simple “on-off” and volume control combination switch. All audio leads are shielded. When the remote control is not used, a local volume control on the TV receiver is used in the conventional manner. It may be mentioned that the particular TV receiver used with this remote-control system employs printed circuitry throughout.

A more elaborate remote-control system is marketed by Sentinel Radio Corporation, both for some of their latest TV receivers and for installation in older sets. Shown in Fig. 6, this control unit is much larger than those previously described and contains a small speaker. In addition to the 12-channel selector switch there are fine-tuning, volume, and brightness controls. The latter contains the “on-off” power switch. There is another small switch to select the remote loudspeaker. One of the features of this system is that it is designed to be installed by TV technicians in almost any receiver having a 12-position tuner.

Before describing its installation, consider the circuit as shown in Fig. 9. At the left is the remote unit itself, with all controls and the small personal loudspeaker. The fine tuning is accomplished by varying the oscillator plate voltage just as in the Emerson unit. A switch on the fine-tuning control potentiometer chooses either remote or on-the-set channel selection. The volume control affects the loudspeaker directly and acts either on the remote or local speaker. Brightness is controlled in the conventional manner with the remote control in parallel with the on-the-set one. A 12-position switch selects channels by letting the motor run until the desired position is reached, when the motor circuit is opened.

A relay turns the receiver off and on. The primary winding of the 24-volt transformer is always connected across the line, but draws negligible power. Both the relay and the motor operate...
on 24 volts and are simply and ruggedly constructed. A brief analysis of the circuit of the remote switch and the station-seeking switch on the motor shaft will show that with the former set to channel 2, for instance, the motor will keep turning until the latter switch reaches channel 2.

Each remote-control kit is supplied with detailed installation instructions and it is interesting to note just how the mechanical arrangements are made. In Fig. 8A, the case is shown where the motor is mounted in line with the tuner shaft. A coupler is supplied which connects the rear of the tuner shaft to the motor drive shaft or an extension thereof. Different couplers and a long shaft are supplied permitting almost any mechanical arrangement. For sets where there is insufficient room behind the tuner, a special sprocket and chain can be used as in Fig. 8B, and the motor and drive shaft can be mounted either above, below, or at the side of the tuner. It is necessary to note the channel position of the tuner shaft and to set the coupler or sprocket to get the corresponding channel indication at the remote unit.

The Sentinel remote-control unit is furnished complete with cable, motor, and all hardware and even includes a drill for the tuner shaft locking pin. Two different couplers, shafts, bearings, brackets, and sprockets are supplied, allowing the service technician to mount and arrange the motor assembly in any convenient way.

Servicing

Defects in most remote-control systems are easily separated from the conventional troubles due to the TV receiver itself, because in every instance it is possible to operate the set without the remote features. Once the trouble has been definitely located in the remote-control system it is also relatively simple to determine in which circuit it is. If the tuner switching does not perform properly, the volume control obviously need not be checked. There is, however, one important point which is the same in practically every system. This is the common ground return lead. Be sure to check its path through with an ohmmeter, especially if the remote control does not work properly on any control.

In general, it is possible to divide all defects in remote control devices into the following categories:

- Broken wire or bad insulation.
- Contact trouble.
- Poor lubrication (sticky shafts, detents, or relays).
- Burned-out motors, relays, or solenoids.

Broken mechanical parts (gears stripped, shaft worn, etc.)

In the case of the Zenith “Flash-Matic” system, there are no control wires from the user to the set, and this eliminates the first category, but there could be defective control amplifiers, photocells, and other parts. Troubleshooting this system is not confined to a mechanical check and continuity measurements, and the manufacturer’s data must be followed carefully. Special consideration must be given to the photocells and their sensitivity adjustment.

Broken wires and contact troubles are usually found by inspection and ohmmeter checks. Lubrication troubles may result in excessive wear of bearings or even broken gears, etc. Only replacement with the proper part will remedy this type of defect. At this point it might be mentioned that ordinary lubricating oil may not be satisfactory due to the accumulation of dirt and dust plus the heat generated in the set. Silicone grease is probably the best, but a high grade automobile grease is usually satisfactory for shaft bearings, cams, and other moving parts. Burn-outs in motors, relays, or solenoids are often caused by excessive voltage or current and this may, in turn, be caused by some other defect. Be sure whenever a burn-out of this type is encountered, to check the various voltages both during warm-up and after a few minutes operation.

Other defects such as wornout potentiometers, defective switches, etc., are so similar to those ordinarily found in radio and TV sets that they should not cause the experienced TV technician any trouble.
TAPE RECORDING

By HERMAN BURSTEIN

THE first two articles in this series covered a broad discussion of tape recorders, and a comprehensive analysis of tape and its recording characteristics.

This month we will take up the question of recording and playback losses and their effect on recordings made at the 7.5 ips speed, which is more or less the standard for home-type tape recorders.

Fig. 1 shows the frequency response obtained at a given tape speed if a tape is recorded and played back with a high quality head but without equalization in the preamplifiers. Some of the losses responsible for deviation from flat response take place in recording, while others occur in playback. To a minor extent, these losses vary purely with frequency. Mostly, however, they vary with both frequency and tape speed, which is to say they vary with the wavelength of the induction recorded on the tape. Wavelength equals tape speed in ips divided by frequency in cycles-per-second. Thus a wavelength of 0.005" represents a frequency of 1.5 kc at 7.5 ips and a frequency of 3 kc at 15 ips.

The frequency effect is illustrated by the relationship between the two curves in Fig. 1, which represent the unequalized record-playback response of an actual head at 7.5 ips and at 15 ips. Because of the 2:1 ratio between speeds, each point on the 15 ips curve corresponds to a point one octave lower (half the frequency) on the 7.5 ips curve. For example, the point of maximum response is 6 kc on the 15 ips curve and 3 kc on the 7.5 ips curve.

To the extent that losses vary only with wavelength, the 15 ips curve is related to the 7.5 ips curve as follows. Each point on the 7.5 ips curve is shifted one octave to the right because at higher speed a given wavelength represents twice as high a frequency. These shifted points are then raised 6 db because doubled frequency corresponds to doubled flux velocity in playback, and doubled velocity produces 6 db more playback output.

For simplicity, the following discussion is couched in terms of effects observed at a speed of 7.5 ips. Unless specifically indicated to the contrary, it should be understood that these effects vary with recorded wavelength, although for convenience the discussion speaks in terms of variation with frequency.


Part 3. Even if you buy a complete tape recorder, a knowledge of these losses is important. Should any adjustments or repairs be attempted.

in playback there is a tendency for output of the higher frequencies to be restored, but far short of the original loss caused by demagnetization. Partial restoration occurs because at short wavelengths the core of the playback head is able to neutralize opposite poles.

2. Bias Erase. Present day tape recording, as stated in Part 1, applies a high-frequency bias current to the record head in order to overcome distortion and raise output. As bias current is increased, recorded induction rises, but only up to a point. Thereafter, induction falls with further increase in bias. This fall occurs in part because with increased bias the tape is shifted to a region on its operating characteristic (analogous to that of a vacuum tube) where the input-output slope is less steep, producing less recorded induction. Moreover, large amounts of bias current exert an eras-

Fig. 1. The unequalized record-playback characteristic of a high quality record-playback tape head.

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www.americanradiohistory.com
Fig. 2. Theoretical response of a perfect playback head. This is discussed in text.

Fig. 3. Representation, by means of bar magnets, of sine wave recorded on tape.

Fig. 4. Magnetic potentials scanned by a playback head for three wavelengths (A, B, C) at different phases (1, 2, 3). A equals a magnetic gap of 1/4 wavelength, B a magnetic gap of 1/2 wavelength, while C are curves obtained when magnetic gap is 1 wavelength.

keeps such irregularity relatively small. A slight increase in low-frequency output is sometimes an additional result of the tendency of the entire head to react to magnetic flux.

The response curves in Fig. 1 would rise at about 6 db-per-octave over the entire audio range were it not for treble losses in record and playback. Record losses, which are most responsible, have already been discussed. The principal factor responsible for treble loss in playback is the playback head’s gap length (sometimes called gap width; this dimension is parallel to tape length).

The longer the gap, other things being equal, the poorer the high-frequency response. Modern heads with extremely short gaps produce substantial output to 15 kc. and even beyond at 7.5 kc, assuming a tape recorded with constant magnetic induction at all frequencies.

Apart from the loss due to gap length, the treble losses of a well-designed playback head are relatively slight in the audio range. Roundness of the gap edges causes the head to have a “magnetic gap length” greater than the actual physical gap length, thus limiting playback response at the treble end. Imperfect linearity of the gap’s vertical dimension causes a drop in response at the high end. Losses due to these two factors vary with wavelength. Those that vary purely with frequency are, once again, the result of eddy currents and hysteresis in the playback head.

The output of an “ideal” playback head—one without any losses other than due to gap length—is related by a mathematical formula to recorded wavelength and gap length. The gap length, δ, is “magnetic gap length” rather than physical gap length and is experimentally ascertainable by finding the treble frequency at which response first drops to a minimum. Wavelength is denoted by λ. Response is proportionate to \(20 \log \sin (180° \times \delta/\lambda)\), as illustrated in Fig. 2.

This formula reveals that maximum output occurs when the magnetic gap length equals one-half wavelength and that output falls to zero when gap length equals one full wavelength. These important relationships can be explained non-mathematically as follows.

In order for a voltage to be induced across the windings of the playback head, it is not sufficient that there merely be changes in magnetic flux density as the tape passes the head. It is also necessary that at various instants a magnetic potential (difference in flux density and/or polarity) exist between the edges of the gap, thus, in effect, giving the head a north and south pole at these instants. The gap limits the passing of charges in magnetic potential, such changes being translated by the head as voltages that correspond to audio information. The output level of the head is determined for each wavelength by the
maximum magnetic potential that is periodically presented to the gap.

When the playback head scans a long wavelength it is periodically confronted with relatively small magnetic potentials because each distance along the tape equal to one magnetic gap length represents but little difference in flux density. However, as wavelength decreases (frequency rises), greater potentials are presented to the gap. If the magnetic gap equals exactly one-half wavelength there are instants when, assuming a sine wave, the potential at the gap corresponds to the difference between the positive and negative peaks of the wave, as shown in Fig. 4B. Since this is the greatest magnetic potential that can exist, maximum head output occurs when the gap equals one-half wavelength.

Fig. 4A shows magnetic potentials when the magnetic gap equals one-quarter wavelength. It can be seen that at instants when maximum potential exists across the gap, this potential is only half as great as in Fig. 4B.

When the head scans a wavelength exactly equal to gap length, then, as shown in Fig. 4C, there is at all times a zero difference in magnetic flux at each gap edge. Consequently output of the playback head is zero. When the gap becomes longer than one wavelength, output begins to rise again, reaching another maximum when the magnetic gap is 1½ wavelengths long, another minimum when it is 2 wavelengths long, etc., as shown in Fig. 2. However, this area of operation is of no concern to tape recorders used for audio reproduction.

Given physical gap length, a rough approximation of the frequency at which maximum playback response occurs may be obtained by the formula

\[ F = S/2G \]

where \( F \) is frequency in cps, \( S \) is tape speed in ips, and \( G \) is physical gap length in fraction of an inch. As previously explained, maximum response occurs when \( \delta = \lambda/2 \). For purposes of the present approximation, \( G \) is substituted for \( \lambda \), so that \( G = S/2F \).

In actuality, the frequency of maximum playback response is less than the figure given by this formula because magnetic gap length is greater than physical gap length, since it is impossible to make a gap with absolutely sharp edges. Also, in practice, response tends to fall on the order of 30 db rather than by an infinite amount as frequency increases from that of maximum response to a frequency one octave higher. For example, a high quality playback head with a physical gap length of 0.0025" and operated at 7.5 ips has maximum output at 15 kc, according to the equation \( F = S/2G \). Zero output would occur at 30 kc. Actually, output may reach a maximum at 13.5 kc, drop 30 db between 13.5 kc and 27 kc, and then rise again.

The approximate practical limit to useful response is sometimes considered to be the frequency at which the physical gap equals one-half wavelength; i.e., short, the limit is roughly \( F = S/2G \). This is so for two reasons. First, as explained, the actual frequency of maximum response is somewhat lower than \( F \) in this formula. Second, as shown in Fig. 2, within less than an octave after the frequency of maximum response, playback output drops precipitously; consequently response may be carried to a point not too far above the actual maximum. Thus at a speed of 7.5 ips, using a head with a physical gap of 0.0025", the practical limit is in the neighborhood of 15 kc. At the same speed but with a 0.005" gap, the limit is about 7.5 kc.

Tape recorders sometimes exhibit a playback loss below 50 cps or so owing to the "wrap around" effect. This occurs when the tape contacts a large area of the playback head. Material of the head may then adversely affect magnetic coupling between the tape and the head gap at very low frequencies, where the magnetic flux extends an appreciable distance from the tape. The amount of loss depends in part upon geometry of the head.

A loss in playback response, especially at high frequencies, will result (Continued on page 150)

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**Fig. 1.** Principal factors responsible for losses of a record-playback head operating at 7.5 ips. Lines shown are approximate values for the record-playback head represented in Fig. 1, having a physical gap of 0.0025" and operated at 8 ma. The gap length loss would be considerably greater for longer gaps. Refer to the article.
Adapting the "Ultra-Linear" Williamson to 6550 Operation

A new high-power output tube, the 6550, will find many applications in converting present-day amplifiers and in new equipment. Up to 100 watts push-pull can be had.

Since its introduction many years ago, the Williamson amplifier has undergone a few design changes to further improve its performance. As originally described by Williamson, the amplifier was a 15-watt unit designed for low distortion, uniform output, and small phase shift over the entire audio range. Since the original conception of the Williamson amplifier, American manufacturers have jumped on the bandwagon and today one will find many variations of the original circuit.

Performancewise there is wide variation among the different units made in this country. One of the circuit improvements made by American manufacturers came with the application of "Ultra-Linear" operation to the output tubes, a mode of operation which doubled output power and further reduced distortion. This amplifier has been widely accepted by audiophiles with the result that there are about twenty commercial amplifiers on the market today which incorporate this design feature.

The application of "Ultra-Linear" operation to the Williamson-type amplifier increased the output power to 30 watts using the same type of output tubes operating at the same voltages. When this circuit was first introduced it was immediately noted that the new combination provided better sound, even at the low volume levels which the original amplifier could handle. This phenomenon has resulted in a new evaluation of the power requirements of an amplifier as a part of an audio system and, in general, it has been observed that in amplifiers of analogous design, the unit of greatest capacity will sound best.

The attainment of high power in audio amplifiers has become relatively easy and inexpensive due to two factors, the increased efficiency of the "Ultra-Linear" output circuit and the introduction of new output tubes with greater power handling capabilities.

One recently introduced tube, the Tung-Sol 6550, is particularly adaptable to output stages of the "Ultra-Linear" type and can be used to advantage in the "Ultra-Linear" Williamson circuit to provide an amplifier of 60-watt capacity having an intermodulation content at maximum output of 6/10th of one per-cent. This amplifier differs only in a small degree in dimensions and number of circuit elements from its predecessors, and many Williamson-type amplifiers can easily be modified to take advantage of the improved performance.

Amplifier Circuit

An examination of the circuit diagram reveals the basic Williamson circuitry of the first three stages. The first two, the input voltage amplifier and direct-coupled cathode phase inverter, are familiar and unchanged even with regard to tube type, the 6SN7. The driver stage also remains a 6SN7, with but one change. Individual cathode resistors have been added to provide a slight amount of local feedback in order to improve the loop feedback phase characteristics and increase the stability margin of the amplifier.

The output stage is coupled to the driver through a resistance capacity network which provides conventional RC coupling at signal frequencies and an attenuated direct coupling at subsonic frequencies. This again introduces an improved low-frequency phase characteristic which adds to the stability margin of the amplifier. The use of this combined RC and direct coupling is made possible by the choice of fixed bias operation of the output tubes whereby the required negative bias is obtained from a separate bias supply. The fixed bias supply consists of $T_d$, a 6.3 volt, 1 amp. filament transformer; a 50 ma. selenium rectifier $R_s$; resistor $R_m$; and electrolytic capacitors, $C_1$ and $C_2$.

In order to reduce hum to a minimum in preamplifiers that are to be powered from the main amplifier, a positive bias has been applied to the heater line through resistors $R_m$, $R_s$, and capacitor, $C_3$. If a separately powered preamplifier is to be used, this network can be eliminated, together with the hum balancing potentiometer $R_m$ and the centertap of the 6.3 volt winding on the power transformer $T_s$ can be grounded. "B plus" voltage for operation of the preamplifier can be taken either from point $X$ or $Y$ depending on the preamp to be used.

"Ultra-Linear" Output Stage

The "Ultra-Linear" type of output stage is characterized by output tubes of the tetrode type with the screens of the tubes connected to taps equally positioned about the center of the output transformer. The choice of the stage can most readily be understood by the following considerations: first, if the screen of an output tube is connected to the plate, the tube functions as a triode, and the plate characteristic curves are concave downward. Secondly, if the screen is connected to "B plus," the tube operates as a tetrode, and the plate characteristic curves are concave upward. If, however, the screen is connected to a tap on the primary of the output transformer, a type of operation is obtained midway between triode and tetrode. Depending upon the type of output tube used, the tap can be chosen to result in an almost linear set of plate...
characteristic curves, and this mode of operation has been termed "Ultra-Linear." It has been determined experimentally that the best winding point for the 6550 is with the tap located at 40% of the primary turns.

"Ultra-Linear" operation of an output stage has sometimes been described as the application of negative feedback to the screen grids of the output tubes. If this concept is used to explain the operation, it should be noted that the feedback is of the power type rather than the more usual voltage or current feedback, and power is supplied to the screen grids over the operating cycle. It can be demonstrated mathematically that when power feedback is applied to the screen grid of a tube, the linearity of the plate characteristic curves can be improved over and above the amount normally to be expected by a consideration of voltage feedback only.

The output transformer is an Aeromag TO-330. This transformer is ideally suited for the 6550 tubes, providing the correct impedance match for maximum power and lowest distortion, and primary taps located at 50% of the total winding. The frequency response of the TO-330 is flat ±1 db from 10 cps to over 100 kc., thereby providing the necessary low phase shift over the audio range for best feedback stability and faithful transient response. The halves of the primary winding are tightly coupled to make available a full 60 watts of output over the entire audio range 20 cps to 20 kc. Although the nominal rating of the transformer is 30 watts at 20 cps, no difficulty was experienced in obtaining full undistorted output at the low frequency extreme. Too much emphasis cannot be placed on the fact that an amplifier cannot be better than its output transformer irrespective of the circuit used. This component serves many functions in a feedback amplifier as well as providing an impedance match between the output stage and the speaker. However, all of the necessary conditions can be met by a propitious choice of design and this unit can, in fact, be improved in certain performance categories, for example, bandwidth over and above the circuit with which it is associated.

Feedback Stability

In a feedback amplifier it is always desirable to maintain a maximum amount of feedback stability in order to assure complete stability under all conditions of output power level and output load. The degree of stability of a feedback amplifier is generally rated in terms of stability margin, meaning the amount of additional feedback in db that can be added before the amplifier becomes unstable and oscillates. This design figure is usually taken under conditions of rated resistive output load. However, loudspeakers are not constant resistance devices, but present to the amplifier an impedance containing a large reactive component over a good portion of their operating range. Moreover, in the band outside of the range of the speaker, the impedance may be almost completely reactive. It is desirable, therefore, to have a stability margin of 6 db or more to assure complete stability.

The stability characteristics of a feedback amplifier are associated with the bandwidth and phase shift characteristics of the amplifier circuit and output transformer, and there are several choices available to the designer to increase the stability of a given amplifier. First, bandwidth may be traded for stability. In this procedure loss networks are added to shape the amplifier response curve so that the response of the amplifier falls off by the amount of feedback plus the stability margin before the phase of the feedback voltage becomes regenerative. Secondly, gain within the useful band may be traded for stability. In this

Table 1. Performance characteristics of the converted "Ultra-Linear" amplifier.

| Power Output | 60 watts @ 1000 cps; within ± .5 db of 1 kc. level @ 60 watts over range 20 cps to 30 kc. |
| Frequency Response | Intermodulation Distortion 60 and 3000 cps mixed 4:1, equiv. sine-wave power |
| Hum and Noise | Rise time 20 kc.—2 microseconds; overshoot on 20 kc.—none observed; ripple on 20 kc.—approx. 1%: droop on 20 cps—5% |
| Feedback Stability Margin | 20 db |
| Damping Factor | 10 db |
| Sensitivity | 15 |

Complete schematic diagram of the 60-watt version of "Ultra-Linear" Williamson.

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procedure local feedback may be added to stages within the amplifier in order to reduce their contribution to the phase shift. Thirdly, the bandwidth of the stages may be extended by the use of certain design techniques, and the phase shift correspondingly reduced.

The first method is subject to the criticism that it restricts the amplifier band reducing the rise time with regard to square wave response and, in this manner, affects the fidelity of transient reproduction. The first and third methods may be combined; the bandwidth increased and then loss networks added.

An appreciable increase in the bandwidth of the amplifier described has been achieved by the use of the TO-350 transformer. The response of the amplifier, with feedback, is flat to over 200 kc. An adequate stability margin of 10 db has been maintained by the use of methods two and three. A small amount of degeneration has been added to the driver stage by the inclusion of individual cathode resistors. The subsonic bandwidth has been extended and shaped by the addition of the 470,000 ohm coupling resistors $R_c$ and $R_m$. With these added resistors the bias developed on the grids of the output tubes is partially dependent on the voltage developed at the plates of the driver tubes, and a plate current balancing control has been added to the output stage. The procedure of balancing plate current has been facilitated by individually fusing the output tube cathodes. To check plate current the fuse is removed. The fuse clip serves as a convenient tie point for the connection of a milliammeter.

**Construction of the Amplifier**

The amplifier can be constructed on a chassis 8" x 12" x 3". A careful arrangement of parts permits direct point-to-point wiring of the stages and a short, direct feedback connection between the output transformer and the first stage. The axiom for wiring amplifier stages is to have leads as short and direct as possible. It is desirable to twist filament leads; also leads to the power switch and preamp power connector. A neater job will usually result if filament, switch, and power supply circuits are wired first, then "B plus" circuits, then signal circuits less the coupling capacitors. The coupling capacitors are added last, and since these are generally large, they may be looped over the space from stage-to-stage. The coupling capacitors to the output stage can terminate on pin No. 6 of the 6550 sockets, since this pin is not a tube connection and can be used as a tie point.

Care should be taken when wiring the output transformer to see that the proper color coding is observed for the primary leads. Make certain that the trace leads are connected to the output tube that is energized from the cathode of the phase inverter. If these leads are incorrectly connected the amplifier will motorboat when it is turned on. Correct phasing can be restored by either reversing the transformer leads or by reversing the connections of the coupling capacitors at the phase inverter section of the first tube.

The total cathode current per output tube will run about 75 ma, with a plate supply voltage of 425 volts and a grid bias voltage of minus 48 volts. If the cathode current differs considerably from this figure, it may be advisable to change the value of $R_m$ until normal bias and plate current is obtained.

**Conversion of Existing Amplifiers**

It will occur to many that their Williamson may be converted to take advantage of the increased power output offered by the 6550 tube by simply adding a few extra components and changing the output transformer. One precaution should be taken, however, against overloading the power transformer. The plate current drain of the output stage has been increased from the 100 ma. drain of the usual KT-66 tubes to 150 ma., and a power transformer that is operating close to maximum rating will not be able to supply the additional drain. Many power transformers will, however, be able to take it, and one should not rush to replace the transformer if it feels hot in service. A safe operating temperature for this component is 140 degrees F. which is an uncomfortable temperature to the hand. However, if the power transformer ran at an uncomfortable temperature before conversion, it should be replaced.

**Performance**

The measured performance figures of the amplifier are given in Table 1. The frequency response at low output levels is flat from 2 cps to 220 kc. Maximum power of 60 watts is delivered at all frequencies between 20 cps and 30 kc. The square wave response at 20 cps shows 5% droop, and at 20 kc, the square wave is clean with no overshoot and a rise time of 2 microseconds. The intermodulation figures are particularly good, being only 0.15% at 30 watts and 0.6% at 60 watts. A compromise in the operation frequency of 60 and 3000 cps, mixed 4:1.

Much has been written about amplifier testing and on the interpretation of test results. However, the deeper one goes into the field of amplifier design, the more apparent it becomes that the best test instrument is the human ear with music supplying the signal source. Unfortunately, the ear cannot supply a numerical rating of merit, but only a comparison of "better" or "not as good." The amplifier described in this article has been subjected to comparative listening tests with both the older "Ultra-Linear" Williamson using KT-66's and with other good amplifiers. Listeners were generally agreed that this amplifier had many points of superiority.

The relative importance of the power amplifier in a high-fidelity system has always been a controversial subject. There are those who maintain that a low power amplifier of 5 watts or so is adequate for good reproduction and qualify this by the indisputable statement that the average sound power required for good room volume is no greater than this figure. Others state that a moderately good power amplifier is a much more perfect device than other elements of the reproducing system, in particular phono pickups and speakers. Both of these schools of thought fail to recognize some basic facts relating to requirements imposed upon the power amplifier. In the first case, although average room volume may require only a few watts, peak powers may exceed the average by 10 times or more, and it is the fidelity with which these peaks are reproduced that contribute to the feeling of presence. With regard to the second point, it is true that there is still room for improvement in pickups and speakers, however, any additional contribution to intermodulation distortion in the

(Continued on page 136)
STEREOPHONIC FM—a significant step toward greater realism in the reproduction of sound—is no longer a matter of technical development but of devising a satisfactory economic inducement for FM stations to provide this service.

Multiplex transmission, which enables an FM station to broadcast one or more "subchannels" simultaneously with the main audio channel, has been perfected to the degree necessary to win FCC sanction. This year, effective July 1, the FCC gave approval to FM stations wishing to go on a multiplex basis.

Already some of the largest FM stations in the country have installed or ordered multiplex equipment. Although there may be some experimental stereophonic broadcasts at the outset, the subchannels will initially be used essentially for commercial services to paying subscribers. Such services consist most commonly of music devoid of advertising which is beamed to restaurants, hotels, offices, factories, etc. Similar music programs interspersed with announcements are directed to stores, transit line passengers, and other special audiences.

Current plans, however, do not ignore the home audience. If these plans materialize, multiplex will enable the home listener to hear the two channels of a stereophonic program by tuning in just one station. Present stereophonic broadcasts, conducted a few hours a week by several stations, rely on joint use of the FM and AM transmitters of these stations. Since AM is usually the weak sister, reception is often marred by static, limited frequency response, co-channel interference, fading, and other defects of AM. Multiplex makes possible stereophonic reception coupled with the blessings of FM.

At the same time, it may develop that stereophonic broadcasts to the home will be on a "pay-listen" basis in order to make it economically feasible for FM stations to offer this service.

One possibility, in line with the present thinking of a leading multiplex developer and manufacturer, is that fixed-frequency adapters, readily attached to regular FM tuners of suitable design, will be leased or sold by FM stations to home subscribers, and that these adapters will be operable only by means of control cards sold to subscribers on a monthly or annual basis.

**Brief History of Multiplex**

The name of the late Major Edwin H. Armstrong figures prominently in the development of multiplex as well as single-channel FM. His experiments in 1934, 1939-40, and after the war produced basic concepts concerning modulation that are reflected in today's multiplex equipment.

After World War II, several companies and independent research laboratories undertook similar investigations, which at first focussed largely upon the problem of transmitting facsimile signals via the multiplex method without impairing the quality of the audio channel as received by conventional FM tuners in general use. Success in facsimile transmission eventually led to solution of the problem of broadcasting two audio channels on a single frequency without crossmodulation between channels and with a high signal-to-noise ratio.

In 1950 W. S. Halstead head of Multiplex Development Corporation, publicly demonstrated the first multiplex transmission of two independent music sources by a single FM station. He also presented the first stereophonic broadcasts by a single FM station. Two spaced microphones were used to pick up an instrumental trio at experimental Station KEXX, operated by MDC. Although frequency response of the subchannel was, at that time, limited to 8000 cps, observers judged the demonstration a decided success. In

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**The FCC has finally given its approval. If financial problems can be worked out to support this new idea, it could become an added boon to all hi-fi fans.**

By BURT HINES
1953 Major Armstrong and his research group at Columbia University demonstrated his multiplex system before the Radio Club of America. However, whereas MDC's multiplex system did not interfere with main channel reception by conventional FM tuners, Major Armstrong's method required special tuners for main channel reception.

Following its two-channel demonstration in 1950, MDC filed application with the FCC requesting authorization for the use of multiplex by FM stations. By the time authorization arrived in 1955, MDC in conjunction with Crosby Laboratories had developed equipment permitting high-fidelity stereophonic broadcasting. It had also succeeded in transmitting two or more subchannels on a single carrier, although frequency response is limited to 8000 cps or less when more than one subcarrier is used. The equipment developed by MDC is being commercially promoted and sold by Multiplex Services Corporation. The latter has entrusted manufacture of the equipment to two firms well known for quality of product, Gates Radio, which is making the transmitting equipment, and Browning Laboratories, which is making FM tuners, multiplex adapters, and other receiving equipment to MSC specifications.

Benefits to the Home Audience

Technical specifications for MSC's equipment spell performance consistent with the highest standards of audio reproduction. Two-channel transmission (main channel and one subchannel) can cover the full audio range of 50-15,000 cps on each channel, although an 8000 cps cut-off is generally used for background music and similar programs. The signal-to-noise ratio on the subchannel is about 55 db, which is substantially better than an AM tuner can produce and compares favorably with present ratios for the majority of standard FM tuners now in use. The signal-to-noise ratio on the main channel is considerably better than 60 db. At full modulation, harmonic and intermodulation distortion are kept below 1.5% on the subchannel and below 5% on the main channel.

If stereophonic reception is brought into the home on a subscription basis, the listener may expect benefits even on single-channel sound in the way of a variety of choices as to what he may hear. Fig. 1 illustrates MSC's present thinking as to the choices offered a home listener via a "Multicast" adapter attached to his regular FM tuner. At the bottom of the adapter would be five push-buttons, marked from left to right "main channel program," "stereophonic program," "subchannel music only," "subchannel news-time," and "subchannel news-time only." If the listener wishes to hear the main channel, he would push button 1, which gives him the program he would normally hear on his regular FM tuner. However, if he wishes a special multiplex program devoid of announcements, he may push button 3. If a stereophonic program is on the air, he would push button 2, assuming he has an amplifier and speaker for each of the two channels. An FM station might very well provide different or more extensive musical programming on the subchannel, in which event button 4 may suit the listener's preference. In case the latest news or time checks are wanted, button 5 would bring in such fare at regular two or three minute intervals, between musical selections.

Under a subscription plan it is expected that FM stations would be in financial position to provide the latest and best in high quality programs, featuring high-fidelity stereophonic tapes. A paying system is also expected to provide FM broadcasters with the revenue which will enable them to increase the number and quality of live music broadcasts.

Even though it may not reach the home for some time, multiplex may nevertheless prove a boon to the high-fidelity audience by providing FM stations with the revenue needed to improve the extent and quality of their FM programs. It is hoped that multiplex will help lift the FM industry out of its economic doldrums by enabling stations to offer subscription services for the first time or to expand their existing services of the kind. An improvement in the fortunes of FM broadcasters should be good news to the high-fidelity public, which has been apprehensively watching the number of commercial FM stations dwindle over the last few years instead of grow as anticipated. It stands to reason that the number and quality of FM programs are likely to rise if FM station owners find their lot a profitable one.

The Subscription Proposal

Of course it cannot be said for certain that stereophonic FM will be made available to the home audience only on a subscription basis. However, since this is a strong possibility, it is worth presenting some detail on MSC's subscription proposal.

As previously indicated, MSC visualizes sale or rental of an adapter for regular FM tuners of suitable type, the adapter being operated by means of a control card sold to the listener on an annual, monthly, weekly, or similar basis. Whereas anyone could tune into the main channel on a standard tuner, the subchannel and choices of program material transmitted on the subchannel would be heard only via the adapter by inserting the control card as indicated in Fig. 1. Volume controls at the left and right of the adapter would control gain on each channel.

To discourage pirating of programs by unauthorized listeners, a multicast program would send out an intrusion signal on the subchannel during intervals between musical selections. This could take the form of squelches, distortion, or other annoying sound or it could be in the nature of a repeated announcement that unauthorized reception of the subchannel is a violation of the law and subject to criminal prosecution under Section 605 of the Federal Communications Act pertaining to private communications. The control card would enable the adapter to remove the intrusion signal.

To permit removal of the intrusion signal by authorized adapters, the transmitter would send out a series of "security" code pulses at ultrasonic frequencies (frequencies above the audio range). Accompanying these pulses would be random decay pulses intended to confuse "pirates" and cause faulty operation of illegally operated adapters. The control card shown in Fig. 1 would cause proper contacts to be
made in the adapter at a designated time so as to permit effective reception of the code pulses. The nature of the code would vary from week to week, and possibly from one time of day to another. Correspondingly, the punched holes would be changed. By the time the code could be broken, a new code and new card would be in effect. Altogether, it is felt by MSC that legal protection of subchannel transmission, complexity of the code system, and patents on security control equipment will prevent unauthorized subchannel reception to any significant degree.

In order to give the subscriber a choice as to what he wants to hear on the main channel (buttons 3, 4, 5), the transmitter would use methods somewhat similar to present "beep" control. Transmission of ultrasonic control signals, filtered out or accepted by the adapter according to the button position, would determine what portion of the subchannel program could be heard.

**How Multiplex Works**

Although multiplex is a technical feat of a very high order inasmuch as it permits several program channels in the same radio spectrum space previously occupied by one channel, it is not difficult to understand, in principle, how it works, as depicted by the block diagrams of Figs. 2 and 3.

Fig. 2 represents a two-channel multiplex transmitter. The main channel is designated by squares and rectangles and the subchannel by circles. In essence, the subchannel is added through low-level frequency modulation of the FM main carrier by a subcarrier, which is a ultrasonic signal that is frequency modulated by the subchannel program source. Fig. 2 assumes a subcarrier of 35 kc.

With the exception of the multiplex modulator and the low-pass filter, the main channel stages are the same as in a conventional FM transmitter. However, equipment of special design is required for those stages prior to the power amplifiers in order to insure high quality performance. The purpose of the low-pass filter following the main channel source is to remove audio harmonics in the same range as the modulated subcarrier and thereby eliminate interference on the subchannel.

As on the main channel, the subchannel program source goes through a low-pass filter (to remove harmonics above the useful frequency range) and a pre-emphasis network, then frequency modulates a signal of several hundred kilocycles. After frequency multiplication, the subchannel signal goes through a mixer, where it is beat down to 35 kc. by a heterodyne oscillator. This 35 kc. subcarrier then frequency modulates a submultiple of the main carrier frequency (16.3 mc. in Fig. 2), which has already been modulated by the main channel audio source. The main carrier submultiple is also modulated by control signals in the range of 20-50 kc. which are introduced between musical selections; as previously discussed, these signals are intended to prevent unauthorized subchannel reception. From this point, the main channel and subchannel travel together, going through further frequency multiplication, power amplifiers, and the broadcast antenna.

The subcarrier center frequency must be at least 20 kc. above the upper limit of the audio spectrum (15 kc.) so that the modulated subcarrier does not break into the main channel. Subcarrier modulation of the main carrier is required by the FCC to be at a level at least 60 db below audio modulation of the main carrier in order to prevent audible crosstalk between the two channels on regular FM tuners. Whereas full modulation of the main carrier corresponds to a frequency deviation of 75 kc., maximum frequency modulation of the subcarrier is limited to about 6 kc. in order to avoid cross-modulation between channels. Despite these limitations on the extent to which the subcarrier modulates and is modulated, a signal-to-noise ratio of 55 db or greater is obtainable in subchannel receiving equipment.

**The Stereophonic Future**

It is difficult to resist the conclusion that stereophonic FM in the home is an inevitable outcome of multiplex, although it is a matter of speculation how long this will take. Music—classical, popular, and in-between—has a (Continued on page 188)
Part 1. The invention of the "speaking machine" by Thos. A. Edison. First of a new series of articles dealing with the design and development of the phonograph.

By OLIVER READ
Editor, RADIO & TELEVISION NEWS

HIGH-FIDELITY phono recording and reproduction owes its inception to a discovery by Thomas A. Edison who, in 1876, hit upon the basic idea that has since resulted in the development of the modern phonograph. Edison's discovery came at a time when his interest was divided and when he was experimenting with all sorts of electrical gadgets. Edison always had a flare for "experimenting," but his first real invention took place in 1864 at Indianapolis, Indiana, where he built an automatic telegraph repeater. This was considered the forerunner of numerous inventions to follow. His invention of a stock ticker in Boston resulted in a payment to Edison of $40,000. With this he established a laboratory at Menlo Park and at West Orange, New Jersey.

Unlike the discoveries of Leon Scott and the invention of the "Phonograph" in 1857, which provided a means whereby visual records could be made of the vibrations appearing on a diaphragm, Edison's discovery, followed by a patent application filed in December, 1877, claimed "a means for recording permanent characters of the human voice and other sounds—from which characters such sounds can be reproduced and rendered audible again at a future time."

The tremendous importance of Edison's discovery is clearly revealed by reading his application for patent filed December 24, 1877. It reads in part as follows:

"The invention consists in arranging a plate, diaphragm, or other flexible body capable of being vibrated by the human voice or other sounds, in conjunction with a material capable of registering the movements of such vibrating body by embossing or indenting or altering such material, in such a manner that such register marks will be sufficient to cause a second vibrating plate or body to be set in motion by them, and thus reproduce the motions of the first vibrating body.

"The invention further consists in the various combinations of mechanism to carry out my invention.

"I have discovered, after a long series of experiments, that a diaphragm or other body capable of being set in motion by the human voice does not give, except in rare instances, superimposed vibrations, as has heretofore been supposed, but that each vibration is separate and distinct,
and therefore becomes possible to record and reproduce the sounds of the human voice.

"In the drawings, Fig. 1 is a vertical section, illustrating my invention, and Fig. 2 is a plan of the same.

"A is a cylinder having a helical indenting-groove cut from end to end—say, ten grooves to the inch. Upon this is placed the material to be indented, preferably metallic foil. This drum or cylinder is secured to a shaft, X, having at one end a thread cut with ten threads to the inch, the bearing P also having a thread cut in it.

"L is a tube, provided with a longitudinal slot, and it is rotated by the clockwork at M, or other source of power.

"The shaft X passes into the tube L, and it is rotated by the means, and passing through the slot on the tube L, the object of the long slot being to allow the shaft X to pass endwise through the center or support P by the action of the screw on X. At the same time that the cylinder is rotated it passes toward the support O.

"B is the speaking-tube or mouthpiece, which may be of any desired character, so long as proper slots or holes are provided to re-enforce the hissing consonants. Devices to effect this object are shown in my application, No. 143, filed August 28, 1877. Hence they are not shown or further described herein.

"Upon the end of the tube or mouthpiece is a diaphragm, having an indenting-point of hard material secured to its center, and so arranged in relation to the cylinder A that the point will be exactly opposite the groove in the cylinder at any position the cylinder may occupy in its forward rotary movement.

"The speaking-tube is arranged upon a standard, which, in practice, I provide with devices for causing the tube to approach and recede from the cylinder.

"The operation of recording is as follows: The cylinder is, by the action of the screw in X, placed adjacent to the pillar P, which brings the indenting-point of the diaphragm G opposite the first groove on the cylinder, over which is placed a sheet of thick metallic foil, paper, or other yielding material. The tube B is then adjusted toward the cylinder until the indenting-point touches the material and indent it slightly. The clockwork is then set running, and words spoken in the tube B will cause the diaphragm to take up every vibration, and these movements will be recorded with surprising accuracy by indentations in the foil.

"After the foil on the cylinder has received the required indentations, or passed to its full limit toward O, it is made to return to P by proper means, and the indented material is brought to a position for reproducing and rendering audible the sounds that had been made by the person speaking into the tube B.

"C is a tube similar to B, except that the diaphragm is somewhat lighter and more sensitive, although this is not actually necessary. In front of this diaphragm is a light spring, D, having a small point shorter and finer than the indenting-point on the diaphragm of B. This spring and point are so arranged as to fall exactly into the path of all the indentations. This spring is connected to the diaphragm F of C by a thread or other substance capable of conveying the movements of D. Now, when the cylinder is allowed to rotate, the spring D is set in motion by each indentation corresponding to its depth and length. This is a short article and therefore it is not necessary to go into the details of this arrangement."

(Continued on page 149)
HEARTS of audio designers were gladdened by Tung-Sol’s announcement last year of the 6550 pentode, filling a long-felt need for an amplifier tube in its power class. Previously, tubes of this kind commonly used in American versions of the Williamson circuit did not fill the demand for a triode-connected output stage tube which could deliver the peak power requirements of a home installation at operating conditions well within the tube’s maximum rating. The 6550 is rated to deliver 28 watts in the push-pull triode connection, which allows a safe reserve of power handling capacity for those who wish to design conservatively even for a large home installation. In pentode operation a pair of tubes will deliver 100 watts reliably.

Examination of the 6550 tube data given in Table 1 shows that the most unusual requirement is the large screen current swing between “no-load” and “full-load” conditions. For operation at the 100-watt output ratings, the current swing of 4 to 41 ma. is at the limit of what can be handled by VR tubes. In actual practice it would be unwise to use VR tubes because normal variations in line voltage to the amplifier power supply would very likely shift the current swing to a range that could not be handled by the VR tubes. Conservation design dictates the use of a separate 300-volt supply of good regulation. If we are to realize the 100-watt output at low distortion, a fixed bias supply is also required. By now the power supply problem alone looks formidable enough, on the grounds of complexity and cost, to discourage the 100-watt project. However, if a single power transformer could be obtained with all the necessary windings, the problem would be relatively simplified and much less expensive. Such a transformer is available as the Chicago Standard PCR-300, from which both screen and bias supplies can be taken through taps on the main high-voltage winding. The requirement of good regulation on the screen supply is met by a choke-input filter system, which fortunately happens to provide exactly the right voltage.

The same power transformer can be used for triode operation if the plate supply is changed from capacitor input to choke input, reducing the voltage to about 475. A unique feature is that a d.c. heater supply for a separate pre-amplifier can now be obtained from the bias supply taps without exceeding transformer current ratings.

Pentode Operation

To make the most of the high power output capability of the 6550, pentode operation at 600 plate volts along with fixed bias would seem sensible. A circuit along the lines of that made famous by Williamson no doubt would be highly satisfactory, but in order not to overlook other possibilities, several alternative circuits were investigated.

Some public attention has recently been focused on the use of push-pull feedback from the plates of both output tubes. If the feedback is applied to the driver cathodes, large amounts of feedback can be used without danger of oscillation. In a two-stage feedback system, oscillation cannot occur because phase shift will not reach the 180 degrees required for oscillation. Feedback in this case will reduce the phase shift as well as amplifier gain, thus making it easy to apply additional feedback around the output transformer and still maintain stability.

Bearing in mind that the distortion should be reduced by an amount equal to the feedback factor, it appears that an amplifier with lower distortion than the Williamson can be built because greater feedback can successfully be employed. This rosy outlook will receive a jolt when an intermodulation distortion meter is used to measure the results of such designs. Different feedback circuit configurations were tried, all taken from both output tube plates, and none gave lower distortion than when feedback from the transformer output winding (à la Williamson) was used alone. The important factor in balance between both sides of the push-pull circuit was taken into account.

Rather than waste space with a detailed proof of these facts, let us look at the results obtained by a reputable manufacturer employing the foregoing techniques. A widely advertised amplifier on today’s market uses push-pull feedback from the output tube plates plus feedback around the output transformer. The advertisement states that 36 db of feedback is employed and that the intermodulation distortion at full output is 1%. Now 36 db feedback is a 63 times reduction, and the initial amplifier distortion should be reduced this much. However, tubes of the 5881 class used here can have I.M. distortion as low as 4% with no feedback. We can therefore expect 0.06% I.M. with feedback. The great discrepancy is due in large part simply to the use of the two kinds of feedback applied together as described, one of which is not wholly beneficial.

An attack on amplifier distortion may well be aimed at the output stage.
alone since by far the most distortion is introduced in this unit. Application of plate-to-grid feedback will not do, because aside from the question of whether or not distortion is materially reduced, we cannot tolerate reduction of the a.c. grid circuit impedance to the low values which will result with the 50,000-ohm maximum d.c. resistance specified by the manufacturer in this service. A more attractive method is to use a tertiary winding in series with the cathodes. This circuit, facetiously dubbed "super-ultralinear" by Williamson, has not enjoyed the popularity in this country that it deserves. With it, distortion levels lower than those obtained with triodes can readily be obtained." The feedback used is 100% effective in reducing distortion and furthermore is fully compatible with feedback applied around the output winding. There is, however, a price to be paid. The driving voltage required to get grid voltage reduced by this amount is increased by the feedback factor. Since tubes customarily used as drivers are already called upon to deliver a voltage swing which approaches the limit to be expected for low distortion, we will reach a limit on the amount of feedback that can be judiciously applied. A further limiting factor acting against developing a high driving voltage is the low value of grid resistance required in this service. Hence the 6557 is ruled out and, on the basis of test results, the 5687 was selected. To secure the greatest possible voltage output at the lowest distortion, it is advisable to use the full plate supply voltage of the 6550's on the 5687. A considerable portion of the success of this amplifier is attributable to the large distortion-free grid driving voltage available from the 5687 tube at impedances which suit the 6550 grids.

To offset the disadvantage of added drive requirement we have an unusual bonus in the way of distortion reduction. Ordinarily, distortion is reduced by the feedback factor. That is, if feedback is applied reducing amplifier gain by 10 db, the distortion will be reduced 10 db. In the push-pull stage, local feedback applied in the manner described results in a double reduction in distortion. Ten db of gain reduction results in 20 db of distortion reduction or, in other words, the distortion is reduced by the square of the feedback factor and not by just the amount of the feedback factor. This fact seems to have been overlooked or ignored by some previous writers but well deserves emphasis since it is not common knowledge. It is probable that earlier investigators missed the point or failed to detect it because if only a small amount of feedback is used, the double reduction effect might not be recognized, for the square of a small number is not much greater than the number itself. Matters like push-pull imbalance and driver distortion could mask small gains in distortion reductions. It is not until larger amounts of this kind of feedback are applied that appreciable gains in distortion reduction can be measured to any degree.

The output transformer selected was the new Chicago Standard "Super-Range" transformer developed especially for the 6550's and employing a tertiary winding designed to give the maximum practical feedback. IM distortion using only this type of feedback is under one per-cent. A moderate amount of feedback added around the output transformer will readily bring distortion down to levels so low that it is on or below the threshold levels which a conventional IM distortion meter can measure. It was established that 14 db of outside feedback is sufficient to

PUSH-PULL AMPLIFIER
(Values are for two tubes)

<table>
<thead>
<tr>
<th>Pentode</th>
<th>Triode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed bias</td>
<td>Self bias</td>
</tr>
<tr>
<td>D.C. Plate Voltage</td>
<td>400</td>
</tr>
<tr>
<td>D.C. Grid No. 2 Voltage</td>
<td>275</td>
</tr>
<tr>
<td>D.C. Grid No. 1 Voltage</td>
<td>-23</td>
</tr>
<tr>
<td>Cathode Resistor</td>
<td>-140</td>
</tr>
<tr>
<td>Peak A.F. Grid-to-Grid Voltage</td>
<td>46</td>
</tr>
<tr>
<td>Zero Signal Plate Current</td>
<td>180</td>
</tr>
<tr>
<td>Zero Signal Grid No. 2 Current</td>
<td>9</td>
</tr>
<tr>
<td>Maximum Signal Plate Current</td>
<td>270</td>
</tr>
<tr>
<td>Maximum Signal Grid No. 2 Current</td>
<td>44</td>
</tr>
<tr>
<td>Load Resistance</td>
<td>3500</td>
</tr>
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<td>Power Output</td>
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</tr>
<tr>
<td>Harmonic Distortion</td>
<td>3</td>
</tr>
<tr>
<td>Maximum Grid Circuit Resistance</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 1. Typical operating characteristics for the Tung-Sol 6550 tubes.

The pentode version of the 100-watt amplifier using the new 6553 tubes.
bring the amplifier distortion down to the same order of magnitude as the residual of the meter used in these tests, i.e., 1% at 100 watts. Thus the total feedback of about 20 db in both sides of the push-pull stage brings the net feedback to 34 db applied to the whole amplifier.

Some attention must be paid to balance of the push-pull stages if this phenomenally low figure of distortion is to be realized. The best way is to adjust the balance control while observing either harmonic or IM distortion. A second choice is to read a.c. grid voltages on the 6550's and adjust the balance control for equal amounts on each grid. If neither of these methods is possible it will be sufficiently accurate to adjust the balance control to give equal resistances in the plate and cathode of $V_0$.

Power output developed by the tubes and supplied to the output transformer will be 100 watts. Feedback circuit losses plus transformer losses will reduce the power supplied to the load to about 90 watts. An input level of two volts is required for full output.

**Triode Operation**

A triode amplifier can be built using the same major components as the pentode-connected amplifier. The power and output transformers are admirably suited to the triode requirements. By using choke input on the high-voltage supply, the proper plate voltage will be obtained for triode-connected 6550's. The screen supply is now no longer needed and its components can be dispensed with. For greatest economy the bias supply can also be omitted, and self bias used. In this case the power output delivered to a load will be 25 watts. If fixed bias is used, an additional plate voltage equal to the bias voltage then becomes available, and the output will be 30 watts. In either case the same low figures of distortion will be obtained. Required input level is 1.6 volts.

Tertiary feedback can also be profitably employed. However, since the initial stage gain is lower than in the case of the pentode version, less feedback becomes available with the same tertiary winding. Nevertheless it is profitable to use this kind of feedback since it alone will reduce amplifier distortion to 0.4%. Feedback on both sides of the push-pull stage is 7 db and with 14 db of feedback added around the output transformer, residual distortion is too low to be measured. Calculated IM distortion is 0.08% and this is borne out by examination of the residual oscilloscope trace of IM meter output. These figures were obtained by merely balancing the drive voltages to the 6550 grids. If an IM meter is available it is possible to get the IM down to about 0.06% at 25 watts equivalent sine-wave output.

These remarkably low figures of distortion are due in part to the superlative output transformer. By using the transformer at one-fourth of the output power capabilities, distortion contributed by the transformer is virtually zero.

"Ultra-Linear" Operation

The output transformer used for pentode and triode operation also has taps for "Ultra-Linear" operation placed at the position on the plate winding which gives minimum distortion. The feature of "Ultra-Linear" operation is that an output power greater than that obtained from triodes can be obtained at a distortion level intermediate between that of triodes and pentodes without the complication of a screen supply.

It has been experimentally determined that small amounts of tertiary feedback do not produce any reduction of distortion in this case, probably because of masking effects of the screen feedback. However, sufficient feedback is available in this output transformer to bring about a four times reduction in distortion through use of the tertiary winding alone. Addition of 14 db of outside feedback to this 12 db of tertiary feedback brings the net amplifier distortion to 0.25% IM. Amplifier input required is 1.7 volts for full output of 40 watts sine-wave power using self bias on the 6550's and essentially the same components and circuitry as for the triode version.

**Feedback Considerations**

No instability problems will be experienced in using tertiary feedback since it is applied around only one stage. For this reason it is well to use as much feedback as possible in this position in the circuit. Fortunately it turns out that with a given tertiary winding, greatest feedback will be obtained in a pentode stage where it is most needed. Fidelity obtained in the pentode circuit is very nearly comparable to that of a triode stage using the same transformer. In view of the greater power efficiency of pentodes, triodes will be the second choice in a circuit of this type.

Tertiary feedback has been tried with other tube types with similar good results. It seems that this kind of feedback should find wide application in low power amplifiers, where the smaller driving voltages required simplifies the design problem. To equal the performance of most amplifiers on the market, it will not be necessary to use feedback around the output transformer in addition to tertiary feedback. But since there are no problems peculiar to combining these two kinds of feedback, it is a relatively simple matter to add outside feedback. It should be noted that outside feedback will not be necessary to reduce the amplifier output impedance since tertiary feedback will take care of that matter.
The considerations involved in applying feedback around several stages seem to be well known but not always applied. In simplest terms, the requirement is that all stages except one shall have a flat frequency response extending well past both ends of the audio frequency spectrum, and that one stage shall be rolled off in response at both ends of the spectrum. Failure to observe these principles in several near-copies of the Williamson circuit has sometimes resulted in unstable performance and consequent unjustified criticism of the Williamson circuit. The greatest error in current practice is to ignore the requirement at the high frequency end where rarest opportunities for trouble exist. Conditions of resonance or near resonance in the output transformer at ultrasonic frequencies will usually produce the amount of phase shift required for oscillation unless steps are taken to reduce amplifier gain at those frequencies. A very simple means of doing this is by a resistance-capacitance combination introduced at the plate of $V_{ma} (R_c-C)$. If this is omitted, the tube and wiring capacitances must be trusted to do the job, and they may not.

At the low-frequency end of the spectrum the primary shunt inductance of the output transformer in series with the output tube plate resistance furnishes a smooth roll-off. The trouble which sometimes arises, manifested by motorboating, is due to not carrying the amplifier frequency response flat for enough below the transformer’s roll-off frequency. This situation is aggravated by today’s output transformers which are designed with the large inductance necessary to get low intermodulation distortion. The roll-off frequency, then, is so low it is inconvenient to use interstage coupling networks large enough for the requisite frequency response. Requirements for low frequency roll-off can be more efficiently met by tailoring one of the interstage coupling networks. Either the last stage or driver stage input coupling capacitors can be reduced in size. The phase shift introduced will be in the opposite direction of that due to transformer inductance and will tend to offset the latter in a beneficial way. Since a low value of grid resistance is specified for the 6550’s, the logical place to use small coupling capacitors is at these grids.

The finished amplifier embodying these principles is stable and trouble-free. No ringing appears on square-wave response. In the pentode-connected amplifier, frequency response is down 3 db at 100 kc. from mid-frequency response, and down zero db at 20 cps. This is excluding $R_c-C$. It is wise to include $R_c-C$ to reduce possible unwanted signals below the audible spectrum. The amplifier will operate as well as much undistorted power at 20 cps as at mid-frequencies.

It may occur to the reader that it should be possible to use the transformer secondary as the feedback winding. On output transformers that have 4, 8, and 16-ohm taps, the center tap of the 16-ohm winding is at 4 ohms. If the 4-ohm tap is ground, the ends of the winding will be returned to the cathodes of the output stage. This reasoning neglects the fact that the output winding has a low impedance load imposed on it, whereas the tertiary does not. As a result, the voltage fed back is unsuitable, especially where the load is a loudspeaker with its varying resistance and reactance. No simple substitute for the tertiary exists.

A choice of a maximum of 14 db feedback around the output transformer was made for several reasons. First, that amount is usually sufficient to bring distortion below that of most amplifiers on the market. Second, if more feedback were used, amplifier input voltage requirements would be beyond that which can be obtained at low distortion from some preamps. Third, instability problems are less likely to occur. Tertiary feedback does not aggravate the stability problem in applying outside feedback, rather it eases the problem. Stable operation with as much as 40 db outside feedback has been obtained by proper attention to control of frequency response.

Current feedback can be more readily applied than in conventional amplifiers. One way of looking at the situation is to consider that tertiary feedback reduces amplifier distortion, and current feedback around the output transformer reduces loudspeaker distortion. However, in a general purpose or distribution amplifier, current feedback may be undesirable and therefore has been omitted. Those desiring it can easily include it by placing an adjustable resistor of not more than two ohms in series with the output winding and returning the cathode of $V_{ma}$ to the junction. The negative voltage feedback from the output should then be omitted.

Two clear-cut advantages result from use of a tertiary winding: an amplifier of lower distortion can be built, and feedback is more easily applied without oscillation troubles. This has made it possible to produce an amplifier setting a new high standard combining features of fidelity, efficiency, simplicity, and power output.

REFERENCES

All other parts are the same as shown in parts list accompanying pentode version (Page 51).

| R1 | 100 ohm, 10 w. res. |
| R2 | 200,000 ohm, 1/2 w. res. |
| R3 | 1200 ohm, 1 w. res. |
| R4 | 3300 ohm, 2 w. wirewound res (IRE Type BW-2) |
| R5 | 220 ohm, 1/2 w. res. |
| C1 | 20 µfd, 450 v. elec. capacitor |
| C2 | 0.02 ufd, 1000 v. capacitor |
| SR1, SR2 | Selenium rectifier, 150 v. @ 7 ma. |
A Portable Transmitter-Receiver for 148 mc.

The day has long passed when the modulated oscillator type of transceiver would be tolerated as a simple device for short range v.h.f. communications. Postwar communication practices have proven that only crystal-controlled transmitters provide the stability required for use on FCC-assigned channels.

This article describes such a crystal-controlled transceiver, designed primarily for use in the 148.14 mc. CAP channel, which was installed in a 65 hp Taylorcraft airplane. By the substitution of a suitable crystal in the transceiver, this unit can also be used in the 144-148 mc. amateur band. The tuning range of the receiver is from 143.5 mc. to 149 mc. The basic transmitter/receiver chassis, without "A" and "B" batteries, weighs less than four pounds; it is thus ideally suited for portable use.

The chassis is built into a carrying case containing three 45-volt "B" batteries and four 1 1/4-volt "A" batteries for convenient use in an airplane or car. Unless the unit is intended for field portable use, an antenna may be permanently attached to the vehicle in which the transceiver is to be used. The antenna is connected to the set by means of conventional coaxial fittings. Prior to installation in the airplane, the unit weighed slightly less than 18 pounds including antenna, case, batteries, headset, and microphone.

Receiver Sensitivity

Power output of the transmitter is approximately 0.5 watt. The receiver sensitivity is more than adequate and is limited only by the ambient electrical noise generated in the airplane or car in which it is installed. Because the receiver is of the superregenera-

tive type, the limiting action which takes place in the detector permits reception through unusually high electrical noise levels. Provided the received signal is a well-modulated voice signal, the sensitivity of the set becomes insufficient only when the average power of the interfering noise signal is greater than that of the received carrier. Power output of the transmitter is adequate for general air-to-ground coverage; several signal reports have confirmed its performance over distances up to 50 miles.

Tube Lineup

Tubes having 6-volt indirectly-heated cathodes were chosen for use in the transceiver after a careful evaluation of their performance, heater input, plate input, and commercial availability, as compared with directly-heated battery tubes. The advantages of the tubes selected are particularly evident at frequencies above 75 mc. A further advantage is that a unit using these tubes is readily adaptable for use with either 6-volt d.c. or 110-volt a.c. power supplies. Total drain on the "B" supply is 35 milliamperes at 135 volts in the "Transmit" position and 18 milliamperes at 135 volts in the "Receive" position. Drain on the "A" supply for either position is 0.975 ampere at 6.3 volts. The unit described here has been operated from batteries for more than 20 hours. The "A" batteries were replaced after approximately 18 hours of use. The "B" batteries still deliver more than 120 volts under transmit load; it appears, therefore, that their life will be in excess of 30 hours for intermittent operation. Microphone voltage is supplied from a small 3-volt battery. Since the microphone drain is about 20 milliamperes in the "transmit" position only, this battery will outlast both the "A" and "B" batteries.

Description of Unit

The transceiver consists of the r.f. stage of the transmitter, the receiver stage, and the audio stage, which serves as both the amplifier for the receiver and modulator for the r.f. stage of the transmitter. Switching from "Transmit" to "Receive" is accomplished by means of a 4-pole, double-throw switch.

Basically, the transceiver consists of a 6AK5 crystal oscillator having a tuning range from 72 to 75 mc., a 6AK5 frequency doubler, and a 6AK5 power amplifier. Plate modulation to the power amplifier is supplied by a 6AK6 tube.

The receiver consists of a 12AT7

By J. F. STERNER
Tube Div., Radio Corporation of America

A compact, battery-powered CAP unit which is suitable for 2-meter ham use too.

RADIO & TELEVISION NEWS
R—10,000 ohm, 1/2 w. res.
Rn—2700 ohm, 1/2 w. res.
Rn—47000 ohm, 1/2 w. res.
Rn—800 ohm, 1/2 w. res.
Rn—50000 ohm, 1/2 w. res.
Rn—1 megarohm, 1/2 w. res.
Rn—220,000 ohm, 1/2 w. res.
Rn—470 ohm, 1/2 w. res.
c, C1, C2, C3, C4—1-8 µfd., trimmer (Erie Type #33-10)
C1—47 µfd. ceramic capacitor
C2—5 µfd. ceramic capacitor
C3, C4—470 µfd. mica capacitor
C5—13 µfd. ceramic capacitor
C6, C7—220 µfd. ceramic capacitor
C8, C9—100 µfd. mica capacitor
C10—23 µfd. 200 V, paper capacitor
C11—5 µfd. ceramic capacitor
C12—11 µfd. mica capacitor
C13, C14—1500 µfd. ceramic capacitor
C15—3 µfd., tuning capacitor (2-plate APC type with 30° shift or Hamsarkind Type MAC-5 with two plates removed)
C16—10 µfd., 25 v., electrolytic capacitor
C17—270 µfd. mica capacitor
L1—6 t. #18 tinned wire wound on Ohmite 2 megarohm, 1-watt res. Coil length 19/32" (resistor 19/32" long, 13/64" dia.)
L2—9 t. #18 tinned wire, 1/3" i.d., spaced wound 1/6" long
L3—3 t. #18 tinned wire, 3/4" i.d. spaced wound 1/6" long
L4—3 t. #20 insulated wire, 3/4" i.d., interwound with low potential end of L1. (Actual coupling to be adjusted for maximum excitation then cemented in place with Duco cement)
L5—3 t. #18 tinned wire, 1/3" i.d., spaced wound 1/4" long
L6—1 t. #20 insulated wire, 1/3" i.d., Coupled to low potential end of L1. (Adjust for maximum field strength with antenna connected)
L7—4 t. #18 tinned wire, 1/3" i.d., spaced wound 1/4" long, Cathode tap 1 1/2" from low potential end
RFC1, RFC2—1 phy. 30 t. #32 wire wound on IRC 100,000 ohm, 1/2-watt res. (3/16" long, 21/64" dia.)
SO1—4-prong plug and socket
J4—2-circuit jack (Mallory Type #702B)

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Complete schematic diagram of the crystal-controlled 148.14 CAP transceiver. With a different crystal, unit may be used for 2 meters. Heater and switching circuits are shown lower right. Note S1, S2 on r.d. chassis, S3 and SO1 are on carrying box.

double triode, one triode section of which operates as a grounded-grid amplifier and the other as a superregenerative detector. No provision is made for controlling the volume or the amount of regeneration in the detector circuit. Because the grounded-grid amplifier isolates the antenna, antenna variations do not affect superregeneration.

The grounded-grid amplifier also prevents serious radiation when the unit is in the "Receive" position. No volume control is included because the unit is intended for operation in areas where the outside noise level is high. The audio output from a pair of 2000-ohm earphones is satisfactory even for operation in aircraft.

Over-all view of transceiver. Complete. It weighs less than 18 pounds.

Under-chassis view. Although parts are uncrowded, chassis is compact.

The point of superregeneration of the detector is pre-set by means of the tap connection to coil L1. The location of this tap point is not critical; when the tap is adjusted as described in the parts list, the unit operates with supply voltages ranging from 100 to 150 volts.

(Continued on page 154)
SERVICING

TAPE recorder servicing can be a very profitable sideline for the TV-radio service technician. Tape recorder sales are steadily increasing so that the service market is consequently expanding in proportion. The fact that many recorders are relatively high in price permits the technician to obtain adequate remuneration for his work—a state of affairs that is not often encountered in the radio field, where low-cost sets have become commonplace.

In this article, representative troubles and service procedures will be considered rather than the theory of tape recorder operation. The information presented should permit an intelligent technician to cope, with some expectancy of success, with typical tape recorder troubles.

Major Troubles

The easiest trouble to locate is encountered when the motor(s) and amplifier are inoperative with the “off-on” switch at the “off” setting. Among the possibilities are a blown fuse, open line cord or plug, or defective switch. No experienced TV-radio technician will have any trouble in tracking down defects of this nature.

When the tape recorder does not reproduce, turn the volume control to maximum and put your ear to the speaker. If some background noise is audible in the speaker—or becomes markedly audible when the grid of the first amplifier is disturbed (by scratching it with a wire, for instance), the amplifier and speaker may be ruled out as possible sources of the trouble. A defect in the reproduce head or an open in the amplifier input circuit, should now be checked.

To test the amplifier and speaker without removing the tape recorder from its cabinet, feed a signal from a microphone or phono pickup to the appropriate input jack of the amplifier. (Turn the volume control setting down far enough to avoid acoustic feedback, due to the close positioning of the microphone to the speaker.) If the signal (speech or music) can be heard in the speaker, the amplifier and speaker may be eliminated as possible sources of trouble. If the signal is not heard, a pair of earphones may be used to determine where the signal is being lost. If the phones detect the signal at the output of an inverter stage, for instance, but not at the plate of the succeeding output stage, trouble in the latter is indicated.

If the tape recorder will reproduce, but won’t record, one of the following troubles may be present: the coil of the recording head may be open (it is assumed that separate heads are used for recording and reproducing. If only one head is used for both functions, an open in the head coil will, of course, cause the recorder to be inoperative on both record and reproduce settings); there may be dirt on the face of the recording head; the pressure pad (when one is present) may not be making proper contact with the head, or may be worn or damaged; or the recording bias voltage may be inadequate.

Visual inspection of the recording head assembly (see Fig. 3) will quickly reveal if the pressure pad is normal in appearance and adjustment, or whether dirt is present on the head. The recording bias voltage may next be checked with a voltmeter and compared with that listed in the manufacturer’s service notes. This is the a.c. high-frequency voltage present across the head.

If no trouble is revealed during these and related tests, a new recording head should be tried. It is not advisable to make a continuity check of the coil in the recording head—passage of d.c. meter current through the coil will magnetize it. When such a test must be made, use the highest range of the meter and demagnetize the head after the test, as described later in this article.

When no erase is present, or erasing is incomplete, permitting the old recording to be audible in the background of the new one, one of the following troubles may be present: the coil in the erase head may be defective; pressure pads used to keep the tape in proper contact with the erase head may be worn, damaged, or improperly adjusted; dirt may be present on the face of the erase head; or the oscillator tube or circuit (particularly the oscillator coil) may not be operating properly. It is worth noting that the oscillator tube, which often functions as a power amplifier as well as an oscillator, may continue doing its duty as an amplifier while it is delinquent as an oscillator.
A very practical guide to the repair and maintenance of magnetic tape recorders such as used in the home.

When a recording has been made at an extremely high level, complete erase may be difficult or impossible to obtain via normal methods. A permanent magnet may be used in such cases to remove the strong magnetic pattern present on the tape. Hold the magnet over the tape (but don't bring it near the heads), with the tape in motion. Some hiss will be heard if the tape is played back when this operation is completed. The hiss should disappear when the tape is erased once more in the tape recorder.

A pronounced hissing noise in the background of the desired signal is often due to the magnetization of one or more of the heads. When the magnetization is very strong, a sputtering noise rather than a hiss will be audible. Demagnetization of the heads, as will be described shortly, will test for the source of trouble, as well as remedy it.

To determine whether the playback or the recording head is responsible for the noise, completely erase a tape. To eliminate the recording head as a possible source of trouble, keep the tape from coming into contact with it by inserting a shim between the head and the tape. Now play back the unrecorded tape. If the noise level is excessive, the playback head is magnetized. If the noise level is no longer excessive, the recording head is magnetized. Of course, this does not apply to recorders on which one head is used for both recording and playback.

Heads may become permanently magnetized not only by coming into contact with a magnetized object, such as a magnetized tool or a permanent magnet, but also because of a component defect in an amplifier, or through improper operation of the tape recorder. Any condition that tends to send d.c. current through the reproduce or record head, or places a large, non-sinusoidal pulse on the record head, will magnetize the head. Such magnetization may cause the noise level to rise as much as 5 to 10 db, and can ruin good tapes by partial erasure of their high-frequency content. (This is particularly disastrous when expensive pre-recorded tapes are involved.)

To avoid magnetizing a head, observe the following precautions: 1. Never remove a tube from the recording amplifier stages while the machine is recording. 2. Don't connect or disconnect the leads going to the tape recorder input, or to the head, while the machine is recording. 3. Avoid saturating the recording amplifier with excessively high input signals. 4. Don't test heads for continuity with an ohmmeter.

To demagnetize a head, use a unit known as a "head demagnetizer." A number of tape recorder manufacturers make such units. The demagnetizing procedure is as follows: Turn the "on-off" switch of the tape recorder "off." Bring the tip (or tips) of the demagnetizer near the head core, and move it up or down the entire length of the core three or four times, straddling the air gap at some time during this process. Remove the magnetizer very slowly.

Only the record and playback heads usually require demagnetization; the electromagnetic erase head commonly demagnetizes itself. If the capstan or tape guides (see Fig. 2) become magnetized, a procedure similar to that just described will demagnetize them.

Distortion and Noise

In recorders using a permanent magnet as well as an electromagnetic erase head for erase purposes, an inoperative a.c. erase head will cause a hissing noise to be audible in the background of a recording. Erase may otherwise be normal. An improper oscillator supply voltage may also be the cause of the noise. To check whether the a.c. erase head is defective, hold the tape against the permanent magnet head while on "record," and bring the tape alternately towards and away from the a.c. erase head. Now play back the tape. If the tape noise is punctuated by intervals of silence, the head is not defective. If the noise remains constant and the oscillator bias voltage reading is normal, a new a.c. erase head should be substituted.

Improper contact between the erase head and the tape, due to the presence of sludge or dirt on the erase head, may cause erasure to be incomplete, and reduce the signal-to-noise ratio in consequence.

Excessive noise may be introduced in some cases when several ground points (instead of one) are used in an amplifier stage. An inexperienced technician may set up such a condition in making component replacements. Defective tubes and components may also introduce noise. Microphonic tubes are apt to cause howls.

When the volume of the playback signal is weak (and the recording is known to be good) check for the following: dirty reproduce head; improper positioning of, or defects in, pressure pads; tape wound on wrong side (dull side of tape should be wound in); defective reproduce head; improper alignment of reproduce head; weak tubes; low plate or screen voltages in amplifier stages.

When the playback section is known to be good, and the tape recording sounds fuzzy, faint, or distorted, the trouble may be: no or insufficient high-frequency bias to record head; worn or dirty pressure pads at record head; improper positioning of pressure pads; dirty or defective record head. An over-recorded or under-recorded tape may also be the source of such trouble.

(Continued on page 96)
A 13-Watt All-Triode “Infinite Feedback” Amplifier

Construction details on a well-designed, all-triode unit which is right size for the average home audio system.

In one of the author’s previous articles he described a 35-watt amplifier with a novel combination of features, namely 100% negative feedback around the output transformer and the output and driver stages, together with sufficient positive feedback around the driver stage to cause it to oscillate in the absence of the negative feedback. That article presented the mathematical basis of the design and showed that the arrangement can lead to a very stable amplifier having extremely low distortion and approximately zero output impedance. These principles were applied to the design of an amplifier using class-A push-pull 300B tubes in the output stage and the unit was found to develop 37 watts at 2% (r.m.s. sum) 1M distortion, or 35 watts at a distortion limit of 1%.

Two features of this amplifier make it somewhat unsuited for average home use. The output power of 37 watts is far in excess of that required in most homes, and the low input impedance of the amplifier necessitates a special final stage in the preamplifier with which it is to be used. Need seems to exist for a smaller amplifier which, while retaining the same circuit features, will have a maximum output on the order of ten watts, sufficient for home systems utilizing all but the most inefficient speaker systems. That the input impedance should be sufficiently high to permit the use of most available preamplifiers is a further requirement.

These objectives have been accomplished in the circuit to be described here. At the same time, because every part of the circuit has been designed with a view toward economy of construction, the new amplifier can be made at a cost somewhat less than comparable Williamson units. That no sacrifice in performance has been made to economy should be strongly emphasized; nevertheless, the final circuit does not contain a single unnecessary component.

Design

The circuit diagram of the complete amplifier is shown in Fig. 1. For the output stage, tubes of the class including 1614, 5881, KT-66, and 350B were selected. Not only are such tubes widely available but their characteristics are so similar that they may be used interchangeably with no modification of the remainder of the circuit. All of them have a maximum plate dissipation on the order of 26 watts when connected as triodes (with the exception of the 350B, for which the dissipation is 34 watts). The greatest power is developed by operating them near their maximum ratings. A control is incorporated into the stage for balancing the plate currents of the output tubes, but this adjustment has a very small effect on hum level.

The output transformer is a Triad S-35A, a reasonably-priced component of exceptional characteristics. In this circuit the full output power of 13 watts is available from less than 16 to over 30,000 cps. The entire circuit has been designed around this transformer; preliminary calculations seem to indicate that a wider frequency response is of no benefit whatever in audio amplifiers. As in the earlier 35-watt amplifier, the secondary of the output transformer is connected in balanced fashion, with the 0 and 16-ohm taps attached to the 16-ohm speaker and the 4-ohm tap grounded through the driver bias resistor paralleled with a small bypass capacitor. The speaker lines are at a small positive d.c. potential and must not be grounded to the chassis in any manner.

Various output stages were tested in the experimental work, including straight pentode and “Ultra-Linear” arrangements. Both these circuits increased the available power output to about 18 watts. Both appeared to have the common property that while the distortion level was quite low if the amplifier was connected to a load of the correct impedance, if rose objectionably as the load impedance was reduced below the correct value. This tendency was not observed with the triode connection; a reduced load resistance lowered the maximum power output but the distortion at lower levels increased only slightly. The “Ultra-Linear” output stage requires an output transformer considerably more expensive than the one indicated in this article and the nominal increase of output power does not seem to warrant this extra cost.

The output stage is thus quite conventional; the bypass capacitor across the cathode resistor common to the output tubes has been eliminated in the interest of economy with no measurable adverse effect upon performance.
A neon bulb shunting the grids of the output tubes limits the input voltage and prevents destruction of the tubes in the event the speaker leads are accidentally shorted together. (Shorting the speaker leads together effectively removes the negative feedback and permits the drivers to oscillate.) Tubes like the 5881 are considerably more resistant to this type of abuse than the 300B's used in the larger amplifier but they are nonetheless ruined in less than a minute by shorting the speaker lines in the absence of the neon-bulb limiter.

The push-pull driver is a single 12AU7, around which sufficient positive feedback is fed to produce oscillation in the absence of the negative feedback. The cathodes of the 12AU7 are connected directly to the secondary of the output transformer, providing 100% negative feedback, preventing oscillation of the drivers, and indeed, resulting in an extremely stable amplifier. Output tubes of the heater-cathode type bring up several problems not encountered with the filament type used in the larger amplifier. When early models of the present unit were turned on, the driver tubes heated up much more rapidly than the output tubes and oscillation occurred for a few moments, until the output tubes “caught up.” This oscillation was heard as a loud “whoop” in the speaker—frightening to many listeners. A great deal of work went into the design of the positive-feedback loop to eliminate this effect, and it never occurs in the latest circuit.

The input stage, which is also the inverter, is a dual triode with a large common cathode resistor. Signal is fed into one grid and the other grid is grounded through a capacitor. The outputs from the two plates are very closely balanced and have practically identical internal resistances. The circuit is well balanced and, except for the grid connections, completely symmetrical. 60-cps hum created by the large heater-to-cathode voltage, and 120-cps hum from the power supply appears in-phase at the two plates and is canceled at the transformer. Also, because it is quite degenerative, the input stage introduces a negligible amount of distortion.

Modification for push-pull input is easy made and consists of reconnecting the first stage so that the two inputs are fed to the two grids. This means that for push-pull input the grid shown grounded in the circuit diagram is removed from ground and connected to the other side of the input. A dual gain control is then required.

During the experimental work on early versions of this amplifier, changing the input tube was found to have a profound effect on the distortion. The resistances inserted between the 12AX7 plates and the driver grids overcome this tendency and allow replacement of the 12AX7 with no special precautions as to selection. They also permit this tube to be lightly loaded while at the same time a comparatively low resistance is presented to the 12AU7 grids, improving the high-frequency response. A grounded tube shield will eliminate any tendency of the first stage to pick up hum, but the shield has been found unnecessary in most cases.

A 75,000-ohm potentiometer is employed as a gain control in the amplifier's input. This resistance is not too low for the great majority of preamplifiers if they have an output capacitor no smaller than 0.25 μF. The use of a gain control larger than 100,000 ohms may result in an increase in hum and a loss of high frequencies at certain settings, since the input capacitance of the inverter stage is appreciable.

Because of the symmetry of the amplifier, the power supply can use a minimum of filtering without increasing the hum level. The large amount of feedback in the amplifier helps keep the hum level quite low even with unbalanced output tubes, although badly unbalanced tubes decrease the stability at low frequencies and in extreme cases can cause motorboating.

Construction

The entire amplifier and power supply can be mounted on a 7 by 9 by 2-
inch chassis if the layout is done carefully. The necessary compactness is achieved by mounting components directly on the output-tube sockets while using a terminal strip for the first two stages. The photographs show the completed amplifier and an underchassis view which clearly illustrates how the terminal strip is mounted. The terminal strip should be assembled by attaching the resistors first, followed by the capacitors.

Coupling capacitors of the highest quality should be used in constructing the amplifier. The writer has made over a dozen units, and in every case where excessive hum or distortion was encountered the trouble could be traced to a leaky capacitor which was throwing the two halves of the amplifier out of balance. Except for the few 5% resistors indicated on the diagram, no precision or specially selected or matched components are required to assure satisfactory performance.

The constructor must be cautioned not to change the values of any components in the circuit or to use tubes other than those specified. Changes very often have an unexpected result; for instance, decreasing the size of the coupling capacitors between the input and driver stages actually causes a rise in the bass response and may lead to motorboating.

Figs. 2 and 3 show the frequency response into a 16-ohm resistive load and the r.m.s. sum intermodulation distortion at various output levels. An input of 0.5 volt is sufficient to drive the amplifier to full output. The unit shows an output resistance of approximately zero ohms over the range of audible frequencies, which forces the most refractory speaker to behave docilely. Although the response is quite flat listeners are often impressed with what seems to be greater bass response than that attainable with other flat amplifiers, and this can be attributed to the high damping factor (by the usual definition, the damping factor is infinite). The improvement is especially noticeable with woofers of low efficiency.

The amplifier is very stable and shows no tendency to motorboat or, unless overdriven, to oscillate at any frequency or output level. A capacitance of 0.1 μfd. shunted across the speaker terminals does not cause any oscillation or other evidence of instability; this is far in excess of the capacitance presented by any speaker system. The entire amplifier can be wired in a few hours' time and no special precautions as far as lead dress, shielding, or bus bar ground are necessary if the layout of the experimental model is followed. The noise level of several chassis with the inputs shorted varied somewhat with the tubes used but a value greater than 2 mv. = 77 db below 13 watts was never encountered. In all the experimental amplifiers built by the author ground connections were made to any convenient chassis point.

Summary
Since the appearance of the article describing the 35-watt unit several commercial amplifiers have been developed featuring "variable damping factor." The articles describing these amplifiers draw various conclusions as to the damping factor desirable for results of the highest quality.

If, instead of the 1-megohm fixed positive-feedback resistors in the amplifier described here, a dual potentiometer was employed, the output resistance of the amplifier can be controlled within small limits. When the amount of positive feedback is reduced the output resistance increases up to a maximum corresponding to a damping factor of 4; if the amount of positive feedback is increased the output resistance becomes negative. As the latter occurs, however, the stability of the amplifier becomes much worse, and a damping factor of −1.0 can certainly not be obtained.

When the positive feedback is varied in either direction from the optimum (sufficient to make the driver oscillate in the absence of negative feedback) the distortion of the amplifier at a given output level increases. The increase is gradual while the positive feedback is being lowered. On the other hand it rises rapidly as the positive feedback is increased beyond the optimum value. For this reason, the use of such a control to obtain negative damping factors is not to be encouraged. No circuit has yet been devised which will, at the same time, produce a large negative damping factor and low amplifier distortion. This objection does not apply, of course, to amplifiers in which a control is provided to vary the output resistance between positive limits.

An amplifier of the type described here, unfortunately, will not make a five-dollar speaker in a cardboard box perform like a two-hundred-dollar assembly in a folded horn. It will still, of course, and sometimes the effort becomes so strenuous that oscillation occurs. Such oscillations have been touched off by overloading the amplifier during efforts to obtain resounding bass from tiny speaker enclosures. Given the amplifier, the remedy in such cases lies in either of two directions: a better speaker system should be installed or a filter should be inserted before the amplifier to remove the low frequencies which the system cannot reproduce anyway. Used in conjunction with a speaker of comparable quality, the amplifier is capable of results which have, to date, been thoroughly pleasing to well over a hundred persons and displeasing to only two or three.

REFERENCES
LAST MONTH we described "Minipack #1," a small power supply capable of one per-cent regulation over a 75 to 175 volt range. Recently a second power supply became necessary. Rather than borrow voltage from another source, "Minipack #2" was designed to meet the following specifications: 150 volts d.c. output at a maximum load current of 35 ma; regulation, better than a VR tube's three per-cent. No transformer was available, thus the circuit developed as follows.

The spare parts box contained some 75 ma selenium rectifiers and a dual 10 afd, 450 volt electrolytic capacitor. Voila! These components eliminate the transformer shortage! "Minipack #1's" electronic regulator circuit filled the bill to complete the circuit. Here's the story of "Minipack #2."

The Circuit

Fig. 2, the schematic diagram, demonstrates the "Minipack's" simplicity. Start with the 117 volt a.c. line cord, connected directly to the three tube filaments, which are in series. The filament transformer is eliminated but the tubes are illuminated! Continue to Rs, a 100-ohm, 2-watt carbon resistor which prevents inverse peak current damage to selenium rectifiers SR, and SR'. G, one half of the dual 10 afd, 450- volt capacitor, works in series with line voltage input. This voltage multiplier, being a full-wave rectifier-doubler, is the only circuit available wherein both capacitors have a common negative. The scheme allows use of the single-can dual capacitor, the can serving as the common negative return.

Essentially, the doubler functions by charging C1 and C2 in parallel and discharging them in series, and the peak output voltage equals 2.85 times the r.m.s. line voltage under "no-load" conditions. "No-load" potential at point X measures 285 volts.

Cascade multipliers have poor regulation: with a few ma. load, X drops from 285 to 206 volts. Regulated maximum i.e. must be less than the doubler's loaded output to permit well-controlled potential within the 150 to 190 volt region.

The 5085 gate tubes act as a variable series resistance controlled by the 12AX7 regulator tube. Action is similar to automatic volume control in superhet receivers. The 12AX7 amplifier controls the gate's bias, which varies the gate tubes' resistance, which controls the output, which controls the 12AX7's plate current, and so on. That cycle has a very fast time constant, resulting in steady output voltage irrespective of load fluctuations. The "Minipack’s" output holds constant at one volt in 100 for 25% variations in line voltage or load resistance.

Resistors Rs and Rp prevent parasitic oscillation. The 5085's are paralleled to allow higher current passage through the gate. (Continued on page 126)

Fig. 1. Top chassis view of the "Minipack #2." It can be built in a 2 1/4" x 2 1/4" x 5" utility box.

A miniature "permanent B battery"— delivers 145 to 190 volts at 35 milliamperes with ±1% regulation yet uses no transformers.

Fig. 2. Complete schematic of power supply. The judicious selection of tubes eliminates the need for a filament transformer since the tubes operate in series across the line.

R1—100 ohm, 2 w. carbon res.
R2—31 ohm, 1/2 w. carbon res.
R3—10 megohm, 1/2 w. carbon res.
R4—220,000 ohm, 1/2 w. carbon res.
R5—470,000 ohm, 1/2 w. carbon res.
R6—100,000 ohm carbon pot
R7—100,000 ohm, 1/2 w. res.
C1, C2—10/10 mfd., 450 v. elec. capacitor (Mallory FP-231)
C3—1 mfd., 200 v. paper capacitor
SR1—5 ma. selenium rectifier (Sylvania NB-5)
PL1—Miniature neon bulb, NE-2
V1—5085 tube
V2—12AX7 tube

By ROB WAGNER, W6WGD
Research and Development Lab.
Dalmo-Victor Co.
An inexpensive metal lunch box will house this compact, easily-built portable.

The circuit uses standard parts.

By BRUCE MORRISSETTE

A battery-operated portable receiver that will provide reception on the FM bands is a "rare bird" indeed but when such a circuit also offers reception of the sound portions of TV channels 2 through 6, the user has a veritable "jewel" of a set.

The trim, efficient portable to be described will bring in the sound portions of channels 2 through 6 as well as the entire FM broadcast band of 88-108 mc. It is calculated to fascinate and entertain both children and adults.

Construction

An attractive green-and-gray metal lunch box, measuring approximately 6" x 8" x 3", is used to house the FM-TV portable. This "cabinet" is available at any large dime store for about a dollar. Holes to clear the antenna plug, tuning capacitor shaft, and volume control shaft are cut in one end of the box while a pattern of holes for the speaker opening is drilled in the opposite end. A sheet of aluminum or steel, 5/8" x 11/2", is shaped to form a chassis to fit the lunch box. Bend up a small lip (1/4") at one end and a 2 1/8" panel lip at the other. The chassis bottom measures exactly 8 1/4" x 5 3/4" for the box shown, but the builder should, of course, check the dimensions of his box before cutting and bending the aluminum sheet.

Holes to permit the controls to pass through the end of the box are cut to 5/8" to allow free passage of the shafts. Shaft nuts are used only on the inner chassis panel holes. These holes measure 5/16". If the chassis is fitted properly in the case, in the inverted position shown in Fig. 3, mounting screws will jut into the free space below the box lid and the whole unit will fit snugly and have no tendency to rattle when the lid is closed.

The "E" batteries are fastened together with tape and mounted one on top of the other with a metal or cloth strap. The "A" battery was mounted vertically by means of an iron bracket which happened to fit—a similar bracket can easily be fashioned from aluminum or other scrap. The little 2" FM speaker is a readily available item. It will give surprisingly good volume and tone. Mount it on two spade bolts through the chassis in the position shown in Fig. 1. Its small output transformer is mounted below the speaker. If the builder is unable to secure an output transformer small enough to fit under the speaker, space for a larger unit may be made by moving the VR-V, subassembly forward.

Tuning capacitor C1 is a Hammerlund MCD-50-M, but any standard two-gang capacitor rated at about 3-35 mfd-per-section will work nicely. If the plate selected has more than the required capacity or if the tuning range is greater than needed, remove one or two plates from each stator and rotor section by prying them loose carefully with a long-nose pliers. The smaller the over-all capacity range, the greater will be the bandspread and the greater the ease of tuning.

Battery tubes capable of operating at TV and FM frequencies are not plentiful but the acorn type 957 works fine in the required range. Mount the tube by fastening the two "E" panels with a piece of stiff wire. Bend the wire downward to form a bracket and screw to the chassis. If microphones develop, wedge a piece of sponge rubber under the tube.

The other tubes are mounted on aluminum subassembly brackets: V6 on a 1 1/4" x 2" high bracket close to the volume control and V3 and V1, on a plate 2 1/2" x 2 1/4" near the speaker. Tie points support resistors R9, R16, and R2. It is important, particularly in wiring the first stage, to keep all leads as short as possible. When working with high-gain stages, oscillation problems arise quite frequently and therefore special care should be taken when wiring this circuit. The disc ceramic capacitors, specified in the parts list, are compact and inexpensive and of considerable assistance in eliminating crowding.

Circuit

The circuit diagram of the receiver is given in Fig. 2. The antenna is coupled through an insulated banana jack and a twisted-wire "gimmick" capacitor to the grid side of the superregenerative coil-and-capacitor combination, Lm-Cm. Wrap the gimmick wires together for about 1 1/2 inches. Lm is formed by winding 12 turns of #18 enameled wire over any 3/4" diameter shaft, clipping off the turns, soldering the ends to the capacitor stator lugs, and spacing the turns to a coil length of about 1 3/4". Correct frequency coverage is obtained when Lm and Cm tune together from 58 mc. (Channel 2 sound) to 108 mc. (High end of the FM band).

Such frequency-measuring devices as signal generators, grid-dip meters, etc., are useful but not essential in working out the frequency coverage. The important thing is to be sure the receiver tunes throughout the range of available TV and FM stations in your location in the channel 2-6 and FM range. This is best determined by an on-the-air check of the completed receiver. It is simple...
to make adjustments in \( L_n \) at any time.

The placement of parts and wiring is critical because of the frequencies involved. Note that the 957 detector tube is located on the opposite side of the tuning capacitor from \( L_n \). Grid lead resistor \( R_n \) and capacitor \( C_n \) connect from the 957 grid pin to the stator of \( C_n \) (grid side). A direct wire joins the plate pin to the plate side of the \( C_n \) stator from which plate isolating choke \( RFC \) connects to the filter \( C_n - RFC \) which eliminates the superregenerative "quench." Audio is developed across plate resistor \( R_n \) and coupled to the first audio amplifier, \( V_n \) through \( C_n \). RFCs and \( C_n \) keep r.f. from the other filament circuits. Both \( RFC \), and \( RFC \), may be small commercial high-frequency chokes or may be closewound with about 37 turns of \#30 enameled wire on the bodies of any \( \frac{3}{4} \)" diameter resistors of 500,000 ohms or more.

\( R_n \) provides the grid-leak bias for \( V_n \) and the volume control. \( R_n \) also functions as a plate resistor for this tube. One resistor and one coupling capacitor are saved by this arrangement. The center arm of \( R_n \) leading to the grid of \( V_n \) (through \( C_n \)) picks up any amount of the audio developed across \( R_n \) from zero to maximum.

The \( V_n \) stage is identical to that of \( V_n \) except for the fixed plate resistor, \( R_n \). Bias for the power output tube, \( V_n \), is obtained by returning the minus terminal of \( B_1 \) to the junction of \( R_n \) and \( R_n \). This gives about \(-3 \) volts fixed bias while the high value grid resistor \( R_n \) increases this slightly by grid-leak action when an audio signal is present. \( C_n \) and \( C_n \) are tone-control elements which cut down excessive high-frequency response in the small speaker. Observe that the filament of \( V_n \) must be wired in the parallel manner, with pin 5 grounded and pins 1 and 7 connected together. The "hot" side of all filament leads goes to one side of switch \( S \), which disconnects the tube filaments in the "off" position, thus automatically stopping the flow of "B+" current and cutting off all drain on both "A" and "B" batteries.

Some means was required to prevent "motorboating" feedback through the power supply in the three-stage, high-gain amplifier. The best practical solution proved to be the use of independent "B" batteries for \( V_n \) and \( V_n \). This arrangement is less wasteful of battery power than it seems. The drain on \( B_1 \) is only \( .15 \) ma. which means that the life of \( B_1 \) is practically shelf life. The drain on \( B_2 \) is \( 7 \) ma. Only \( B_2 \) will need to be replaced in normal use. The "A" battery should last several months and \( B_1 \) up to a year or more with moderate use.

**Hints on Adjustment**

The circuit and parts values for this portable have been carefully determined by design and experiment and (Continued on page 158)

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**Fig. 2.** Complete schematic diagram of the FM-TV sound portable. Antenna length is frequency sensitive and must be carefully determined. Parts are all standard.

**Fig. 3.** Rear view of receiver. Chassis is bent to fit lunch box.

**Fig. 4.** Completed receiver housed in an inexpensive metal box.
For fast servicing in the home and on the bench, use the test points described here.

All of the new RCA Victor black-and-white television receivers have totally new chassis which differ from previous years’ models. Representative of this new, completely restyled and refined group in the “Super” series is the 21-inch model 21T6082, the “Headliner,” shown in Fig. 1. The model 21T6082 uses a vertically mounted KCS96 chassis shown in Fig. 4. Some of the features of this chassis include five printed-circuit boards, a new synchronization stabilizer circuit, and the use of solderless, wrapped-wire connections.

This receiver includes many test points for rapid servicing checks. TP1, reached through an opening on the side of the tuner (see Fig. 2), is the oscillator injection and r.f. alignment test point. Oscillator injection voltage, measured with a vacuum-tube voltmeter should be from 2 volts (minimum) to 5.5 volts (maximum). The mixer grid test point, TP2, is used for i.f. alignment purposes.

The KRK30F u.h.f.-v.h.f. tuner, optional with this receiver, consists of a type KRK29H v.h.f. section and a separate “piggy-back” u.h.f. section. Continuously variable tuning is utilized when tuning u.h.f. A simplified “slow-fast” mechanism permits coverage of the entire u.h.f. television band in as little as 2½ seconds, yet provides vernier operation for fine tuning.

The u.h.f. tuning control also includes the RCA Victor “return without retune” feature. This means that, due to the operation of the clutch in the tuning mechanism, if a u.h.f. channel has been tuned in, the channel selector switch can be set to any v.h.f. channel and then, when desired, be returned to the previous u.h.f. channel without the need for retuning the u.h.f. channel. To service technicians in an area where both u.h.f. and v.h.f. stations are operating, such a tuning system is of great advantage when checking or comparing reception.

Five printed-circuit boards are used in the KCS96 chassis. These, made up as separate units, are designated as PC-101, which includes the sound i.f., ratio detector, first audio amplifier, and audio output; PC-102, three stages of picture i.f. and the second detector; PC-103, video amplifier and output, a.g.c. rectifier, 1st sync amplifier, and the noise cancellation circuit; PC-104 (shown in Fig. 3B), sync output, vertical oscillator, and vertical output; and PC-105, the horizontal sweep oscillator and control circuits. Note the novel method of showing the layout of each printed circuit board used in Fig. 3B. The printed boards are shown in such a manner that it is possible to “see through” the printed board. This greatly simplifies circuit tracing and locating components.

The individual components that make up each printed board should be replaced independently, when necessary. Only extensive damage to the printed connecting strips, or breakage of the board, would necessitate replacement of the complete board. When removing and replacing components, every possible precaution should be taken to prevent damage to the connecting strips. Soldering should be done with extreme care to prevent excess solder from causing shorts. If one of the connecting strips on the printed circuit board is cracked or broken, it may be repaired easily. A short length of tinned copper wire
should be placed across the break. The joint is then soldered by flowing solder over the break and the length of wire. A small soldering iron should be used since too much heat may cause a break or a short in the copper circuitry. 

Another new feature used in these receivers is the wrapped-wire connection. These connections consist of six or seven turns of wire, tightly machine-wrapped around special side stud bars. They are both electrically and mechanically equal or superior to conventional soldered connections and should not be considered to require soldering. However, when rewiring is necessary, or the original tightly wrapped connection has once been unwound, conventional soldering methods must be used to replace the connection. An enlarged view of a "wire-wrap" solderless connection is shown in Fig. 3A.

All check points on this chassis can be conveniently reached from the top (rear) of the chassis, without removing the chassis from the cabinet. By inserting a test probe through the openings at the printed circuit board mounting supports, and through the openings where the tubes extend through the chassis it is possible to measure tube pin voltages. Of course, caution must be exercised not to short the probe to the chassis while making "B+" measurements. The high voltage fuse is readily accessible and has a snap-in type mounting which, together with the other features described before, enables rapid, efficient, and convenient servicing.

The voltage chart, Table 1, provides a reference for locating the most common causes of receiver troubles.

<table>
<thead>
<tr>
<th>TUBE</th>
<th>CIRCUIT FUNCTION</th>
<th>TEST POINT</th>
<th>VOLTAGE (NO SIGNAL)</th>
<th>SERVICE PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>6AQ5</td>
<td>Audio output</td>
<td>Pin 5</td>
<td>187</td>
<td>If voltage is incorrect, check C118 (screen bypass) or R122 (cathode bias).</td>
</tr>
<tr>
<td>6DE6</td>
<td>1st pix i.f. ampl.</td>
<td>Pin 5</td>
<td>103</td>
<td>If no voltage, check pin 6; if voltage is normal at pin 6, check transformer winding.</td>
</tr>
<tr>
<td>6DE6</td>
<td>2nd pix i.f. ampl.</td>
<td>Pin 5</td>
<td>231</td>
<td>If no voltage, check pin 2; if voltage is normal at pin 2, check screen pin 6; if screen voltage is normal, check transformer winding.</td>
</tr>
<tr>
<td>6AS8</td>
<td>3rd pix i.f. ampl.</td>
<td>Pin 2</td>
<td>0</td>
<td>If voltage is present, check 3rd i.f. transformer, T101, for shorted winding.</td>
</tr>
<tr>
<td>6AS8</td>
<td>Pix 2nd detector</td>
<td>Pin 8</td>
<td>0.47</td>
<td>If voltage is too high, check T101.</td>
</tr>
<tr>
<td>6AQ5</td>
<td>Video output</td>
<td>Pin 5</td>
<td>171</td>
<td>If voltage is too high, check wiring for short to pin 6. If too low check T105 or R105 (plate 82).</td>
</tr>
<tr>
<td>BC87</td>
<td>Horizontal osc.</td>
<td>Pin 6</td>
<td>199</td>
<td>If voltage is incorrect, check R127-C180 (at pin 7).</td>
</tr>
<tr>
<td>EBQ6-GTB</td>
<td>Horiz. sweep output</td>
<td>Pin 5</td>
<td>-22.0</td>
<td>If voltage is incorrect, adjust C100, horiz. drive control, and check R10 (cathode bias).</td>
</tr>
</tbody>
</table>

*Measure with 1 megohm, ½ watt resistor in series with probe.  ** At minimum setting of volume control.
The recent action of Columbia Records in establishing a "Record Club", brings sharply into focus a situation which for some time now has been a matter of growing concern to the record companies. This has been the phenomenal mushrooming of many "record clubs", some of which were the offspring of some of the small record companies, and some of which were subsidiaries of well-known book clubs. Starting in a modest way and attracting little attention at first, these clubs have flourished to the extent that some of them can afford full page ads in magazines like Life and the Saturday Evening Post. What really jolted the big record companies were the fantastic statistics compiled at the close of 1954, which showed that these record clubs now took a 15 per cent bite out of the over-all record market, and even more incredible, they accounted for 35 per cent of total classical record sales!

Figures like these cannot be ignored and Columbia took a deep interest in getting into this chunk business and thereby set the record industry on its ear! Boy, you should hear some of the howls! Victor promptly announced they would not sponsor any record club, stating that this was unfair to the retail seller, who after all is "the bulwark of the industry, etc., etc." Some of the larger New York dealers (who have very little to lose since their thatness is largely mail-order anyway) filled The New York Times with ads supporting the new club. The smaller dealers, smoke pouring out of their ears, were making loud charges of the Columbia club and demanding that a company representative meet with them to discuss the matter. I understand some hapless individual was put in the back room, to what ends, I wouldn't know.

Some of the more hot-headed dealers gave the entire Columbia catalogue the heavy hand and flatly stated that as long as there was a Columbia record club, they would not stock Columbia records.

In format the Columbia club is much like the other clubs. You join by signing up at your local record shop (a sop to the dealer from Columbia) which entitles you to a free record from a prescribed group of recordings. For every two selections you buy, you get a special bonus record free. You do not need to buy more than four records per year. The records are mailed directly to your home (one of the dealers' pet gripes). Sounds like the old familiar pitch, doesn't it? What I personally think of this development is of little moment. I neither condemn nor condone the Columbia action. It is easy enough to see the issues from both sides. Columbia contends that their club will stimulate greater interest in records and that as a result more people will visit the record retailer. Certainly there is some validity in this concept. The retailer claims that the club will keep customers out of his store, and he will thereby lose sales, especially of the "impulse" type. His argument would also appear to have some merit. On the other hand, the dealers have displayed a strange apathy to the fact that once a person has signed up for the record club at a particular store, the dealer receives 20 per cent of the selling price of any records the customer buys at the time of joining and any records purchased in the future. Irrespective of who is morally right or wrong in this hassle, several facts are clearly evident for those who want to see them.

First of all, except for the bigger urban centers of population, the average record customer has not been able to buy his records at a discount. In essence, the Columbia club gives these buyers a discount, even if it is in the form of records rather than cash. The second thing that comes to mind is: who are these people who have joined these record clubs? I feel I am on fairly safe ground when I say that these people are outside of what is normally considered the record-buying public. These are the people to whom the old record price of $3.95 was just too much for their indulgence, and who probably feel that even the present price is pegged too high. There are lots of people who are not musically trained but "know what they like" and who will pay if the tariff is not too steep. Who can say what particular stimulus prompted their interest in classical music? After all, the average person probably has no idea what publicity about good music these days. Articles in digest type magazines, the women's magazines, stories on hi-fi in the Sunday supplements, have been a very large part of the stereotonic realism of Cinemara and CinemaScope movies, this is only part of the barrage that has been elevating our cultural level.

Now let's face a few facts squarely in the eye—many people are not musically erudite. With both good and bad records on the market today, they still can't appreciate the difference between a Toscanini performance and one by Joe Doakes if it bit them (I do not depereate these people for this, I am merely stating fact). It is for our great good that so many people have found that, whatever motivations are involved, they like to hear the Beethoven 5th or the Tchaikovsky 6th, etc. Now these people, like any other group, can be reached by advertising and be told what is good for them and what they should buy. That is the function of competitive interests and I leave that to them.

The golden opportunity for Columbia and any other equipment manufacturer, if they will just take the trouble to see if, it is this: not everyone can be a musicologist, or musically educated. But God gave everyone a set of ears and rich or poor, saint or sinner, most people hear all. The only way the musically uneducated can judge whether they like recording "A" better than recording "B" or vice versa is how it sounds to them! Now there is an intelligent, well-produced program with good quality records, good quality playback equipment sold at sensible prices and you have a huge new market.

In popular language with liberal use of visual aids, people should be educated to the whys and wherefores of a diamond stylus, the philosophies of separate enclosed speaker systems, what an analog tape does and why one unit must be higher priced than another, acoustical considerations in the average home or apartment, etc. There is a contention that this music is too demanding and will not absorb this sort of info, or that they don't give a toot. I flatly state that I could go into any town you want to name, even the reportedly "East Podunk"—the synonym for hicks with hayseed in their hair—give a lecture demonstration before the FTA and the garden club and the Lions, Kiwanis, Rotary, etc., and guarantee a fair percentage of converts to hi-fi music reproduction. As long as people can hear, most can perceive the difference between what is good and what is bad music. I insist that good home hi-fi quality can be manufactured and merchandised to sell at prices at the same or slightly higher levels than presently prevail. The manufacturer who has the money and the courage to follow through can do a deal like this has a gold mine waiting for him!

Getting back to the bigtime major label record clubs, I say I don't think they are here to stay and I predict that denials or no, other companies will soon be in the field. What the ultimate effect on the retail seller will be is hard to contemplate—have the pot simmer a while and I'll report on this again in a month or two.

Equipment Used This Month: New Pickering EP-3000 cartridges, The Marchant preamp, 30-watt McIntosh amplifier, Jensen "Imperial" speaker system.

SCHUMAN, WILLIAM SYMPHONY #6

PISTON, WALTER SYMPHONY #4


Every year Columbia issues a spate of recordings by contemporary American composers, which I personally find of great interest. I find much the same thing in this year's output, while in this series and much that, admittedly, is not the most inspired writing and even some which is downright pretentious. In music as in any other field, there is a great deal of chaff with the wheat, but good, bad, or indifferent the American composer deserves to be heard and Columbia is to be congratulated for it.

I heartily deplore the attitude displayed by certain pseudo-intellectual critics who think it is "smart and fashionable" to deprecate the works of our contemporary composers the same way as these critics sneer at the "poor musical illiterate" who happen to like Tchaikovsky's "Romeo and Juliet" or the "1812 Overture. No one should pay any attention to these flautant pundits—they all have a congenital dislike of any red-blooded, pulse-pounding music as it makes them sweat and stick even the gasket in their tiny ears! Well, now that I have gotten that off my chest, I can tell you that this recording is one of the most musically interesting and sonically exciting of the current crop. Schuman is a vital force in our contemporary musical society and his writing is unique for its rhythmic, propulsive force and intense emotionalism. (Continued on page 160)
New acoustic filtering keeps out ALL interference

- New turntable design principle, acoustic filtering, prevents speaker, building and motor vibrations from ever reaching the turntable. This frees record playing from distortion found in conventional systems.
- Center-gear drive, with torsional filtering, eliminates "garbling" of high frequencies which results from the flutter inherent in rim drive.
- Separate vernier control of each speed allows super-exact pitch adjustment. Convenient pushbutton selection of 33½, 45 and 78 rpm speeds.
- Optical stroboscope for extremely precise speed settings, even while record is playing.
- Built-in vibration isolation and pickup arm mounting system simplify installation.

**TECHNICAL SPECIFICATIONS**

- Rumble: more than 60 db below recording level — wow and flutter: less than 0.1% — built-in slip-clutch permits cueing — heavy non-magnetic cast aluminum turntable — heavy-duty special induction motor with dynamically balanced rotor — extremely low hum field — pickup arm mounting board furnished with turntable — dimensions: 16½" x 14½" x 7½" — accessory mahogany base $14.95* *Slightly higher west of Rockies.

The 310 FM Tuner, $99.95*

**Sensational FM Performance at a Best-buy Price**

There are NO weak stations with this new tuner

- Terrific 3-microvolt sensitivity makes distant stations sound as clear and strong as those nearby.
- New wide-band FM design gives super-selectivity, to separate stations so close together you would ordinarily pass right over them.
- Wide-band circuitry insures rock-steady, drift-free reception, so you never need readjust tuning.
- Automatic gain control always keeps tuner perfectly adjusted, no matter how the signal varies.

**TECHNICAL SPECIFICATIONS**

- 2-megacycle wideband detector — 2 stages of full-limiting — 80 db rejection of spurious response from cross-modulation by strong local signals — low-impedance output — equipped for multiplex — beautiful accessory case $9.95* *Slightly higher west of Rockies.

310 FM BROADCAST MONITOR TUNER

For perfectionists and connoisseurs, H. H. Scott offers the 310 FM tuner. High Fidelity Magazine says: The 310 "... is a tuner that seems as close to perfection as is practical at this time." The Audio League Report says: "The 310 is the most sensitive tuner we have yet tested." Price, including case $149.95 East Coast; $157.45 West Coast.
Hi-Fi Questions and Answers

By ED BUKSTEIN

What is high-fidelity?

To give it a formal definition, high-fidelity is that characteristic of a sound reproducing system which enables it to reproduce sound that is, as nearly as possible, like the original sound. The real test of a high-fidelity system is whether or not a listener can tell, without looking, that he is listening to a recording rather than a "live" orchestra. The listener can easily tell the difference, the system is low in fidelity. A high-fidelity system would reproduce the sound so authentically that only a trained listener could perceive the difference.

What is a "flat" sound system, and why is it desirable?

A sound reproducing system is said to be flat if it responds equally well to all of the frequencies applied to it. This is a prerequisite of high-fidelity sound reproduction. If the sound system is not flat (if it favors some frequencies over others), the tube, violin, or piccolo of an orchestra may sound disproportionately loud. Within limits, it is possible to compress the range of flatness in one system with another, with a consequent improvement in fidelity. For example, an amplifier with exaggerated low-frequency response may be used to partially compensate for a loudspeaker which is deficient in low-frequency response.

What is a mono-range loudspeaker?

Many high-fidelity systems use two loudspeakers, one for the high frequencies (the tweeter) and the other for the lows (the woofer). When only one speaker is used for the full spectrum of audio frequencies, it is known as a mono-range loudspeaker.

Hi-fi enthusiasts often talk about spatial distribution of a loudspeaker. What do they mean?

Spatial distribution refers to the directional properties of a loudspeaker. The run-of-the-mill loudspeaker concentrates the high frequencies in a narrow beam along its axis, while the low frequencies are dispersed over a wider angle. A listener directly in front of the loudspeaker will therefore hear the high notes as well as the lows, while a listener off to one side will hear the low notes only. A woofer-tweeter combination generally has a more uniform spatial distribution than a single speaker, although some mono-range loudspeakers are specifically designed for improved spatial distribution.

The input stage of a high-gain amplifier is sometimes shock mounted on rubber supports. What is the purpose of this arrangement?

Spatial distribution causes the elements to vibrate. This variation of the spacing of the tube elements causes the plate current to be modulated and results in a howl in the loudspeaker. Shock mounting of the tube base, and the use of sponge rubber or other sound absorbing material around the tube envelope, isolates the tube from sound waves and other vibrations. In addition, the tube should be a selected, low-microphonic type.

What is the purpose of a record compensator?

A record compensator is a circuit which boost the low frequencies and de-emphasizes the highs. This is necessary because the low frequencies are attenuated and the high frequencies are boosted during recording. Low-frequency attenuation is required to prevent the cutting stylus from swinging too far and cutting into adjacent grooves on the record, and high frequency pre-emphasis is used to improve the signal-to-noise ratio. Because of lack of standardization and agreement among recording companies, different degrees of compensation are required for records manufactured by different companies. For this reason, record compensators are provided with a switching arrangement to substitute part values and permit compensation for records issued under various domestic and foreign labels.

What is meant by the term "transient distortion" when applied to loudspeakers?

When a signal is suddenly applied to the voice coil of a loudspeaker, the cone does not instantly vibrate at the frequency of the applied signal. Further, when the signal is suddenly removed, the cone may continue to vibrate (like a tuning fork) for a length of time. As a result of these characteristics, the reproduced sound differs from the original, and this difference is referred to as transient distortion. The inability of the cone to stop vibrating as soon as the applied signal is removed is known as acoustic hangover, and causes each note to persist and merge with the next. This blurring of the sounds robs the reproduction of its clear and crisp qualities.

---

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10-day approval. In 10 days I will either send you $4.00 plus postage or return book promptly and owe nothing.

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Radio & Television News
ONLY really wide-range AM, plus super-selective FM

- Now you can receive the full 10 kc frequency range broadcast by the better AM stations. Entirely new IF and detector circuits make this possible for the first time.

- New AM detector insures distortionless reception even if stations modulate to 100%. Conventional detectors give distorted AM above moderate modulation percentages.

- Three-position IF-bandwidth switch for perfect AM reception under any signal conditions.

- New wide-band FM design gives super-selectivity to let you separate stations so close together you would ordinarily pass right over them.

- Wide-band design insures drift-free reception.

TECHNICAL SPECIFICATIONS

FM Section:
- 3 mv. sensitivity for 20 db quieting — 2-megacycle wideband detector — 80 db rejection of spurious cross-modulation response by strong local signals — automatic gain control — equipped for multiplex. AM Section:
- 3 mv. sensitivity — 10 kc whistle filter — extended frequency response to 10 kc — ferrite loopstick antenna — output jacks for binaural — beautiful accessory case $9.95* 
* Slightly higher west of Rockies.

Includes famous DNS — makes worn records sound new again

- Complete professional equalizer-preamplifier with magnificent new 30-watt power amplifier.

- Amazing, patented DNS (dynamic noise suppressor) eliminates record noise and rumble, but without losing audible music as fixed filters do.

- Seven-position record compensator exactly equalizes practically any record made.

- Unique features for tape-recording, with three special inputs for recording and monitoring.

- Special provision for playback of pre-recorded tape through your 210-D.

- Continuously variable speaker damping control.

TECHNICAL SPECIFICATIONS

Input selector for 3 high-level inputs, 2 low-level phone (magnetic), and one high-level phone (constant amplitude) — NARTB tape playback curve — frequency response flat from 19 cps to 35,000 cps — adjustable record-distortion filter — harmonic distortion less than 0.5% — first-order difference-tone intermodulation less than 0.25% — beautiful accessory case $9.95* 
* Slightly higher west of Rockies.

Write for FREE BOOKLET giving complete details on entire H. H. Scott line.

November, 1955
BARNEY stepped out of the picture show into a cloudy, chilly, November Sunday afternoon; but he felt good—very good, he told himself. Margie, his One and Only, had curiously forsaken him this weekend to visit a girl friend at the state college; and he had just evened the score by seeing a picture starring Marilyn Monroe, whom Margie disparagingly called "that woman" and whose name she would scarcely let Barney mention, yet whose pictures she somehow never missed.

And, he recalled with deep satisfaction, when the blonde star first slithered across the screen, his wolf whistle had topped the whole chorus. That would teach Margie to leave him all alone!

As he was passing Mac's Service Shop he noticed a light back in the repair department, and then he saw Mac, his employer, standing at the service benc and beckoning him to come in.

"Hey, Boss, don't you get enough of this sweat-shop during the week?" Barney wanted to know as he let himself inside with his key.

"Guess not," Mac admitted with a slow grin. "The wife is visiting her sister up in Chicago today, and I feel rather at loose ends. Finally I decided to come down here and do a little playing with the equipment with which we have to work all week long; and you know something? I'm getting a big kick out of it. Takes me back to when I was getting started in radio when I hardly had time to sleep or eat because I was so interested in experimenting. I had almost forgotten how much fun it is to work calmly, leisurely, and without interruption with good test equipment purely for the joy of seeing what you can do with it."

"Just exactly what have you been doing?" Barney pressed.

"For one thing I've been checking out the new wide-band scope we got a couple of weeks ago and which I have not had time to test."

"What do you mean 'checking it out'? All you have to do is read the specifications and you know what it will do."
HUM

HUSHING DESIGN

makes Mallory’s “25th Anniversary” model the quietest vibrator ever

TAKE a look inside the Mallory 25th Anniversary Vibrator—and you’ll see why it’s so free of mechanical hum. The vibrator mechanism “floats” in a bell-shaped rubber liner. Noise produced by the vibrating element just doesn’t have a chance of getting to the case or mounting plug.

That’s not all. The rubber cup at the plug end also “floats” in place... never touches the can at more than one point. Even the leads are designed to minimize transmitted noise.

The net result is the quietest-running vibrator you’ve ever seen... or heard. Its mechanical hum is actually less than the electrical noise emitted by the speakers of most auto radio sets. And it costs no more than previous Mallory models.

On every vibrator replacement job, treat your customers to the quietest performance on the market. Check your stock today... and call your local Mallory distributor for quick delivery.

*Pat. Pending
A NEW IN-CIRCUIT CAPACITOR LEAKAGE TESTER

A recent discovery about capacitor leakage resistance is the basis for the Simpson model 383 capacitor tester.

CAPACITOR leakage resistance is different from other types of resistance. The former is unstable, i.e., it can be made to change its value by subjecting it to a pulse of voltage. This principle is used in the new Simpson Electric Company model 383 capacitor leakage tester to detect deteriorating capacitors without disconnecting them from the circuit. The tester will detect a leaky capacitor even when it is shunted by a low value of circuit resistance.

Fig. 1 is the schematic diagram of the in-circuit capacitor leakage tester. The type 2050 tube is a thyratron in which the control-grid bias determines the point at which the tube will fire, and the actual firing is effected by the plate voltage. When the function switch (comprised of three sections ganged together) is in the "test" position, high voltage is fed to the plate of the thyratron. This voltage builds up to the firing potential at which time the thyratron fires, sending a large pulse of voltage across the 600 ohm resistor in its plate circuit and into the test circuit.

The meter is protected by the two bypass capacitors which also integrate the pulse to obtain a faster rise time. This pulse is then applied across the capacitor under test. Since the leakage resistance of a defective capacitor varies with the voltage across the capacitor, the meter will indicate a varying resistance in the external circuit.

In the "meter adjust" position, the meter is adjusted to the static characteristics of the circuit via an internal battery voltage.

Although this instrument is designed to check paper, mica, and ceramic capacitors ranging from 1 µfd. to .25 µfd., it can also detect intermittent resistors, transformer leakage from winding to core, and similar effects. This instrument will not check electrolytic capacitors, nor will it give a positive leakage indication when the unit under test is shunted by a coil.

When testing parallel or series networks of capacitors mixed with resistors, the amount of meter deflection across each capacitor will tell whether it is good or bad.

Fig. 1. Schematic diagram of the Simpson model 383 in-circuit capacitance tester.
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O-10 LABORATORY TYPE OSCILLOSCOPE: The world's largest selling oscilloscope kit, and the most successful oscilloscope in history. Designed especially for color and black-and-white TV service work. Its 5 megacycle bandwidth and new 500 Kc sweep generator readily qualify it for laboratory applications. Features easy-to-assemble etched metal circuit board construction.

WA-F2 HIGH FIDELITY PREAMPLIFIER: This is the world's largest selling hi-fi preamplifier kit. Features complete equalization, 5 separate switch-selected inputs with individual pre-ser level controls, beautiful modern appearance, high-quality components.

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BENTON HARBOR 15, MICHIGAN

November, 1955

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there is no substitute for
HEATHKIT QUALITY

YOU GET MORE: All first-run, top quality parts—the latest in electronic design—complete and comprehensive step-by-step assembly instructions with large pictorial diagrams and assembly drawings. Proven performance through the production of thousands of kits.

1 Heathkit ETCHED CIRCUIT
COLOR-TV

5" OSCILLOSCOPE KIT

This deluxe quality oscilloscope has proven itself through thousands of operating hours in service shops and laboratories. Features the best in components—and the best in circuit design.
Features amplifier response to 5 Mc for color TV work, and employs the radically new sweep circuit to provide stable operation up to 500,000 cps. In addition, etched metal, pre-wired circuit boards cut assembly time almost in half, and permit a level of circuit stability never before achieved in an oscilloscope of this type.
Vertical amplifiers flat within 2 db from 2 cps to 1 Mc, down only 1/2 db at 3.58 Mc. Vertical sensitivity is 0.025 volts, (rms) per inch at 1 Mc. Tube circuit employs a SUP1 CRT.
Plastic molded capacitors used for coupling and bypass—preformed and cabled wiring harness provided.
Features built-in peak-to-peak calibrating source—retrace blanking amplifiers—push-pull amplifiers and step-attenuated input.

2 Heathkit ETCHED CIRCUIT

5" OSCILLOSCOPE KIT

This is a general purpose oscilloscope for the more usual applications in the service shop or lab, yet is comparable to scopes costing many dollars more.
Features full size 5" CRT (5BPI), built-in peak-to-peak voltage calibration—3 step input attenuator—phasing control-push-pull deflection amplifiers—and etched metal pre-wired circuit boards.
Vertical channel flat within ±3 db from 2 cps to 200 Kc, with 0.09 V, rms/inch, peak-to-peak sensitivity at 1 Kc. Sweep circuit from 20 cps to 100,000 cps. A scope you will be proud to own and use.

3 Heathkit LOW CAPACITY

PROBE KIT

Scope investigation of circuits encountered in TV requires the use of special low capacity probe to prevent loss of gain, circuit loading, or distortion. This probe features a variable capacitor to provide correct instrument impedance matching. Also the ratio of attenuation can be controlled.

4 Heathkit ETCHED CIRCUIT

SCOPE DEMODULATOR PROBE KIT

Extend the usefulness of your Oscilloscope by observing modulation envelope of R.F. or I.F. carriers found in TV and radio receivers. Functions like AM detector to pass only modulation of signal and not signal itself. Applied voltage limits are 30 V. RMS and 500 V. DC.

5 Heathkit ETCHED CIRCUIT

3" OSCILLOSCOPE KIT

This compact little oscilloscope measures only 9½" H. x 6½" W. x 4½" D., and weighs only 11 lbs! Easily employed for home service calls, for work in the field or is just the ticket for use in the ham shack or home workshop. Incorporates many of the features of the Model OM-1, but yet is smaller in physical size for portability.
Employing etched circuit boards, the Model OL-1 features vertical response within ±3 db from 2 cps to 200 Kc. Vertical sensitivity is 0.25 V. RMS-inch peak-to-peak, and sweep generator operates from 20 cps to 100,000 cps. Provision for r.f. connection to deflection plates for modulation monitoring, and incorporates many features not expected at this price level. 8-tube circuit features a type 3GP1 Cathode Ray Tube.

HEATH COMPANY
A Subsidiary of Daystrom, Inc.
BENTON HARBOR 15, MICHIGAN

RADIO & TELEVISION NEWS
fill your test requirements WITH HEATHKITS

DESIGNED FOR YOU: Heath Company test equipment is designed for the maximum in convenience. Besides being functional, Heathkits represent the very latest in modern physical appearance, and incorporate all the latest circuit design features for comprehensive test coverage.

1 Heathkit ETCHED CIRCUIT VACUUM TUBE VOLTMETER KIT
Besides measuring AC (rms), DC and resistance, the modern-design V-7A incorporates peak-to-peak measurement for FM and television servicing.
AC (rms) and DC voltage ranges are 1.5, 5, 15, 50, 150, 500, and 1500. Peak-to-peak AC voltage ranges are 4, 14, 40, 140, 400, 1400, and 4000. Ohmmeter ranges are X1, X10, X100, X1000, X10K, X100K, and X1 megohm. Also a db scale is provided. A polarity reversing switch provided for DC measurements, and zero center operation within range of front panel controls. Employs a 200 µa meter for indication. Input impedance is 1 megohms.
Etched metal, pre-wired circuit board for fast, easy assembly and reliable operation is 50% thicker for more rugged physical construction. 1% precision resistors for utmost accuracy.

2 Heathkit 20,000 OHMS/VOLT MULTIMETER KIT
The MM-1 is a portable instrument for outside servicing, for field testing, or for quick portability in the service shop. Combines attractive physical appearance with functional design. 20,000 ohms/v. DC, and 5000 ohms/v. AC. AC and DC voltage ranges are 0-1.5, 5, 50, 150, 500, 1500 and 5000 volts. Direct current ranges are 0-10 µa., 15 ma., 150 ma., 500 ma., and 15 amperes. Resistance ranges are X1, X10, X100, X1000 providing center scale readings of 15, 1500 and 150,000 ohms. DB ranges cover -10 db to -45 db.
Features a 4½” 50 µa. meter. Provides polarity reversal on DC measurements. 1% precision resistors used in multiplier circuits. Not affected by RF fields.

3 Heathkit ETCHED CIRCUIT RF PROBE KIT
The Heathkit RF Probe used in conjunction with any 11 megohm VTVM will permit RF measurements up to 250 Mc with ± 10% accuracy. Uses etched circuits for increased circuit stability and ease of assembly.

4 Heathkit ETCHED CIRCUIT PEAK-TO-PeAK PROBE KIT
Now read peak-to-peak voltages on the DC scale of any 11 megohm VTVM with this new probe, employing etched circuit for stability and low loss. Readings made directly from VTVM scales, from 5 Kc to 5 Mc. Not required for Heathkit Model V-1A/VTVM.

5 Heathkit 30,000 VOLT D.C. HIGH VOLTAGE PROBE KIT
For TV service work or similar application for measurement of high DC voltage. Precision multiplier resistor mounted inside plastic probe. Multiplication factor of 100 on the ranges of Heathkit 11 megohm VTVM.

6 Heathkit HANDITESTER KIT
The Model M-1 measures AC or DC voltage at 0-10, 30, 300, 1000, and 5000 volts. Measures direct current at 0-10 ma. and 0-100 ma. Provides ohmmeter ranges of 0-2000 (20 ohm center scale) and 0-300,000 ohms (3000 ohms center scale). Features a 400 µa. meter for sensitivity of 1000 ohms/volt. Because of its size, the M-1 is a very handy portable instrument that will fit in your coat pocket, tool box, glove compartment, or desk drawer. Makes a fine standby unit in the service shop when the main instruments are in use, or is ideal for the hobbyist or beginner. An unusual dollar value.

HEATH COMPANY
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BENTON HARBOR 15, MICHIGAN

November, 1955
The Model TS-4 features a controllable inductor for all-electronic sweep, improved oscillator and automatic gain circuitry, high RF output, center sweep operation, and improved linearity. It sets a new high standard for sweep generator operation, and is absolutely essential for the up-to-date service shop doing FM, black-and-white TV, and color TV work.

Voltage regulation and effective AGC action insure flat output over a wide frequency range. Electronic sweep insures complete absence of mechanical vibration. Sweep deviation controllable from 0 up to 40 Mc, depending upon base frequency. Effective two-way blanking. Fundamental output from 3.6 Mc to 220 Mc in 4 bands. Crystal marker provides markers at 4.5 Mc and multiples thereof. Crystal included with kit. Variable marker covers from 19 Mc to 60 Mc on fundamentals, and up to 180 Mc on harmonics. Provision for external marker.

Heathkit LINEARITY PATTERN GENERATOR KIT

The new-design Model LP-1 produces vertical or horizontal bar patterns, a cross-hatch pattern, or white dots on the screen of the TV set under test. No internal connections required. Special clip is attached to the TV antenna terminals. Instant selection of the pattern desired for adjustment of vertical and horizontal linearity, picture size, aspect ratio, and focus. Dot pattern presentation is a must for color convergence adjustments on color TV sets.

Extended operating range covers all television channels from 2 to 13. Produces 6 to 12 vertical bars or 4 to 7 horizontal bars.

Heathkit LABORATORY GENERATOR KIT

The Heathkit Model LG-1 Laboratory Generator is a high-accuracy signal source for applications where metered performance is essential. It covers from 100 Kc to 30 Mc on fundamentals in 5 bands. Modulation is at 400 cycles, and modulation is variable from 0-50%. RF output from 100,000 µv. to 1 µv. 200 µa. meter reads the RF output in microvolts, or percentage of modulation. Fixed step and variable output attenuation provided. Features voltage regulation, and double copper plated shielding for stability. Provision for external modulation. Coaxial output cable (50 ohms).

Heathkit CATHODE RAY TUBE CHECKER KIT

This new-design instrument holds the key to rapid and complete picture tube testing, either in the set, on the work-bench, or in the carton. Tests for shorts, leakage, and emission. Features Shadowgraph test (a spot of light on the screen) to indicate whether the tube is capable of functioning.

The Model CC-1 tests all electromagnetic deflection picture tubes normally encountered in television servicing. Supplies all operating voltages to the tube under test, and indicates the condition of the tube on a large "GOOD-BAD" scale. Features spring loaded test switches for operator protection. The CC-1 is housed in an attractive portable case and is light in weight — ideal for outside service calls.

Heathkit DIRECT READING CAPACITY METER KIT

Not only is this instrument popular in the service shop, but it has found extensive application in industrial situations. Ideal for quality control work, production line checking, or for matching pairs. Features direct reading linear scales from 100 mmf to .1 mfd full scale. Necessary only to connect a capacitor of unknown value to the insulated binding posts, select the correct range, and read the meter. The CM-1 is not susceptible to hand capacity, and has a residual capacity of less than 1 mmf.

Heathkit TV ALIGNMENT GENERATOR KIT

Heath Company
A SUBSIDIARY OF DAYSTROM INC.
This is one of the biggest signal generator bargains available today. The tried and proven Model SG-8 offers all of the outstanding features required for a basic service instrument. High quality components and outstanding performance.

The SG-8 covers 160 Kc to 110 Mc on fundamentals in 5 bands, and calibrated harmonics extend its usefulness up to 220 Mc. The output signal is modulated at 400 cps, and the RF output is in excess of 100,000 uv. Output controlled by both a continuously variable and a fixed step attenuator. Also, audio output may be obtained for amplifier testing. Don't let the low price deceive you. This is a professional type service instrument to fulfill the signal source requirements in the service lab.

1. **Heathkit . . . IMPEDANCE BRIDGE KIT**

The IB-2 features built-in adjustable phase shift oscillator and amplifier, and has panel provisions for external generator. Measures resistance, capacitance, inductance, dissipation factors of condensers, and storage factor of inductance.

D, Q, and DQ functions combined in one control. 1/2% resistors and 1/2% silver-mica capacitors especially selected for this instrument. A 100-0-180 microfarad meter provides null indications. Two-section CRL dial provides 10 separate "units" with an accuracy of ±5%. Fractions of units read on variable control.

2. **Heathkit "Q" METER KIT**

The Heathkit Model QM-1 will measure the Q of inductances and the RF resistance and distributed capacity of coils. Emulates a 4½-50 microampere meter for direct indication. Will test at frequencies of 150 Kc to 18 Mc in 4 ranges. Measures capacity from 40 mmf to 450 nmf within ± 3 mmf. Indispensable for coil winding and determining unknown condenser values. A worthwhile addition to your laboratory at an outstandingly low price. Useful for checking wave traps, chokes, peaking coils, etc. Laboratory facilities are now available to the service shop and home lab.

3. **Heathkit 6-12 VOLT BATTERY ELIMINATOR KIT**

This modern battery eliminator will supply 6 or 12 volt output for ordinary automobile radios as well as 12 volts for the new models in the latest model cars. Output voltage is variable from 0-8 volts DC, or 0-16 volts DC. Will deliver up to 15 amperes at 6 volts, or up to 7 amperes at 12 volts. Two 10,000 mfd filter capacitors insure smooth DC output. Two panel meters monitor output voltage and current. Will double as a battery charger. Definitely required for automobile radio service work.

4. **Heathkit DECADE RESISTANCE KIT**

Twenty 1% precision resistors provide resistance from 1 to 99,999 ohms in 1 ohm steps. Indispensable around service shop laboratory, ham shack, or home workshop. Well worth the extremely low Heathkit price.

5. **Heathkit VIBRATOR TESTER KIT**

Tests vibrators for proper starting and indicates the quality of the output on a large "GOOD-BAD" scale. Checks both interrupter and self-rectifier types in 3 different sockets. Operates from any battery eliminator delivering variable voltage from 4 to 6 volts DC at 4 amps. Ideal companion to the Model BE-4.

6. **Heathkit DECADE CONDENSER KIT**

Provides capacity values from 100 mmf to 0.111 mfd in steps of 100 mmf. ± 1% precision silver-mica condensers used. High quality ceramic switches for reduced leakage. Polished birch cabinet. Extremely valuable in all electronic activity.

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**BENTON HARBOR 15, MICHIGAN**

November, 1955
The Heathkit Model TC-2 is an emission type tube tester that represents a tremendous saving over the price of a comparable unit from any other source. At only $29.50, you can have a tube tester of your own, even if you are an experimenter, or only do part time service work. Extremely popular with radio servicemen, it uses a 4½” meter with 3-color meter face for simple “GOOD-BAD” indications that the customer can understand. Will test all tubes commonly encountered in radio and TV service work.

Ten 3-position lever switches for “open” or “short” tests on each tube element. Neon bulb indicates filament continuity or short between tube elements. Line adjust control provided. The roll chart is illuminated. Sockets provided for 4, 5, 6, and 7-pin, octal, and loctal tubes, 7 and 9 pin miniature tubes, and the 5 pin Hytron tubes. Blank space provided for future socket addition. Tests tubes for opens, and shorts, and for quality on the basis of total emission. 14 different filament voltage values provided.

**Heathkit PORTABLE TUBE CHECKER KIT**

The Model TC-2P is identical to the Model TC-2 except that it is housed in a rugged carrying case. This strikingly attractive and practical two-tone case is finished in proxylin impregnated fabric. The cover is detachable, and the hardware is brass plated. This case imparts a real professional appearance to the instrument. Ideal for home service calls, or any portable application.

**Heathkit TV PICTURE TUBE TEST ADAPTER**

The Heathkit TV picture tube test adapter is designed for use with the Model TC-2 Tube Checker. Test picture tubes for emission, shorts, and thereby determine tube quality. Consists of 12-pin TV tube socket, 4 ft. cable, octal connector, and necessary technical data. (Not a kit.)

**CONDENSER CHECKER KIT**

Use this Condenser Checker to quickly and accurately measure those unknown condenser and resistor values. All readings taken directly from the calibrated panel scales without any involved calculation. Capacity measurements in four ranges from .00001 to 1000 mfd. Checks paper, mica, ceramic and electrolytic condensers. A power factor control is available for accurate indication of electrolytic condenser efficiency. Leakage test switch-selection of five polarizing voltages, 25 volts to 450 volts DC to indicate condenser operating quality under actual load conditions. Spring-return test switch automatically discharges condenser under test and eliminates shock hazard to the operator. Resistance measurements can be made in the range from 100 ohms to 5 megohms. Here again, all values are read directly on the calibrated scales. Increased sensitivity coupled with an electron beam null indicator increases overall instrument usefulness.

For safety of operation, the circuit is entirely transformer operated. An outstanding low kit price for this surprisingly accurate instrument.

**VISUAL-AURAL SIGNAL TRACER KIT**

This signal tracer is extremely valuable in servicing AM, FM, and TV receivers, especially when it comes to isolating trouble to a particular stage of the circuit under test.

This visual-aural tracer features a high gain RF input channel to permit signal tracing from the receiver antenna input clear through all RF, IF, detector, and audio stages to the speaker. Separate low-gain channel provided for audio circuit exploration. Both visual and aural indication by means of a speaker or headphone, and electron beam “eye” tube as a level indicator. Also incorporates a noise locater circuit for DC noise checks, and a built-in calibrated wattmeter (30-600 watts). Panel terminals provided for “patching” output transformer or speaker into external circuit for test purposes. Designed especially for the radio and TV serviceman. Cabinet size: 9½” wide x 6½” high x 5” deep. A real test equipment bargain.
Model HD-1

Used with a sine wave generator, the Model HD-1 will check the harmonic distortion output of audio amplifiers under a variety of conditions. Reads distortion directly on the meter as a percentage of the input signal. Operates between 20 and 20,000 cps. High impedance VTVM circuit for initial reference settings and final distortion readings. Ranges are 0-1, 3, 10, and 30 volts full scale. 1% precision resistors. Distortion scales are 0-1, 3, 10, 30 and 100% full scale. Requires only 3 volt input for distortion test.

**Heathkit AUDIO ANALYZER KIT**

This instrument consists of an audio wattmeter, an AC VTVM, and a complete IM analyzer, all in one compact unit.

Use the VTVM to measure noise, frequency response, output gain, power supply ripple, etc. Use the wattmeter for measurement of power output. Internal loads provided for 4, 8, 16, or 600 ohms. VTVM also calibrated for DBM units. High or low impedance IM measurements made with built-in 6KC and 60 cps generators. VTVM ranges are .01, to 300 volts in 10 steps. Wattmeter ranges are .15 mw. to 150 w. in 7 steps. IM scales are 1% to 100% in 5 steps.

**Heathkit AUDIO GENERATOR KIT**

This new Heathkit Model features step-tuning from 10 cps to 100 Kc with three rotary switches that provide two significant figures and multiplier. Less than .1% distortion. Frequency accurate to within ±5%.

Output monitored on a large 4½” meter that reads voltage or db. Both variable and step-type attenuation provided. Meter reads zero-to-maximum at each attenuator position. Output ranges (and therefore meter ranges) are .01, .03, .1, 1, 3, 10, 30 volts. Step-tuning provides rapid positive selection of the desired frequency, and allows accurate return to any given frequency.

**Heathkit AUDIO OSCILLATOR KIT**

(SINE WAVE — SQUARE WAVE)

The Model AO-1 features sine wave or square wave coverage from 20-20,000 cps in 3 ranges. It is an instrument specifically designed to completely fulfill the needs of the serviceman and high fidelity enthusiast. Offers high level output across the entire frequency range. Low distortion and low impedance output. Features a thermistor in the second amplifier stage to maintain essentially flat output through the entire frequency range. Produces an excellent sine wave for audio testing, or will produce good, clean, square waves with a rise time of only 2 microseconds.

**Heathkit RESISTANCE SUBSTITUTION BOX KIT...**

Provides switch selection of 36 RTMA 1 watt standard 1% resistors ranging from 15 ohms to 10 megohms. Numerous applications in radio and TV work, and essential in the developmental laboratory.

**Heathkit AC VACUUM TUBE VOLTMETER KIT...**

The Heathkit AC VTVM features high impedance, wide frequency range, very high sensitivity, and extremely wide voltage range. Will accurately measure a voltage as small as 1 mv. at high impedance. Excellent for sensitive AC measurements required by laboratories, audio enthusiasts and experimenters. Frequency response is substantially flat from 10 cps to 50 Kc. Ranges are .01, .03, 1, 3, 1, 4, 10, 30, 100, and 300 v. RMS. Total db range -52 to +32 db. Input impedance 1 megohm at 1 Kc.

**Heathkit CONDENSER SUBSTITUTION BOX KIT...**

Very popular companion to Heathkit RS-1. Individual selection of 38 RTMA standard condenser values from .0001 mfd to .22 mfd. Includes 18” flexible leads with alligator clips.

BENTON HARBOR 15, MICHIGAN

November, 1955
HEATHKIT HAM GEAR
for high quality at moderate cost

DOLLAR VALUE: You get more for your Heathkit dollar because your labor is used to build the kit instead of paying for someone else's. Also, the middleman's margin of profit is eliminated when you deal directly with the manufacturer.

1 Heathkit DX-100 PHONE & CW TRANSMITTER KIT
The reception given this amateur transmitter has been tremendous. Reports from radio amateurs using the DX-100 are enthusiastic in praising its performance and the high quality of the components used in its assembly. Actual "on the air" results confirm the careful design that went into its development.

The DX-100 features a built-in VFO, modulator, and power supplies, and is completely bandswitching for phone or CW operation on 160, 80, 40, 20, 15, 11, and 10 meters. All parts necessary for construction are supplied in the kit, including tubes, cabinet, and detailed step-by-step instructions. Easy to build, and a genuine pleasure to operate.

Employ push-pull 6C5's modulating parallel 6L6's for RF output in excess of 100 watts on phone and 120 watts on CW. May be excited from the built-in VFO or from crystals (crystals not included with kit). Features five-point TVI suppression: (1) pi network interstage coupling to reduce harmonic transfer to the final stage; (2) pi network output coupling; (3) extensive shielding; (4) all incoming and outgoing circuits filtered; (5) inter-locking cabinet seams to eliminate radiation except through the coaxial output connector. Pi network output coupling will match 50 to 600 ohm non-reactive load. Illuminated VFO dial and meter face. Remote control socket provided.

The chassis is made of extra-strong 1/16" gauge copper-plated steel. It employs potted transformers, ceramic switch and variable capacitor insulation, solid silver loading switch terminals, and high-grade well-rated components throughout. Features a pre-formed wiring harness, and all coils are pre-wound.

High-gain speech amplifier for dynamic or crystal microphones, and restricted speech range for increased intelligence. Plenty of audio power reserve.

Measured 20½" W. x 13½" H. x 16" D. Schematic diagram and complete technical specifications on request.

2 Heathkit VFO KIT
The Model VF-1 covers 160-80-40-20-15-11 and 10 meters with three basic oscillator frequencies. Better than 10-volt average RF output on fundamentals. Features illuminated and pre-calibrated dial scale. Cable and plug provided to fit crystal socket of any modern transmitter.

Enjoy the convenience and flexibility of VFO operation at no more than the price of crystals. May be powered from plug on the Heathkit Model AT-1 transmitter, or supplied with power from most transmitters. Measures: 7" H. x 6½" W. x 7" D.

3 Heathkit CW AMATEUR TRANSMITTER KIT
The Model AT-1 is an ideal novice transmitter, and may be used to excite a higher power rig later on. This CW transmitter is complete with its own power supply, and covers 80, 40, 20, 15, 11, and 10 meters. Features single-knob bandswitching, and panel meter indicates grid or plate current for the final amplifier. Designed for crystal operation or external VFO. Crystal not included in kit.

Incorporates such features as key click filter, line filter, copper-plated chassis, pre-wound coils, 32 ohm coaxial output, and high quality components throughout. Instruction book simplifies assembly. Employ 6AG7 oscillator, 6LA final amplifier. Operates up to 35 watts plate power input.

4 ANTENNA COUPLER KIT
The Model AC-1 will properly match your low power transmitter to an end-fed long wire antenna. Also attenuates signals above 36 Mc, reducing TVI. 32 ohm coax. input power up to 75 watts to 89 meters--tapped inductor and variable condenser--neon RF indicator--copper plated chassis and high quality components. Ideal for use with Heathkit AT-1 Transmitter.

HEATH COMPANY A Subsidiary of Daystrom, Inc.
BENTON HARBOR 15, MICHIGAN

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MODERN DESIGN: You can be sure of getting all the latest and most desirable design features when you buy Heathkits. Advanced-design is a minimum standard for new Heathkit models.

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November, 1955
EASY TO BUILD: The assembly instructions supplied with Heathkits are so complete and detailed that anyone can assemble the kits without difficulty. Plenty of pictorial diagrams and step-by-step instructions. Information on resistor color codes, soldering, use of tools, etc. Build it yourself with confidence!

1. **Heathkit ADVANCED-DESIGN**
   **HIGH FIDELITY AMPLIFIER KIT**

   The 25 Watt Model W-5 is one of the most outstanding high fidelity amplifiers available today—at any price. Incorporates the very latest design features to achieve true "presence" for the super-critical listener.

   Features a new-design Peerless output transformer, and KT66 output tubes handle power peaks up to 42 watts. The unique "tweeter-saver" suppresses high frequency oscillation. A new type balancing circuit results in closer "dynamic" balance between output tubes. Features improved phase shift characteristics and frequency response, with reduced IM and harmonic distortion. Color styling harmonizes with the Heathkit WA-P2 Preamplifier and the FM-3 Tuner.

   Frequency response—within ± 1 dB from 5 cps to 160 kc at 1 watt. Harmonic distortion only 1% at 25 watts, 20-20,000 cps. IM distortion only 1% at 20 watts, using 80 and 3,000 cps. Output impedance 1, 8, or 16 ohms. Hum and noise—99 db below rated output. Uses two 12AU7's, two KT66's and a 5R4GY.

   **KIT COMBINATIONS:**

   W-5M Amplifier Kit: Consists of main amplifier and power supply, all on one chassis. Complete with all necessary parts, tubes, and comprehensive manual. Shpg. Wt. 31 lbs. Express only.

   W-5M Combination Amplifier Kit: Consists of W-5M Amplifier Kit listed above plus Heathkit Model WA-P2 Preamplifier Kit. Complete with all necessary parts, tubes, and construction manuals. Shpg. Wt. 28 lbs. Express only.

   $59.75

   $79.50

2. **Heathkit DUAL-CHASSIS WILLIAMSON TYPE**
   **HIGH FIDELITY AMPLIFIER KIT**

   This is a very popular high fidelity amplifier kit that features dual-chassis type construction. The resulting physical dimensions offer an additional margin of flexibility in installation. It features the famous Acrosound TO-300 "ultra-linear" output transformer, and has a frequency response within ± 1 db from 6 cps to 150 kc at 1 watt. Harmonic distortion only 1% at 21 watts. IM distortion at 20 watts only 1.3% at 60 and 3,000 cps. Rated power output is 20 watts. Output impedance 4, 8, or 16 ohms. Hum and noise—88 db below 20 watts. Uses two 6SN7's, two 5881's, and a 5V4G.

   **KIT COMBINATIONS:**

   W-3M: Consists of main amplifier and power supply for separate chassis construction. Includes all tubes and components necessary for assembly. Shpg. Wt. 29 lbs. Express only.

   W-3: Consists of W-3M Kit listed above plus Heathkit Model WA-P2 Preamplifier described on opposite page. Shpg. Wt. 31 lbs., Express only.

   $49.75

   $69.50

3. **Heathkit SINGLE-CHASSIS WILLIAMSON TYPE**
   **HIGH FIDELITY AMPLIFIER KIT**

   This is the lowest priced Williamson type amplifier ever offered in kit form, and yet it retains all the usual features of the Williamson type circuit. Main amplifier and power supply combined on one chassis, and uses a new-design Chicago output transformer. Frequency response—within ± 1 db from 10 cps to 100 kc at 1 watt. Harmonic distortion only 1.5% at 20 watts. IM distortion at rated output, 2.7% at 60 and 3,000 cps. Rated power output is 20 watts. Output impedance 4, 8, or 16 ohms. Hum and noise—95 db below 20 watts. Uses two 6SN7's, two 5881's, and one 5V4G.

   Instructions are so complete that the kit may be assembled successfully even by a beginner in electronics.

   **KIT COMBINATIONS:**

   W-4AM: Consists of main amplifier and power supply for single chassis construction. Includes all tubes and components necessary for assembly. Shpg. Wt. 28 lbs. Express only.

   W-4A: Consists of W-4AM Kit listed above plus Heathkit Model WA-P2 Preamplifier described on opposite page. Shpg. Wt. 35 lbs. Express only.

   $39.75

   $59.50

HEATH COMPANY
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BENTON HARBOR 15, MICHIGAN

RADIO & TELEVISION NEWS

www.americanradiohistory.com
ATTRACTIONELY Styled: Heathkit high fidelity instruments are not only functional, but are most attractive in physical design. Such units as the preamplifier and the W-5 main amplifier are designed for beauty as well as performance. They blend with any room decor and are the kind of instruments you will be proud to own.

1 Heathkit HIGH FIDELITY PREAMPLIFIER KIT

This outstanding preamplifier is designed specifically for use with the Heathkit Williamson type amplifiers. It completely fulfills the requirements for remote control, compensation and preamplification, and exceeds even the most rigorous specifications for high fidelity performance.

Features five separate switch-selected input channels (2 low level and 3 high level), each with its own input control. Full record equalization with four-position turnover control and four-position rolloff control.

Output jack for tape recorder - separate bass control with 18 db boost and 12 db cut at 50 cps - treble control offering 15 db boost and 20 db cut at 15,000 cps - special hum control to insure minimum hum level - and many other desirable features. Overall frequency response (with controls set to "flat" position) is within 1 db from 25 cps to 30,000 cps. Will do justice to the finest available program sources. Beautiful satin-gold finish.

Power requirements from the Heathkit Williamson type high fidelity amplifier - 6.3 VAC at 1 amp, and 300 VDC at 10 Ma. Uses two 12AX7's and one 12AU7.

2 Heathkit 20-WATT HIGH FIDELITY AMPLIFIER KIT

This Heathkit Model offers you the least expensive route to high fidelity performance. Frequency response is ± 1 db from 20-20,000 cps. Features full 20 watt output using push-pull 6L6's, and incorporates separate bass and treble tone controls. Preamplifier and main amplifier are built on the same chassis. Four switch-selected compensated inputs and separate bass and treble tone controls provide all necessary functions at minimum investment. Features miniature tube types for low hum and noise.

Uses 12AX7, two 12AU7's, two 6L6G's and a 3V4G. A most interesting "build-it-yourself" project, and an excellent hi-fi amplifier for home use. Well suited, also, for public address applications because of its high power output and high quality audio reproduction. Another Heathkit "best-buy" for you!  

3 Heathkit 7-WATT AMPLIFIER KIT

The redesigned Model A-7D features a new type output transformer for tapped screen operation, and provides improved sensitivity, reduced distortion, and increased power output.

The full 7-watt output of the Model A-7D is more than adequate for normal home installations. Frequency characteristics are ± 1 1/2 db from 20 to 20,000 cps. Potted output and power transformers employed. Push-pull output - detailed construction manual - top quality parts - high quality audio without great expense. Output transformer tapped at 4, 8, and 16 ohms. Bass and treble tone controls provided on the front chassis apron.

Model A-7E: Provides a preamplifier stage with two switch-selected inputs and RIAA compensation for variable reluctance or low level cartridges. Preamplifier built on same chassis as main amplifier. Model A-7E. Shipping weight 10 lbs. $18.50.

BENTON HARBOR 15, MICHIGAN

November, 1955
HEATHKIT HIGH-FIDELITY FM TUNER KIT

MODEL FM-3

Shpg. Wt. 7 lbs. (with cabinet)

$24.50

The new Heathkit Model FM-3 features tremendous circuit improvements and brand new physical design. Sensitivity is better than 10 µV. for 20 db of quieting, and it employs a completely modern tube line-up for high gain and stable operation. Incorporates its own power supply, and has provision for low-level or high-level output at low impedance.

The attractive Model FM-3 matches the WA-P2 Preamplifier in color, styling, and physical size. Incorporates automatic gain control, a highly stabilized oscillator, and illuminated tuning dial. Educational treatment of construction manual simplifies assembly for the newcomer to electronics. IF and ratio transformers are pre-aligned, and the front-end tuning unit is pre-assembled and aligned. Uses 6BQ7A as a cascode type RF stage, 6U8 oscillator-mixer, two 6C56's as IF amplifiers, a 6AL5 ratio detector, a 6C4 audio amplifier, and 6X4 rectifier.

Features

- Brand New, Modern FM Circuit Using Latest Type Miniature Tubes.
- Low-Noise Cascade RF Stage-Two IF's-Ratio Detector-Stage of Audio.
- Extremely Good Sensitivity and Band-Pass for Outstanding Performance.
- Strikingly Attractive Satin-Gold Finish to Match Heathkit Model WA-P2 Preamplifier.
- Compact Physical Dimensions for Most Pleasing Appearance and Increased Circuit Efficiency.

HEATHKIT BROADCAST-BAND RECEIVER KIT

MODEL BR-2

$17.50

Less Cabinet

Shpg. Wt. 10 lbs.

Build your own radio receiver with confidence, even if you are a beginner. Complete instructions supplied. Features transformer-type power supply, high-gain miniature tubes, built-in antenna, 5½" speaker, and planetary tuning from 550 Kc to 1500 Kc. Adaptable for use as AM Tuner and phono amplifier. Educational treatment of the construction manual helps the beginner learn about radio circuits and parts as he builds.

CABINET: Fabric covered plywood cabinet with aluminum panel as shown. Part 91-9, Shpg. Wt. 5 lbs., $4.50.

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Radio & Television News

94

www.americanradiohistory.com
All of the care lavished on a TV stage set is taken in setting up this month’s cover photo.

The cover of this issue of Radio & Television News will be of small interest to anyone not concerned with the set, but it was of considerable importance to the people directly responsible for it. The TVN delegation was now to meet, in turn, seventeen people concerned with the set, from vice-presidents to stagehands! They embraced a full crew of artists, designers, scenic painters, costumers, prop men, carpenters, electricians, and again, Mr. Desfor and his staff photographer, Jack Zwillinger, quietly and efficiently looking after a thousand details. It was a model of magnificent organization.

The picture making then proceeded. Each time the model’s pose was changed at the photographer’s direction, the entire crew moved into action, as if carefully rehearsed for weeks, moving lights, cameras, and props. Without hearing an order given, every man acted as part of a well-oiled machine.

When a designer called for six feet more of floor area, a man moved in with a bucket of colored calcimine and a huge brush and with a few giant swipes it was done. What’s more, it was dry in two minutes. Another painter, looking askance at a wall mirror, gave the frame a fast coat of gold flake for authenticity. As the dramatic “production” proceeded, design plans and element charts were rechecked again and again.

Then the photographer wheeled his camera back for a shot of the crew at work—the picture of the picture, as it were. A dungareed stagehand stopped him.

“Can’t you hold this up a half-hour or so,” he asked, “till I shave and change to my tuxedo?”

When it was all over, Editor Read and his R & TVN assistants had the sensation that they had witnessed the tense drama of achieving the perfection demanded by one of NBC’s top-rated network shows.

A postscript about the Edison phonograph on the cover. It, along with other items in Read’s fabulous collection, was displayed at the Radio & Television News exhibit at the Audio Fair in New York.

For additional information on the evolution of the phonograph, see the article on page 58 of this issue.
When the recordings contain considerable distortion, and the recorded sound level is low, an improper recording bias is often responsible. If a voltage check verifies that this is the case, a defect in the oscillator coil, tube, or associated circuit may be the cause. In tape recorders where a bias adjustment is provided, the adjustment should be checked whenever the output tube is changed.

Insufficient erase can result in distortion. Playing back an erased but unrecorded tape will help determine if this is the source of trouble.

When the sound coming from the tape machine varies regularly in pitch, the symptom is referred to as either "wow" or "flutter," depending on the rate of variation. A pitch variation that occurs approximately once every second is generally described as wow. A variation that occurs ten times or so per second is called flutter.

Wow and flutter are most obvious when piano or organ music, or slow passages of music, are being reproduced. Any trouble that causes the tape to pass the record or reproduce head at a varying speed may produce flutter or wow.

Some common causes of flutter and wow are as follows (remedies are suggested in parentheses): slipping of idler wheel, due to dirt or oil on the rubber drive (clean wheel); idler not turning freely on shaft (lubrication needed); flat spot on idler wheel (replace wheel); tight feed or take-up spindle, pressure roller, or flywheel shaft (lubricate); insufficient tension on a flywheel belt (increase tension); sludge deposits on heads, capstan shaft, or capstan pressure roller (clean). Many other troubles similar to those described can produce flutter and wow.

Sometimes, wow and flutter may be due to excessive tape curl, resulting from uneven tightness of wind. Such edge curl may prevent the tape from following an even path as it passes the heads. Portions of the tape are apt to flap in passing, causing wow or flutter.

Flutter meters are commercially available which reveal the presence (or absence) of excessive percentages of flutter and wow. See Fig. 1.

A loud buzz or hum may be caused by a partial short to chassis in a motor bypass capacitor. Improper setting of a hum balance control may be responsible for excessive hum, as may cathode-to-heater leakage in a tube—particularly the one used in the first stage, or a defective ground connection. Loss of capacitance in a filter capacitor, of course, produce marked hum. Reversing the line plug will reduce the hum level in many instances where a slight but objectionable hum is audible.

Mechanical Trouble

Clutches are used in many tape recorders to keep the tape under proper tension and prevent slack or stretch. Clutches are driven by idler wheels at the rear or by clutch plates, as shown in Fig. 5. (Continued from page 67)

Fig. 4. Slip clutch system used in many tape recorders to keep the tape under proper tension and prevent slack or stretch.

Fig. 5. Brake used in "Webcor" recorder.
Introducing

THE FLUXVALVE PICKUP

the first really new pickup in a decade

The FLUXVALVE is made by perfectionists — for perfectionists. Literally the cartridge of the future, its unique design meets the demands of all presently envisioned recording developments, including those utilizing less than 1 mil styli.

There is absolutely nothing like it!

The FLUXVALVE Turnover Pickup provides the first flat frequency response beyond 20kc! Flat response assures undistorted high frequency reproduction—and new records retain their top "sheen" indefinitely, exhibiting no increase in noise. . . . Even a perfect sylus can't prevent a pickup with poor frequency characteristics from permanently damaging your "wide range" recordings.

With this revolutionary new pickup, tracking distortion, record and stylus wear are reduced to new low levels. The FLUXVALVE will last a lifetime! It is hermetically sealed, virtually impervious to humidity, shock and wear . . . with no internal moving parts.

The FLUXVALVE has easily replaceable styli. The styli for standard and microgroove record-playing, can be inserted or removed without use of tools.

For a new listening experience, ask your dealer to demonstrate the new FLUXVALVE . . . words cannot describe the difference . . . but you will hear it!

PICKERING & CO., INC. Oceanside, N.Y.

PIONEERS IN HIGH FIDELITY

"For those who can hear the difference"

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November, 1955
MORE POWER
35 Watts—RATED
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LESS DISTORTION
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Slightly higher West of Rockies

The NEW
Pilot
HI-FI
AMPLIFIER
Complete with Preamplifier and Tone Controls
Model AA-905

NEW 12-WATT AMPLIFIER
Allied Radio Corporation has released a newly restyled version of its "Knight Bantam" 12-watt amplifier.

Housed in a metal cabinet with cork-grain finish, the new amplifier is a perfectly matched companion for the company's "Bantam" FM-AM tuner or other basic tuner.

Ready for use on table top, mantel, or bookshelf, the "Bantam" can also be installed behind panels without removal from its metal cabinet. It measures only 3 1/2" x 13" x 10 1/2". There is a 3.3 megohm input for ceramic phonograph cartridges, a level control on the tuner input, and a variable damping control plus the other features incorporated in the predecessor model.

"MUSIC LOVERS" CARTRIDGE
A new cartridge which is said to eliminate the problem of induced hum, cartridge drug caused by magnetic attraction to steel turntables, etc., has been announced by Shure Brothers as its "Music Lovers" cartridge.

The definition is such that it will reproduce all instruments sharply and clearly yet there is a subtle softness that reproduces the original voice and music with a naturalness that is sought by hi-fi fans.

The cartridge features a "twin-lever" needle shift transport which eliminates cumbersome turnover mechanisms. It provides a lower mass and individual needle compliance for 78, 33 1/3, and 45 rpm response. Needle replacement is accomplished in seconds without need for tools.

15" COAXIAL SPEAKER
Stromberg-Carlson, a division of General Dynamics Corporation, has come out with a new 15" coaxial loudspeaker which will reproduce the full audio range from 30 to 20,000 cps without distortion.

The performance of the speaker and its low cost are attributed to a new concept of speaker construction wherein a 3/16 aluminum "voice ring" replaces the conventional voice coil and voice coil leads in the tweeter. The voice ring is attached to the apex of the high-frequency diaphragm and has

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37-06 36th St., Long Island City 1, N.Y.
Please send complete description of the new AA-905. I am also interested in the following literature:

☐ Pilot AM-FM tuners
☐ Other Amplifiers
☐ Pilot Component-Console Systems

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Profession:__________________________

RADIO & TELEVISION NEWS
no mechanical connection to the speaker circuits.

The RF-465 speaker will handle 35 watts throughout the entire frequency range and the angle of coverage exceeds 90 degrees.

3-WAY SPEAKER SYSTEM
Sherwood Electronic Laboratories, Inc. has announced the availability of a new low-distortion, 3-way speaker system with a 5½ cubic foot, curved-horn cabinet.

Designated as the "Forester," the new unit is based on the principle of complete acoustical and electrical isolation of each of three specially-designed speakers (12", 8", and 5") for covering the audio range with only .6% IM distortion at 10 watts.

The individual speakers and the 300-5000 cps, 12 db/octave electrical crossover are available in kit or assembled form. The cabinets are offered in fashionable contemporary, mahogany traditional with gold-tooled leatherette top and in French Provincial styles.

PORTABLE TAPE RECORDER
Especially designed for vacationers, doctors, lawyers, clergymen, teachers, comedians, etc. is the new "Melatone" portable tape recorder recently intro-duced by Raytronic Laboratories, Inc. housed in a lightweight (14 lb), 12 case which resembles a piece of age, the new recorder features a single knob control for rewind, fast forward, or playback with full stop and e positions. A side jack is available for connecting an external speaker. The unit may be used as a p.a. system, if desired. The recorder can be operated in either open or closed positions and comes equipped with a microphone with long cord, and a spare

New Sonotone 1P Cartridge

1. Easy to install. Just two models fit most arms now in use. Cartridge is less than 1" long, 8/10" wide with bracket. Time-saving hardware included.
2. Ceramic element gives flat response (see curve)—requires no preamplification or equalization. No deterioration problems with other types...virtually immune to hum pickup.
3. Replaceable needle, diamond or sapphire. Models for 33-1/2 rpm, or 78 rpm.
4. Extreme lateral compliance and low-mass design give superior tracking, low wear.
5. Needles snap in, snap out easily.

Tap the Huge 45 RPM Changer Market!
Install this new Sonotone 1P, and give your customers exciting, true, wide-range response. At one stroke, you make a good sale, cut installation time, avoid problems found with other types of cartridges...and build your reputation for quality work and professional advice. No other cartridge has all the advantages this 1P gives you! With sapphire, $7.50; with diamond, $25.00.

RESPONSE 30-15,000 ± 3 DB!

Sonotone Corporation
Elmsford, N.Y.

Write Dept. CN-115 for free Phono Modernization Manual

November, 1955
50-Watt, All-Triode!

THE LABORATORY STANDARD

FISHER AMPLIFIER MODEL 50-AZ

"Of the very best!"—High Fidelity Magazine. Will handle 100 watts peak. World's finest all-triode amplifier. Uniform response within 1 db from 5 to 100,000 cycles. Less than 1% distortion at 50 watts. Hum and noise content 96 db below full output—virtually non-measurable! Oversize components and quality workmanship in every detail. Includes FISHER Z-MATIC, at no additional cost.

$159.50

FINE ACCESSORIES

MIXER-FADER · Model 50-M
NEW! Electronic mixing or fading of any two signal sources (such as microphone, phone, radio, etc.) No interstriction loss. Extremely low hum and noise level. High impedance input; cathode follower output. 12AX7 tube. Self-powered. Beautiful plastic cabinet. Only $19.95

PREAMPLIFIER-EQUALIZER · 50-PR-C
WITH VOLUME CONTROL
50-PR-C. This unit is identical to the 50-PR but is equipped with a volume control to eliminate the need for a separate audio control chassis. It can be connected directly to a basic power amplifier and is perfect for a high quality phonograph at the lowest possible cost.

New, Low Price $19.95

HI-LO FILTER SYSTEM · Model 50-F
Electronic, sharp cut-off filter system for suppression of turntable rumble, record scratch and high frequency distortion — with absolute minimum loss of tonal range. Independent switches for high and low frequency cut-off. Use with any hi-fi system. New, Low Price $24.95

PREAMPLIFIER · Model PR-6
A self-powered unit of excellent quality, yet moderate cost. Can be used with any low-level magnetic cartridge, or as a microphone preamplifier. Two triode stages. High gain. Exclusive feedback circuit permits long output leads. Fully shielded. Uniform response, 20 to 20,000 cycles. The best unit of its type available. Only $10.95

Prices Slightly Higher West of the Rockies
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FISHER RADIO CORP. · 21-23 44th DRIVE · L. I. CITY 1, N. Y.

5" pickup reel. It will record at either 3 or 1½ ips as desired.

"MAGNETIC NOISERASER"
A device which operates through a carefully-engineering magnetic circuit and eliminates all signals and background noise on tapes has been introduced by Minnesota Electronics Corporation as its "Magnetic Noiseraser." Said to restore tape to a completely erased condition, the new unit permits indefinite useful tape life with a minimum of background noise. It also conditions new tape and increases dynamic range. Operation of the device is simple as it merely involves placing the entire reel on a spindle. A switch is turned on and the reel is slowly rotated manually through slightly more than one complete revolution. The spindle is then removed, the reel slowly drawn off the top surface of the instrument and then the switch is turned off. The entire operation takes approximately 15 seconds.

BOGEN SOUND EQUIPMENT
A new catalogue of public address amplifiers, sound systems, and sound accessories is now being offered by The David Bogen Co. Inc. as its Catalogue PA555.

The publication lists complete characteristics for the new "J" series of p.a. amplifiers and lists complete sound systems for permanent installations, both indoors and out, as well as portable systems.

Listed accessories include microphones, stands, cone speakers, trumpet speakers, wall bafles, line-to-speaker matching transformers, recessed bafles, rack mountings, and vibration isolating bases. Also included are portable phonograph units, transcription players, industrial high-power paging systems, and a music-instrument amplifier.

"PANASONIC" SPEAKER
R. I. Mendels, Inc. is handling the distribution of the new "Panasonic" Model 8P-W1, 8" speaker which has recently been introduced to the trade.

The new speaker provides a frequency response of 40 to 16,000 cps and features a patented phase equalizing globe for better high-frequency response, a patented elliptical corrugation of the cone to eliminate standing waves, and a cone with a super-compliant edge for exceptional low-frequency response.

The Model 8P-W1 has separate tweeter and woofer cones, coaxially mounted with a mechanical crossover.

RADIO & TELEVISION NEWS
and screening which develops optimum characteristics for use in speaker diaphragms. The woofers are made by applying different degrees of molding pressure so that different parts of the diaphragm have different mechanical resistances.

"CROWN LP" RECORDER

A new professional-type tape recorder has been introduced by International Radio & Electronics Corporation as the "Crown LP.

The company claims that this unit is the only 3-speed recorder and playback unit now on the market which uses 14" reels. The recorder incorporates a built-in amplifier and has 30 watts peak output. The .5 watt peak has less than 1% distortion. Outputs of 4, 8, and 16 ohms are available.

The "Crown LP" is designed for rack mounting and has a 19" x 21" panel. It meets all NARTB standards and has electromagnetic brakes for positive action and smooth stops. It will handle 15, 7½, and 3½ ips tapes (NARTB equalized) and 1½ ips tapes by means of a special speed reducer.

THE "ERICORDER"

The Ericsson Corporation is now marketing a push-button controlled tape recorder under the tradename "Ericorder".

Frequency response of the unit is from 40 to 13,000 cps. The wow is less than 3 per-cent. Tape speed is 7½ and 3½ ips and the unit records as a dual-channel instrument. At high speeds the recorder will handle 45 min-

November, 1955

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Immediate Sensation!

THE FISHER
Master Audio Control
SERIES 80-C

I took FISHER to improve on FISHER. When we introduced our Model 10-C Master Audio Control three years ago it was immediately acclaimed the finest instrument of its type. Like its renowned counterpart, the new FISHER Master Audio Control, Model 80-C, represents another milestone in engineering excellence, ease and flexibility of use, and workmanship of a quality normally encountered only in broadcast station equipment...these are its outstanding characteristics. It took FISHER to improve on FISHER.

Chassis Only, $99.50 • Mahogany or Blonde Cabinet, $9.95

 Remarkable Features of THE FISHER 80-C
• Professional, lever-type equalization for all current recording characteristics. • Seven inputs, including two Phone, Mic and Tape. • Two cathode-follower outputs. • Complete mixing and fading on two, three, four or five channels. • Bass and Treble Tone Controls of the variable-crossover feedback type. • Accurately calibrated Loudness Balance Control. • Self-powered. • Magnetically shielded and potted transformer. • DC on all filament; achieves hum level that is inaudible under any conditions. • Inherent hum: non-measurable. (On Phono, 72 db below output on 10 mV input signal; better than 85 db below 2V output on high-level channels.) • IM and harmonic distortion: non-measurable. • Frequency response: uniform, 10 to 100,000 cycles. • Separate equalization and amplification directly from tape playback head. • Four dual-purpose tubes, all shielded and shock-mounted. • Separate, high-gain microphone preamplifier. • Push-Button Channel Selectors with individual indicator lights and simultaneous AC On-Off switching on two channels (for tuner, TV, etc.) • Master Volume Control plus 5 independent Level Controls on front panel. • 11 Controls plus 5 push-buttons. • Three auxiliary AC receptacles. Size: Chassis, 12 1/2" x 7 1/2" x 4 1/2" high. In cabinet, 13-11/16" x 8 1/4" x 5 3/4" high. Shipping weight, 10 pounds.

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is needed for separating signal components which are close together while broad selectivity is advantageous when scanning the spectrum or when input signals contain small amounts of frequency modulation.

**AUDIO LEVEL INDICATOR**

A versatile vacuum-tube audio level indicator, the Model 5514, has just been introduced by Kilpatrick Electronic Laboratory.

Unlike conventional vu meters, the new indicator may be used anywhere in any audio system from preamplifier to speaker or recording head. The input impedance is 1 megohm and reference level (3% scale) is adjustable from 7 to 350 volts peak. Feedback stabilization makes the indication independent of line and tube fluctuations.

Adapter-cable assemblies are available for rapid connection at the power amplifier stage or connection may be made to the monitor or spare output jack. The Model 5514 is currently available in three styles: a 3½" panel mounting unit, a 4½" panel, and a 4½" portable unit.

**VIKING TAPE DECK**

Viking of Minneapolis is marketing a compact, inexpensive tape deck which provides a frequency response of 40 to 14,000 cps at 7½ ips. Used with a NARTB compensated equalizer amplifier, response will fully meet broadcast requirement for minimum distortion, flutter, and wow.

The Viking FM-5 tape deck uses a 1½ pound capstan flywheel, which is belt-driven from a floated motor plat-
America's TOP Tuner!

THE
FISHER
FM TUNER
MODEL FM-80

World's Best by LAB Standards

For almost two decades we have been producing audio equipment of outstanding quality for the connoisseur and professional user. In the cavalcade of FISHER products, some have proven to be years ahead of the industry. THE FISHER FM-80 is just such a product. Equipped with TWO meters, it will outperform any existing FM Tuner regardless of price! The FM-80 combines extreme sensitivity, flexibility and micro-accurate tuning. Despite its full complement of tubes and components, the FM-80 features an unusually compact chassis of fine design. Chassis Only. $139.50. Mahogany or Blonde Cabinet, $14.95.

Outstanding Features of THE FISHER FM-80
- TWO meters; one to indicate sensitivity, one to indicate center-of-channel for micro-accurate tuning.
- Armstrong system, with two IF stages, dual limiters and a cascade RF stage. Full limiting even on signals as weak as one microvolt.
- Dual antenna inputs: 72 ohms and 300 ohms balanced (exclusive!).
- Sensitivity: 1/2 microvolt for 20 db of quieting on 72-ohm input; 3 microvolts for 20 db of quieting on 300-ohm input.
- Chassis completely shielded and shock-mounted, including tuning condenser, to eliminate microphonics, and noise from otherwise accumulated dust.
- Three controls — Variable AFC/Line-Switch, Sensitivity, and Station Selector PLUS an exclusive Output Level Control.
- Two bridged outputs. Low-impedance, cathode-follower type, permitting output leads up to 200 feet. 11 tubes. Dipole antenna supplied. Beautiful, brushed-brass front panel.
- Self-powered.
- Weight: 15 pounds.
- Chassis Size: 12 3/4" wide, 4\(\frac{1}{4}\)" high, 8 1/2" deep including control knobs.

Price Slightly Higher West of the Rockies

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FISHER RADIO CORP. • 21-23 44th DRIVE • L. I. CITY 1, N. Y.

NEW FISHER AMPLIFIER

Fisher Radio Corporation has come out with a new 30-watt amplifier, the 80-AZ, which features the firm's "PowerScope" peak power indicator calibrated in watts in order to provide maximum speaker voice coil protection.

Distortion is less than .5% at 30 watts and less than .05% at 10 watts. The amplifier is capable of handling 60-watt peaks.

Response is uniform from 10 to 50,000 cps and ±1 db from 20 to 20,000 cps. 1M distortion is less than .5% at 25 watts and 2% at 10 watts.

There are three controls on the unit, "PowerScope", "Z-Matic", and "Input Level.

STEPHENS "SUPER TWEETER"

By popular request, Stephens Manufacturing Corporation is now making available its tweeter, normally used in its "Tru-Sonic" 152AX and 122AX coaxial speakers, as a separate No. 212 "Super Tweeter."

The new unit features the company's double exponential horn to assure wide, even dispersion of highs. It has a handspun aluminum diaphragm activated by a fully-enclosed magnetic structure. Smooth frequency response from 5000 to 18,000 cps is obtained with this tweeter.

"KNIIGHT" AM-FM TUNER

Allied Radio Corporation is now offering its low-cost "Knight" AM-FM tuner which has been designed as a companion unit to the 12-watt "Ban-tan" amplifier.

Since it is a "basic" unit it has only
two front panel controls, "tuning" and "function selector," making it ideal for use with amplifiers or preamps having full sets of controls. A third control, "output level," located on the rear panel, prevents overdriving the amplifier.

The highly sensitive, 7-tube plus rectifier, circuit provides good reception, even in weak signal areas. An automatic frequency control circuit locks in stations as their dial setting is approached. This feature also eliminates drift during tuner warm up.

AM-FM RECEIVER

David Bogen Co. Inc. has added an AM-FM receiver to its line of audio equipment. Known as the RR550, the new unit includes FM sensitivity of $2.5 \mu V$ for 30 dB quieting (70 ohm input measured using IRE standards). The AM sensitivity is 5 $\mu V$ for 20 db signal-to-noise ratio.

A tuning meter, which works on both AM and FM, is included along with an a.f.c. defeat switch on the panel. There is a built-in ferrite loop for AM and a built-in line antenna for FM.

Provisions are also made for the use of external antennas including 70 ohm unbalanced and 300 ohm balanced.

"DOUBLE-PLAY" TAPE

A new magnetic recording tape that will double the playing time over standard recording tape has been announced by ORadio Industries, manufacturer of the "Irish" brand of recording tape. The new tape will be known as the "Irish" Double-Play Recording Tape, No. T-2400.

Up to four hours can be recorded without a reel change at 1 1/2 ips and eight hours dual track. The 7" reel, standard with most home-type recorders, accommodates 2400 feet of the tape. The secret of the increased tape age is the use of the new .5 mil. "Mylar" film. It is virtually tear resistant, is unaffected by temperature extremes, and cannot dry out and embrittle with age.

"STATICMASTER" SYSTEM

Nuclear Products Company has developed a new "Staticmaster" system to meet the specific needs of broad-
casting stations where it is not always possible to take the time to neutralize
the static charge on the record to zero after the brush has eliminated surface dust.

The system consists of the company's standard record brush plus a special ionizing unit mounted on a polished chrome flexible arm and base. The brush is used to clean the records and neutralize all surface static electricity. The flexible arm permits accurately locating the ionizing unit so that the radiation is effective in maintaining the neutralization of the entire surface.

PROFESSIONAL TAPE UNIT
Tellectro Industries Corporation is now offering a new magnetic tape recorder-reproducer which has been especially designed for broadcast and high-fidelity applications.

The Model 1000 is a portable dual track recorder and reproducer which will operate at either 71/2 or 15 ips. Frequency response is 30 to 10,000 cps ± 2 db at 71/2 ips and 30 to 15,000 cps ± 2 db at 15 ips. Rewind time is one minute for 2400 feet of tape. The unit operates on 115 volts, 60 cycles.

3-SPEED TAPE DECK
Fenton Co. is again announcing a new tape deck, this model providing three speeds in a more elaborate layout.

Known as the "Brenell Hi-Fi" deck, the new unit has three independent motors driving the capstan, feed, and take-up reels and is provided with instantaneous mechanical braking. All braking, switching, and pinch-roller operations are positively interlocked in two simple control knobs.

The speed selection mechanism consists of a precision-ground capstan and a 2:1 ratio screw-on sleeve, permitting either 3¾ and 7½ ips or 7½ and 15 ips operation. The heads are completely shielded with Mumetal to eliminate 60 cycle hum and meet NARTEB requirements.

AUDIO ATTENUATOR
Cinema Engineering Company, a division of Aerosco Corporation, is in production on a new type of audio attenuator which features self-wiping contacts of nickel silver, carbon composition, and wire wound resistors.

The unit is available in 150, 250, and 600 ohms. The resistance element values are standard 5% accuracy. The audio ladder controls have a 6 db inherent insertion loss. All other network types of mixer controls have zero loss. Other tap units are available in potentiometer, "T," ladder attenuator networks. Controls are capable of handling levels of ± 30 dbm.

HARTLEY ENCLOSURE
Hartley Products Co. is currently marketing a newly-designed non-resonant enclosure which will house either one or two of the firm's non-resonant 215 speakers.

Available in either blonde or mahogany finishes, the unit includes a two-stage acoustic filter which eliminates air and cabinet vibration. The enclosure is 30" x 18" x 16" deep.

A.F. WAVE ANALYZER
Federal Telephone and Radio Company is handling the distribution of a new a.f. wave analyzer, the Type FT-FNA. The instrument is self-contained and includes an analyzer, two-axis recorder, filter, and other apparatus for complete manual or automatic frequency range.

The unit provides both narrow and wide band operation, offers logarithmic calibration.

(Continued on page 132)
ALLIED'S own KNIGHT ELECTRONIC KITS...

better by far... and you SAVE MORE

Get the most for your money in ALLIED'S KNIGHT Test Instrument Kits. Have the lab precision quality, the dependable accuracy, the professional styling you want—and SAVE MONEY.

KNIGHT Kits are the last word in electronic design and the easiest to build. Instruction manuals are a marvel of simplicity and clarity for quick assembly without guesswork. You need only a soldering iron, screwdriver and pliers to assemble and own these professional quality instruments. Build one and you'll want to own more of these fine matched units.

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November, 1955

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SERVICE technicians specializing in audio work and serious audiophiles require certain items of test equipment not normally found on the service bench in order to properly analyze the operation of audio equipment.

Among the test units most often used for audio servicing are the audio wattmeter, the a.c. vacuum-tube voltmeter, and the intermodulation analyzer. The recently-released Heathkit Model AA-1 audio analyzer offers all three of these important facilities in a single instrument. A separate audio oscillator is not required in view of the fact that this new instrument generates, within itself, two audio signals—a low 60 cycles and a high 6 kc. Both of these signals are brought out to individual binding posts and can be used separately for testing or mixed for IM measurements.

Rear view of instrument. Assembly requires careful attention to details.

This new unit tests power output, noise, gain, overload characteristics, and IM characteristics and offers non-inductive load impedances of 4, 8, 16, and 600 ohms, which may be selected by means of the "Load Selector" switch. A high-impedance position is provided for stage-to-stage or other high impedance circuit analysis.

The a.c. vacuum-tube voltmeter incorporates three stages which provide 10 millivolt full-scale sensitivity. Two diodes in a half-wave bridge supply the d.c. for the 200 µa. meter. The non-linearity of crystal diodes at low voltage levels is compensated by making the meter movement non-linear in the opposite direction. Another diode and variable resistor are shunted across the meter allowing adjustment of meter linearity, thus insuring decading accuracy.

Power measurements are made in conjunction with the a.c. vacuum-tube voltmeter and precision compensation networks to correct voltage in relation to power dissipated in the high-wattage load resistors. Since the power dissipated is related to the voltage out of the input network, the meter scale can be calibrated directly in watts. Power output can be read in dbm or watts on the red meter scales.

The intermodulation analyzer operates much the same as a broadcast radio receiver. Mixed high and low frequencies are fed to the analyzer which amplifies the high frequencies but rejects all low frequencies except those actually modulating the higher...
frequency. The modulated high-frequency signal is set to a predetermined level and is then detected or demodulated. The remaining signal appears as a low-frequency component and is passed through a low-pass filter to remove residual high-frequency components. The remaining signal is intermodulation and is indicated on the meter in percentage.

The power supply for the instrument consists of a full-wave 6X4 rectifier with filtered d.c. output. Plate voltages are supplied to the rectifier and filaments from the power transformer as well as voltages for the low-frequency signal source. Separate filtering systems are provided for the high-frequency oscillator and analyzer to insure complete isolation. The AA-1 is designed for 105-125 volts, 50-60 cycles. It draws 20 watts.

In addition to the “Load Selector” switch mentioned previously, the instrument has a “Function Selector” switch which controls all operations of the unit. In the first position, the input terminals are connected directly to the v.t.v.m. decade and the instrument operates as a 1-megohm input a.c. vacuum-tube voltmeter, unless the load selector is on one of the internal load positions. The next function is “Power” and the output of the wattmeter voltage-correcting divider is connected to the v.t.v.m. decade.

Measurement of the low- and high-frequency test level is done in the “LF-HF” test position of the switch. Initial adjustment for IM measurement is made with the switch in the “Set Level” position. In the full clockwise position, the v.t.v.m. decade is connected to the output of the IM analyzer and the low-frequency intermodulation component is read directly on the meter.

The v.t.v.m. decaying is handled by the “Range” switch. It controls all functions of the audio analyzer and the proper meter scales are marked on the front panel in terms of full-scale readings. Operating levels of the low and high frequencies can be checked individually by placing the test switch in the appropriate position.

The Model AA-1 uses five tubes. In kit form, it lists at $39.50.

---

Complete schematic diagram of the Heathkit Model AA-1 audio analyzer. The unit is powered by a full-wave rectifier with filtered d.c. output.
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The subtitle "From Tin Foil to High Fidelity" is indicative of the scope of this volume. Covering the entire phonographic era from 1877 to the present, this book is something of a tour de force. The author, who is New York Editor of High Fidelity magazine, spent years collecting his material and verifying his findings with many of the principals involved in the early experiments with recorded sound.

While most people are aware that all was not smooth sailing for Edison and his successors, few realize the downright "skullduggery" involved as well as the legal and commercial battles that shaped up before the industry was "tamed." In addition to the claims and counterclaims that were wafted around, the recording artists themselves added many colorful chapters to phono history.

Mr. Gelatt has told his story interestingly and well, drawing upon numerous anecdotes to point up his text. We believe that modern audiophiles will find this fascinating, as well as giving them a true appreciation of the fact that "they never had it so good!". The text material is illustrated with a number of historic photographs and some reproductions of the original sketches of equipment as submitted by the inventors in connection with their patent applications.

"SECOND THOUGHTS ON RADIO THEORY" by Cathode Ray of Wireless World. Published by Hilfre and Sons Ltd., London. Available in the U. S. from The British Book Centre, 122 E. 55th Street, New York 22, New York. 403 pages. Price $5.00.

Those who have access to the monthly British publication, Wireless World, will need no introduction to "Cathode Ray." For over twenty years he has conducted a monthly column devoted to the task of de-mystifying radio theory. That he has succeeded admirably in his self-appointed chore is attested to by the thousands of "fans" who consider the column "must reading.

In order to satisfy these devotees and introduce "Cathode Ray" to an even larger audience, some forty of his articles have been collected and compiled into this book which will serve admirably as a textbook for the beginner, a "refresher" course for the "old timer," and a reference volume for all who are interested in radio and electronics.

The author's style is completely informal with the text material written in the first person. Before the reader has gone five pages, the impression of a friendly discussion has been established with the result that it is possible to acquire a lot of valuable information painlessly.

The text covers an amazing amount of territory for so slender a volume, but we are willing to wager that readers of this book will add a surprising amount of "know-how" by the time they are through. Self-testing problems and answers have been included as an extra bonus.


This volume, written by Radio & Television News' Television Consultant, is for the practicing and experienced TV technician. Those without a thorough understanding of monochrome television principles will find this text rough sledding since the author has assumed that only those who really know their radio and black-and-white television circuitry will be able to "graduate" to servicing color receivers.

Because of this limitation in the scope of the volume, the reader is directed to the similarities and differences between monochrome and color receivers which precludes all discussion of basic television theory. This is a valid position inasmuch as the complex and relatively expensive color receivers will not be entrusted to the offices of the novice technician or apprentice.

Those whose background qualifies them for color service work will find this volume extremely helpful in preparing for the deluge that is sure to come or in the actual day-to-day servicing of existing receivers if the technician is operating in an active color market. The author covers the principles of colorimetry; color TV signals; the color TV system; picture tubes and their circuits; typical color receivers; antennas, tuners, and I.F. sections; the special circuitry unique to color; installation and troubleshooting procedures involving the actual receiver; and, finally, miscellaneous troubleshooting techniques.

The technician seeking an advantage over his less alert competitors will find this volume a real help in putting him ahead of the game for the new boom in color TV.


That many well-qualified and thoroughly-trained service technicians go into bankruptcy every year can not be attributed to a lack of knowledge of their subject but rather to their lack of "know-how" when it comes to the various business aspects of their operations.

So important are these "plus" techniques that the General Electric Company, in conjunction with Rider, has
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International Radio & Electronics Corp.
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prepared this handbook covering advertising, direct mail, and window and store displays.

The text material is chock full of practical, down-to-earth suggestions for service operations of all sizes and degrees of complexity. A variety of methods within each category is offered to permit the greatest possible flexibility of operations.

Technicians whose businesses show signs of seasonal slumps or have contracted alarming cases of "no-customeritis" should study the excellent suggestions offered in this handy manual and then, having put them into practice, watch their businesses grow.


This second book in the current "Q & A series" covers the servicing aspects of video circuits.

Since this text has been written for the benefit of practicing TV technicians as well as for would-be technicians, the presentation is practical rather than theoretical. The book is divided into five sections dealing with video i.f. amplifiers, video detectors, video amplifiers, d.c. restorers and a.g.c. circuits, and video i.f. alignment.

Each question (and they are all practical questions involving actual service cases) is followed by a concise answer which, in turn, is followed by a discussion in which the subject is enlarged upon and presented in greater detail for the benefit of the technician who desires more background data on the answer.

The text is illustrated by means of CR tube pictures, scope patterns, schematics, etc., for maximum utilization of the information contained in the body of the book.


This is a supplementary and companion volume to the same publisher's "Most-Often-Needed 1955 Television Servicing Information" which was released earlier in the year.

This latest handbook includes material recently released by the manufacturers, service data, changes in production models, as well as complete circuit and servicing information on a number of receivers which came out during the summer months. Sets from Admiral, Bendix, Capehart-Farnsworth, CBS-Columbia, Crosley, Emerson, General Electric, Hallicrafters, Hoffman, Motorola, Muntz, Olympic, Packard-Bell, Philco, RCA, Raytheon, Stromberg-Carlson, Sylvania, Westinghouse, and Zenith have been included in this new volume.

Service technicians will find this volume as complete and helpful as were the earlier volumes in this series. -50-
Hams to Participate in “Operation Deepfreeze”

MORE than 130,000 radio amateurs will vie for a chance to penetrate the Aurora Australis and swap QSL cards with men of the Navy’s “Operation Deepfreeze” in the Antarctic between March 1956 and February 1959.

Task Force Forty-Three will put out from East Coast ports late this fall in the first leg of setting up bases for American participation in the International Geophysical Year, 1956-1957. The first goal is the establishment early next year of two bases, Little America Station on Kainman Bay and an Air Operating Facility at McMurdo Sound.

The Seabees and aviation personnel put ashore in this first phase of the operation will be accompanied by communicators who will have been licensed to set up stations KC4USA at Little America and KC4USV at McMurdo Sound about March 1, 1956.

These bases will serve as springboards from which some 150 construction men will move overland to set up Byrd Station in Marie Byrd Land and from which aviators will air-shore men and materials to establish South Pole Station at the South Pole itself, when KC4USB and KC4USN will be out about March 1st.

Selected volunteers will “winter-over” at Little America Station and at the Air Operating Facility between February and December 1956 in order to get a head start on construction of the other bases before the task force ships can penetrate the pack ice in Phase Two. Scientists and supporting personnel will winter over at all bases between later phases of the operation.

This will be the first time American amateurs will have an opportunity to communicate with Americans in the Antarctic since the Byrd expedition in 1939 and the Finn Ronne expedition at Marguerite Bay in 1948. (No ham facilities were available in “Operation Highjump” during 1946-47.)

The FCC has allocated a block of call letters, KC4USA through KC4USZ, for use in the Antarctic in the event other ham stations become feasible. The Navy radio crew has acquired gear to operate c.w., voice, and single-sideband. They will operate on the 80, 40, 20, 15, 11, and 10 meter bands.

Chief Radioman A. B. Garrett, USN, has emphasized that the Navy is anxious to contact amateurs in the States who have sufficient power and phone patch facilities. Hams are asked to contact Commander Task Force 43, Attn: Staff Communications Officer, Room 831 Old Post Office Building, 12th & Pennsylvania Ave., N.W., Washington, D.C.

The Navy’s objective in providing the ham gear is morale. There will be 1500 men in the task force of which 150 will winter-over. It is in order to provide communications facilities for these men that the Navy is setting up this communications network.

The Navy amateur operators will fit their ham communications into their work routine on a recreational basis so they cannot predict at this time what hours they might be on the air. Nor can they predict when the Aurora Australis will work for or against good transmission or reception. Chief Garrett says that the Navy men will be on the air as often as possible and that by the time the task force puts to sea every radioman in his crew will have at least a general license.

Ham radio will be so important in “Operation Deepfreeze” that the Navy will give the amateur equipment preferential treatment in allocating valuable cargo space. The reaction of one veteran explorer and an ardent ham is that “No equipment could be considered more vital than ham equipment! What better morale instrument is there in the world than a chance to talk to the folks back home?”

The cooperation of all U.S. amateurs is sought for this project and it is to be hoped that, with their legendary spirit of helpfulness, amateurs will contact the group at the Washington address to offer their facilities for keeping the wintering-in Navy men in touch with home. Write today and give your name, address, call letters as well as details of your amateur equipment.

November, 1955
Fully 80% to 90% of tubes that have gone dim in service can be reactivated to furnish up to years of "bright as new" service.

GOODBYE "Rejuva-Tube" isn't just a gadget to give picture tubes a temporary shot in the arm — even most tubes that have gone "flat" using a booster can be rejuvenated.

PORTABLE — It's compact, light weight and easy to use. Check and rejuvenate picture tubes right in the set in a few minutes.

DEALERS! Now you can sell those "dim-out" trade-ins at a good profit.

SERVICEMAN! Sell rejuvenation service — it's a real money maker. Test and quickly rejuvenate picture tubes in the customer's home. An inexpensive instrument that protects your profit on service contracts.

PROVEN — Tubes rejuvenated experimentally over three years ago are still showing good pictures.

• Restores cathode emission and brightness.
• No guesswork — only device that meters cathode activity during rejuvenation. Tells you when to stop rejuvenation to prevent damage to cathode emitting surface. Built-in current limiter prevents accidental cathode ribbon burn-outs!
• Complete tester — detects open or shorted elements and leakage as high as 3 megohms between elements. High quality lab instrument style construction.
• Has special metered circuit to remove "particle" shorts between heater and cathode.
• Checks cathode emission and grid cut-off characteristics.
• Predicts approximate life expectancy of tube — identifies gassy tubes.

WRITE FOR MANUAL ON REJUVENATION WITH THE "REJUVA-TUBE"

TRANSISTOR PORTABLE
Raytheon Manufacturing Company's Television and Radio Division, Chicago, Illinois is in production on a new transistorized, twin-speaker portable radio receiver, the "Super-T."

The company estimates that the receiver will operate for 2500 hours, or two years' normal playing time, on a single "A" battery pack. It will also play for 500 hours on the power from four standard flashlight batteries in case an "A" pack is not available.

Completely portable, it can be used anywhere. Batteries slip easily into place. The set weighs 8 pounds, has a leatherette finish over a solid hardwood cabinet, a carrying handle, and a gold-finished speaker grille.

LINEARITY PATTERN GENERATOR
Heath Company of Benton Harbor, Michigan is currently in production on a new test instrument that has been designed specifically for the accurate adjustment of monochrome or color TV receivers.

The Model LP-1 linearity pattern generator provides an extended operating range which covers all television channels from 2 to 13 with the unused TV channel being used for linearity adjustments, even in metropolitan areas with several stations in operation. The unit employs a regulated power supply for stability and is characterized by high quality components throughout.

The instrument produces vertical or horizontal bar patterns, a cross hatch pattern, or a white dot pattern on the
Have you ever seen or heard of the Exponential Antenna? You have not, for until now it was unknown to the engineering world.

**WHAT IS EXPO?**

EXPO, the exponential antenna, represents an historical technical advance that eliminates the crippling frequency limitations of all known antennas by the use of exponentially curved elements.

The ultimate in antenna design! One antenna for all 82 channels with gains progressively increasing with increase of frequency. This principle recently discovered is the basic answer to the limited bandwidth problem. There is no need for multiple antenna installations or other expedients to gain slightly wider bandwidth operation.

**Higher gains**
- one antenna
- one transmission line
- one installation.

That is EXPO.

Servicemen will appreciate the ease and speed of installing EXPO:
- occupies less space — pleasing appearance — supreme performance. Its performance sells it for you.

Will you be among the first to see it perform? Consult your distributor, or for further information, write:

*Patent applied for.*

HOLLOWAY ELECTRONICS CORP.
Fort Lauderdale, Florida
Especially

where space is limited

TV receiver under test. No internal connections to the receiver are required. A special clip on the shielded output cable is merely attached to the antenna terminals of the TV set. A function switch provides instant selection of the pattern desired for adjustment of vertical and horizontal linearity, picture size, over-all aspect ratio, and focus. The unit will produce 6 to 12 vertical bars or 4 to 7 horizontal bars. The Model LP-1 is available in kit form and can be assembled in one evening.

TRANISTOR FOR HAMS

A new transistor, designed to meet the demands of radio amateurs, hobbyists, and experimenters for a stable and inexpensive unit, has been introduced recently by General Electric Company as the 2N107.

The new transistor is the first in a series that the company plans to market for the exclusive use of amateurs and hobbyists. It is a p-n-p audio transistor produced by the fused junction process. Others in the line will include i.f. and r.f. p-n-p units made by the fused junction process and r.f. n-p-n transistors made by the new regrown process.

A free booklet containing suggested circuits for using the 2N107 is available from the distributors stocking the transistor.

PROGRAM TIMER

Gorell & Gorell of Haworth, New Jersey in now offering a patented timer and programming instrument which provides ten instantly-selected speeds: 1, 5, and 15 minutes, 1, 4, and 12 hours, 1 and 2½ days, and 1 and 4 weeks.

In operation it is only necessary to slide the pickup gear along its shaft to select the desired speed. The cam or program disc up to 6" diameter can be obtained for use with any reasonable number of switches. The 6" program disc will handle 10 switches.

Other models are available with 13 speeds. Over-all speed range is more than 40,000 to 1.

Write for a data sheet giving complete information on this "M. G. Timer."

ELECTRONIC SYMBOLS TEMPLATE

A. Lawrence Karp, 16 Putnam Park, Greenwich, Conn. is now offering a new "Electronic Symbols Template" to the industry.

The new unit carries the engraved symbols that are most commonly used in the industry and are the most difficult and time-consuming to draw. The template includes switches, rectifiers, coils, transformers, heaters, rheostats, antennas, capacitors, fuses, batteries, solenoids, sockets, tubes, plugs, and thermal overload marks.

The template is engraved on .030 vinyl plastic and measures 7" x 5".

Write the company for full details on this and other electronic and communications templates in the line.

PASTE SOLDER

Mico Instrument Company, 83 North Trowbridge Street, Cambridge, Massachusetts has developed a new non-corrosive paste solder especially for the electrical and electronic equipment industries.

The new product consists of powdered solder suspended in a non-corrosive flux that can be used for all delicate soft-soldering operations as well as routine tasks. It cleans, tins, and solders in one operation. The flux residue is non-corrosive. The paste solder comes in ¼ and ½ pound sizes.

PORTABLE P.A. UNIT

Associated Designers, 135 East Las Tunas Drive, San Gabriel, California is now offering a compact, 10-watt public address amplifier that operates from either a 6 or 12 volt battery.

Known as the "Portavox," the unit is built for use in automobiles, boats, etc. It is rugged, small, and is built in two packages which fasten together forming a single unit, if desired. Frequency response is 60 to 12,000 cps. All controls are on the amplifier section panel which measures 2½" x 5½".

Power may be supplied from the cigarette lighter receptacle on the car dash.

The manufacturer will supply complete specifications on request.

COLOR BAR-DOT GENERATOR

Hycon Mfg. Company, 365 South Arroyo Parkway, Pasadena, California is now marketing a new color bar-dot generator which simplifies the adjustment, testing, and troubleshooting of color television receivers.

Every color sequence and linearity adjustment necessary for optimum re-
ADVANCE! Raise your earning power—learn
RADIO-TELEVISION-ELECTRONICS
by SHOP-METHOD
HOME TRAINING

GOOD JOBS AWAIT THE
TRAINED RADIO-TV TECHNICIAN
There is a place for you in the great Radio-Television-
Electronics industry when you are trained as National
Schools will train you at home!
Trained technicians are in growing demand at good pay
—in manufacturing, broadcasting, television, communica-
tions, radar, research laboratories, home Radio-TV service,
and other branches of the field. National Schools Master
Shop-Method Home Training, with newly added lessons
and equipment, trains you in your spare time, right in
your own home, for these fascinating opportunities.
OUR METHOD IS PROVED BY THE SUCCESS OF
NATIONAL SCHOOLS TRAINED MEN, ALL OVER
THE WORLD, SINCE 1905.

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

National Schools Training is All-Embracing
National Schools prepares you for your choice of many
job opportunities. Thousands of home, portable, and auto
radios are being sold daily—more than ever before. Tele-
vision is sweeping the country, too. Co-axial cables are
now bringing Television to more cities, towns, and farms
every day! National Schools' complete training program
qualifies you in all fields. Read this partial list of opportu-
nities for trained technicians:
Business of Your Own • Broadcasting
Radio Manufacturing, Sales, Service • Telemarketing
Television Manufacturing, Sales, Service
Laboratories: Installation, Maintenance of Electronic Equipment
Electrolysis, Call Systems
Garages: Auto Radio Sales, Service
Sound Systems and Telephone Companies, Engineering Firms
Theatre Sound Systems, Police Radio
And scores of other good jobs in many related fields.

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

November, 1955
YOU can't BURN it out!

HICKOK
MODEL 455

- Exclusive overload cut-out system.
- Protection of all practical ranges.
- Protects meter and entire internal circuit against accidental burn-outs.

"Greatest engineering achievement in VOM history

Latest Design

VOLT-OHM-MILLIAMMETER

The Model 455 is a new portable multimeter that incorporates the latest engineering advancements including the new technique that protects both meter and the entire internal circuit against accidental burn-outs. In fact, any high voltage or current may be applied directly across any function, including ohms, without danger to the meter movement or associated components.

This instrument is available in two models: Industrial Model 455... has a sensitivity of 20,000 ohms per volt AC or DC; Audio Model 456... has a sensitivity of 20,000 ohms per volt DC and 1,000 ohms per volt AC. The 456 also includes dB ranges and provision for output measurements.

THE HICKOK ELECTRICAL INSTRUMENT CO.
10524 Dupont Avenue • Cleveland 8, Ohio

Ask for a demonstration of this most practical YOM from your Radio-Electronic Parts Jobber today!... Or write direct for technical details.

ceiver performance is available in this one compact instrument which is suitable for both production-line testing and in-the-home servicing.

Three color sequences are offered, each graphically portrayed on the instrument's front panel for ease in identification. Color band "A" is the complete NTSC sequence, band "B" has four bars (G-Y at 90 degrees, R-Y, B-Y, and black) while band "C" consists of black, I, Q, black. Quadrature signals are held within 1 degree. All three color sequences are selected by means of a single, front-panel control. Linearity adjustments, convergence adjustments, and standard synchronizing signals are all provided. The completely portable, self-contained tester weighs 22 pounds and measures 8½" x 11" x 13\%".

CONTROL LUBRICATOR
R-Columbia Products Co., Inc., 305 Waukegan Ave., Highwood, Illinois is now offering a new tool that cleans and lubricates TV or radio controls in sixty seconds or less.

Known as the "TrolMaster," the unit is designed to save technicians' time since it is not necessary to remove the cabinet from the set or to take the back off the cabinet. The procedure is simple, involving the removal of the control knob and the application of the solvent by means of the tool. The unit works on either single or dual controls. By the addition of a simple adapter which screws into the "TrolMaster," it can also be used to clean and lubricate auto radio controls.

For complete details on this tool and the recommended solvents to be used with the device, write the company for a copy of its Bulletin No. 21.

SHORT-WAVE RECEIVER
David Bogen Co., Inc., 29 Ninth Avenue, New York 14, N. Y. is now offering a new high-fidelity AM receiver for use on short-wave and standard broadcast bands.

The RR29 is an 11-tube, 6-band superheterodyne receiver which is available in chassis form or housed in a mahogany cabinet complete with two loudspeakers as the Model RR29W. It is designed to operate on 110 volts d.c. and 110, 150, and 220 volts, 50-60 cycles a.c. The short-wave frequencies from 4.7 to 18.1 megacycles are covered in

RADIO & TELEVISION NEWS
BARGAINS — BARGAINS! Look at these unbelievably low prices. Our entire stock of reconditioned, "good-as-new" equipment must go at these drastically reduced prices. All units have been carefully checked. All bands and functions on receivers and all ranges on test equipment are guaranteed to meet manufacturers' original tolerances when shipped to you. Although this is only a partial list of our huge inventory, bargains like these simply will not last. Don't miss the boat — write, wire, phone, or use the handy coupon today! All merchandise subject to prior sale so please indicate first and second choice when ordering.

COMUNICATIONS EQUIPMENT

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Price</th>
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<td>Central Electronics 20A</td>
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<td>199.50</td>
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<tr>
<td>Collins 32V1 Transmitter</td>
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<td>29.50</td>
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<tr>
<td>Collins 32V2 Transmitter</td>
<td></td>
<td>29.50</td>
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<tr>
<td>Collins 32V3 Transmitter</td>
<td></td>
<td>49.50</td>
</tr>
<tr>
<td>Collins 32SA1 with speaker</td>
<td></td>
<td>29.50</td>
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<td>Collins 32SA2 with speaker</td>
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<td>29.50</td>
</tr>
<tr>
<td>Collins 32SA3 with speaker</td>
<td></td>
<td>49.50</td>
</tr>
<tr>
<td>Collins 310B1 Exciter</td>
<td></td>
<td>150.00</td>
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<td>Collins 310B3 Exciter</td>
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<td>Elmo AS4 Mobile Transmitter</td>
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<td>Elmo PMR6A Mobile Receiver</td>
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<tr>
<td>Elmo PMR12A Mobile Receiver</td>
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Full stock of Elmo power supplies.

Write for prices.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Price</th>
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<tr>
<td>Heath</td>
<td>AT1 Transmitter</td>
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<td>Viking I - Wired</td>
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<td>WRL Globe Trotter</td>
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<tr>
<td>Zenith</td>
<td>Transceivers Clipper less battery</td>
<td>42.50</td>
</tr>
</tbody>
</table>

TEST EQUIPMENT

Detects 67 Geiger Counter | 92.50|

Superior TV Tube Tester | 32.50|

Radion FM5000 Field Strength Meter | 34.50|

DYNAMOTOR BARGAIN

Brand new government surplus 12 VDC input, 600 VDC, 600 MA output. Can be filtered with 2 mil paper condensers. Starting relay not included, but has a snap-on mounting plate with Jones 5" x 8" slot for input and output leads. Sizes: 5" x 4" in., 8" in., 10" in. Only... $34.95

CROSS HATCH GENERATORS

Hickok 620 | 49.50|

Superior Cross Bar | 17.50|

SIGNAL GENERATORS

Approved Electronics A100 | 14.50|

Approved Electronics A200 | 17.50|

General Electronics H200 | 17.50|

Heath | Model D | 19.50|

Heath T52 | Wired | 27.50|

Hickok 208X | 89.50|

Johnson TVG-1 | 179.50|

RCA 195 | 39.50|

Precision E200 | 25.50|

Precision E400 | 79.50|

RCA W595A | 29.50|

RCA W596A | 124.50|

Superior TV30 | 17.50|

Supreme 571 | 19.50|

Triplet 3433 | 39.50|

Vision Research TS950 | 19.50|

VACUUM TUBE VOLTMETER

Jackson 109 | 27.50|

Jackson 645 | 27.50|

RCA 165 | 27.50|

RCA 195 | 39.50|

SIGNAL TRACERS

Foster T51 | 17.50|

Heath T2 | Wired | 17.50|

McCurdy Silver 900 | 17.50|

Precision Electronics 201 | 17.50|

CONDENSER CHECKERS

Wire for complete list.

OSCILLOSCOPES

Dumont 164E 3 inch | 29.50|

Dumont 208 3 inch | 79.50|

Dumont 224A 5 inch | 59.50|

Eico 425 | Wired | 44.50|

Eico 470 | Wired | 47.50|

Heath 66 | Wired | 44.95|

Heath 95A | Wired | 74.50|

Hickok 155A | Wired | 79.50|

HUNDREDS OF ADDITIONAL GOOD BUYS IN USED COMMUNICATION AND TEST EQUIPMENT. SEND FOR COMPLETE LIST.

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November, 1955
INTERNATIONAL'S
NEW
TV RECTIFIER
REPLACEMENT
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FREE!
NYLON TV TOOL
With every pack of 4 TV Selenium Replacement Rectifiers...
A PAIR and a SPARE PAIR!

You can't miss with International's New "BONUS PACK"! You'll get the best in TV replacement rectifiers. Each BONUS PACK contains a pair for immediate use, and a spare pair for your next job—PLUS a Nylon TV Alignment Tool worth $1.00—ABSOLUTELY FREE!

SPECIFY INTERNATIONAL RECTIFIERS for long, dependable performance—the Widest Range in the Industry! Best for you... Best for your service customers!

Ask your distributor for details about "Bonus Pack" today!

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WORLD'S LARGEST SUPPLIER
OF INDUSTRIAL METALLIC RECTIFIERS

five bands with the sixth band covering standard broadcasts.

The r.f. frequency response is 40 to 4000 cps within 3 db and power output is 2 watts at 2 per-cent distortion. Bandwidth is 8 kc for 3 db and 20 kc for 56 db attenuation. Sensitivity is rated at 1 microvolt and 30 microvolts for 6 db and 40 db signal-to-noise ratios respectively. Separate inputs are provided for phono and auxiliary sources.

TV SERVICE KIT
The Electronics Distributor Division of Erie Resistor Corporation, Erie, Pa., has added a "Ceramic" TV service kit to its line of kits for technicians. The new kit consists of an assortment of 62 general-purpose high-voltage and bypass disc "Ceramics"; temperature-compensating tubulars, printed circuits, and high-voltage filter units packed in a convenient 18-section plastic case. The capacitors selected are those the service technician requires most frequently.

"POSTAGE STAMP" TOROIDS
Hycoy Company, Inc., 11423 Van-owen Street, North Hollywood, California has added a new unit, which has been designed specifically for use in printed circuitry, to its "Postage Stamp" toroid coil series.

The tinned No. 20 AWG wire leads of the new coils are spaced in accordance with the standards recently proposed by the RETMA Automation Committee. The unit consists of a subminiature molybdenum permalloy toroid core with a winding having a residual hole as small as 1/16" diameter. Windings are impregnated with a special compound and the finished coil is encased in epoxy plastic. Over-all dimensions are: 13/16" x 13/16" x ¾". Bulletin STP, providing complete technical data, is available from K. T. Eckardt, sales manager of the firm.

SYLVANIA TUBES FOR TV
The Radio Tube Division of Sylvania Electric Products Inc., Emporium, Pa. has announced the development of two new tubes, the 6CS7 and 25DN6, for vertical and horizontal TV circuit applications.

The Type 6CS7 is a miniature 9-pin, medium-mu, dual triode with dissimilar sections and is suitable for vertical deflection and oscillator applications using conventional transformer supply voltages. The output section has a very high plate dissipation rating of 6.5 watts, high pcv, and an absolute peak positive pulse plate voltage of 220 volts. The other triode section is intended for service as an oscillator, detector, or amplifier. The tube is designed for series string or conventional parallel operation.

The 25DN6 is a beam-power pentode rated for television service as a horizontal deflection amplifier and is designed especially for use in "off-the-line" series string settings using low "B+" voltages. The tube has a desirable low plate knee characteristic at zero bias.

REMOTE CONTROL UNIT
Of interest to technicians is the new remote control unit for television receivers which is being offered by Sentry Radio Corporation of Evaston, Ill. for the replacement or reconditioning market.

The unit is a small, lightweight plastic box which can be placed on the viewer's lap or can rest on the chair arm or floor. It has all of the controls of the TV set including "on-off-volume," fine tuning, brightness, and channel changer, allowing complete operation from as far away as 20 feet.

The individual speaker of the unit permits some members of the family to study or read while others watch TV with the sound at a low level. This remote unit is designed so that it can be installed in virtually all TV receivers.

SILICON POWER RECTIFIERS
Automatic Manufacturing Corporation, 65 Gouverneur St., Newark 4, N. J. is now in production on a new line of silicon power rectifiers which the company claims to be the smallest and lightest on the market.

The new silicon rectifiers are of the diffused-junction type and are available in six voltage ranges capable of handling voltages as high as 1000 volts with d.c. output currents on the order of 300 to 400 milliamperes. The units take up only 3/100 of a cubic inch of space and weigh 7/100 of an ounce. They have been tested to operate at temperatures as high as 200 degrees C. are shockproof and vibrationproof and have a "virtually infinite life."

A data sheet on the new line is available on request.

www.americanradiohistory.com
TRY these modern power resistors

Servicemen everywhere are finding IRC's unique approach to wire wound power resistors is ideal for today's service requirements. Try them yourself, and benefit by these exclusive IRC features:

- **COMPACT RECTANGULAR DESIGN** for easier assembly in tight circuits
- **AXIAL LEADS** for better stability and handling
- **CLEAR, PERMANENT MARKINGS** for fast identification
- **CONSERVATIVE RATINGS** permit continuous operation at full power
- **FAMOUS IRC ELEMENT** sealed in ceramic case for complete insulation and protection
- **2 SIZES**—PW-7, for seven watts and PW-10, for ten watts
- **FULL COVERAGE OF RESISTANCE VALUES** for today's service needs

BUY handy Resist-O-Card assortments

Your IRC Distributor has these new power resistors in 2 convenient assortments of popular values. The values are printed on each card . . . you always know what you have, and you always have what you need.

RESIST-O-CARD = 19, 7 Watt assortment of 20 popular values—$6.20 net

RESIST-O-CARD = 20, 10 Watt assortment of 20 popular values—$6.50 net

INTERNATIONAL RESISTANCE CO.
Philadelphia, Penna.

FOR 10 WATT POWER RESISTOR REQUIREMENTS SPECIFY IRC ASSORTMENT = 20.
ASSORTMENT = 20 INCLUDES 20 PW-10 RESISTORS IN SELECTED VALUES—$6.60 NET.
Superior's new
Model 670-A

SUPER METER

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

SPECIFICATIONS:

D.C. VOLS: 0 to 7.5/15/75/150/1,500/7,500 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: 9 to 1,000/10,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers)
REACTANACE: 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:

Built-in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

The Model 670-A comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions.

$28.40

Superior's new
Model TV-11

TUBE TESTER

SPECIFICATIONS:

★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Pentode, Estamet, Hearing Aid, Thyatron, Miniatures, Sub-Miniatures, Valves, Sub-minis, 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 RCA 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
★ EXTRA SERVICE-The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscil-
★ tester sells for $15.85. But, if you believe that Television is here to stay, then you must agree that the difference in price is more than justified by the many years of valuable service you will get out of this indispensable instrument.

Incidentally, the Model TV-40 is the only low-priced C.R.T. Tube Tester, which includes a real meter. Meters are fine for gadgets and electronic-lab testers, but there is no substitute for a meter with an honest-to-goodness emission reading scale.

$47.50

Superior's
New Model
TV-40

C.R.T. TUBE TESTER

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

SPECIFICATIONS:

★ Tests all magnetically deflected picture tubes from 7 inch to 30 inch types.
★ Tests for quality by the well established method. All readings on "Good-Bad" scale.
★ EASY TO USE: Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube base (no 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.

$15.85

About Testing Picture-Tubes...

Of course you can buy an "adapter" which theoretically will convert your standard Tube Tester into a picture-tube tester. Sounds fine—but it simply doesn’t work out that way!

We do not make nor do we recommend use of C.R.T. adapters because a Cathode Ray Tube is a very complex device and to properly test it, you need an instrument designed exclusively to test C.R.T. Tubes and nothing else. As compared to a make-shift adapter, which sells for about five dollars, our Model TV-40 C.R.T. Tube Tester sells for $15.85. But, if you believe that Television is here to stay, then you must agree that the difference in price is more than justified by the many years of valuable service you will get out of this indispensable instrument.

Incidentally, the Model TV-40 is the only low-priced C.R.T. Tube Tester, which includes a real meter. Meters are fine for gadgets and electronic-lab testers, but there is no substitute for a meter with an honest-to-goodness emission reading scale.

$15.85

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 Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

Moss Electronic Distributing Co., Inc.
Dept. D-178, 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. If payment is not received within the time indicated, interest and any other charges provided for my monthly payments will be due. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

Model 670-A. Total Price $28.40 $2.00 within 10 days. Balance $26.40
Model TV-11. Total Price $47.50 $3.50 within 10 days. Balance $44.00

Name
Address
City... Zone... State

RADIO & TELEVISION NEWS

www.americanradiohistory.com
The Model TV-50 GENOMETER

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

<table>
<thead>
<tr>
<th>A. M. Radio</th>
<th>F. M. Radio</th>
<th>Amplifiers</th>
<th>Black and White TV</th>
<th>Color TV</th>
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</thead>
</table>

7 Signal Generators in One!
- R. F. Signal Generator for A.M.
- R. F. Signal Generator for F.M.
- Audio Frequency Generator
- Bar Generator
- Cross Hatch Generator
- Color Dot Pattern Generator
- Marker Generator

SPECIFICATIONS:

R. F. SIGNAL GENERATOR:
The Model TV-50 Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics. Accuracy and stability are assured by use of permeability trimmed Hi-Q coils. R.F. is available separately, modulated by the fixed 400 cycle sine-wave audio or modulated by the variable 300 cycle to 20,000 cycle variable audio. Provision has also been made for injection of any external modulating source.

VARIABLE AUDIO FREQUENCY GENERATOR:
In addition to the fixed 400 cycle sine-wave audio, the Model TV-50 Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal. This service is used for checking distortion in amplifiers, measuring amplifier gain, trouble shooting hearing aids, etc.

BAR GENERATOR:
This feature of the Model TV-50 Genometer will permit you to throw an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars. A Bar Generator is acknowledged to provide the quickest and most efficient way of adjusting TV linearity controls. The Model TV-50 employs a recently improved Bar Generator circuit which assures stable never-shifting vertical and horizontal bars.

CROSS HATCH GENERATOR:
The Model TV-50 Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect. This service is used primarily for correct ion trap positioning and for adjustment of linearity.

DOT PATTERN GENERATOR (For Color TV)
Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50 will enable you to adjust for proper color convergence. When all controls and circuits are in proper alignment, the resulting pattern will consist of a sharp white dot pattern on a black background. One or more circuit or control deviations will result in a dot pattern out of convergence, with the blue, red and green dots in overlapping dot patterns.

MARKER GENERATOR:
The Model TV-50 includes all the most frequently needed marker points. Because of the ever-changing and ever-increasing number of such points required, we decided against using crystal holders. We instead adjust each marker point against precise laboratory standards. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc. (3579 Kc. is the color burst frequency.)

$47.50 NET

SHIPPED ON APPROVAL
NO MONEY WITH ORDER — NO C. O. D.

Try it for 10 days before you buy. If completely satisfied then send $11.50 and pay balance at rate of $6.00 per month for 6 months. No Interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

November, 1955

Moss Electronic Distributing Co., Inc.
Dept. D-178, 3849 Tenth Ave., New York 34, N.Y.

Please rush one Model TV-50. I agree to pay $11.50 within 10 days and to pay $6.00 per month thereafter. It is understood there will be no finance, 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 __________

125

www.americanradiohistory.com
The "Minipack #2"  
(Continued from page 71)

The 12AX7's second section, a cathode follower, extends the gate's maximum "open" condition by allowing the control grids to operate at a higher positive bias at the top of the control range. Voltage divider $R_5$, $R_6$, and $R_7$ is proportioned so that the 12AX7's grid #2 permits operation within the class A amplifier range. Output variations in the round-robin manner just described apply as bias to grid #2, starting the regulatory cycle.

$C$, offers a return path to grid #2 for minute output fluctuations caused by a.c. ripple. Filtering results from the round-robin cycle in the same way that voltage regulation is effected, and no filter chokes are required.

The neon bulb, $P_L$, has a constant voltage drop of about 55 volts when ignited. Current flowing from "B+" through $R_5$ causes the bulb to "fire," and its voltage drop is applied to the 12AX7's cathode #3 as a stabilized reference voltage. Potential difference between grid #2 and cathode #3 represents control grid bias, thus variation of potentiometer $R_6$ allows output voltage control within the pack's specified limits. Grid-to-cathode voltage measures from −0.7 to −3.2 volts over the usable output range.

Construction

The "Minipack" is built in a small utility box measuring 2½ x 2½ x 5 inches. All components mount on the "I"-shaped open half of the box, as shown in Fig. 3, allowing easy access for wiring.

$S_R_1$ and $S_R_2$ are mounted on a #6-32 machine screw which passes through both rectifiers and bolts to the chassis. Dual capacitor $C_1$-$C_4$ must be insulated from the chassis. As the voltage doubler has no direct connection with either side of the 117 volt a.c. line, the "B−" output is isolated from chassis ground, minimizing the possibility of shock or power line short circuit.

The 5085 gate tubes mount side by side, which facilitates their parallel wiring. The 12AX7 control tube is located beside the output control potentiometer, $R_6$. The neon bulb, $P_L$, secured within a rubber grommet, protrudes just above the 12AX7 socket's base.

Parasitic suppression resistors $R_5$ and $R_6$ are soldered directly between $C_1$'s positive lug and pins 5-6 of the gate sockets. A small stand-off insulator is the "B plus" tie point for $C_6$, $R_5$, and $R_6$, each of which connect directly to other components. Fig. 3 shows how this point-to-point wiring results in neatness and efficient parts location.

Power output connections are made with a cut-down Jones barrier strip mounted beneath the neon bulb regulator. $P_L$ does double duty as a VR tube and "Power On" pilot lamp.

Applications

The "Minipack" supplies "B+" to variable frequency oscillators, converters, or any small device requiring well-regulated low current plate voltage. When a bias supply is needed, connect a 500,000 ohm potentiometer across the power output terminals and return "B−" to the biased equipment's ground. Negative bias taken from the pot's center arm is variable from zero to 190 volts.

Don't try to run a kilowatt amplifier with the "Minipack"! A maximum of 35 milliamperes is the limit; excessive current drain results in loss of regulation and consequent a.c. ripple.

Supposing you don't like the idea of a "floating B minus"? Connect a 0.1 µfd. 200 volt paper capacitor from "B−" to chassis, à la table model radios.

Finally, don't put tube shields or fingers on the heated 5085's. They're designed to operate hot... hot enough to permit the "Minipack" to supply voltage and function as a cigarette lighter too!
If you’re willing to lose your job tomorrow to a technically-trained man, turn the page, mister

But, if you’re interested in an honest-to-goodness career in the vigorous young electronics industry, here’s how you can step ahead of competition, move up to a better job, earn more money, and be sure of holding your technical job even if the brass is firing instead of hiring.

The “how” is CREI training in radio-television-electronics. You don’t have to be a college graduate. You do have to be willing to study—at home. You can do it while holding down a full-time job. Thousands have. However, you must have some prior electronic experience, either in military service, professional employment, experimenting, or ham operating. Since 1927 CREI has provided alert young men with the technical knowledge that leads to more responsibility, more job security, more money. More than a quarter century of experience qualifies CREI to train you.

What qualifies you for CREI? If you have a high school education, you’re off to a good start. If you have a knack for math, so much the better. If you are currently working in some phase of the electronics industry, you’ll get going faster. But remember this: CREI starts with fundamentals and takes you along at your own speed. You are not held back by a class, not pushed to keep up with others who have more experience or education. You set your own pace. Your CREI instructors guide you through the lesson material and grade your written work personally. You master the fundamentals, then get into more advanced phases of electronics engineering principles and practice. Finally you may elect training at career level in highly specialized applications of radio or television engineering or aeronautical radio.

How good is CREI training? Here are a few ways to judge. Ask an electronics engineer, if you know one.

Ask a high-school or college physics teacher. Ask a radio station engineer. Check up on our professional reputation: CREI home study courses are accredited by the Engineers’ Council for Professional Development; CREI is an approved member of the National Council of Technical Schools. Ask personnel managers how they regard a man with a CREI "ticket." Look at this partial listing of organizations that pay CREI to train their own personnel: All American Cables & Radio, Inc.; Canadian Aviation Electronics, Ltd.; Canadian Broadcasting Corporation; Columbia Broadcasting System; Hoffman Radio Corp.; Machlett Labs.; Glenn L. Martin Co.; Magnavox Co.; Pan American Airways, Atlantic Division; Radio Corporation of America; United Air Lines. Finally, ask a CREI graduate to tell you about our Placement Bureau, which currently has on file more requests for trained men than we can fill.

What’s the next step? The logical one is to get more information than we can cram into one page. The coupon below, properly filled out, will bring you a fact-packed booklet called "Your Future in the New World of Electronics." It includes outlines of courses offered, a resume of career opportunities, full details about the school, and tuition details. It’s free.

Note: CREI also offers Residence School instruction, day or evening, in Washington, D.C. New classes start frequently. If you are a veteran discharged after June 27, 1950, let the new GI Bill help you obtain competent instruction. Check the coupon for more data.

November, 1955
The new McIntosh power amplifier MC-30 is unequalled for quality reproduction of high fidelity sound. The basically different, patented McIntosh Circuit guarantees a new standard for low distortion — 1½% harmonic, 20 - 20,000 cycles, even at full power output! Hum and noise level — inaudible (90 db full output). This outstanding performance assures new listening enjoyment without fatigue. Quality crafted by amplification specialists for lifetime satisfaction. There’s nothing like the McIntosh. Hear it at your dealer’s.

Write today for complete specifications

McINTOSH LABORATORY, INC. 326 Waver St., Binghamton, N. Y.
Export Division: 25 Warren St., New York 7, N. Y. Cable: Simantrice, New York
NOW! TEST TUBES IN SECONDS!
MAKE NEW PROFITS in MINUTES!

on every service call

![Image of a portable dynamic mutual conductance tube tester]

NEW PORTABLE DYNAD-QUIK MODEL 500
DYNAMIC MUTUAL CONDUCTANCE TUBE TESTER

ONLY $109.95

TESTS 99%
OF ALL TUBES* in use today for:

- DYNAMIC MUTUAL CONDUCTANCE SHORTS
- GRID EMISSION
- GAS CONTENT
- LEAKAGE
- LIFE EXPECTANCY

*Including new 600 mil series tubes.

PORTABLE—CAN BE USED ANYWHERE
Handsome, rugged, luggage style carrying case, covered in durable, black leatherette. Removable slip-hinged cover. Size: 15 1/2" x 14 1/2" x 5 1/2". For 105-125 Volts 60 cycle, A.C. Net wt. 12 lbs.

SEND FOR BULLETIN 500-N
Made by the makers of the famous CRT 350

B&K MANUFACTURING CO.
325 N. SOUTHPORT, CHICAGO 13

November, 1955

Now you can easily cut servicing time—make more on-the-spot tube sales—prevent costly call-backs—and give a better service guarantee! DYNAD-QUIK—the new top quality, low cost, portable tester quickly checks all weak and inoperative tubes—and easily does the complete job with laboratory accuracy right in the home! You create greater customer confidence because your customer sees for himself the true tube condition. Easy to operate—in just a few minutes you can quickly check all the tubes in a TV set. You can depend upon DYNAD-QUIK because it tests under the dynamic heavily loaded conditions that are the actual operating conditions of the set. At such low cost DYNAD-QUIK quickly pays for itself—and continues to make money for you every day!

DYNA-QUIK DOES IT FASTER, EASIER, MORE ACCURATELY
- Makes complete tube test in as little as 12 seconds per tube—faster than any other tester!
- One switch tests everything! No multiple switching—no roll chart.
- Laboratory accuracy right in the home! Large 4½ plastic meter has two scales calibrated 9-6,000 and 0-18,000 microhoms.
- Shows customer true tube condition and life expectancy on "Good-Bad" scale!
- Automatic line compensation! Special bridge continuously monitors line voltage.
- 7-pin and 9-pin straighteners mounted on panel!
- Never Obsolete! New overlay panels with up-to-date markings available from factory, when required.
NEW SYLVANIA TEST EQUIPMENT
FULLY WIRED—READY TO OPERATE

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>TUBE TESTER</td>
<td>Type 620 + Test tubes, direct meggen, switching tests up to 40 megohms</td>
<td>$139.95</td>
</tr>
<tr>
<td></td>
<td>Type 604 TV Laboratory Oscilloscope + calibrations on a self-adjusting screen</td>
<td>$299.00</td>
</tr>
<tr>
<td></td>
<td>Type 301 Service Polymeter + 17 megohm eftive indicator resistance</td>
<td>$109.00</td>
</tr>
<tr>
<td>CAPACITETESTER</td>
<td>TELETEST Capacitester + 5 important functions</td>
<td>$44.95</td>
</tr>
<tr>
<td>WIN-TRONIX</td>
<td>Dynamic sweep circuit analyzer for all vertical and horizontal trouble-shooting</td>
<td>$695.00</td>
</tr>
<tr>
<td>JACKSON TUBE TESTER</td>
<td>A standard type tester at an amazing price</td>
<td>$495.00</td>
</tr>
</tbody>
</table>

**BOSIPT**
REVOLUTIONARY NEW CATHODE RAY TUBE CHECKER AND REVITALIZER
- Knocks out shorts between elements
- Revitalizes cathodes by decontamination method
- Restores emission

All at the amazing price of $3.97, never before accomplished under $5.95 plus 20c postage

**NEW SYLVANIA BRAND RECEIVING TUBES FROM
tees and really hot values**

**TELEVISION NEWS**
3211-13 Washington St.
Jamaica Plain 30, Mass.

www.americanradiohistory.com
IN QUALITY TEST EQUIPMENT
IN RADIOS, PHONOS AND HIGH FIDELITY COMBOS

NEW, ADVANCED Precise TEST EQUIPMENT
KIT FORM—ALL NEW COMPONENTS—NO SURPLUS

No. 315K 6 1/2" OSCILLOSCOPE

- Has frequency compensated vertical and horizontal attenuators, along with balanced vertical & horizontal amplifiers entirely solid through VMIC.
- Has SCPI type tube with geo- accelerating. Both horizontal and vertical sections are deflec-tion-voltage input type and have 12 divisions. Don't let cost stop you.
- Sweep rate from approximately 12 cycles to 650 C. Hard vacuum type sweep circuit.

Price $49.95

OLYMPIC HIGH FIDELITY RADIO & PHONOGRAPH

- Handcrafted cabinet in mahogany or blonde
- 1 5 W output at less than 2% distortion
- G.E. Reluctance pickup
- 4 pole shaded VM motor
- 2 metal backed speakers, 12", 8" and 3 1/2"
- 12 tube AM-FM radio

ALL FOR $149.95 in mahogany

Absolutely free of charge if you purchase.
US. SEND FOR COMPLETE INFORMATION—TODAY!

T.E.E-V.E.
Supply Co.
3211-13 Washington St., Jamaica Plain 30, Mass.

November, 1955

No. 308K 6 1/2" OSCILLOSCOPE

- Does everything more expensive commercial scopes can do and does it better.
- Full 1 1/2" tube operated specially for this model.
- Electronic multiplier allows any part of a signal to be magnified up to 25 times equivalent to 10" of horizontal deflection.
- High frequency-Sweep Frequency-Normal Frequency
- Intensifier-Beam Deflection
- Circuit is self contained. Can be used with output coupling.
- PKG.4 sisters of other features found only in more expensive scopes.

For $129.95

SONIC CAPRI PHONOGRAPH

- Unbreakable plastic
- Guaranteed for 5 years against breakage
- 3 speed player for all records
- Precision built stereosonic sound
- Retractable tone arm
- Available in sea foam green and pearl grey

Lots of 6

$13.95

Available with built-in 5-tube radio.

Lots of 6

$21.95

No. 111K TUBE TESTER

- Checks both emission & GM separately
- Allows emission current to be measured directly on the meter.
- Tests have high quality tubes for reference (available).
- Tests all lines for emission & GM at the flick of a switch.
- Short tests simply make without complicated switch manipulation.
- Measures tube bias directly.
- Tests all types of tubes including select family & cathode ray tubes.

Price $69.95

SONIC "PEE-WEEN" RADIO

- 5 tube radio
- 6" PM speaker
- 2 IF stages
- Built-in loop antenna
- Available in ivory, red, green and gray

A sensational radio at any price.

Single unit $13.45 Wt. 4 lbs.

Lots of 6 $12.95

Lots of 12 $12.69

Send for our November list of specials on Component Parts—Lowest prices in the U. S.—Highest Quality
Oscilloscopes are gold mines for servicemen who learn to use them fast and accurately—and in a less than two weeks a new, completely revised 2nd edition is available that really shows you how.

In plain, easily understood language, MODERN OSCILLOSCOPES AND THEIR USES teaches you just when, where and exactly how to use your oscilloscope. You learn how to handle tough jobs easier and faster than you may have dreamed. Every detail is clearly explained—from making connections to adjusting circuit components and setting oscilloscope controls.

Equally important, you learn how to analyze oscilloscope patterns accurately and in far less time. Almost 400 illustrations including dozens of pattern photos make things doubly clear.

This big book is more widely used than any other of its type—because it goes right down to "brass tacks." No involved mathematics. No complicated discussions. You learn exactly what the oscilloscope is and exactly how to use it on all types of AM, FM and television service (including color)—from locating troubles in a jiffy to handling tough realignment jobs.

Send coupon for 10-day free trial. You be the judge!

PRACTICE 10 DAYS FREE!

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232 Madison Ave., New York 16, N. Y.
Send me enclosed copy of NEW 2nd edition of 370-page MODERN OSCILLOSCOPES AND THEIR USES for 10-day FREE EXAMINATION. I'll keep book if it's what I want. I will then send you $2.50 (remittance in full payment). I hasten to return book postpaid in good condition and owe you nothing.

Name
Address
City, Zone, State

For sales in U.S.A.—Price $7.00, cash only. Money back if you return book in 10 days.

Rinehart Books Are Sold by Leading Book Stores
LAFFITTE RADIO LEADS THE FIELD IN TRANSISTORS CIRCUITS KITS & COMPONENTS

TWO TRANSISTOR RADIO RECEIVER KIT

This representative two transistor radio has been designed to give the user a very compact and attractive instrument for general use. The transformers, audio stages, and other components are all mounted on a single chassis. It features: 1) Two Transistors, 2) B.B.S. X.1F.S, 3) Transistor Circuits and "How to Do-It-Yourself." Kit includes: Net $10.95

K-80 Complete Kit with Batteries

2 TRANSISTOR POCKET RADIO KIT

Utilizing the Transistor and crystal diode, Detectors and voices, the pocket transistor radio is a most attractive and useful instrument. Here is an ideal low cost two transistor radio kit for students, experts, and the individualDo-it-yourselfer. Kit consists of: 1) Two Transistors, 2) Crystal Diode, 3) Transistor Circuits and "How to Do-It-Yourself." Kit includes: Net $8.95

K-71 Complete Kit

WEBSTER • GARRARD • COLLARO

3-SPEED • HI-FI • RECORD CHANGER

Now Lafayette makes it possible for you to save money on the three most popular makes of record changer. When you buy Lafayette, feel certain of the quality, efficiency and durability. Kit Consists of: 1) Three-Speed Change, 2) Hi-Fi Gear Box, 3) Automatic Start, 4) 100 Watt Power Amplifier, 5) Home Town Record. Net S120.00

K-70 Complete Kit with Batteries

TRANSPORT POCKET RADIO RECEIVER KIT

This representative two transistor radio has been designed to give the user a very compact and attractive instrument for general use. The transformers, audio stages, and other components are all mounted on a single chassis. It features: 1) Two Transistors, 2) B.B.S. X.1F.S, 3) Transistor Circuits and "How to Do-It-Yourself." Kit includes: Net $10.95

K-80 Complete Kit with Batteries

2 TRANSISTOR POCKET RADIO KIT

Utilizing the Transistor and crystal diode, Detectors and voices, the pocket transistor radio is a most attractive and useful instrument. Here is an ideal low cost two transistor radio kit for students, experts, and the individualDo-it-yourselfer. Kit consists of: 1) Two Transistors, 2) Crystal Diode, 3) Transistor Circuits and "How to Do-It-Yourself." Kit includes: Net $8.95

K-71 Complete Kit

LAFAYETTE GEIGER COUNTER KIT WITH HIGH SENSITIVITY VICTOREEN TUBE B88

Lafayette Geiger Counter Kit with High Sensitivity Victoreen Tube B88 is one of the most outstanding kit Boys in the competitive electrical market. It is easy to build, it is reliable, it is sturdy. Kit includes: 1) Tube B88, 2) Crystal Diode, 3) Special Voltage Transformer, 4) Printed Circuit Board, 5) Microscope, 6) Vacuum Tube Tester, 7) Complete Instructions for quick assembly. Kit Net $11.95

K-76

TRANSPORT 455 KC I.F.

Specially designed for Transistor circuits with 7.95 in. dial to 7.75 in. Antenna, and 100,000 cycles. Kit Consists of: 1) 455 kc I.F., 2) Crystal Diode, 3) Transistor Circuits and "How to Do-It-Yourself." Kit includes: Net $1.25

K-72

REMOTE CONTROL FOR SILENT TV

For Hard-Of-Hearing For Late Listening

The hard-of-hearing can listen to radio or TV without turning the volume so high that others can't stand the noise. They can listen with loud speaker cut off, or if others want to listen with normal volume volume. Suitable for noisy programs. Let the Kids listen and view, with speaker cut off. Comes complete with 13 directional picks, 8 separate feet of cable and a portable microphone. Net $1.95

M-75

MANUFACTURE DOLLAR

ADDED EDITIONAL EAR PHONE 1.95

Add 10% to normal prices. Net $8.95

K-72

LAFAYETTE GREATSTE Tape Buy Ever!

1200 FT. REEL HIGH FIDELITY RECORDING TAPE

Shp. Wt. 14 oz.

LAFAYETTE made a terrific deal with one of the leading manufacturers of recording tape to supply us with their regular tape which sells for almost twice our price, for an ALL TIME RECORD LOW PRICE. This is a genuine high quality recording tape obtainable. High performance, uniform signal-to-noise ratio, with maximum uniform frequency response. In lots of 10 rolls 1.59 $8

K-106

MINIATURE CRYSTAL MICROPHONE

Here's a typical miniaturized crystal microphone, designed for portable installations. It is ideal for Walkie-Talkie, Transistor radios, audio equipment. Complete Kit includes: 1) Miniature Crystal Microphone, 2) Fitting, 3) Wire, 4) Cartridge. Kit Net $1.95

M-108

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Radio, TV, Hi-Fidelity, Drafting equipment, telescopes, check full line of new products. Write today for FREE COPY. NET $11.95

K-119

1195

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Imported Binoculars

All have coated lenses — clipped in prices — light weight all metal bodies. Complete with case and straps. Fully guaranteed for 6 mos. against mechanical and electrical defects. B88

Add 10% to normal prices. Net $8.95

M-75

TELEPHONE PICKUP

For Record Playing TELEPHONE PICKUP

Induction telephone pickup. Transistor circuit designed to pick up with no trouble wires or telephone connections. Excellent for home or business use on the telephone. Complete set includes: 1) Telephone Pickup, 2) Crystal Diode, 3) Transistor Circuits and "How to Do-It-Yourself." Kit includes: Net $2.95

M-105

K-75

FREE CATALOG

1,000 ohms per Volt

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110 VOLTS 60 CYCLES AC

MODEL RW-27C Complete Simply, $7.95

NS-19

1200 page electronic buying Guide, Transistors, radio, TV, Hi-Fidelity, Drafting equipment, telescopes, check full line of new products. Write today for FREE COPY.

November, 1955

133
Sono Tone Corporation is in production on a compact, 12-watt amplifier which has been designed especially to be used with the firm's ceramic cartridge and other cartridges not requiring equalization and premplification.

The HFA-100 has a frequency response from 15 to 20,000 cps ± 1% with the tone controls in the flat position. The unit incorporates five controls and has four inputs. Currently the HFA-100 is available in either solid mahogany or solid walnut, with a brass panel.

**NEW TAPE CATALOGUES**

"TAPE-OF-MONTH RELEASING"

Recorded Tape of the Month Club, Inc. has announced that its entire tape library will be made available on a retail basis independent of its Club operation. The catalogue is released on 7" reels recorded at 7½ ips. The recordings range from classical music, pops, jazz, dramatic readings, satire, folk songs, and others.

**RECORDED TAPE DIRECTORY**

Electronic Specialties, manufacturer of the "Fidelio" tape player, is offering our readers free copies of its new tape directory which lists currently available recorded tapes from a number of manufacturers.

The tapes are classified as to "mood." No attempt has been made to rate the tapes for quality but all are of at least commercial quality or better. The listing includes the recording firm's name and address, label name and number, playing speed, nominal playing time, reel size, playback curve, etc.

**RECORDED TAPE LIBRARY**

Berkshire Recording Company has announced a new library of recorded tapes which includes, in part, recordings of the Haquín Society.

Music lovers have a choice of three differently priced series, each designed to meet a specific need. The "Hi-Fi Supreme" series provides up to one hour of recorded material at 1½ ips, dual-track, on a 7" reel. The "Royal Deluxe" series offers a two-hour program. This 7" reel is recorded at 3¾ ips, dual-track. The "Extended Deluxe" series provides three hours of recorded material on a 7" reel and is recorded at 3¾ ips, dual-track.

**JOIN TWO PHONO CORDS**

By ARTHUR TRAUFLER

This shielded connector is easy to make and allows two phono cords, or any other kind of cords with phono plugs on them, to be quickly joined together. This connector is simply a metal can containing two standard phono jacks wired in parallel.

Any small can, at least 15/16" in diameter, having a friction lid is OK. The writer uses metal "Herb-Ox" bulbon cube cans. As shown in Fig. 1, cut off a 1 1/4"-long bottom section using a thin-blade, fine-tooth hacksaw, and then file the sawed edge smooth. Drill the three necessary holes in the bottom of the can and install a standard phono jack in the usual manner. Then install another phono jack in the lid of the can, as shown.

**Fig. 1. A small bulbon cube can is used to make this phono cord connector unit.**

Wire the two jacks in parallel using insulated flexible wire or, if desired, just run a wire from the center electrode lug of one jack to the center electrode lug of the other jack, and let the metal can act as the connector for the two outside electrodes of the jacks. In the latter case, be sure that the jacks make good contact with the can lid and can bottom, and be sure that the lid makes good contact with the bottom. When completely wired, solder the lid to the can's bottom section.

As shown in Fig. 2, the writer simply wrapped a 1 1/4" wide strip of "Mystik Tape" around the can to improve its appearance. Otherwise, the can could have been given a coat of enamel to cover the lettering.

**Fig. 2. The completed construction. Mystik tape is wrapped around to improve looks.**
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TUBE PLACEMENT CHARTS
14. Top and bottom views are shown. Top view is positioned as chassis would be viewed from back of cabinet.
15. Blank pin or locating key on each tube is shown on placement chart.
16. Tube charts include fuse location for quick service reference.

TUBE FAILURE CHECK CHARTS
17. Shows common trouble symptoms and indicates tubes generally responsible for such troubles.
18. Series filament strings are schematically presented for quick reference.

COMPLETE PARTS LISTS
19. A complete and detailed parts list is given for each receiver.
20. Proper replacement parts are listed, together with installation notes where required.
21. All parts are keyed to the photos and schematics for quick reference.

FIELD SERVICE NOTES
22. Each Folder includes time-saving tips for servicing in the customer's home.
23. Valuable hints are given for quick-access to pertinent adjustments.
24. Tips on safety glass removal and cleaning.

TROUBLE-SHOOTING AIDS
25. Includes advice for localizing commonly recurring troubles.
26. Gives useful description of any new or unusual circuits employed in the receiver.
27. Includes hints and advice for each specific chassis.

OUTSTANDING GENERAL FEATURES
28. Each and every PHOTOFACT Folder, regardless of receiver manufacturer, is presented in a standard, uniform layout.
29. PHOTOFACT is a current service—you don't have to wait a year or longer for the data you need. PHOTOFACT keeps right up with receiver production.
30. PHOTOFACT gives you complete coverage on TV, Radio, Amplifiers, Tuners, Phonos, Changers.
31. PHOTOFACT maintains an inquiry service bureau for the benefit of its customers.

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November, 1955

135
The Great Uranium Rush Is On!

ATOMIC AGE OPENS
NEW AND PROFITABLE MARKET
FOR RADIO AND TV DEALERS

A vast, new proven market for electronic instruments has been created by the Uranium boom. This market has been stimulated by uranium bonuses paid by the Government totaling over $1,790,000 to date. These bonuses are in addition to the prices paid for the Uranium ore.

You can make money serving this market by handling the leading line of Geiger Counters and Scintillators. This line is produced by Precision Radiation Instruments, Inc. World's largest manufacturer of Portable Radiation Instruments... It includes top values at every price level from $29.95 to $1995.00.


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Within the Industry (Continued from page 30)

ELECTRONICS

Power amplifier makes itself felt by the generation of new combination tones which further change the identity of a musical instrument, and produce the effect of blurring the sound. This latter effect can be easily demonstrated in a comparison test by playing a poor recording with lots of surface noise. The noise will be there in each instance, but will be much less objectionable with an amplifier of lower distortion. Finally, one must recognize that a condition of interaction exists between the speaker and the power amplifier. A high power, amplifier of low and constant internal impedance exerts better control over the speaker characteristics at high peak powers.

REFERENCES

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Flanged Locking Precision Interlocking Engineered
65 sizes and shades for the laboratories, manufacturer, industrial, experimenter, builder, and general applications where metal boxes are required. Stocked by all electronic and geophysical distributors. Send for free catalog.

LMB 1011 Venice Blvd.
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McGee's Famous 12 AND 15 INCH COAXIAL P.M. HIGH FIDELITY SPEAKERS

Model CU-14Y, 12" high fidelity coaxial PK. receiver. Response from 50 to 20,000 cps. Full 6.8 ohm. Audience V magnet in the 15" speaker. Special superluxed transformers. Response flat within 0.5 db. Mahogany cabinet. $49.95. Choice of 11 thru 20,000 cycle transformers. Values include 5" neutral and 3" high frequency tweeter. Pickup transformer. Separate bass and treble tone controls. Radiographed carbon. Tuned to 1670 K.C. Fine \$20.00 extra. Sale price \$12.95. McGeorge cox speaker, at \$23.95.

WEBCOR 3 SPEED CHANGER WITH RPX-050 G. E. CARTRIDGE

114-45, 3-speed auto record changer with G. E. RPX-050 variable reluctance cartridge. Plays all 45's, 78's and all 3's. Shifts out after last record. Has normal position to prevent bending the needle. Separate bass, treble and tonal changes. Sale price \$29.95. McGeorge cox speaker, at \$38.95.

REGULAR $65.00 LIST COLARRO 3 SPEED HI-FI CHANGER

Imported $19.95 from England Price \$38.95

Less Cartridge


ENGLISH GARRARD CHANGERS

RC-80 WITH GE $68.95

RC-502A

RC-80 Changer 3-speed automatic record changer with G. E. RPX-050 variable reluctance cartridge. Plays all 45's, 78's and all 3's. Shifts out after last record. Has normal position to prevent bending the needle. Separate bass, treble and tonal changes. Sale price \$68.95. McGeorge cox speaker, at \$78.95.

HALLICRAFTERS 7-8A

Regular $89.50 $69.95

McGee's SALE PRICE

HALLICRAFTERS 7-8A

High Fidelity

* AUTOMATIC FREQUENCY CONTROL

HALLICRAFTERS 7-8A

McGee's $89.50 $69.95 - McGee's SALE PRICE

11-TUBE FM-AM HALLICRAFTERS

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TELEVISION CONSOLE CABINETS AT LESS THAN FACTORY COST!

FOR YOUR TV CHASSIS—MODELS FOR 27 INCH TO 16 INCH CHASSIS

10 INCH TV CHASSIS $49.95

RT-21MA

12" Magno-Pan TV CHASSIS $49.95

RT-21MA, Mahogany Television-Phone combination cabinet with cabinet doors. 20" and 24" TV chassis and radio changer. 331/2", high. 22", wide and 141/2" deep. Mahogany finish. Has room for 8" or 10" speaker. Cabinet and all speakers included. Sale price \$49.95.

TELLY 6-TUBE, 2-BAND RADIO KIT $14.95

6-18 MC 550-1650 KC

6 tube, 3 band AM-660 radio kit, complete with speaker and pickup cabinet. Popular with schools and colleges for training radio operators. Sale price \$14.95. McGeorge cox speaker, at \$16.95.

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RESPONSE 20-17500 CPS—PUSH PULL ALL OUTPUT—TWIN TONE CONTROLS

**INPUTS FOR MIKE AND CRYSTAL OR PH. R/O. PHONE PICKUP**

**MODEL HF-20:**
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- With Imperial IV Speaker System.............................$53.95
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- With HF-35GE Speaker System.................................$69.95

(Add $1.00 for HF-30 Instead of HF-20)

A tremendous High Fidelity amplifier value. Response 30 to 17,500 cps electronic bass and treble control by separate tone controls. Use this amplifier with any record changer having crystal or dynamic microphones. 20 watts power output. Use with any omnidirectional or 8 ohm speaker. Bass and treble boost by 4 or 8 ohm radio or amplifier. A variable tone compensating unit is incorporated in the circuit to give a brilliant high fidelity sound, low in distortion. A high volume sound, typifies its music output. It is simple and non-compliment, yet low in cost. A fine amplifier for home music systems or for background music in stores, restaurants, etc. A must for home music systems.

**MODEL HF-30:**
- With GU-141, 12" Coax Speaker.................................$32.95
- With GU-1156, New 16" Jr. Coax..............................$35.95
- With P5-15, 10" Coax Speaker.................................$42.95
- With Imperial IV Speaker System.............................$53.95
- With SP-12125 CR Speaker........................................$44.95
- With HF-35GE Speaker System.................................$69.95

(Add $1.00 for HF-30 Instead of HF-20)

A tremendous High Fidelity amplifier value. Response 30 to 17,500 cps electronic bass and treble control by separate tone controls. Use this amplifier with any record changer having crystal or dynamic microphones. 20 watts power output. Use with any omnidirectional or 8 ohm speaker. Bass and treble boost by 4 or 8 ohm radio or amplifier. A variable tone compensating unit is incorporated in the circuit to give a brilliant high fidelity sound, low in distortion. A high volume sound, typifies its music output. It is simple and non-compliment, yet low in cost. A fine amplifier for home music systems or for background music in stores, restaurants, etc. A must for home music systems.

**CONSOLE HI-FI SPEAKER SYSTEM $49.95**

12" G.E. PM Woofer—10" PM MID-RANGE—
8" GP Model 859 MID-HIGH SPEAKER—
AND 600 CYCLE LC CROSSOVER NETWORK.

Have a truly fine quality in your own home. Designed for home use, exclusively. Similar to the more expensive units, this speaker system has a high quality sound. Complete with 4-way crossover network, 12" woofer speaker, high fidelity tweeter, 8" mid-range, and 8" high frequency speakers. This model HF-35GE Speaker System, as described above, but less than 3000.$16.95. Ideal for use with HF-20 and HF-30 amplifiers described above. Sale price, $84.95.

**5" BLUE STEAKER TWEETER—**

**5" BLUE STEAKER TWEETER—**

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**25 WATT HI-FI SPEAKER SYSTEM**

2-12 Woofers
2-5" Tweeters

**Power Supply**

**$24.95**

**L-C CROSSOVER NETWORK**

25 watt, High Frequency Dynamic Speaker System,
with 4-way crossover network, 2-12" woofer speakers, two 5" tweeter speakers, and separate VHF/CROSSOVER network. The use of high quality dynamic speakers and tweeters is fairly rare, attributed to the high cost of the impedance transformers and high frequency drivers. This model HF-65GE Speaker System, as described above, adds 4-8ohm HF Passive Crossover. Sale price, $129.95. Ideal for use with HF-20 and HF-30 amplifiers described above.

**FAMOUS STANDARD COIL CASCODE TUNERS**

For use with any receiver, this tuners includes both a 12-66 MHz and an 805 MHz filter. Each is a single coil cascode type. Sale price $19.95.

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**$14.95**

**FORSKAL**

**(2) Small compact Universal tuner assembly with 4804 tube and condenser. Many different models of tuners available.**

**$4.95**

**TV Booster**

**(2) Small compact Universal tuner assembly with 4804 tube and condenser. Many different models of tuners available.**

**$6.95**

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**6 TUBE UNIVERSAL MOUNTING AUTO RADIO $1999**

**LESS THAN FACTORY COST!**

- **Sensational Auto Radio Value at a Terrific Low Price.**
- **Made by a Big Name Manufacturer.**
- **Full Superhet—With Tuned R.F. Stage—6 Tubes—Tone Control.**

McGee makes another tremendous purchase and passes the saving on to you. This universal mounting, 6 tube, 6 volt radio is sold in this country and in Canada or at any McGee dealer. R.F. stage, all signal circuits, and tone control are fully tuned for excellent range and reception. Made to sell at a much higher price, by one of America's best known manufacturers. Its exclusive design and features have been underrated in the market. Buy it now at McGee, and save $2.29 extra.

## Controls

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<th>Feature</th>
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<td>Volume</td>
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<td>2 control inputs in 6 positions</td>
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<tr>
<td>Power</td>
<td>2 control inputs in 6 positions</td>
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Overall size: 9" wide, 46% high and 12 1/4" deep. Requires no more room under your dashboard than other radios. Pre-wired for easy and quick installation. Also available for installation at any McGee dealer. We offer a 30-day free trial and 30-day free service, and our guarantee is the best in the business. McGee's sale price: $1999.50. Will be sold at $1999.00 at McGee. A McGee exclusive.

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**1600 OHMS PER VOLT**

**AC-DC**

**WITH TEST LEADS**

**2 FOR $19.50—4 FOR $37.00**

New, small volt-ohm meter 254" tall, 3/4" wide and 1 1/2" thick. 3/4" sensitivity. 2000 ohms per volt. DC units 0 to 1000 in 1 range; AC volts 0 to 1000 in 1 range. DC current 0 to 500 ma in 1 range. Construction—solid-state. 39.95 McGee's price. Can be combined with a small 10 ohm resistor to be used as a small ohm meter. McGee's sale price: $39.95. Will be sold at $39.95 at McGee. A McGee exclusive.

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**6" x 9" SPEAKER**

**CAN BE CUSTOM FIT INTO THE DASH OF MOST LATE MODEL CARS AND TRUCKS**

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**1st Offering—by a Famous Maker**

14-Tube FM-AM Chassis, Williamsson Type Circuit, Ultra-Linear Response. $894.95. With an add.

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**$9.95**

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New 1956 model, 4 tube FM-AM receiver built by a nationally famous Maker of two classic chisels. Essey Model HP-250C. 14 tube FM-AM chassis with push pull output and balanced output and cannot be combined with the PR-3000. Temperament is not adjustable. This receiver is unmatched for performance and sound quality. Ten tubes. Connect to your present amplifier as a booster or can use with the PR-3000. 50 watts output. The amplifier has input and output levels of high and low. Price $894.95. With an add.

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**50-WATT**

**$39.95**

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**NEW 1956 MODEL WITH CRYSTAL MIKE $9.95**

Sensational! New model NCL-23 miniature broadcasting station for microphone and photographer. Can be received on any broadcast radio in the home. No wires to connect. Doesn't rely on a radio station. Has built-in effects for crystal microphones or voice pickups. Easy to operate; one control box from microphone to speaker. Frequency can be adjusted from AM to FM. Noise, static, and interference can be reduced. Frequency broadcast station, complete with crystal voice and instructions. Ship wt. 4 lbs. Not price $9.95.

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$499.95

Descapions! A simple, yet effective television picture tube that have became weak due to cathode or transformer failure. Also repairs other defective picture tubes. Easy to use, and also repairs other defective picture tube. Price $499.95. Includes test lamp, oscillator, and instructions. Ship wt. 4 lbs. Price not price $9.95.

### McGEE RADIO COMPANY

**PRICES FOR KANSAS CITY**

**SEND 25% OR FULL REBATE WITH ORDER.**

**TELEPHONE VICTOR 5092**

1993 McGee St., Kansas City, Missouri

November, 1955

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You be the judge!
Which saves you more time?

1. Having the dual-control replacements you need—right at your fingertips—in Centralab’s handy Fastatch® FR-22A Kit?

... or —

2. Chasing all over town to find an exact replacement?

Think of all the popular TV, radio, and auto sets you know about. Think of all the different controls they use—all the different combinations of resistance values, tapers, taps, switches, and shaft lengths (actually over 600).

Could you find enough shelf-space in your shop to carry exact replacements of more than 600 original-equipment controls? Could you afford to tie up the money necessary to buy more than 600 controls?

The average distributor can’t, we know. And that’s why he’s so frequently “out of” the exact replacement you’re looking for. That’s why you either have to go to distributor to distributor until you do find one that has the control in stock—or have to wait until the distributor gets delivery on a special order. Meanwhile, your customer gets mad, because you have to delay fixing his set.

Doesn’t this make more sense?

For less than $25, a Fastatch FR-22A Kit gives you a practical, working stock of replacements for over 80% of the carbon dual-concentric controls you run up against (even more, now that the new Centralab wirewounds are available). You can match 121 different combinations of resistance and taper, to duplicate exact electrical characteristics.

You get 11 Fastatch front units, 11 Fastatch rear units, 4 Fastatch switches, and 2 auto-type adapter switches—all 100% factory assembled, tested, and guaranteed.

See your Centralab distributor

See the FR-22A at your Centralab distributor. Or, write for bulletin 42-223.

Front and rear units snap together easily.

A 5-year-old has done it—in just seconds!

Spot Radio News

(Continued from page 24)

minimum of six contacts to the chassis, required to operate any one of the three proposed decoding systems.

To break the toll system using a code card, the brief said, it would only be necessary to install a series of rotary switches that would duplicate the switching operations performed by the code card. The same technique could be used for the other scrambling plan, it was also noted. In other words, the Commission was told, it is possible to devise an electronic skeleton key that would automatically open all of the locks in the code chain.

Commenting on the coin-operated device, the brief reported that even here the code could be broken, even though the coin-operated switch was an intricate device linked to a decoder which consists of 19 tubes, five relays, six solenoid-operated ratchet devices, an electric motor and an assortment of gears, cams, sprockets, and electronic components. The only function of this elaborate equipment, it was noted, is to switch on the decoder, in much the same fashion as the second dime in a telephone coin box brings on the dial tone. This entire mechanism could be replaced with an “off-on” toggle switch, the FCC was told.

All of these weaknesses, said the brief, could be overcome with a wired system, which utilizes no coding programs would be available only to subscribers tapped on to the system. To prove the validity of the wireless code-breaking point, the Commission was told that a supervised demonstration could be held. One station in Philadelphia was described as willing to participate in such a test. And to prove the practicality of the wired idea, the brief added, the company was planning to make its own public-acceptance tests in Casper, Wyoming; Tyler, Texas; and Muscle Shoals (Florence, Sheffield and Tuscumbia), Alabama.

In support of the toll plan, the Chicago set-maker proponent said that his method is the...“only one yet suggested, short of government financing and control, that would dilute network domination of the broadcast industry and permit TV to become a truly national and competitive service, such as contemplated by Congress in the Communications Act and by the FCC in its allocation of TV channels.”

AN ELECTRONIC DEVICE, a lightweight detector (about twenty ounces), designed to add electronic eyes to ground observer personnel during periods of darkness or poor visibility, that will tighten our air defense, has been developed by engineers of the Air Research and Development Command at Rome (N.Y.) Air Development Center at Griffis Air Force Base.

Mounted on a hat, the receiver operates on the basis that any enemy aircraft penetrating our defenses would
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Quick-switch design. Input levels
improved. Includes 6V6GT diode and
4 high-grade ceramic transistors.
In stock. $129.50. Free Air.
The new BO-14 Super-Range transformer is typical of the 43 high fidelity output transformers that CHICAGO STANDARD can supply. Used in a newly developed circuit with 6550 tubes, it provides a flat frequency response from 10 cycles to beyond 200,000 cycles and a power response, at 100 watts, of 15 to 30,000 cps, ± 2 db, with only 0.2% intermodulation distortion at 100 watts. The BO-14 is tapped for 8 and 16 ohm speakers and 70 volt sound systems and can be used for triode, pentode or ultra-linear operation.

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ANNOUNCING THE

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THE FIRST STAGGER-TUNED TELEVISION ANTENNA

The ZEPHYR ROYAL employs three "wing" dipoles, stagger-tuned, to provide even higher and more uniform gain, absolute flat response on all channels 2-13—a necessity for color TV. It is tuned on six pre-determined frequencies in the same way that stagger-tuned circuits are used in I.F. stages in TV receivers.

The ZEPHYR ROYAL is not just an addition to the famous TRIO ZEPHYR, but is a completely new electrical design—not just for promotional purposes. A new phasing method provides increased directivity—and functionally is equally well on the highs as well as the lows.

The elimination of minor lobes, to an extent never before realized in an all-channel antenna, finally banishes all co-channel interference. All of the gain is packed into one efficient forward lobe.

Try a new TRIO ZEPHYR ROYAL. You'll find that in gain and directivity it's the best all-channel TV antenna ever produced for color or black and white.

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The antenna everyone's talking about! The ZEPHYR is a high performance, single lobe antenna, employing two revolutionary "wing" dipoles. Three half waves in phase, combined with an integrated director makes each dipole a unidirectional antenna on the high channels.

The ZEPHYR uses two "wing" dipoles, one resonated on the low ends of channels 2-6, and 7-13, the other on the high end of these channels. These composite dipoles, both driven, together with fully functional parasites elements, produce the high performance to size ratio never before achieved in antenna design.

There's sharp directivity too, on all channels—comparable to a yagi.

TRIO believes that with the introduction of the ZEPHYR and the ZEPHYR ROYAL, the need for stacked arrays is eliminated.
for the machine to detect its own malfunctioning components and pinpoint their location, enabling the operator to make needed corrections, thus increasing the reliability of the machine.

The computer, which will contain over four-hundred operational amplifiers, making it the largest single integrated unit of its type, will be able to simulate all of the movements of a guided missile in flight. Thus the cost of building and testing flying missiles, to determine their suitability, will be greatly reduced.

The device, expected to cost about a million dollars, will be housed in a six-thousand square-foot room in the aeronaautical research lab at WAD's facilities in Dayton, Ohio.

ALL THE TV BANDS, the very-highs and the ultra-highs, should be used and every effort made to insure such use promptly.

Thus declared FCC Commissioner Rosel Hyde, during a recent address before the Lions Club in Washington. He viewed an immediate re-examination of the TV allocation program as an absolute "must," in order to provide conditions which would be favorable to the growth of the high bands.

Warning that without solid attention now, u.h.f. will . . . "wither and die . . . and buried with it may be our hopes for a nationwide competitive system" . . . Hyde said that we must face . . . "present realities and examine the existing situation, not with a view to allocating blame, but to see what can be done to correct trends which have developed, and to press for the proper development of a . . . system . . . in the American tradition."

Elimination from active use of seventy of the eighty-two channels, the Commissioner added, would drastically curtail the present and future scope of the industry. It would result, he pointed out, in TV . . . "becoming a limited, protected, and necessarily regulated service, rather than the dynamic service contemplated by Congressional policy."

Reviewing the variety of plans now being suggested to the Commission to extend the very-high band assignments, Hyde said that the proposed "squeezing-in or shoe-horn technics (involving lower power, lower antennas, directional antennas, etc.), if experience in other fields is to be relied upon, can be expected to cause interference in outlying areas . . ." and therefore the cumulative effect would be "to "provide additional services in population centers, at the expense of outlying areas where it is most needed."

The Commissioner felt that any such move would inevitably . . . "undermine present incentive to the development of the ultra-high channels . . ."

In his opinion, any general course of action, which looks forward toward the licensing of stations . . . "under a system with a built-in low ceiling on future expansion, should not be adopted until we have at least made
Recently, in Detroit, TV displayed its versatility as acting as a traffic guide. One of the key expressways, a three-camera chain was set up in an experimental program to handle accidents and congestion on the roads. The cameras, tied to a control room three miles away, were placed on pedestrian bridges overlooking the highway, which leads downtown Detroit with suburban areas. Through an ingenious control system, the cameras could be raised, lowered, panned, and tilted to provide complete visual coverage of this extremely busy thoroughfare. It is believed that TV can provide that split-second control which will avoid costly tieups due to accidents and other road problems.

The cost of such a system was described as ridiculously low, when compared with the huge costs involved in building the thoroughways and the road efficiency the tele-coverage network can offer on a reliable basis. L.W.
Buying an Amplifier?
(Continued from page 40)

Some loudspeaker manufacturers have been following the practice of rating the impedance on the average value over the audio range. Fig. 4 illustrates this on a typical impedance curve of a loudspeaker. Now, an amplifier is tested to give its full rated output when it is loaded with a dummy resistance of the value specified for the output tap used. If the amplifier is tested on the 16-ohm output tap, a 16-ohm dummy resistance load will be used for measurements. Many loudspeakers will be found to dip below their nominal impedance value over a range of mid-frequencies and, for this reason, they will absorb more power from the amplifier than is indicated by measuring the voltage on the voice coil terminals. This means that when the amplifier is connected to a loudspeaker it will not appear to give its rated power output.

This method of rating also tends to make the efficiency of the loudspeaker look better because the calculation of power input may show only, say, 9 watts where the loudspeaker may actually be absorbing 15 watts. The writer suspects that this method of rating loudspeaker impedance may have arisen due to an endeavor on the part of the speaker manufacturer to make the sensitivity of his unit appear favorable in comparison with other units, and average impedance is quite a legitimate interpretation.

As the reader will not usually have facilities for checking the impedance of a loudspeaker system at different frequencies, he had best take the loudspeaker manufacturer’s word for it and match it to the amplifier according to its rating.

Next comes the specification of input impedance and loading level. By loading level, the manufacturer means the voltage input required to give full output. The input impedance should match whatever the user intends to connect to the input. If the audio amplifier does not include a preamplifier and the user has in mind a separate preamplifier, then the output impedance of the preamplifier and input impedance of the power amplifier should match, both in impedance and level.

Many preamplifier outputs are cathode followers rated at 600 ohms. However, in this case the output impedance rating is not indicative of the load with which the preamplifier should be terminated. It will invariably work better into a high impedance grid, than into a 600-ohm load. This will be discussed more fully in a subsequent article on the choice of a preamplifier.

Power amplifiers have an input, either high impedance to grid or a line impedance of 600 ohms through a transformer. The former is the more practical arrangement for most purposes. If the output from the pream-
Picking Winners...

You’re always in luck when you use a Stephens System. These Tru-Sonic Speaker components are designed to mix and match with quality inbred across the board!

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Your best low cost buy, 801
Low frequency driver is 15” 105LX, with a 2½ lb. Alnico V magnet, 2” voice coil, large spider assembly and sturdy cast aluminum frame. System 801 has a 216 high frequency driver, 814H multicellular horn, and Stephens 800X-2 network and attenuator. Range is from 30 to 18,000 cps. 25 watts power capacity. Net $165.00. For an excellent, three-way system, add a 214 super tweeter and 5000X crossover.

Super two-way system 803
Uses two 103LX low frequency drivers, the finest available; a Stephens 216 high frequency driver releasing full 20 watts above 800 cps. Horn is the multicellular 824H, 2 cells high and 4 cells wide. System 803 utilizes 800X crossover and attenuator. Frequency range extends from 20 to 18,000 cps. 30 watts power capacity. Net $269.25.

Note: This speaker system converts to a three-way system with the addition of a Stephens 214 super tweeter and 5000X network.

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The Hi-Fi Dream Tape Recorder
3 Speeds—10” Reels
Priced lower than any other professional recorder with equal standards... Full details in our December—January catalog.

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November, 1955
NEW STOCK OF PRE-TESTED TELTRON TUBES GUARANTEED! . LOWEST PRICES EVER!
All tubes individually tested... unconditionally guaranteed for one year!
GIFT OFFER! One 16QG tube will be shipped FREE with any $10 or more accompanying this ad.

FREE Bonus Offer!

MODEL 625K
May be bought outright from Teltron for $34.95
This special order is FREE with any $10 or more accompanying this ad.
We have a full stock of T.V. picture tubes.
Resistors will be sent at no extra charge.
All tubes RCA licensed and guaranteed for one year.

FREE $2.20 list value Bonus Box of three 6SN7 tubes and 25 assorted resistors with each order of $25 or more.

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RADIO & TELEVISION NEWS

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motion is conveyed to the diaphragm either by vibrations through a thread or directly by connecting the spring to the diaphragm \( P \), and these motions being due to the indentations, which are an exact record of every movement of the first diaphragm, the voice of the speaker is reproduced exactly and clearly, and with sufficient volume to be heard at some distance.

"The indented material may be detached from the machine and preserved for any length of time, and by replacing the foil in a proper manner the original speaker’s voice can be reproduced, and the same may be repeated frequently, as the foil is not changed in shape if the apparatus is properly adjusted.

"The record, if it be upon tinfoil, may be stereotyped be means of the platter-of-paris process, and from the stereotype multiple copies may be made expeditiously and cheaply by casting or by pressing tinfoil or other material upon it. This is valuable when musical compositions are required for numerous machines.

"It is obvious that many forms of mechanism may be used to give motion to the material to be indented. For instance, a revolving plate may have a volute spiral cut both on its upper and lower surfaces, on the top of which the foil or indenting material is laid and secured in a proper manner. A two-part arm is used with this disk, the portion beneath the disk having a point in the lower groove, and the portion above the disk carrying the speaking and receiving diaphragmic devices, which arm is caused, by the volute spiral groove upon the lower surface, to swing gradually from the center to the outer circumference of the plate as it is revolved or vice versa."

From the above, we find a very crude method for the recording and reproduction of sound. Edison’s application made four important claims as follows:

1. "The method herein specified of reproducing the human voice or other sounds by causing the sound-vibrations to be recorded, substantially as specified, and obtaining motion from that record, substantially as set forth for the reproduction of the sound vibrations.

2. "The combination, with a diaphragm exposed to sound-vibrations of a moving surface of yielding material—such as metallic foil—upon which marks are made corresponding to the sound-vibrations, and of a character adapted to use in the reproduction of the sound substantially as set forth.

3. "The combination, with a surface having marks thereon corresponding to sound vibrations, of a point receiving motion from such marks, and a diaphragm connected to said point, and responding to the motion of the point, substantially as set forth.

4. "In an instrument for making a

---

DISTINCTIVELY NEW and different, the beautiful Crown Tenn-A-Liner Model CAR68 is shown in combination with the exclusive Crown TV Planter. The planter, in forest green and chocolate brown china, is a completely separate unit that opens an entirely new field for antenna rotator promotion. Styled for feminine buy-appeal, the Tenn-A-Liner has sleek modern lines . . . handsome three-tone color styling . . . and harmonizes with dark or blonde woods, modern or traditional furnishings.

And remember, Crown gives you the highest profits in the TV antenna rotator field. Don’t miss your chance to cash in! SELL WITH CONFIDENCE . . . SELL CROWN!

FEATURES THAT MAKE CROWN THE MOST DEPENDABLE, EASIEST TO SELL ROTATOR ON THE MARKET

Modern styling
Smooth, constant, dependable performance under all conditions
Exclusive "Weather-Guard" design
Over-strength aluminum castings
Internal automatic brake
Only 1.06% of units sold require service

CROWN CONTROLS Co., Inc. NEW BREMEN, OHIO

November, 1955
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-UP TOWERS

...will remain at

the maximum reading of

the device until

reset by a knob on the
dial face.

CORRECT STYLUS PRESSURE NOT

GUARANTEES MINIMUM STYLUS

AND RECORD WEAR, BUT ASSURES

SOUND PICK-UP AT MINIMUM DISTORTION.

Dealers -

Why not investigate...

WRITE FOR ILLUSTRATED FOLDER

GEORGE SCHERR CO., Inc.

200-Ry Lafayette St., New York, N.Y.
opera. This was all made possible by the rotating cylinder which was turned by various methods beginning first with the so-called hand-powered machine which relied on constant physical rotation of a handle and stabilized to some extent by heavy flywheels to maintain some degree of stability.

While Edison, on his original application spoke of his invention as a "phonograph" or "speaking machine," other makers later referred to their products as "Graphophones," "Gramophones," "Zon-o-phones," and "Talking machines," etc.

The first records were made in the following fashion: above the rotating cylinder and mounted to a diaphragm was a recording stylus suspended in a ring-like container. Coupled to the assembly head, a flat of a flexible hose was a long metal horn having a slight taper. The thickness of the glass-like diaphragm used on the "recorder" varied from .003 to .008 of an inch. A feed screw engaged a carriage containing the diaphragm assembly to thread its way across a rotating cylinder. The recording stylus performed two functions. First it cut a shallow groove about .001 inch deep in the material and, when modulated by sound, indented the vibrations resulting from sound further into the groove. The process was akin to embossing. This method of recording employed a vertical vibration rather than the lateral methods later devised by Berliner and others. The first Edison cylinders were recorded at about 100 grooves per inch, and the speed of rotation was 160 rpm. Playing time was 2 minutes. During recording, sound waves (vibrations) were funneled to the diaphragm through the long horn and impinged upon the cylinder. Thus, each sound wave, having its own peculiar vibration, would be indented on the wax cylinder.

The reproduction or playing back of these vibrations was a reversal of the recording process. In place of the cutting stylus, Fig. 7A, a special sapphire point, ground carefully to the shape of a door knob, Fig. 7B, was used. Vibrations appearing on the rotating cylinder were those transmitted to the diaphragm and, in turn, would reproduce the same sound waves as were originally recorded.

**Fig. 7.** (A) Enlarged view of the cutting sapphire and (B) reproducing sapphire.
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143G9 | 5301 | 143G9 | 5301
143G9 | 5301 | 143G9 | 5301

- On 100 tubes, 19c each
- On 200 tubes, 18c each
- On 500 tubes, 16c each
- On 1000 tubes, 13c each

The Duplication of Cylinders

One of the most severe problems in the early days of recording was a satisfactory means for producing duplicates of recorded cylinders. It was customary then to place a group of recording machines on shelves in the recording studio. The new recordings were played by the radio stations at the points of the audience. If the cylinders were not played at the points of the audience, they were distributed by the radio stations for replay. The result was that the cylinders were distributed by the radio stations for replay. The result was that the cylinders were distributed by the radio stations for replay.

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Few people realize that these first commercial machines relied on a source of direct current for their operation. Such a machine was produced in 1880, see photo on page 58, which contained a direct-current motor that operated from a 2-volt battery supply. This was known as Type M and two models were produced—one known as the "Victor Diaphragm" model—and the other as the "Balmoral." These machines were bulky and weighed over 50 pounds. They were equipped with a speaking tube for recording, a shaver to remove sounds from a cylinder for re-use, and a hearing tube for use during reproduction.

A dual pulley, mounted on the armature shaft, coupled to the drive shaft and feed screw of the machine by means of a flat hand-sewn leather belt, provided driving power to rotate the cylinder and its feed screw. Another belt, shown in the photo on page 58, was coupled to a vertically mounted governor to stabilize the rotation of the cylinder. An ingenious electric limit switch was included so that when the speed of the machine became excessive, a shut across the motor supply would cut the field current and reduce the driving power and slow the machine.

In operations, this make-end-break action resulted in considerable wow due to the rapidly fluctuating voltage. This was not too noticeable on these early machines because they were designed as dictating devices.

Some of these models (and they are now quite rare) were sold by the North American Talking Machine Company of New York and were identified as Class M. There was a restriction on a nameplate stating that the machine could not be used in the State of New Jersey.

Several varieties of the Model M were produced during the year 1880, the main difference being in the cabinet and the accessories. The Model M used a standard-size wax cylinder and was a single-speed job providing two minutes recording at a speed of approximately 180 rpm.

Following chapters of this series will tell of the Edison developments to follow, the inventions of Emile Berliner (specifically the disc phonograph), Eldridge Johnson, Tainter and Bell will be revealed.

(To be continued)
148 mc. Transceiver
(Continued from page 65)

Assembly and Testing

It should be emphasized that because of the frequencies involved, variations in layout, parts, and/or wiring may cause difficulty in obtaining satisfactory performance. Close attention should be paid to the layout as indicated in the photographs.

After the unit is assembled and wired, it should be checked and inspected before power is applied. Visual inspection of the mechanically assembled parts may disclose screws which weren't tightened. Checking the wiring with the schematic may disclose an omission or a shorted or unsoldered connection. After the assembly is checked, the receiver is aligned and tested as follows:

1. Turn "Transmit-Receive" switch, S₁, to "Receive" position.
2. Plug headset into J₁.
3. Connect all batteries.
4. Connect antenna to T₁.
5. Adjust tuning capacitor C₁ so that the plates are meshed about 15 degrees.
6. Turn on power switch S₂.
7. Connect the signal source, which may be either another 148.14 mc. transmitter or a calibrated signal generator, to the antenna. Adjust capacitor C₁ until a 148.14 mc. signal is heard in the earphones.

For alignment and testing of the transmitter, the following pieces of test equipment should be available if maximum performance is to be obtained.

a. High-impedance voltmeter such as an RCA WV-77A "VoltOhmyst" or equivalent.
b. A v.h.f. receiver tunable to 148.14 mc.
c. Field-strength meter tunable to 148.14 mc. or a v.h.f. receiver with meter to indicate the relative field strength.

The transmitter is adjusted as follows:

1. Adjust the external v.h.f. receiver to 148.14 mc.
2. Turn switch S₁ to "Transmit" position.
3. Adjust capacitor C₁ until the signal reads "null" on the crystal oscillator "locks in" at the correct frequency. Then, adjust capacitor C₂ and readjust C₁ until the most stable condition of "lock in" is obtained, or until C₁ can be varied over the widest range with the crystal still "locking in" at the proper frequency.
4. Connect the voltmeter to the junction of resistor R₃ and capacitor C₄. Adjust capacitor C₄ and the coupling between coils L₃ and L₄ until maximum voltage is noted (between -25 and -30 volts with a "B" supply voltage of 135 volts.) Final adjustment of the power amplifier is made with the antenna connected. The radiated field strength is measured with either the field-strength meter or the meter of the external v.h.f. receiver.

5. Adjust capacitor C₆ for maximum field strength and then adjust the coupling between coils L₃ and L₄ for maximum field strength. (It may be necessary to adjust C₃ and L₃ and L₄ alternately to maximum strength.)

After maximum field strength is obtained, reduce the coupling between L₃ and L₄ until the indicated output drops about 10 per-cent. Recheck tuning of C₃.

6. Check modulation by talking into the microphone and listening on the external receiver.

As mentioned previously, this equipment was installed in a light airplane. The antenna system consists of a police-type, car-top whip 18 inches long fed by a length of 50-ohm coaxial cable connected to the antenna jack J₅. The antenna is mounted at the top center of the windshield. The shield of the coaxial cable is connected to a metal crossbar located directly under the antenna. The metal crossbar and metal structure under the antenna provide a ground plane. If metal sheathing is available on top or bottom of the airplane, the antenna can be mounted on the sheathing and the coaxial shield grounded directly adjacent to the insulator. The manufacturers of this type of antenna usually furnish car-installation instructions which can be followed for either cars or airplanes.

If desired, the transceiver can be housed in a portable carrying case for field use. A suitable antenna can be made by fitting a piece of stiff 0.050 inch hard brass rod into a female coaxial fitting and plugging it directly into the receptacle J₅. The chassis, batteries, and carrying case form a ground plane for the antenna. A double-pole, single-throw switch (S₃) and a receptacle (SO₁) in the top of the carrying case permit plugging in an external power supply when battery operation is not required.

---

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By H. LEEPER

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November, 1955
from poor contact between tape and playback gap. This loss is especially severe at high frequencies, where the magnetic flux extends but a small distance from the tape. A film of minute thickness, such as produced by wear of tape oxide, can virtually obliterate high frequencies. Poor contact may also result from improper adjustment of pressure pads, tape tension devices, etc. Fig. 5 shows how serious the losses can be. At 7.5 ips, separation of as little as .001" reduces response about 5 db at 5 kc. Separation of .001" reduces response at 5 kc by more than 40 db. (Although not necessarily of the same order, losses due to poor contact also occur in recording.)

Imperfect azimuth alignment is often a source of high frequency loss in playback. Correct azimuth alignment means that gap height is exactly perpendicular to tape length. Fig. 6 shows the severity of losses for a wavelength of .001" at 7.5 ips. This represents a fringe of 7.5 in. In the case of a half-track playback head, misalignment of only 30 minutes of arc reduces output about 17 db. Losses are even more drastic for a full-track head. Thus misalignment of only 12 minutes of arc causes 20 db attenuation at 7.5 kc.

It is assumed in Fig. 6 that the recording is made with a perfectly aligned record head, and that it is the playback head which is misaligned. However, a perfectly aligned playback head and an imperfectly aligned record head also produce the results indicated in Fig. 6. In the case of recorders using a combination record-playback head, the problem of azimuth alignment, except in the case of severe departure from perpendicular, is insignificant as long as use of the machine is confined to recording only for itself and playing only its own recordings.

The losses associated with poor azimuth alignment can also be caused by skewing of the tape as it passes the head. That is to say, the angle of the tape relative to the gap may be constantly changing due to faults in tape guides and tension devices.

High frequency losses due to poor azimuth alignment may be explained as follows. Assume the tape has been recorded by a perfectly aligned head. If the playback head is also perfectly aligned, all points of the left edge of the gap, at a given instant, are in contact with the same magnetic potential. A similar condition is true for the right edge. But if the playback gap is inclined from perpendicular, the left edge will contact different magnetic potentials at various points along the edge. At high frequencies, where magnetic poles are close together, the inclined gap edge will contact a number of north and south poles, which cancel out. Thus the net magnetic potential confronting the left edge of the gap is less than if the edge were

**Tape Recording**

(Continued from page 51)
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Summary

The response curve of a pair of record and playback heads, as shown in Fig. 1, is not flat principally as the result of (1) treble losses in record due to demagnetization and bias erase, (2) bass loss in playback owing to the playback head being a constant velocity device, and (3) treble losses in playback due to gap length and other losses in the playback head. Fig. 7 shows approximations of these major losses for a head having a .00015" physical gap, with bias current close to optimum, and with tape speed at 7.5 ips.

In addition to the losses shown in Fig. 7, there may be losses at the low end of the bass spectrum due to excessive wrap of the tape around the playback head, treble losses resulting from poor contact between head and tape, and treble losses caused by imperfect azimuth alignment of either the record or playback head. Finally, some bass boost may occur as the result of the head as a whole reacting to the tape's magnetic flux.

Next month we will go into the question of the important role played by bias current and the problems it raises with respect to equalization of frequency response.

(Continued Next Month)

FM-TV Sound Portable

(Continued from page 73)

should be followed as closely as possible. The completed receiver should work well from the start. Since some builders may run into trouble in one way or another or may not be able to duplicate some of the components used by the author, here are a few hints for getting the most out of the receiver.

First, the antenna length is somewhat frequency sensitive. Try a 12-inch or longer wire. Gimmick C should give just enough coupling so that squeezing the hand around the insulated antenna wire increases the voltage up to the point where the detector goes out of regeneration, as evidenced by the cutting off of all sound. Particular TV or FM stations may be favored by cutting an antenna to the best length for that station, or an over-all compromise may be used. A "ringing" sound similar to feedback indicates improper antenna coupling and may be eliminated by shortening the antenna or decreasing the number of turns in the "gimmick." Once the antenna coupling is set for clear, loud reception, it should need no further attention.

Tune the receiver carefully. In the absence of a signal, the superregenerative "hiss" will be quite loud. This is a
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Sign that the receiver is working. A station tuned in will cause the hiss to drop below the audible level, unless signal strength is too weak. For all FM signals, and this includes the signal of TV channels, the receiver must be tuned slightly to one side of center. This is necessary because "slope" detection permits the superregenerative detector to demodulate the FM signals which, in normal FM and TV sets, require many stages of amplification followed by a discriminator or ratio detector circuit. Always tune for best quality of sound rather than maximum volume, then adjust the volume with control R.

If any distortion appears in the audio output after the receiver is carefully tuned, try a slightly higher or lower value of plate resistor R. Select the value that gives the best quality at both the high-frequency FM end of the dial and the low-frequency maximum capacity end. Since the superregenerative detector likes a particular LC ratio for best performance, a different tuning capacity may work better with a different number and spacing of coil turns. Be sure the "A" battery is fresh. You should be able to see the filament burning in the 957 tube or it will oscillate sluggishly or not at all. A voltmeter across either "A" or "B" batteries should not change its reading appreciably as the set is turned off and on. If the voltage drops noticeably when the set is turned on, the battery should be replaced.

In normal use, this portable receiver will not interfere with TV sets or other receivers. Since it is tuned to TV sound channels its slight re-radiation is not of the type that causes interference with picture or sound. When it is tuned through a picture carrier TV frequency (the picture may be "heard" in the speaker: as an unpleasant 60-cycle buzz due to sync pulses) it will cause a momentary herringbone pattern to cross the screen of a TV receiver in the immediate vicinity that is tuned to that channel. The interference is brief and of negligible intensity—no worse, in fact, than the re-radiation of many TV tuners with "leaky" oscillators. Since the portable is not left tuned on picture carriers, and is usually played away from houses, no interference problem will arise.

The portable may be played in any position or while it is being carried by the handle. You will notice that high-frequency TV and FM signals vary considerably in strength as you move about so pick a spot where reception is good before putting the set down for a listening session. Except in valleys or among tall metal-frame buildings the set will work well up to 25 miles from the average TV or FM station. Actually, the volume of the portable may be used as a rough-and-ready indication of field strength and could be employed for such purposes as locating a TV antenna on top of a roof, but the set is not a test instrument. It was built for relaxation and entertainment—so have fun!

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(Continued from page 76)

This 6th symphony is described as a one movement work, but the discerning listener will quickly discover there are six fairly discrete sections or motivations ranging from larghetto to presto in expression. From the opening bars the work is unmistakably identified with Schuman. The same rich brass textures, the clever use of percussion as dramatic counterpoint, the ascending and descending runs on the woodwinds, characterizing this work as in his earlier symphonies. I am reminded most of all of his third symphony, especially by the rousing, almost frenzied finale. (Incidentally, the 3rd was issued some years back by Columbia and is a most exciting work, well worth your attention.) Yes, there is atonality and dissonance in this work, but Schuman's unique chordal structures and his fresh ideas on the expression of these sonorities make for an easily assimilable score. As a hi-fi piece, this will be a delight to the aficionados. The liberal use of all types of percussion, which is very clean and articulate, the bite of the trombones and trumpets, the soaring woodwinds, and the clean delineation of the strings mark this recording as one of the highest of Columbia efforts. Ormandy is a good man for this sort of repertoire and this is apparent in the metronomic precision of his tempi and the intelligent balance he brings throughout the score. My one quibble with this recording you may find odd! I think the Philadelphia men played the score with their usual precision and astringence. I think this score calls for a less "fat" and sumptuous string tone, and generally less orchestral weight. Perhaps my feeling this way is heightened by the fact that I own a piece which is just a shade over-reverberant and tends to increase the illusion of mass.

The Piston work is equally interesting, if a somewhat less subtle and dappled work, than Schuman. Cast in four movements, this score is not as rough-hewn as the Schuman and is better suited to the Philadelphia talents. The smooth sweetness of the strings, especially the violas, can be heard to advantage in the third movement. The second movement, ballade, and the finale, energico, will appeal most to devotees of exciting sound, what with the rollicking woodwinds, the dance-like figures for the strings and brass, and the free use of percussion, especially the tympani and cymbals in the last movement. Through out both symphonies, frequency and dynamic range is quite wide, transients are cleanly reproduced, and pre- and post-echo groove distortion is minimal. This disc is supposed to be reproduced with the RIAA curve, but I found the old NARTB more suitable to my ear. If you have been feeling adventurous in your musical appetite, try this "modern" Whatever other reaction you might have, I am sure you won't be bored!

**ORGAN MUSIC FROM SWEELEINCK TO HINDEMITH**


Although the masters of these recordings are several years old, this is the best organ recording to come my way in some time. This is not so much a question of super hi-fi sound, though it is not unimportant, but rather that all picture of good sound, splendid performances, superb instrument. I was fortunate enough to have heard Heitmann in this country several years ago, and the instrument was obviously hampered by the modern voicing of the Molier he played. I was impressed at that time by his economical tech-
niques; some have even accused him of being too pedantic and dry, a result, probably, of hearing some organists long on the razzle-dazzle and short on authentic interpretations. The program in this album is varied and interesting, but the highlights for me were the Bach "Toccata and Fugue in D Minor," which was given a beautifully integrated and loving performance with extremely luminous registration, done in the best classic manner (compare with any recording of the work done on a modern instrument for a real surprise) and the fascinating Hindemith "Organ Sonata #1." Of all modern works for organ, I think this is the most interesting both from a structural and listening standpoint. Old Heitmann, who has been dead about two years now, showed his versatility by turning in a fine performance notable for its careful phrasing and dynamic shadings.

You lovers of the organ bass will not find any ultra-lows on this disc, but what bass pedal is heard is superbly clean as is the rest of the haroque voicing. No instrument is mentioned but it sounds like Heitmann's favorite in the DOM in Berlin. Sound is quite wide range, distortion, transient or otherwise, negligible. Most appreciated were the fabulous acoustics and the over-all balance achieved by the engineers which make for one of the most pervasively "live" organ sounds I have heard. If you really like organ, and not just the hi-fi potential of the pedals, I can recommend this most highly.

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Confusing, ain't it? Well, not really—it's just Mercury records clever and sensible way of presenting its version of "The Young Person's Guide to the Orchestra." On one disc we have the delightfully urbane voice of Deems Taylor narrating along with the music, and for those who like their "Guide" straight, another disc sans narration. Mr. Taylor also holds forth on the "Nutcracker Suite," which I understand is the first time this has been done, and on the other disc, the "purists" get a considerable bonus in the form of the record premiere of Argentinian composer Ginastera's "Concert Variations."

As to the results? Well, the "Guide" has been pretty thoroughly documented on a number of recordings, but as far as I'm concerned this is the last word on the subject. I find Mr. Taylor's easy, unstained delivery completely in good taste as well as perfectly articulate. His beautifully modulated voice seems equally fitting whether the recording is being addressed to adults or to children. The narration on the "Nutcracker" is not "corned" up as it could have been so easily, and I find it quite diverting.

In the "Guide," Mr. Dorati has accomplished another of his orchestral tours-de-force. There is some quite astonishing material here and people will be attracted as much by the virtuoso playing of the orchestra and the brisk, unflagging performance as they will by the incredible super-fi sound. That this disc will find wide use as a demonstration piece, encompassing as it does, the

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The music for the "Nutcracker" is excerpted from the complete ballet Mercury issued last. The Gisserie piece is of more than passing interest, with the brilliant orchestration, although most of it is smaller scaled from chamber orchestra. Instrumental definition is, if anything, even more startling than the "Guide" and the remarks made on the "Guide" are equally applicable here. Either of the two discs is hi-fi realism at its best and need no discussion here. Since this is Mantovani's native idiom, no reason why it should be cause for alarm. Rest assured, there is none of the Mantovani mannerisms in evidence here, as he plays it straight.

Katchen is a natural for these works and the vigorous and spontaneity of his reading could only stem from a person who was obviously enjoying himself. His rhythmic sense is most acute and he combines this valuable trait with deft clean phrasing and strong melodic line, which doesn't bog down in sentimentality.

With regard to the sound, this disc has no close competition. The piano is big toned and exhibits no ringing or harshness. Transparent detail is exceptional. Now, it would be unfair to say that Mantovani or Wagner was not popular. The Mantovani orchestra gives a good account of itself and the whole is heard in one of London's most spectacularly equipped recording studios. This disc, Dynamics, which are so important in these scores, are very wide and the balance between piano and orchestra is good although slightly favoring the piano. Don't let Mantovani scare you away—this definitely is the top version on these very popular Gershwin scores.

DPORAK

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TAMAR (SYMPHONIC POEM)


RADIO & TELEVISION NEWS
Sir Thomas is always a formidable protagonist of Dvorak music in this recording. A version by Rafael Kubelik is forthcoming, this would appear to be the closest we shall get to that elusive word, "definitive". Sir Thomas' reading is notable in his forthright delineation of the "Variations," all the while managing to keep the score well integrated. As always, he has his magnificent orchestra under firm control and this helps no end in matters of balance and dynamics. I could wish for a little more brilliance in the sound, but generally the recording is quite good with nice clean strings and good acoustics.

The Balakireff tone poem, "Tamar," is somewhat less successful, not so much from the performance as from the recording itself. The recent Ansermet effort on the Columbia recording was a smoother, more "romanticized" reading, in better keeping with this sometimes dullish score. The new sound was one of their best jobs, this is very good indeed, whereas this disc again suffers from a lack of brilliance and a bass line not as clean as I would like. Everything considered, the disc is worth the price of admission for the wonderful job Sir Tommy does on the Dvorak "Variations."

BENNY GOODMAN AND HIS ORCHESTRA


This disc is for enthusiasts with long memories, because some of the material goes "way back!". This is the Benny Goodman and the Goodman orchestra as I remember it—the red hot hand driving, hand swinging outfit, with the bespectacled young man who made such wonderful sounds on his licorice stick. There are some all-time Goodman favorites on this disc such as "Six Flat Unfurnished", "Buda", "The Man I Love", and a terrific "Jumpin' at the Woodside" among others. The sound is obviously dated and obviously has been enhanced, with some reverberation and equalization trickery. On good wide range equipment the sound is quite listenable and is, I would say, a pretty fair representation of what the great Goodman band sounded like in the old days. If you're a Goodman fan, this is a "must".

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**Musician Looks at Hi-Fi**
(Continued from page 41)

**Playback**

Listening to the results of a recording session frequently proves a bit disappointing. The sound is often harsher and more edgy than the quality of sound perceived while playing. On occasion, an individual instrument or a certain passage clearly heard on stage seems to assume a different place within the over-all recorded balance. Certainly the type of playback equipment used and the lack of the final editing and recording refinements at that moment, play an important part. Since all musical and some technical improvements during a session are based on the playback, the more realistic the playback can offer, the higher the degree of self-criticism which can be supplied by the player.

**Home Reproduction**

After the recording has been optimized and edited, what can we finally expect to hear at home, on a fine hi-fi system? We must first of all take into consideration the following facts; the most sensitive aural response lies within the range of 500-8000 cps (frequencies above 15,000 cps being inaudible to most people.) There is considerable variation in what people hear under the same conditions, particularly regarding music, as well as some deterioration in hearing with advancing age.

There are also distortions in the ear at low frequencies, and we must also allow for masking effects. Masking effects occur when one of two tones of different frequency is increased in volume and thereby renders the other tone inaudible. Generally masking comes about when frequencies are fairly close together. (2-3 octaves.) Furthermore generalizations are difficult to arrive at, because of the differences in individual record pressings and listening-room acoustics.

In all the following listening tests these high fidelity components were used by the courtesy of Custom Classics, Cleveland, Ohio: Weathers pick-up arm; Rek-O-Kut T-12 turntable; McIntosh CS preamplifier; McIntosh MC-30 amplifier; and two Bozak B305 speakers and enclosures.

The listening room, 14 feet wide, 16 feet long, and 12 feet high, is fairly well damped, with carpeted floor. 64 square feet of the wall area is treated with acoustical tile. The remainder of the walls and ceiling is hard.

In comparing several of the leading labels it was observed that they could be distinguished by certain individual traits. None of them was entirely free from cracks and slight hisses noises. Even the factory-sealed records showed occasional scratches. In listening for accurate reproduction of the various
sections of the orchestra and comparing them with live sound, the string sections, especially violins, were the least natural. We discovered the speakers to be the most essential factor for improving or ruining the potential of a given recording.

Strong hi-fi responses seem to be stimulating to some people, while others prefer the more mellow tone quality and volume which one might hear in the first row or amidst the orchestra itself. The author's preference would be an objective position such as the center of a hall or the dress circle. Hi-fi addicts sometimes delight in such slogans as "sharp brasses, edgy strings, enormous percussion triumphs." These impressions would often prove musically incorrect when checked against the score, however effective these distortions.

Loudness

In order to test the effect of loudness on reproduction we used the clarinet solo at the opening of the 3rd movement of Rachmaninoff's "Symphony No. 2" (Capitol). The test was made without loudness compensation. The set was adjusted to correspond to a level which might be heard in the center of a concert hall. A reduction of 10 db showed no considerable change in the orchestral balance. A reduction of 20 db, however, distorted the musical balance beyond reason. The increase of 10 db above the original level caused considerable surface noise and the relation of the solo clarinet to its accompaniment became unbalanced.

Frequency Response

In trying to test the effects of a flat frequency response versus bass and treble boost, we had to favor the flat response, which offered greater musical clarity. Although more apparent "presence" was achieved with the treble boost, the resulting surface noise seemed to cancel any advantage gained. While bass boost was not as objectionable, the texture of the music was nevertheless obscured.

The author wishes to emphasize that these statements represent a personal reaction which, due to room acoustics and equipment variations, may call for individual modifications.

Discs Versus Tape

Discussing such controversial matters as the difference between tape and discs or the importance of overtones, the musician is caught in a web of contradictory statements by the experts. The absence of stylus noises, rumbles, changing of sides, and storage problems and the possibility of transferring discs to tape, all seem to be attractive features serving the cause of music well. The musician contends that it is the overtone structure which characterizes the instruments and supplies timbre and tone color. Tape suffers from some limitations in this regard. In comparing the frequency range of the fundamentals with that of the entire spectrum, it is clear that...
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**General Musical Remarks**

From a musician's point of view, the technical limitations are superseded by the restrictions hi-fi recording places on the performer by replacing human impulses with electrical ones. The audience is an essential participant in any performance which is generated by inspiration and life. The performer, if he is to give his best or perhaps even surpass himself, needs the attention and approval of his audience. He senses keenly to what extent the audience is participating after playing for only several minutes. The recording session entirely eliminates these very vital aspects of making music.

Furthermore, we are denied the visual enjoyment of a live performance and of what is generally called the "concert atmosphere." If these facts would be realized and understood by the many listeners whose entire musical knowledge is based exclusively on listening to records, we would create standards and conditions most certainly of advantage to the recording industry. We would be wiser not to try to duplicate the concert hall despite the progress made, but to create our individual standard of phonograph music, which will supplement and enrich our general musical experience.

On a subject as diversified as hi-fi one could not expect absolute agreement, either amongst musicians or laymen. Furthermore the very existence of the musical artform depends on individual and sometimes contradictory reactions toward the same subject matter. It is a well known fact that musicians rarely agree in judging the merits of a musical interpretation. An interpretation of the same work even by the same musician will differ from performance to performance depending on the artist's mood and physical well-being, acoustic conditions, audience reaction, and the change and maturing of thought and emotion. The listening requirements for the non-musician basically do not vary from those of the musician. The latter might be inclined to concentrate more on the content and details of interpretation, whereas the non-musician is often satisfied with the mere stimulation of emotions.

**Conclusion**

It would be difficult to deny the progress and accomplishments of the record industry. Although the musician realizes the need for further mechanical improvements, there are some other aspects connected with hi-fi recording which are most valuable to him. To name only a few, there is the advantage of repeated hearings of complex works, hi-fi productions of new...
music. American or otherwise, under the guise of "opera," "opera," we come to the field only by the ‘admirable' record of the most famous “appreciation" records, authentic recordings of records by famous composers and orchestras, and recent electronic research into the field of musical composition.

With the appearance of hi-fi LP, complete operas have been brought to Americans living thousands of miles removed from the Metropolitan Opera House in New York. It has enabled us to hear, for the first time, some of the most beloved and the iron operas, in their complete form and introduced some of Europe's finest musicians and orchestras prior to their personal appearances over here.

In the field of pop music hi-fi has actually created new styles. Here the engineer has taken over from the musician by adding fancy sound flquires such as bird calls, the barking of a dog, and above all the echo chamber. Well known is the trick of a singer singing a duet with himself, which has as its chief characteristic the absorption of the artist into the stereo image in the Bach "Double Concerto for Two Violins," with Heifetz playing both parts. Although many of these effects are being undone, we hear some interesting and sophisticated use of the stereo effect on popular recordings nowadays. By the use of the oboe, the French horn, and even the harpsichord there has been somewhat of a reconciliation between the long-haired and the short-haired musician.

The together of the hi-fi LP has shifted the responsibility for maintaining our cultural level as far as music is concerned from a few individuals to the record buying and listening public. There is a danger in accepting a musical performance by repeated listening to the same recording of it, or by mechanical manipulations of one's hi-fi set. If we are to have participating and discriminating listeners, their judgment must be based on as much listening experience with actual live music as possible. Only then will the highs and lows are exaggerated or overemphasized the sound is robbed of its natural musical quality. The hunt for the elimination of rumbles, scratches, and rattles often strips the music of its freshness and spirit. The technical alterations diminish the high fidelity of music. If hi-fi is not to become an end in itself, its interdependence with live music, the composer, the critic, performer, and educator must be realized. Frequently the technical alterations of a new composition will be followed up with a recording of it. Just as often the reverse is the case, when a musician will perform a piece of music, which was initially heard on records. The reactions of a reputable critic to a live performance or a recording obviously have an important influence on the entire musical scene. Particularly from an economic point of view this interrelation is of utmost consequence. Without this mutual influence, the industry's interests, economic or otherwise, nor further development and cultural progress can be served.

---

November, 1955

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MAGAZINE TIE-IN
V-M Corporation of Benton Harbor, Michigan has opened a new dealer merchandising campaign which includes a mailing to 4500 dealers announcing the company's "Pleasurama" selling theme.

The entire program, led by McCull's magazine marketing concept with its family "togetherness" theme, will be keyed to increasing activity in dealers' stores. At the point of sale each of the company's models will carry the McCull's "Use-Tested" product tag to perform a "sales-making" job. Consumer magazines will be used to full advantage to increase dealer support.

Companion units include new, sales-tested permanent display fixtures, and complete in-store promotions with 4-color paper, silk, and die-cut 3-dimensional hardboard pieces to carry the "Pleasurama" theme to the shopper. TV and movie trailers, radio announcements, and newspaper advertisements will supplement the other items in the campaign.

Complete information on the sales program is available from the company or local V-M distributors.

TIE-IN FOR TEENAGERS
A merchandising tie-up between Emerson Radio and Phonograph Corporation of 14th & Coles Streets, Jersey City 2, New Jersey and the Arthur Murray Dance Studios has resulted in "Emerson featuring in its new line the "Arthur Murray Music Box," a three-speed portable designed for teenagers.
FT-243 NOVICE CRYSTALS New E-x-T-e-n-d-e-d Frequencies

80 METER NOVICE

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40 METER NOVICE E-X-T-E-N-D-E-D

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DOUBLING TO 40 METERS E-X-T-E-N-D-E-D

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Available in FT-243 3/4" spacing, pin diameter .093" and in DC-34/S6. Prepr. listed in KC. Please state pin size and type of crystal when ordering.

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MISCELLANEOUS FREQUENCIES

In FT-243... 1.99

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At no additional cost, purchasers of the new phonograph, the Model 839, will receive an Arthur Murray "Let's Dance" book worth $1.25 and a $15.00 certificate good for two dance lessons at any Murray studio.

As a part of the campaign, the company has prepared and is furnishing to distributors promotion packages containing a three-color lithographed counter display consisting of a combination product wrapper and turntable dancers; three-color streamers for dealers' stores; consumer postcards designed as direct mailers, store give-aways, or statement stuffers; advertising mats; and other promotional devices.

**FURNES S SELL SERVICE**

Betty Furness is spearheading a program which will reach 93.8 per-cent of television set owners in 99 cities across the nation, urging them to rely on their service technicians for set repairs rather than tinkering with their sets themselves.

The message will be carried on the Westinghouse-sponsored "Studio One" series which is viewed by an estimated 20,288,000 people weekly. Stressing the slogan "Don't do it yourself," Miss Furness will tell viewers to patronize the dealer who uses the company's "Reliability" tubes.

At the dealer level, the campaign will be implemented by life-size store displays of Miss Furness holding a Westinghouse tube carton. Dealers will also be provided with booklets pointing out the hazards of amateur tinkering which they can hand out to their customers.

**RECOTON MERCHANDISER**

Recoton Corporation, 52-35 Barnett Ave., Long Island City, New York has two display cards available to merchandize its 45 rpm record inserts and its #3D "Combo" card which carries an assortment of 3-speed phonograph needles.

The insert display card carries 5 inserts to a package with 24 packages to the card. The second display carries 12 packs of the 50-cent osmium needles, 12 of the $1.00 super-osmium units, and 8 of the $1.50 nylon needles.

Write the company for full details on these assortments.

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Alpha Wire Corp., 430 Broadway, New York 13, New York has packaged...
FUSE DISPENSER

Littelfuse, Inc., 1805 Miner Street, Des Plaines, Illinois has designed a new single-channel fuse dispenser which saves time and money for service technicians. The dispenser can be handily mounted by screws in single, double, or multiple channels right over their work benches.

In addition to answering the storage problem, the new dispensers facilitate storage of its most popular plastic tubing items in an attractive 2-color, self-service counter display.

The new “ServiceSpool” assortment standardizes and streamlines the merchandising and inventory of plastic tubing. Convenient, handy, neat, it is made up of uniformly-priced spools covering 6 colors each of the 7 most popular sizes.

The assortment has been carefully planned to meet the most general market needs yet is highly flexible to accommodate individual requirements. The “Alphlex” tubing is UL approved and meets or exceeds the specifications of a MIL-1-631B, ASTM-D876, and ASTM D922.

**INTERCOM DISPLAY**

Funon Electric Company, 150-09 South Road, Jamaica, New York has started distribution of a compact intercom display for dealers.

The unique point-of-sale merchandiser is actually part of the inner protective material used in the firm’s regular corrugated shipping carton. Each of the “Fanfare” two-station intercom systems will be shipped in this special packaging with the self-contained display.

**FUSE DISPENSER**

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In addition to answering the storage problem, the new dispensers facilitate storage of its most popular plastic tubing items in an attractive 2-color, self-service counter display.
Become an **ELECTRICAL ENGINEER**

Major in Electronics or Power BS Degree in 36 months
Prepare now for a career as an electrical engineer or engineering technician — and take advantage of the many opportunities in these expanding fields.

You can save a year by optional year round study. Previous military, academic, or practical training may be evaluated for advanced credit.

**Enter Radio and Television — courses 12 to 18 months**
You can be a radio technician in 12 months. In an additional 6 months you can become a radio-television technician with a degree in Applied Science degree. Color television instruction is included in this program.

These technician courses may form the first third of the program leading to a degree in Electrical Engineering. Twenty-one subjects in electronics, electronic engineering and electronic design are included in these courses.

Courses also offered: radio-television service (12 mos.); electrical service (6 mos.); general preparatory (3 mos.).

**RESISTOR ASSORTMENTS**
Sprague Products Company, 51 Marshall Street, North Adams, Massachusetts has four kits available which carry popular values of its new axial-lead “Blue Jacket” resistor line.

The set consists of four separate card-mounted kits, one a sampler, and three assortments, each available individually. Sampler RK-1 includes ten popular radio-TV values from the 3, 5, and 10 watt lines. RK2 has fifteen of the most popular 3-watt values while assortment RK-3 has fifteen 15-watt units and RK-4 has fifteen of the 10-watt values.

Terms—January, April, July, September
Faculty of specialists, 50,000 former students — annual enrollment from 40 states, 23 foreign countries. Non-profit institution. 22nd year. Courses approved for veterans. Residence courses only.

**MATTISON SILVER ROCKET 630 CHASSIS with TUNABLE BUILT-IN BOOSTER**

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The superb **LIDO**, one of 36 unusual designs made to please you and your customers. Blend perfectly in any setting . . . traditional or modern.

**DEALERS! SERVICE DEALERS!**
Become the "important" dealer in your area for the FINEST CUSTOM- BUILT LINE OF TV RECEIVERS AND TV CABINETS. They are BIG PROFITS in it for you! FREE! Write for Mattison's merchandising portfolio explaining the "UNASSEMBLED PLAN" and "$1,000,000 FLOOR PLAN."

When you buy from Mattison you need only one source of supply! You can buy a Mattison Chassis, a Mattison Cabinet or a complete Mattison TV set!

**MATTISON TELEVISION & RADIO CORP.**
10 West 181st St., Dept. KN, N. Y. 53, N. Y.

**RESISTOR FACTORY!**

*Manufactured with integrity*

**MATTISON TELEVISION & RADIO CORP.**
10 West 181st St., Dept. KN, N. Y. 53, N. Y.
A New Audio Control  
(Continued from page 45)

voltage is reduced for each channel added. This increases the gain of the two tubes to offset the mixing loss. No degradation of quality occurs as channels are mixed in. When a channel is out of the circuit, it is grounded to prevent crosstalk.

The signal is taken from the cathode of the second tube in the first common pair to give a low-impedance drive for the following loudness control and tone control circuits. This is another important factor in the remarkable signal-to-noise characteristic of the unit: the low impedance keeps down stray hum pickup and noise in the equalization and switching circuits that follow these controls.

The loudness control can be switched in or out from the front panel and is connected to the first section of a dual master volume control. At low settings of the master volume control, with the loudness circuit switched in, there is maximum accentuation of the bass and treble ends of the spectrum, to match the low-volume Fletcher-Munson curve. At high settings of the master volume control, the accentuation is lessened, as shown on the curves of Fig. 3. Thus the amount of loudness compensation at any given loudness can be adjusted to personal taste and to the acoustic characteristic of the room by the relative settings of the mixer level controls and the master volume control. To increase the compensation at any given loudness, it is only necessary to set the master control down and the mixer control up or vice versa.

The tone control circuit is essentially the Baxendall circuit, with modifications to reduce the noise level. This is also a selective-feedback equalization circuit, with the feedback taken from the plate to grid of tube $V_m$, which functions purely as a tone control tube—there is basically no gain in the stage.

The tone control curves are shown on the chart of Fig. 4: they are of the variable-crossover, constant-slope variety, with a maximum boost or cut of 15 decibels at both the bass and treble ends of the spectrum. The tone control knobs have marker dots which show instantaneously where the "flat" setting is.

The use of pairs of triodes with appreciable negative feedback around each pair gives the unit as a whole extremely high stability, with freedom from variation in performance because of normal aging of tubes or other components, or normal shifts in supply voltage.

The four feedback loops in the unit also aid in producing the truly vanishing level of the distortion and noise. Harmonic distortion is 0.05% (five-hundredths of one per-cent) at an output of five volts, more than enough to drive most power amplifiers to full output. Intermodulation distortion is

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Transformer and two chokes in conservatory with 2 1/2 volt AC bias. Full kit...
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6 volt AC CoIl...6 pair 0.7...
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Output 225 volts. 2 1/2 ma. Small size. Brand New in original box...
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375 watts...
275 watts...
175 watts...
95 watts...
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Some description as above but 0-200 microamps. Made in rubber casing which may be removed if desired. Same type as 1000 divisions. Brand New...
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5.5 to 6 volt DC input
Output 225 volts. Duty Filters...
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Metal strip, mean pull and many useful parts. The
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BIG BARGAINS IN LITTLE TYPE
FLX TRANS 1500 v. 2400 watts...
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Under chassis view. Terminal strip construction makes servicing very simple.

unmeasurable at the same 5 volts output.
At 10 volts, 1 m. distortion is 0.2%, and at 15 volts it is 0.65%.

The noise level, including hum and all other sources of noise such as tube bias, is better than 85 decibels below the signal at 2 volts output, on the high level channels. On the phono channels, the noise is 62 db below a 10-millivolt input signal. Distortion and noise have, in effect, been "designed out" of this unit.

The two output circuits, one for feeding a tape recorder and the other for the main power amplifier connection, are both from cathode followers, allowing the use of long cables without loss of signal quality. The tape recorder output follows the first pair of direct-coupled triodes, so any of the input channels can be mixed to feed it, with a total gain from high-level signal input to tape recorder output jack of 3 decibels.

The main cathode-follower output has an exclusive circuit which contributes to the low noise level of the unit. The second half of the master volume control is connected in parallel with the cathode-follower load resistor, that is, the volume control is right across the output cable.

This placement of the volume control has been avoided in the past, because (1) a low-resistance control in this position upsets the performance of the cathode-follower tube, producing high distortion; (2) a high resistance con-

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trol does not bother the tube, but produces a high impedance for the output cable to "look back" at, whenever the control slider is in the mid-range of the resistance. This makes the cable susceptible to hum and noise pickup, and produces loss of high-frequency response in the cable capacity.

In the present unit, the control has a comparatively high resistance, but negative feedback is taken from a tap on the control back over the two final stages. This lowers the output impedance for all settings of the control, so that cable noise and loss effects are practically eliminated.

It allows the control to be put at the output of the unit, with the advantage that the signal-to-noise ratio is not impaired as the control is turned down. If the control were ahead of one or more stages, the noise produced in those stages would not be reduced as the signal is reduced by the control. With the control across the output, signal and noise are reduced in the same proportion, as the control is turned. The maximum gain from all high level inputs to this output is 21 db.

The power supply has two separate rectifier circuits, one for the plate voltage and one for the direct current which is used on the heaters of all tubes. The plate supply is a full-wave circuit using two selenium rectifiers and a four-section resistance-capacitance filter, which practically eliminates plate-supply ripple. The direct current for the tube heaters comes from a selenium bridge rectifier and two-section filter and is another essential factor in the extremely low noise level of the unit.

A separate winding on the power transformer supplies all indicator and pilot lights. The specially-designed transformer is completely potted and magnetically shielded with a very low temperature rise which means long life for the various small parts in the unit.

Terminal board construction keeps the small parts below the chassis firmly in place. All tubes and associated parts are on a separate rubber-molded subchassis to reduce microphonic effects. The unit is completely shielded, with a metal bottom plate.

Arrangement of the controls on the front panel has been carefully designed for maximum convenience and quick identification. By putting a large knob for the master volume control in a visually-emphasized sub-panel, at the left end, and the tone controls in similar prominence at the other end, it is possible for those members of a family who have no interest in the more complex functions to adjust the unit, undisturbed by "all that stuff in the middle."

The symmetry of the arrangement, the outward slope and the brushed-brass finish of the panel, present a modern, clean-cut appearance.

It can be seen from the foregoing that the new Fisher 80-C represents a complete and extremely flexible audio center.

November, 1955

Sangamo wire lead mica capacitors

Now! Packaged for your convenience!

Save time—do away with the cluttered mess of tangled wire leads. Use Sangamo Mica Capacitors, now mounted on spacesaving cards.

These high quality mica capacitors are the finest available anywhere—at any price. They are fabricated with carefully selected premium grade imported mica and are molded in Humidite for unequalled moisture resistance. You can depend on these wire leads for completely trouble-free TV replacements.

Each card of five capacitors has capacity rating and wvde clearly marked. Each card shows the new RTMA Standards and the new MIL-C-5-A color code.

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  - **Price:** $1
  - **Descp.** Best kit in our line. Simple to build. Separate gain, volume, tone control, etc. For use in portable TV, etc. Requires 110-120 V, 60 c.p.s., 2-watt tube. Reg. 92.25.

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**Write for bargain bulletin**

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### Radio-TV Service Industry News

**As reported by the television technicians lecture bureau**

**AS THE present year swings along toward its close, a quick glance over the records of the months that have slipped by reveal some very significant trends in the established service industry.**

The first is the extremely high mortality rate among one-man shops. In appraising the effect of the economic pressures that have been forcing small operators in all types of activity out of business, it is necessary to define what is normally called a one-man service shop. This is the type of shop that was most common in pre-television days in which a single individual handled everything in connection with the business. Since more than eighty per-cent of the radio service jobs were brought to service shops, it was possible for a technically competent, person-minded individual to make a fairly good living out of a radio service business.

Television reversed the flow of business. Where eighty per-cent of the radio service jobs were brought to shops by the set owners, more than eighty per-cent of television service is completed in the customers' homes. This one factor alone added considerably to the expense burden of a service business. Regardless of whether he operates out of his home or a business location, the individual who attempts to run a service business entirely by himself must carry an overhead burden that is beyond the productive capacity of the average man. Hence the high mortality rate in this type of business.

Many TV service businesses are successfully operated by man and wife teams. These are classified as two-man shops since the wife is able to relieve the technician of all of the time-consuming details that are involved in the operation of any type of service business. There are many very successful businesses of this type in operation. But they are distinctly highly individualistic enterprises in which the economic stop when the couple takes a vacation or the technician is laid up by sickness.

When an electronic service business reaches the point where its average volume will support the full-time efforts of three men, it acquires a basis of stability. The fact that the business is able to maintain the average annual gross volume of forty to fifty thousand dollars that is necessary to support an organization of three men, indicates that its owner has created a successful operational and sales promotion pattern. If the area is comparatively free from service sharpies and sun-downers, the business will grow steadily with a more or less stable income.

However, the incursion of service promotions based upon price, especially low charges for home service calls, will seriously disturb the activities of the established businesses from the dual standpoint of customer relations and service volume. The unfavorable publicity that independent service has gotten from time to time leaves it vulnerable to set owner suspicion whenever extensive service price advertising invades an area. Fast-buck service promoters usually reap a harvest when they invade a new area at the expense of the competent, established service businesses. They can get a lot of service businesses into trouble before the shady character of their operations is revealed.

The experience of having to compete with unethical service operators has served to jar service operators out of their complacency and made them realize that the operation of an electronic service business is no longer healthy for the rugged individualist. It has served to make the owners of legitimate service businesses realize that their only protection is to cooperate with their fellow service businessmen to fight the activities of the gyps and the incompetents.

From coast to coast and border to border, new associations of service business operators are being formed. There is a growing realization that the stabilization of electronic service as a business rests squarely on the shoulders of the men who now operate legitimate, ethical shops. It is becoming widely recognized that industry cooperation and assistance will be given only if the service industry itself shows a willingness to pay the costs of the programs that are necessary to establish the identity and qualifications of the legitimate, established service shops.

**Association Promotion**

The fact that so many new associations are being formed indicates the
widely growing interest in doing something about the problems that beset the electronic service activity. However, far too many associations are formed with the idea that the fact of the existence of the organization will, in some way or another, take care of the problems. No tangible, definitive programs are inaugurated by the officers to insure continued interest of the members.

When a man joins an association he expects to see something happen. Unfortunately, most men usually expect to benefit from some immediate, tangible returns from their association membership. Since the benefits of association membership are largely intangible, interest lags if the officers fail to provide a dynamic program of regular meetings.

The basic weakness of service associations is that the officers assume responsibilities that they usually are not trained to handle. The dues structures are seldom adequate to pay for experienced help to carry out the details of the organization's programs, with the result they are handled as part-time activities of officers who are hard-pressed for time in managing their own businesses.

Every service association should purchase enough copies of a new book recently published to furnish a copy to each of its officers. The name of the book is "How to Organize and Operate a Small Association," and it was prepared by C. D. "Jack" Hughes, managing director of the Kansas Appliance Dealers Association. This book is a gold mine of information for association officials. The address of KADA is 815 Central Building, Wichita, Kansas.

The second significant trend that has been moving forward with quickened speed this year, is the broadening interest in national unity—a joining of the forces of the several national, state, and unaffiliated local associations to work together on service problems that could best be handled on a national level.

Early in August a meeting was held in Pittsburgh, Pennsylvania, to explore the possibilities of achieving national unity for the service industry. It was attended by representatives of most of the national groups and many unaffiliated associations. The delegates boldly met all of the issues that have stood in the way of national cooperation.

The first question that was explored had to do with whether a national association should represent shop owners, technicians, or both. The discussion revealed the universally-held opinion that to be effective, a national service organization should represent all of the elements of service which would include both shop owners and technicians. When brought to a vote, it was unanimously decided that the desirable national organization should represent both shop owners and technicians.

The second question discussed at the exploratory meeting was that of selecting a name for the group which would

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**FERRO-SHEEN HAS THE Smoothest Surface OF ALL RECORDING TAPES**

**What Does This Super-Smoothness Mean To You?**

1. **GREATLY REDUCED HEAD WEAR:**
   - The mirror smooth FERRO-SHEEN surface virtually eliminates disastrous head wear caused by the abrasive surface of ordinary tapes.

2. **NO SHEDDING OF OXIDE:**
   - Unlike ordinary tapes which shed oxide particles that gum up the heads, the FERRO-SHEEN process anchors the oxide to the base so that it cannot come off and deposit itself on the head.

3. **FLATTER FREQUENCY RESPONSE:**
   - The SUPER-SMOOTH SURFACE OF FERRO-SHEEN tape makes better contact with the recording head, resulting in flatter frequency response.

4. **REDUCED 'PRINT-THROUGH':**
   - "Print-Through" is virtually eliminated, even at excessive input levels, because of unparalleled oxide uniformity in FERRO-SHEEN process tape.

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**FERRO-SHEEN is Now Available in these four quality Irish tapes.**

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<td>Ultimate in professional tape for broadcast and studio use. 1200' $3.80 Hi-Fi Net.</td>
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<td>The super-rough tape for masters and recording under adverse climate conditions. 1200' $5.50 Hi-Fi Net.</td>
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**Precision Apparatus Company, Inc.**

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**November, 1955**

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12 Volt, Brand new. $6.25
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Packed new! $6.25
9.1 ohm impedance.
S-31 20 W. W. W. RECEPTION AND TRANSMITTING TUBE.
The delegates also adopted a plan to standardize the name used by all affiliates which are to be known as the Television Electronic Service Associations of the cities in which they are located. Reports were heard on U.H.F., "pay-as-you-see" television, training, and technician accreditation. NATESA voted to adopt the requirements of the RETMA accreditation program as part of its occupational standards and moved to create accreditation bodies in each of its affiliated cities.

Elected to office for the coming year were Frank J. Moch, president; Robert Hester, secretary general; Bertram Lewis, treasurer; Harold Eskin, eastern vice-president; Russ Harmon, eastern vice-president; Vincent Lutz, western vice-president; Jim Faill, western vice-president; P. P. Pratt, eastern secretary; L. C. Stalleu, eastern central secretary; Joe Driscoll, west central secretary; and Albert C. W. Saunders, educational director.

T.E.A. Annual Clinic

For the third year in a row, the Texas Electronic Association presented a highly successful Radio and Television Service Clinic and Electronics Fair. This professionally-handled event is rotated annually between the four major Texas cities: Fort Worth, Dallas, San Antonio, and Houston. This year's event was hosted by the San Antonio Radio and Television Association whose president, A. R. "Al" Niehaus, managed the affair in the capacity of Clinic Chairman.

T.E.A. is a state-wide organization of local service associations which was started originally by the associations in the State's four major cities. Three additional affiliates were added during the San Antonio meeting and service operators from several other Texas cities requested State organization assistance in establishing associations in their areas.

The pattern of the T.E.A. annual clinic starts with a banquet on Friday night, a series of talks on business and technical phases of the service industry starting with a breakfast meeting on Saturday morning, and closes with a highly popular panel discussion session on Sunday morning.

After welcoming addresses by the Mayor of San Antonio, the Attorney General of the State of Texas, and by Forrest Baker, president of the Texas Electronics Association, those who attended the Friday evening banquet heard a stirring keynote address on the "Power of the Serviceman," delivered by Charles Golenpaul, vice-president of the Aerovox Corporation of New Bedford, Mass.

The Saturday sessions featured talks on "Business Management" by Paul H. Wendel, editor and publisher of "Service Management Magazine"; "Selling Service Through Accessories" by Ray Nugent, general sales manager of the...
CHRISTMAS GIFT PROBLEM?

Philo Accessory Department; "Simplified Service Business Control" by Harold Chase, president of the Chase Television Service of Detroit, Michigan; "Automation" by Frank Hedrick, field engineer for the Admiral Corporation; "Transistors in 1955" by Dr. Willis A. Adeock, director of materials and research for Texas Instruments of Dallas, Texas; the "REMTA Vocational Training Program" by Al Coumunt, service coordinator for the manufacturers' association; the "New Texas Tax Law and How It Affects Service Businesses" given by Albert Brown, director of the Store Tax Division of the Texas State Comptroller's Office; "Today's Color" presented by Clint Walters, Administrator of Field Television for the RCA Service Company; and "A Look Into the Future of Electronics" by Dan D. Halpin, general sales manager of the Westinghouse Television-Radio Division.

The complete management and promotion of each year's clinic are handled by the host organization in the city where the annual affair is held. However, the coordination of experience from year to year is maintained through the association's executive secretary, Will A. Shaw, of Fort Worth, Texas.

State-Wide Associations

There is a growing feeling among service business executives that the logical pattern for an effective national service association would be for local associations to form into state associations. The state associations would then send representatives to function in meetings at the national level. This springs from the line of reasoning that the inevitable bills that will be introduced from time to time to regulate electronic sales and service will be done in State Legislatures. While an effective state-wide organization of service associations is functioning it will be able to influence the content of the bills and work for the passage of only those that are in the best interests of the industry as well as the public.

The state-wide pattern of organization started in the east with the formation of the Federation of Radio-Television Service Associations of Pennsylvania. This was followed by the formation of the Empire State Federation of Electronic Technician Associations. However, since the nucleus of both of these early state-wide associations was technicians associations their interests were devoted almost exclusively to the technical aspects of electronics servicing. Because of the growing awareness of interest in technical matters, these groups have had difficulty in gaining the support and interest of the larger service businesses.

In the opinion of many seasoned service association officers, the ideal association would provide a triple combination of services that would appeal to the independent service business operator, the dealer who maintains a top-flight service department, and the technician.
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FT-243 fundamental frequencies

<table>
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<tr>
<th>80 METERS</th>
<th>40 METERS</th>
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| 2510 | 3015 | 4095 | 5025 | 6160 | 7170 | 8195 | 9240 | 10430 |
| 2604 | 3115 | 4195 | 5260 | 6395 | 7460 | 8515 | 9580 | 10750 |
| 2708 | 3225 | 4305 | 5430 | 6615 | 7690 | 8765 | 9850 | 11050 |
| 2812 | 3335 | 4405 | 5560 | 6770 | 7870 | 8965 | 10060 | 11270 |
| 2916 | 3445 | 4445 | 5610 | 6815 | 7970 | 9075 | 10180 | 11400 |
| 3020 | 3555 | 4455 | 5660 | 6970 | 8130 | 9230 | 10340 | 11570 |
| 3124 | 3665 | 4465 | 5710 | 7130 | 8290 | 9405 | 10520 | 11780 |
| 3228 | 3775 | 4475 | 5760 | 7280 | 8450 | 9570 | 10690 | 11960 |
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ELECTRIC TOOL CATALOGUE

A new 25-page 1956 catalogue describing 52 portable electric tools and kits with over 600 accessories, has been issued by Porter-Cable, 58 Exchange Street, Syracuse 8, New York. This free book includes 150 pictures of tools and their uses with complete specifications and prices on electric saws, Sanders, drills, planes, routers, shapers, combination tools, grinders, etc. When requesting a copy of this catalogue, please specify No. 102.

RCA’S COLOR SERVICE MANUAL

RCA Service Company, Inc. of Camden, N. J. has recently published an up-to-date manual designed to aid television service dealers and technicians in installing and maintaining color television receivers.

The 36-page manual was prepared as a supplement to the publication, “Practical Color Television for the Service Industry” published by the firm in 1952. While the supplement contains schematic diagrams and other data in detail dealing primarily with RCA Victor’s two new 21-inch color receivers (Models 21CTB61 and 21CTB62), the publication also provides additional information on color TV receivers in general.

Extensive text, color and black-and-white diagrams and charts, and photographs occupy most of the space in the new booklet. National distribution of this book is being handled by RCA tube distributors or a copy may be obtained from the company. The price is 75 cents per copy.

PERMOFLUX DATA SHEETS

Permoflux Corporation, 2835 N. Kedzie Ave., Chicago 18, Illinois has announced publication of three data sheets which are available on request.

These catalogue sheets cover the firm’s HD-1 hi-fi headset (JH-401), the new “Largo” dual 8 speaker system (JS-S-402), and the “Diminuette” speaker system (JS-S-401). Any or all of these sheets are available on request. Please order by publication number.

TELELECTRO FACILITIES

Telelectro Industries Corporation, 35-16 37th Street, Long Island City 1, New York has issued an informative 24-page booklet describing its facilities and typical products.

Sections of the booklet describe in text and illustration the company’s facilities for designing and engineering, production personnel, and testing. A list of available machine tools and fiers and complete systems. The catalogue also lists amateur receivers, transmitters, and other gear, industrial v.h.f. radio and radiotelephone equipment. Other listings cover a wide selection of kits and supplies, books, manuals, diagrams, tools and hardware, plus thousands of other radio, television, and industrial electronic items.

The catalogue will be sent without charge upon request to the company.

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Let the
master
make life
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for you...
See pg. 169

November, 1955
Starting a Service Business

By Jack Wilson

Pierce School of Radio and Television

Here are a few tips of the trade on how to obtain customers whether you work from a store or home.

So now you have that technical school diploma hanging on the wall and are carrying a wallet-size photo-stat as well. You are prepared to go into business on your own, servicing sets. Perhaps you are one of the fortunate few who either have or could borrow enough capital to open a modern store and even have a franchise for retailing a well-known set. Or, maybe you are the fellow who has purchased some equipment over a long period of time. You have commenced servicing, and have a neat but small workshop in your basement or garage with shelves moderately stocked with tubes, resistors, capacitors, and all other necessary parts just to get started. The sign on your front lawn does not read "Keep Off The Grass" but "John Doe, Radio & Television Repairs."

If you are in the latter category, then this article is for you. It is said to say that radio and television servicing has progressed from just a trade to a profession. Today's service technicians are not doing the same routine thing day after day. With so many advancements being made in the electronics field, they are constantly learning something new. They read the technical magazines and manuals and try to keep abreast of the times. They are eagerly awaiting color television.

But right now, you are interested in obtaining more business so that you can look forward to the future. To start with, you have to make new contacts. One way of going about this is to take a look at the rooftops in your neighborhood. Where the antennas are, there are your prospective customers. One thing to keep in mind at this point is that now you are a salesman and not a technician, so before knocking on doors be sure you look the part. Leave the khaki trousers and the "T" shirt in the wash. You have to be as presentable as the people you are calling on, if not more so. Supply yourself with enough printed business cards stating the name you have chosen for your company, your address, and telephone number. Also, arm yourself with an appointment book—any small notebook will do.

When the lady of the house comes to the door, introduce yourself and offer her one of your business cards. Inform her that you are a radio and television service technician and would like to know if her set is in good working condition. If the reply is yes, tell her that when she does have trouble with either a radio or television set, you would appreciate the opportunity of serving her, and if she is ever satisfied with her present service company, to please give you her ring. Thank her and leave. Do not go into detail about crooked servicing companies, or how much smarter you are at repairing sets than the next fellow, and certainly do not give any hard luck stories. In other words, do not linger; think your prospect and leave. Remember, you are not selling sewing machines or vacuum cleaners, you are selling a service and everyone at some time will need this service. If you leave a favorable impression, you will be answering your phone more often than you think.

On the other hand, if your prospect replies that she is having trouble with her set and would like to have you look at it, make an appointment with her for that evening and return with your kit. Don't be an eager beaver and try to pick up the first few dollars you flush. Your mission today is contacting as many homes as possible to establish yourself in the neighborhood and you might have five appointments at the end of the day instead of wasting all morning or afternoon on the set. Be sure to space your appointments, allowing enough time for each customer.

Not everyone you contact will be presentable, but don't let this bother you. It is surprising how many people will eventually be customers and good friends of yours, because of the word-of-mouth advertising that moves through a neighborhood after you have satisfied a few people. The first day of this type of selling is the hardest. From then on, you can conduct each interview with the graciousness of a good businessman.

Another tried-and-true method of gaining new customers is to approach professional men such as doctors or lawyers. You are sure to find a few sets needing repair if you contact enough of them. A doctor or lawyer meets a lot of people each week and he will not be able to pass you by. It is glad to tell a friend or client about the expert service he received on his set. One technician repaired his dentist's TV set and from the dentist telling a patient and one patient telling another, he had sixteen service calls which he did not have to solicit. These he terms as his "bonus" calls. Incidentally, he has just purchased a new panel truck for his
business, and he graduated only eight months ago from a television servicing school.

One system that is keeping a service technician so busy he works morning, noon, and night is the following. He approaches the superintendents of large apartment buildings and offers them a small commission for every set he services in their buildings. These "supers" are happy to recommend the technician to their tenants, the tenants are happy because they receive good service at a reasonable cost, and the service technician has a lot of steady customers.

Another recent graduate, operating out of a basement workshop, has hit upon a profitable idea by servicing hard-to-fix sets on a flat-rate basis. He works with the larger service and appliance companies only. They welcome the chance to send him these sets because it cuts down on their overhead and they can devote more time to the repairing of the many other electrical items they carry.

As a final touch to this sales picture, you should know something about television personalities themselves. Watch television, read some fan magazines and the television column in your local newspaper. This way you can pass along and exchange information with your customers.

Here are a few ideas for you to start with, now add some of your own and you will soon be a successful businessman working exclusively for the fellow whose name appears on that sign on your front lawn.

CIRCUIT IMPROVEMENT

By DAVE FREEDMAN

It was pointed out in Jesse Jacobson's article ("1250 Volt D.C. Power Supply," March 1955 issue of Radio & Television News) that an inductor with a higher "Q" at 60 cps would give a higher voltage.

Keeping this in mind, the author used the primary winding of a vertical output transformer which has an extremely high "Q" since it is designed to work only at 60 cps. This transformer delivered 900 volts r.m.s. which, when rectified by a half-wave rectifier, produced 1300 volts d.c.

The scheme permits a simple circuit to be used in order to obtain the same results—and all at a reduced cost. It should be mentioned, however, that the size of the tuning capacitor (0.09 nfd. in this case) is determined experimentally as it will vary with the vertical output transformer selected.

A simple improvement on the circuit described on page 84 of the March 1955 issue.

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ENGINEERING WRITING

Here is an ideal way for the engineer or physicist with some aptitude for writing to enter the field of advanced electronics. In this relatively new and expanding area you can make immediate and effective use of your academic training while acquiring additional experience.

Hughes Research and Development Laboratories are engaged in a continuing program for design and manufacture of integrated radar and fire control systems in military all-weather interceptor aircraft. Engineers who produce the maintenance and operational handbooks for this equipment work directly with engineers and scientists engaged in development of radar fire control systems, electronic computers, and other advanced electronic systems and devices.

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DEVELOPMENT
LABORATORIES

Photograph above: Engineer-writer John Burnett (left) works with engineers John H. Haughawout (right) and Donald King to compile handbook information.
FM Multiplexing
(Continued from page 57)

role of increasing importance in daily living. High-fidelity reproduction is part and parcel of this trend, and there are enthusiasts everywhere eager to profit by advanced technical developments which afford a decided increase in listening pleasure. Stereophonic reproduction is such a development and is catching on. People are hearing it in movie houses, in audio showrooms, at audio fairs, and elsewhere. Inasmuch as stereophonic FM is now technically feasible, its failure to make headway would be an exception to the rule that what the public wants the public gets.

The likelihood of stereophonic FM is further increased by the fact that by mid-1956 there will be a substantial number of FM stations on a multiplex basis. The FCC in early 1955 not only sanctioned multiplex but required that FM stations wishing to render "subsidiary communications" services must use multiplex after July 1, 1956. The present simplex ("beep") method of providing subscription services, which mutes segments of a single channel broadcast by means of brief ultrasonic signals, will no longer be permitted. Inasmuch as an FM station is required to provide at least 36 hours per week of public broadcast service on its main channel, it seems that only a moderate sacrifice, if any, would be involved if a station already possessing multiplex facilities were to render several hours a week of live, taped, or disc stereophonic material.

To the audiophile who has already strained his budget or is planning to strain it for just one high-fidelity system, the thought of duplicating this effort to bring stereophonic sound into the home doubtless presents searching questions. How much more will it cost? How much extra room will it take? Is it worth the effort?

As to cost, there is every reason to believe that a two-channel system will cost decidedly less than twice the cost of a one-channel system. For example, a second power amplifier, or two amplifiers on one chassis, can effect a cost saving through use of smaller output transformers inasmuch as the power requirement, for equivalent single-channel sound, is halved on each channel. Moreover, it appears that the total power requirement is less with a stereophonic system. It has been remarked that much of the call for high wattage amplifiers has resulted from the audiophile's desire to suffuse the room with sound from a single source. Given two sources, the effect of spatial distribution can be obtained without blasting. Thus a total of ten watts may be more than adequate for the home in all but exceptional circumstances.

Perhaps the biggest cost saving can be effected in the actual size of power amplifiers. Whereas a super-duper speaker is necessary to achieve super-duper sound on
a one-channel system, considerably smaller and less expensive speakers are very satisfactory in stereophonic applications. In other words, the difference between an inexpensive speaker and a costly one is much less pronounced on stereophonic reproduction than on one-channel sound. In this connection note the relatively modest speakers used by theaters in connection with stereophonic sound.

With respect to the amount of room that a two-channel system takes, two-channel amplifiers, preamplifiers, tape machines, etc. are being produced today in packages hardly, if at all, bigger than their one-channel counterparts. The principal increase in space requirements concerns speakers. But, again, the fact that substantially smaller speakers are adequate in stereophonic reproduction lessens the problem. Moreover, ingenious applications of acoustic principles have brought forth small speaker systems with astonishingly good sound.

Finally, is stereophonic sound worth the effort? Without question one can find sharp division of opinion as to whether stereophonic sound via speakers does something extra for the listener. Majority opinion seems to be that it does, although the three-dimensional sensation is not as profound as provided by binaural reproduction via earphones. Even at its present relatively crude stage of development, two-channel sound via speakers does afford many listeners a substantial margin of pleasure over one-channel methods of reproduction, including (1) reproduction by one speaker, (2) reproduction by two speakers, (3) "pseudo-stereophonic" reproduction by two speakers, one speaker emphasizing bass and the other emphasizing treble.

It must be further considered that any new art requires time to achieve a substantial measure of its ultimate potential. There is no reason to believe that this principle fails to apply to stereophonic reproduction, which is a mere fledgling. Improved techniques in lateral and vertical placement of microphones, selection or development of microphones with optimum response patterns for their designated purpose, and other technical improvements yet unforeseen will very likely enable stereophonic sound to substantially increase its present superiority over single-channel sound. Under these circumstances, FM stereophonic reproduction should be a "natural" for which the public is willing to pay in one form or another.

Listeners in certain urban areas have had just enough of a taste of "stereo" reception, via the binaural (AM-FM transmissions) broadcasts to whet their appetites for the improved reception that can be theirs with both channels transmitted via FM.

Undoubtedly these persons will give FM multiplex a hearty welcome.

REFERENCE

Marsh, R. C. "Yorkshireman in Festival Hall," High Fidelity, August 1955.
MAKING USE OF LOAD LINES

By N. H. CROWHURST

The gap between "theory" and "practice" can be bridged by using graphic tube characteristics and load lines.

Every since the days when electronics went under the name of radio there has been a controversy between the "theory" and "practice" boys. The proponents of "theory" like to start by calculating a circuit in all its detail. After building it, they hand it over to a practical man to make it work. The practical man naturally argues that practice is of greater value than theory because the theorists never manage to arrive at the right answer the first time.

Often the designer who relies on theory does not take all the factors into account. In "theory" a tube has simple characteristics which are listed in a neat little table and by using a convenient formula with algebraic symbols the gain of that tube in a certain circuit can be calculated. An amplifier designed on this basis often misses its objective in one of two ways: either it has less gain than was anticipated; or, if a margin of gain was allowed to take care of this contingency, it turns out to have considerably more gain than was required. It may also be deficient in that although it has the correct gain it will not handle the full output for which it was intended.

This sort of thing happens because the neat little table of tube characteristics does not tell the whole story. The best link between theory and practice, which enables the prospective designer of an amplifier to come fairly close to the right answers the first time, is the use of graphic tube characteristics and the drawing of load lines. To illustrate this we will take a simple voltage amplification stage, the purpose of which is to receive a specified input voltage on the grid of a tube and amplify it as much as possible at the plate, in order to drive the next stage.

Assume that the circuit is the simple one shown in Fig. 1 and that the tube we have chosen has the characteristics shown in Fig. 2. The first thing to do is to draw a load line (Fig. 3) from the "B+" voltage to be used across the tube characteristics at an angle representing the plate resistor Rp.

This is done by taking the "B+" supply voltage of 250, in this case, and dividing it by the value of Rp (25,000 ohms). Thus, 250 volts divided by 25,000 ohms will give a plate current of 10 ma. The load line is then drawn between 250 volts and 10 ma.

Next we want to find what value cathode resistor (Rk) is required to provide the right operating bias. This really is quite simple: we have to find a point along the load line that will be a suitable operating point to give the required degree of grid voltage swing without running into distortion and then find out what resistance in the cathode will give us the bias value corresponding to this operating point.

Suppose we know that the maximum voltage swing applied at the grid of this tube will be 1 volt, then from the tube characteristics we will find that the best operating position is about 1 volt negative so that the swing of 1 volt alternately positive and negative from this position goes from zero to –2 volts. That this will give the minimum distortion can be seen by examining the spacing between the various curves representing different grid voltages. The spacing between the curves for zero, –1, and –2 grid volts is nearer equal along the load line than any other pair of adjacent grid voltage curves. The spacing should be equal so that all of the waveform is amplified.
uniformly. To allow a slight margin, in case the voltage swings a little more than 1 volt to avoid the positive grid region, which causes grid current flow, we will choose a bias voltage of —1.5 volts. This gives us the point B on the load line, shown in Fig. 3.

Referring to the current scale at the left-hand side of the tube characteristics we find that point B represents a plate current of 4.5 milliamps. We now have the information necessary to calculate the value of the bias resistor, $R_b$; it must drop 1.5 volts with a plate current of 4.5 milliamps; this means its resistance value must be $1.5 / 0.0045 = 330$ ohms.

Now, to work out the rest of the circuit, in order to provide a voltage for driving the next stage grid, we need a coupling capacitor $C$, and a grid resistor $R_g$. To calculate the effect of these components on the amplification of the tube we have to recognize two things that may not be obvious at first sight: first, that the coupling capacitor $C$ has no d.c. potential from the grid of the next stage; and second, that at audio frequencies the reactance of capacitor $C$ is negligible.

This means that, as far as audio frequencies are concerned, $R_g$ and $R_f$ are effectively connected in parallel because at one end the reactance of $C$ has negligible effect, and at the other end "B-" is connected to ground through a low reactance decoupling or smoothing capacitor. So we have to draw another load line, to represent $R_g$ and $R_f$ in parallel.

We can easily calculate the value of this load line from the formula $E = (R_f \times R_g) / (R_f + R_g)$. Assume, for example, that we choose 100,000 ohms as the value for $R_g$. $R_f$ has already been set at 25,000 ohms, so the value of $R_f$ works out to be 20,000 ohms.

If $R_f$ is actually 20,000 ohms instead of 25,000 ohms, the load line would be as shown dotted at $AD$ in Fig. 4. But because the d.c. feed to the plate of the tube is only through the 25,000-ohm resistor, the "direct current" load line is truly represented by the line $AB$, and the operating point has been set, by choice of resistor $R_b$, at point $B$. So the "dynamic load line" as it is called.
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or the load line for amplifying purposes, is represented by drawing a line having the same slope as AD, but passing through the point B. This is very simple to construct, by drawing a line parallel to AB through the point B, shown as EF.

It is shown connected between the grid voltage curves for zero and -3 volts, because the actual swing which will be employed for amplification purposes will not be greater than this—actually a little less.

Now we can see how much amplification the stage will give. Point E on the zero grid voltage curve represents a plate voltage of about 98 volts. Point P, on the -3 grid voltage curve, represents a plate voltage of about 180 volts. So the grid voltage variation of 3 volts, between zero and -3, will give a plate voltage variation of 82 volts, from 98 to 180. These are convenient values to read on the graph, but other voltages will run proportionally, so, dividing one by the other, this means that a grid voltage swing of 1 volt will give a plate voltage swing of 82 divided by 3 = 27.3 volts. Otherwise expressed, the stage will show a gain of about 27.

This method of working out the performance of a tube comes a lot nearer to the practical results than calculation using the algebra given in textbooks and the tabulated tube constants given in a tube manual. It will also show without any doubt whether the tube is capable of handling the volume level intended at the particular point in the amplifier without overloading, which use of the tabulated data in a tube manual may overlook.

All that is left in completing the stage is to determine the value of the cathode bypass capacitor Cc. By good engineering standards the reactance of Cc at the lowest frequency to be amplified by the stage should be 10% or less of the cathode resistor, Re. In this case the reactance of Cc at, say, 50 cycles, should be 33 ohms at most. This would work out as 100 µfd.

Pursuing the case we have just considered a little farther, we know that
full volume will represent 1 volt on the grid of this tube, and that this 1 volt on the grid will produce about 27 volts on the plate. From there we can consider the next stage with the characteristics of a suitable tube, knowing that we will now get up to 27 volts swing on its grid.

In this discussion we have been working forward, i.e., we started with 1 volt input, and worked our levels forward toward the output. In practice it is often better to work backward from output to input. We know first what voltage we need at the grid of the output tubes. From there we work backwards to find what tube and what resistance values we can use to get this voltage to drive the output tubes. We then find what voltage this tube needs to swing its grid to give the required plate swing. Then we move back to an earlier stage to find how we can get enough gain from the available input voltage.

Interesting whether we work backwards or forwards, this discussion has shown how valuable a load line can be in determining a circuit for a simple tube. We have kept the discussion to a consideration of voltages, because the kind of stage we have talked about has been the one known as a voltage amplifier.

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**VARIABLE FEEDBACK**

By G. TUTT, VE7JS

Many amateurs, including myself, use their communications receivers for broadcast reception. To improve the audio quality and, at the same time, retain the original design, the following feedback circuit was incorporated in my Bendix RAII.

The feedback was taken from the output plate and tied to one side of a 100,000 ohm pot. The other side of the pot is connected to the positive high voltage. The variable arm goes to the first audio stage. As the control is advanced towards the output plate connection, a decided improvement in fidelity results. At the same time audio gain decreases. When the control is retarded toward the positive high voltage, less feedback occurs and the overall gain returns to approximately normal.

In practice, one setting will be found suitable for broadcast listening and the variable feature is handy for tone and c.w. reception.

In the diagram below, the detector diodes are shown split—one for a.c. and one for audio. The first audio plate bypass can be used as a tone control if desired.

Simple circuit change for improving the audio quality of communications receivers.

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