In this issue:

- Control Unit for Junior Golden Ear Amplifier
- TV Remote Control Units
- Testing Video Amplifiers
- Optimum Load—What Is It?
- Starved-Current Ultra-High-Gain Amplifier
- Getting the Most From Rabbit Ears

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(See page 4)
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MARCH, 1954
ATOMIC BATTERY which makes it possible to convert atomic energy directly and simply into small but usable quantities of electrical energy sufficient to operate a transistor, was announced January 26 by Brig. General David Sarnoff, Chairman of the Board of RCA.

"The RCA atomic battery," said the general, "is now generating sufficient electricity from a minute quantity of strontium-90 to energize a transistor and to produce an audible tone in a telephone receiver." The new experimental battery, as described by Dr. E. W. Engstrom of the RCA Laboratories, consists of a semi-conductor wafer (germanium or silicon), to one side of which has been applied a thin layer of radioactive material (strontium-90 in this case) and to the other side of which an "impurity material" has been alloyed to form a transistor-like junction.

The strontium bombards the wafer with several billion electrons per second. As each of these penetrates the wafer's junction, producing a voltage which would cause a current to flow in an external circuit. This electron action within the wafer is known as "transistor-like" and is directly and simply into small but usable quantities of electrical energy sufficient to operate a transistor, was announced January 26 by Brig. General David Sarnoff, Chairman of the Board of RCA.

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MAJOR E. H. ARMSTRONG, inventor of our present system of frequency modulation and other basic radio circuits died on February 1 at the age of 63.

His most widely used and renowned development, the superheterodyne circuit, is almost universally used in both AM, FM, and TV receivers. He was the inventor of the superregenerative circuit, and an independent inventor of regeneration, though the courts—after a 12-year battle—ruled that de Forest had discovered it earlier. Frequency modulation came in 1935.

His most recent development was a system of multiplexing FM broadcasts so that more than one program could be transmitted simultaneously at the same frequency.

His FM station KE2XCC operating on 92.1 mc is known by radio engineers throughout the world. There, Armstrong did much of his FM development, and the station became the prototype of modern FM stations.

Armstrong served in the Army Signal Corps in World War I. In World War II his major contributions were in the field of radar, much of which is still secret.

He also contributed many improvements in radio communications, particularly in short-wave transmission. It was upon his recommendation that the Army adapted FM for mobile radio communication.

During his lifetime Major Armstrong received many honors including the Medal of Honor of the I.R.E. and the Army Medal of Merit, presented to him by President Truman in 1947 with a citation stating that "Maj. Armstrong contributed greatly to the improvement of military communications by his inventions in the field of radio and by his unselfish, patriotic service to the Signal Corps."

At the time of his death, Major Armstrong was professor of electrical engineering at Columbia University, from which he graduated in 1913.

DUOSCOPIC TV RECEIVER which permits two audiences to view two different television programs at the same time from the same screen has been introduced by the Du Mont Laboratories.

The receiver, known as the Du Mont Duoscopic, performs as two separate receivers in one. Looking at the Duoscopic receiver with the naked eye, the viewer sees two superimposed pictures. He eliminates one or the other by looking through polaroid filters (placed on a stand in front of the receiver), or by wearing polaroid glasses similar in appearance to those used to view 3-D films. When the glasses are reversed, the viewer sees the other program.

It is possible to tune in one picture that can be viewed without glasses as in a standard receiver.

Individual earpieces are used to separate the sound portions of the programs. A remote control unit permits the viewer to listen to either of the two programs.

The Duoscopic receiver uses two C-R tubes, a dual chassis, and a twin audio system.

The chief uses of the new receiver are expected to be in stores and public places where it may be used as a crowd-stopper, but it is expected that a number of specialized applications may appear and that it may also solve domestic relations problems in television-divided households.

ELECTRONIC TRANSLATOR capable of turning Russian into English has been demonstrated by IBM.

The mechanical part of the device, which is mostly electronic, is the IBM type 701 electronic data processing machine. Russian sentences that are to be translated are first coded on punch cards similar to those used for Government checks, and then fed into the machine. Seconds later, an automatic typewriter spells out the translation.

The electronic translator has a 250-word vocabulary covering a broad range. It converts these words into its own binary language and then translates them, using its "stored dictionary" and "syntax."

RADAR SPEED DETECTION was recently upheld in New York State. Monroe County Judge D. J. O'Mara has upheld an auto speeding conviction based on radar evidence. The appellant, who was convicted last June, argued that there was no proof of the accuracy of the radar detector.

TV ANTENNA ACCIDENTS figured prominently in a recent report by the American Mutual Liability Insurance Co. As a result of the current do-it-yourself rage, the report says, approximately 59,000 TV owners were injured this past year in the process of installing their antennas.

In addition to the accidents definitely attributed to antenna installation, another 47,000 injuries were classified as "roof accidents." No indication was given as to how many of these injuries may have been due to patching the roof after an antenna had been erected by an amateur do-it-yourself installer.

FREQUENCY MODULATION is taking a major role in British broadcasting. To overcome interference to its radio programs by European radio stations, the BBC will build 51 FM transmitters. The estimated construction time is 10 years.
The World's Largest Stocks

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MARCH, 1954
Here's another sensational Raytheon first. It's a different kind of flashlight that sheds a new light on Radio-TV servicing — makes it faster, easier, more profitable.

Here's why Service Dealers from coast to coast are hailing the RAYTHEON BROW-LITE:

- **FREES BOTH HANDS** — work is easier, faster
- **DIRECTS LIGHT AUTOMATICALLY** — you see what you look at in a clear, bright light
- **USES STANDARD PARTS** — 1½ volt penlite batteries and 3 volt penlite bulb
- **ANYONE CAN USE IT** — fits easily above glasses
- **EASY TO CARRY** — folds compactly to pocket size
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- **DURABLE** — made of rugged plastic

RAYTHEON BROW-LITES are available through your Raytheon Tube Distributor. Ask him how to get a supply for you and your men.
Get yourself on the beam
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The beginner's course, Radio and Television Servicing with training Equipment, is extremely thorough. You get extra texts featuring experiments and job assignments. You get equipment second to none. Matched parts for an excellent 5-tube superhet receiver. Your own professional-quality multimeter. A complete single generator kit. High-grade servicemen's tools. The principles of Television including the most up-to-date developments (VHF and Color TV, for example).

The second course quickly reviews the essentials then goes step by step into advanced phases of Radio and Television, including modern methods of installation and repair. Course contains valuable supplementary material. For example, you get a special book giving characteristics of all tubes used in Radio and Television receivers.

Learn by doing! That's the world-famous I.C.S. method. Thoroughly practical. Completely modern. Success proved. The coupon below brings you full details—on Radio and Television Servicing or any of the more than 400 I.C.S. Courses. Mark and mail it today!

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MARCH, 1954

Canadian residents send coupon to International Correspondence Schools Canadian Ltd., Montreal, Canada. . . Special tuition rates to members of the U. S. Armed Forces.
More than ever, light, flexible polyethylene sheathed cable developed by Bell Telephone Laboratories is providing speedy answers to the demand for more telephone service.

But at thousands of splices, the sheath must be thoroughly sealed against moisture. Laboratories engineers developed a protective casing which is quickly and simply bolted in place. The edges and ends of the casing are permanently sealed with a new compound developed by Laboratories rubber chemists.

Now, economical polyethylene cable can be installed much faster and at lower cost. Here is another example of how Bell Laboratories continually finds ways to keep telephone service high in quality, while the cost stays low.

**BELL TELEPHONE LABORATORIES**

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

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TV RECEIVER components:

- C-W Telephone Transmitter
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Dear Mr. Lane: Mail me your NEW FREE BOOK, FREE SAMPLE LESSON, and FREE aids that will show me how I can make BIG MONEY IN TELEVISION. I understand I am under no obligation and no salesman will call. (PLEASE PRINT PLAINLY)

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Phonically approved by the State of New York - Approved by the VA

March, 1954
WHY IT’S BETTER BUSINESS TO REPLACE WITH
Astatic Crystal Pickup Cartridges

IN APPROXIMATELY 75 percent of all cases, the original crystal pickup cartridge for which you are supplying the replacement will be an ASTATIC! The record player manufacturer's highly skilled engineers have carefully selected each Astatic Cartridge because . . . down to the last detail . . . its performance characteristics match the requirements of the particular player or changer. Thus, for finest results, the serviceman replacing the cartridge must again match these requirements. AND ONLY THE PRECISION-BUILT, RECOMMENDED ASTATIC REPLACEMENT CARTRIDGE WILL DO IT. And, despite quality results, cost is almost invariably lower.

One way or another, a substitute cartridge is bound to fall down. It is not sound business to stake your reputation on such substitutions. Beware particularly of claims that ALL cartridge replacement needs can be filled by six or eight magic models. Actually, it takes an absolute minimum of 24 different cartridge models to meet all of today's requirements. The far-sighted jobber or dealer, knowing that what is good for the record-playing public is good for him, sees to it that the kind of cartridge originally intended is used on all replacements. Usually, too, he MAKES DOUBLY SURE OF BEST RESULTS BY RELOYING ON ASTATIC CRYSTAL CARTRIDGES.

NEW STEEL STORAGE CABINET AND DISPENSER FOR ASTATIC CRYSTAL CARTRIDGES

THERE ARE ADVANTAGES for everyone because jobbers dispense Astatic Crystal Cartridges from this handsome, rugged steel cabinet. No one — dealer, serviceman or record player owner — ever gets an Astatic Cartridge which has grown old from being accidentally shunted back and forth on the shelf. This can't happen to Astatic Cabinets because new stock is put in the cabinet by feeding into the top of each bin and the cabinet dispenses the oldest cartridge first, from the bottom of the bin. To make sure that everyone enjoys these advantages, the cabinets are given to Astatic Jobbers entirely free of charge, and purchase to be made. Attractively finished in light grey Hammerlin, this truly fine cabinet keeps ridges together and permits taking accurate inventory in one glance. It is designed to stand solidly on the counter, on the shelf, hang on the wall, or even stack securely when two or more are used. Included is a handy Rolla-fax cartridge replacement chart, which attaches to the top of the cabinet and works like a miniature window blind. Note that the bottom cartridge in each bin always protrudes, for quick, easy grasping.

EXPORT REPRESENTATIVE
401 Broadway, New York, N. Y.
Cable Address: ASTATIC, New York

CORRESPONDENCE

I CAN GET IT WHOLESALE
Dear Editor:

I am beginning to see more and more retail selling prices coinciding with wholesale prices. This results in a state of utter confusion. My first experience in this respect was in a Sears Roebuck retail store. A Hallicrafters communication receiver was on display with the same price tag as quoted in a mail-order wholesale catalog.

My second experience was when I picked up a local newspaper and saw a quarter-page advertisement of an audio center showing standard high-fidelity components at wholesale prices.

My third experience occurred when I received a sound catalog from a wholesale suggesting high-fidelity components be purchased from dealers recommended by him. Those mentioned were recognized retail dealers. What's puzzling me is, at what price is the wholesaler selling the equipment to the retail outlet?

This business of retail and wholesale prices is rapidly becoming merely a reference point from which prices are discounted. That isn't all: how do you price an installation?

For example, suppose we equip a home with a high-fidelity installation; what will govern the price of our job? Will we figure super prices, union rates, private bills, the prevailing wage and list prices, or enter into sealed competitive bidding?

Gentlemen, it's a problem we cannot shelve! The public has a right to know how we do business. If we wish to raise our level, performance must be in accordance with better business practices.

We can borrow from the automotive industry. They set the retail price of an automobile at the factory. The f.o.b. charges to any point in the United States are added to the factory price, resulting in an established retail price for that area. The distributor in the territory conforms with the policy of the auto manufacturer. The only loophole an automobile dealer has in regard to list price is to give you a little extra on a trade-in. If it is as simple as all that for them, there is no reason why the radio industry cannot do the same.

CLYDE D. KIERACH
Arlington, Va.

(Inquiry has shown the Hallicrafters "wholesaler" to be a large Chicago mail-order retail company. There has been considerable confusion between retailers and wholesalers in the electronic field. This confusion has been aided by the retail selling practices of some distributors and a tendency (at least in the past) of some retail mail-order houses to refer to themselves as wholesalers. To discover whether a company is a wholesaler, request their catalog on a plain postcard. If you get it, they are not wholesalers! The question of cut-price selling cannot be so easily resolved, and we would welcome further comment on it from our readers.—Editor)
New CBS-Colortron

NOW IN MASS PRODUCTION

Unique photographic process, like photoengraving, uses aperture masks as negatives to print consecutively the red, green, and blue phosphor dots (250,000 of each) on CBS-Colortron screens.

After tri-color screens are printed, aperture masks are temporarily removed and face plates move on to critical inspection for screen imperfections.

COLOR TV IS COMING . . . faster than you think. The revolutionary new CBS-Colortron . . . a practical color picture tube . . . hastens the day. Already it is in lower-cost, mass production . . . made possible by its simplified, advanced design.

As in black-and-white tubes, the CBS-Colortron's screen is deposited directly onto the inside of its face plate. A unique photographic technique makes this possible. Because each aperture mask serves as a negative to print its tri-color screen, perfect register of mask and screen is automatically achieved and maintained. The rugged, simple, light-weight mask sharply reduces assembly and exhaust problems. And the spherical design of mask and screen simplifies convergence circuitry and adjustment.

The CBS-Colortron is now a 15-inch, round tube. But, as soon as tooling is completed, it will be made in larger sizes. Watch for the new CBS-Colortrons. You'll see plenty of them soon. And you'll be sold on sight by their logical simplicity . . . their superior performance . . . their many advantages.

CBS-Colortron OFFERS MANY ADVANTAGES

Cross-section (face plate, aperture mask, funnel, tri-color electron gun) shows simplicity of CBS-Colortron and its adaptability to low-cost, mass production.

Spherical screen and aperture mask of CBS-Colortron simplify convergence and focus. Electron beams remain in focus over entire surface of screen.

Light-weight (6 oz.), rugged, simple aperture mask of CBS-Colortron minimizes problems of exhaust, handling, and assembly.

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

Manufacturers of Rec. i Tubes Since 1921

CBS-HYTRON, Main Office: Danvers, Massachusetts

A Division of Columbia Broadcasting System, Inc.

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

MARCH, 1954

COMPLETE CBS-Colortron DATA FREE!

Take a look into the future. Write today for complete information on CBS-Colortron 15HP22: Construction . . . operation . . . application . . . installation and adjustment . . . electrical and mechanical data. Four packed pages . . . free!
There's REAL Money in TV Signal Distribution
with the
Add-A-Unit
MASTER TV SYSTEM
for UHF and VHF

The B-T Add-A-Unit System is a new tool.
It is your 'open sesame' to the biggest boom
that has ever hit the TV servicing industry.

Hotels, motels, schools, apartment houses, community develop-
ments, hospitals, and hundreds of others with multi-receiver
problems are clamoring for low cost, easy-maintenance, efficient
TV distribution systems.

This is YOUR BIG MARKET...your real money market

The B-T Add-A-Unit System offers you these advantages:
1. It is the lowest cost amplified distribution system ever designed.
2. It is the easiest system to install under all conditions...requires no special
tools and no outside engineering assistance.
3. Its flexibility is practically unlimited and it can serve 2000 TV receivers as
effectively as it can serve 2.
4. It has no 'bugs' and requires little or no maintenance.
5. It permits complete control of signal strength: amplification or attenuation,
as may be required, assuring high quality reception at all TV outlets from
all available channels.
6. Every B-T Master System installed by you is a sure fire 'clincher' for addi-
tional business.

Let the B-T System Work for You.
The B-T Add-A-Unit Master
TV System consists of the
following B-T units:
• MIXER AMPLIFIER
• DISTRIBUTION AMPLIFIERS
• COMMERCIAL ANTENSIFIER
• RESISTOR OUTLET BOX
• TV SYSTEM ACCESSORIES
Attenuator Matching Transformer
Remote Control Line Splitters
Line Loss Equalizer Weather-Proof Housing

Write to Dept. NC-3 for Free Installation Manual
and Complete Specification Data.
BLONDER-TONGUE LABORATORIES, INC.
Westfield, New Jersey

CORRESPONDENCE

IONIC OSCILLATOR

Dear Editor:

I was greatly interested in the article
"The Ionic Oscillator" in the December,
1953, issue of RADIO-ELECTRONICS. Al-
though it has been well known that
fluorescent tubes and gaseous rectifiers
create hash throughout the radio spec-
trum, the fact that gas tubes will oscil-
late at voltages as low as 22½ is quite
a discovery, as is the use of a resistance
to vary the frequency of multielement
gas tubes. Actually, this principle of
oscillation has been known for many
years. Frequencies as high as 1,000 me
have been detected in rarified gas dis-
charges. A quotation from the book
Conduction of Electricity Through
Gases, Vol. II, by Thomson, published
by Cambridge University Press in 1933,
is appropriate. On page 447 appears the
following:

"Intermittence in the electric dis-
charge under a constant potential dif-
ference seems to have been first ob-
served by Gassiot in 1860. An excellent
account of the researches made on this
subject down to 1926 has been given by
Valle. More recent investigations have
been made by Appleton and West,
Newman, R. E. Clay, Whiddington, Gill,
R. W. Wood, and J. J. Thomson. Direct
experiments on the oscillations of dense
streams of electrons in mercury vapor
have been made by Tenks and Lang-
muir, who estimated the frequency of
some of the vibrations they observed
to be as high as 109 (1,000 mega-
cycles)."

A reference to Gassiot's experiments
is given in Deschanel's Natural Philos-
ophy:

"By means of a battery of some
thousands of cells, discharge in rarified
gases can be obtained without the use
of an induction coil, and with the
advantage of greater steadiness. This has
been done by Mr. Gassiot . . . ."

A more recent application of this
principle was the electrically quenched
spark gap of some years ago. (A series
of gas-filled cavity resonators.) The
discovery of the low-voltage operation
may have interesting microwave pos-
sibilities.

The articles on the Electronic Flame
in RADIO-ELECTRONICS for December,
1952, and February, 1953, also made
good reading. While Mr. Conant's ex-
planation of the action taking place in
his electro-forming apparatus is un-
doubtedly correct, I cannot agree with
his comparison of the electronic flame
to St. Elmo's fire. I believe that the
true explanation of this phenomenon is
to be found in the cover feature of
RADIO-ELECTRONICS, March, 1950. (The
dissociation of diatomic gas molecules
by means of r.f. energy and the sub-
sequent recombination of the unit atoms
with other elements.) This theory
could easily be tested by enclosing the
electronic flame in an inert gas such
as argon or neon.

I find your magazine very interesting
—keep up the good work.

John Novak
San Francisco, Calif.

JOHN NOVAK
San Francisco, Calif.

END

RADIO-ELECTRONICS
"LOCAL" UHF BOW TIE KIT
For local and in-town installations, in strong signal areas. Kit complete.

LIST
No. 9030* (Series 1 accessories) $13.95
No. 9034 (Series 2 accessories) 13.95
No. 9038 (Series 3 accessories) 13.95
No. 9042 (Series 4 accessories) 13.95

"FRINGE" UHF TWO STACK BOW TIE KIT
For fringe areas up to 30 miles (depending on local conditions). Kit complete.

LIST
No. 9033* (Series 1 accessories) $11.75
No. 9033 (Series 2 accessories) 11.75
No. 9037 (Series 3 accessories) 11.75
No. 9043 (Series 4 accessories) 11.75

"DO IT YOURSELF" ANTENNA KITS

CHOICE OF 4 DIFFERENT SETS OF MOUNTING HARDWARE FOR EACH ANTENNA
16 COMBINATIONS TO CHOOSE FROM!

These new TELCO Antenna Kits are just what you need for profitable selling to the "do-it-yourself" market. There's a wide range of styles to meet every requirement . . . with four choices in hardware components for each kit. Your favorite distributor's got them . . . or can get them for you!

*WHAT EACH TELCO KIT CONTAINS

SERIES 1 HARDWARE

Complete Antenna, as shown
1-6 ft. 11/4" Mast
50 ft. Guy Wire
50 ft. UHF Low Loss Line
1-Guy Wire Clamp
4-Screw Eyes
2-Universal Mast Stand-Offs
2-7/" Wood Screw Stand-Offs
1-Mast Base

SERIES 2 HARDWARE

Complete Antenna, as shown
1-6 ft. 11/4" Mast
50 ft. UHF Low Loss Line
2-Universal Mast Stand-Offs
2-3/" Wood Screw Stand-Offs
2-7/" Wood Screw Stand-Offs
1-Chimney Mount

SERIES 3 HARDWARE

Complete Antenna, as shown
1-5 ft. 11/4" Mast
50 ft. UHF Low Loss Line
2-Universal Mast Stand-Offs
2-3/" Wood Screw Stand-Offs
2-7/" Wood Screw Stand-Offs
1-Snap-In Wall Mount

SERIES 4 HARDWARE

Complete Antenna, as shown
1-5 ft. 11/4" Mast
50 ft. UHF Low Loss Line
2-Universal Mast Stand-Offs
2-3/" Wood Screw Stand-Offs
2-7/" Wood Screw Stand-Offs
1-Snap-In Wall Mount

AN ANTENNA STYLE AND HARDWARE SELECTION FOR EVERY INSTALLATION — 16 KITS IN ALL!

NOTE — Special kits for particular areas made to order. Write for details!

FREE!
Your new TELCO Catalog. Ask your jobber . . . or write direct.

TELEVISION HARDWARE MFG. CO.
DIVISION OF GENERAL CEMENT MFG. CO.
910 Taylor Avenue
Rockford, Illinois
over 100,000 already installed!

**CHANNEL MASTER'S fabulous CHAMPION**

the world's most powerful all-channel VHF antenna
—OUT-PERFORMS AND OUT-SELLS THEM ALL!

Never before in the history of television has an antenna received such an overwhelming reception. Channel Master's CHAMPION — in a few short months — has rocketed to the top as the nation's most-wanted, best-selling, best-performing VHF antenna!

**CHAMPIONSHIP Performance:** Only the CHAMPION has the unique new "Tri-Pole", a triple-powered dipole system in which the Low Band dipole also functions as three dipoles tied together, in phase, on the High Band.

All-aluminum. Assembles faster than a 5-element Yagi! The CHAMPION is another great contribution of the Channel Master Antenna Development Laboratories.

**CHAMPIONSHIP Promotion:** The CHAMPION is the antenna America knows best!
- Publicized in leading magazines
- Outstanding dealer Cooperative Advertising Program
- Free newspaper mats, window streamers and TV film commercials

THE STACKED CHAMPION OUT-PERFORMS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>List Price</th>
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<tr>
<td>325</td>
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<td>$3.08</td>
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<tr>
<td>325-5</td>
<td>$4.17</td>
</tr>
</tbody>
</table>

*pat. pending*
**TIE SEPARATE ANTENNAS TO ONLY ONE TRANSMISSION LINE**

**CHANNEL MASTER** inter-action filters

Only Channel Master filters are permanently sealed in a block of moisture-proof, high melting-point electrical wax, locked in an attractive styrene case.

- Single lead
- No switching
- No signal loss
- No inter-action, effective isolation.

- **New!**
  - TENNA-TIE: VHF only
  - ULTRA-TIE: VHF-UHF
  - TRIPLE-TIE: VHF-UHF

- **Use with leads of any length!**
  - TENNA-TIE: VHF only
  - ULTRA-TIE: VHF-UHF
  - TRIPLE-TIE: VHF-UHF

- **JOINS** separate VHF and UHF antennas for use with a single lead.
- **SEPARATES** — VHF and UHF signals at the set or converter where separate terminals are provided.
- **'Free-space' terminals** new low price — $3.75
- **New low price** — $3.50
- **New low price** — $4.86

---

**THE ANTENNA IN COLOR TELEVISION**

by Harold Harris, Vice President, Sales and Engineering

Now that color telecasting is a reality, we will see an ever-increasing flow of color sets to the consumer. Although much is being said and written on the subject of color sets, many unanswered questions remain about the role of the television receiving antenna in color television.

Will present antennas work on color?
Will a special antenna be needed?

The results of thorough laboratory and field tests made by engineers of the Channel Master Antenna Development Laboratories show that practically all present TV antenna types will perform satisfactorily on color. Gain variations as high as 3 DB across one channel can be tolerated. When this figure is exceeded blurring or smearing of the picture may occur. Although there are certain antennas on the market which do have excessive gain variation, this is not the case of the vast majority of present installations.

There are also indications that fringe area color reception may be more critical. This may necessitate the use of fringe area antennas in areas closer to the TV station.

In the nation's most advanced television research laboratory, Channel Master antennas have always been designed for full band width and minimum variation in gain on any one channel.

For this reason, every Channel Master antenna which you have installed in the past, as well as the ones you install today, will provide reception of outstanding quality when color TV comes to your area.

Channel Master antennas were the antennas selected for the tests which led to the F.C.C.'s approval of the National Television Standards Committee color system.

Copyright 1954, Channel Master Corp.
A modern dynamic at an "old fashioned" price

This is a modern dynamic microphone all right... with Alnico V Magnets and moving coils for maximum sensitivity to voice and music. Wide response range and outstanding sound characteristics make it ideal for tape recorder, PA, or commercial broadcasting use. Its design is certainly modern, too... trim, handsome, functional.

And about that price. We call it "old-fashioned" because it's so much lower than you would expect to pay in these expensive days. Only $35.00 list.

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ADA 95D. List Price $35.00
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Business

**Merchandising and Promotion**

CBS-Hytron, Danvers, Mass. is offering service technicians four new sales aids in connection with its nationally advertised Certified Quality Service program: an illuminated Plexiglass sign for indoor use, a metal flange sign, direct-mail postal cards and advertising mats.

Pyramid Electric Co., North Bergen, N.J., is conducting a $5,600 cash prize contest for service technicians. The contest runs from February through April. Contestants must complete the sentence, "I like Pyramid capacitors because...", and send their entry in with the top of a box from a Pyramid dry electrolytic capacitor. J. K. Poff, Pyramid jobber sales manager, announced that duplicate prizes would be awarded to parts distributors from whom winning service technicians made their purchases.

Raytheon Manufacturing Co. Receiving Tube Div., Newton, Mass., reported that about 500 service technicians attended its recent Service Saver meetings held in Reading and Wilkes-Barre, Pa., and Hagerstown, Md. Local distributors sponsored the meetings.

Blonder-Tongue Laboratories, Westfield, N.J., developed an attractive new display carton for all its TV accessories.

Cornell-Dubilier Electric Corp., South Plainfield, N.J., and Radiart Corp., Cleveland, O., are now packaging their CDR rotors in a colorful new shipping carton which also doubles as an "in-stock" box.

Technical Appliance Corp., Sherburne, N.Y., has augmented its field meeting program for TV service technicians. The technical forums, conducted by "Taco" personnel, are held under the auspices of the company's distributors throughout the country.

Radio City Products, New York City, introduced a new test lead counter display which features a storage compartment in the rear of the display permitting the maintenance of a steady stock on hand.

Hallicrafters, Chicago, awarded MG sports cars to the four winning distributor salesmen in its recent contest.

Hallicrafters J. Mahoney, Adv. Mgr., left, and M. Kelly, TV Sales Mgr.

RADIO-ELECTRONICS
23rd Ray Snyder
General Manager

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Vol. 3. RADIO-TELEVISION CIRCUITS: 336 pages, covers power tubes, de-coupling, distortion, photo-tubes, phase inverters, etc.
Vol. 4. LATEST INSTRUMENTS FOR SERVICING RADIO-TELEVISION: 345 pages, covers all types of testing instruments, their use in service work.
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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.

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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.

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Winners were M. Newman, HSM Distributors, Los Angeles; Al Roth, Minsky Bros., Pittsburgh; J. Morris, Century-Ekon Distributors, Minneapolis; and R. Martin, Clado, Buffalo.

Brach Manufacturing Corp., Newark, N. J., introduced its new No. 555 antenna designed for color with a life size “cloak and dagger” display in parts jobbers’ establishments.

Jensen Industries, Chicago, is featuring a versatile needle container of flexible plastic construction which may be used either as a hanging wall display or a shirt pocket container to be taken on service calls. It has been nick-named the Needle Caddy.

Pilot Radio Corp., Long Island City, N. Y., is sponsoring a series of twelve 1-minute spot announcements per week for the next year over station WQXR, New York City, on its high-fidelity components and complete matched systems.

Production and Sales

RETMA reported a record breaking TV set production for the first 11 months of 1953 of 6,765,000, 62% above the 1952 period. Of that total, 1,319,818 TV sets were equipped with u.h.f. tuning facilities. The association also reported radio production of 12,267,441 for the first 11 months of 1952. This was almost 30% better than last year.

Show Notes

The 1954 WESCON (Western Electronic Show & Convention) will be held in the Pan-Pacific Auditorium in Los Angeles, August 25-27.
INTRODUCING the greatest advance in Conical antennas...it's the all-new WALSCO Imperial. Featuring a new "barrier disc" insulator with 2 inches of air space between the terminals to prevent shorts. Soot deposits, dirt, moisture, salt, etc., cannot affect this insulator. The WALSCO Imperial will therefore maintain lasting high gain performance anywhere, regardless of weather conditions. Contact surfaces and terminals will never rust or oxidize. Front end hardware is stainless steel to prevent corrosion losses permanently. Front end elements are pre-assembled to holding plates which are fastened to the insulator with one wing nut. Less than 2 minutes to assemble.

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TR-4... the de-luxe HEAVY DUTY model complete with modern design meter control dial cabinet, using 4 wire cable...
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incorporating all the fine features

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plus these fine features:

* Handsome Meter Dial Cabinet  
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**TR-12** ... a special combination value consisting of complete rotor, including thrust bearing... handsome modern design cabinet with meter control dial, 4 wire cable... **$47.95**

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**TR-11** ... the all-purpose rotor with handsome modern design cabinet with meter control dial, uses 4 wire cable... **$44.95**

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PUSH-PULL outputs in both amplifiers
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EICO EXCLUSIVE! 5" PUSH-PULL SCOPE, T425K,
Only EICO has All These Features
• VERTICAL FREQUENCY RESPONSE:
  flat ± 2 db 10 cps – 1 mc.
• VERTICAL SENS.: .01 volts
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• HORIZ. SENS.: 3 volts rms/in.
• SWEEP RANGE: 15 cps-100 kc.
• THRESHOLD: 5 step pre-compensated
• ATTENUATOR eliminates freq. distortion, overloading.
• CATHODE FOLLOWER inputs to both amplifiers.
• PUSH-PULL outputs in both amplifiers
• RETURN TRACE BLANKING
• INT. VOLTAGE CALIBRATOR
• V & H TRACEx EXPANSION & CENTERING: 1.5x full screen without distortion.
• DIRECT CONNECTION to vert. CRT plates.
• PHASING CONTROL of internal 60 cps
• Y & H TRACE EXPANSION & CENTERING:
  INT. VOLTAGE CALIBRATOR
• RETURN TRACE BLANKING
• 1.5X full screen without distortion.
• ATTENUATOR eliminates fret.
• 60 cps, sawtooth outputs.

High Voltage Probe $6.95
• Extends range of oscilloscopes & voltmeters to 20 kv.

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Hard-to-find picture V & H
Enables rapid adjustment
352K, WIRED $19.95 KIT, $14.95
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  Bridge measurement of peak beam current (proportional to screen brightness)
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RTMA RESISTANCE SUBSTITUTION BOX
1100K WIRE $29.95 KIT, $5.50.
• Enables rapid substitution of resistances from 15 ohms to 10
  meg in duration multiples of \( 15, 22, 33, 47, 68, 100 \) ohms.
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By the Federal Communications Commission

(THE WELL-NGH INCREDIBLE PENETRATION OF RADIO AND TELEVISION INTO EVERY CONCEIVABLE HUMAN ENDEAVOR HAS NOW REACHED UNDREAMED PROPORTIONS. THIS SUMMARY OF PRESENT DAY RADIO USES, BY THE FCC, MAKES SPECTACULAR READING—EDITOR)

RADIO usage extending from the cradle to the grave is encompassed in the flow of applications to the Federal Communications Commission for new or extended radio services.

两类 facilities for calling and otherwise speeding doctors to the homes of expectant mothers as well as other persons requiring medical assistance in rural areas; and in the cities radio-equipped ambulances and other vehicles can bring medical aid.

After the baby arrives, radio-equipped vehicles can deliver milk, pick up and return diapers, and perform other chores in the interest of the newborn.

Going to the other extreme, radio is being used for dispatching vehicles in connection with the death and burial of the departed. This includes the movement of funeral corteges at a number of large cemeteries.

The Commission's now more than 60 different classes of radio stations—which hold over 250,000 authorizations covering the use of some 600,000 fixed and mobile transmitters—represent a varied and rapidly expanding utilization of this instantaneous communication medium.

The wide extent of the application of radio for communication purposes is indicated here:

Public Communication—Domestic and international communication by telephone and telegraph over radio facilities.

Public Safety—Radio aids to police, fire, highway and forestry protection.

Transportation—Radio navigational, safety and communication aids for ships and airplanes; radio dispatching for railroads, street car systems, taxicabs, intercity buses, and highway trucks.

Industry—Radio communication to control and speed the movement of personnel and material in the production and delivery process.

Entertainment—Programming by commercial AM, FM and TV broadcast stations.

Education—Programming by noncommercial educational AM and TV broadcast stations.

Experimentation—Use of radio in research, and for the development of equipment and techniques.

The diversification of radio's uses is shown by the following miscellaneous examples: To control city and highway traffic systems; To direct movement of crews cleaning city streets, water mains, etc. To expedite delivery of food, fuel, building material, etc. To speed repair of home and business office fixtures and appliances; To dispatch trucks to pick up garbage, dead animals, and other refuse; To route rural school buses; To aid beach and other recreation area patrols; To contact workers on isolated ranches, etc. To direct the movement of machinery on large farms; To look for oil on land and under off-shore waters; To spot schools of fish from moving planes and radio their locations to fishing boats; To direct motion picture crews on location; To aid bank and business protective patrol systems; To relay news between reporters on assignment and their newspaper offices; To control model airplanes, etc.; To send fingerprints and other information from one police department to another; To time and photograph the finish of track-racing events.

To communicate between the engine and caboose of long freight trains; between moving trains and wayside stations; and in yard operations; To control railroad track switches by the engineer on a moving train; To pick up and deliver telegrams by auto; To relay telephone and telegraph messages, also TV programs; To bridge gaps in disrupted wire lines; To transmit pictures and facsimile; To control crowds at large regattas, horse shows, golf matches, and other big outdoor events; To transmit orders from "car hops" to kitchens of drive-in restaurants; To control movement of ships in harbors; To page doctors and other personnel; To determine the position of ships and aircraft, also the proximity of objects; To direct firefighters at the scene of a blaze; To enable garage and automobile associations to provide emergency road service; To report weather and many other reports; To supervise and control valves, pressures and fluid levels along pipe lines; To record sunspot cycles, weather radio propagation and study planetary reflection. Also, to provide emergency communication in time of local, regional and national disaster.

Because of the "housing shortage" in the radio spectrum and the increasing demand for service frequencies by recognized radio services, the Commission is unable to allocate radio space for the exclusive use of—to quote one request—a machine "to take the kinks out of woolly hair." However, electronic hair-removing apparatus does function under rules which govern the technical operation of miscellaneous radiation devices to prevent interference.

Though not used for communication purposes, there is growing use of appliances which emit energy that can disrupt radio services—not only TV and aural broadcast reception, but also services on which the safety of life and property depend. It is significant that the collective power of this group now exceeds the total transmitter power required for all forms of radio communication. Some of these units employ power far in excess of the 50-kilowatt maximum permitted FM broadcast stations.

Industrial, scientific and medical equipment employing radio-frequency energy includes heaters for the quick drying of products used in the manufacturing process, medical diathermy machines used in the treatment of sicknesses, welding outfits, etc. Specific frequency bands are provided to absorb their radiations and so keep them from straying into the regular communication channels.

Then there are restricted radiation devices, such as phonograph oscillators; garage-door openers and other remote-control gadgets; electronic cook stoves which heat food from the inside out; community antenna systems in areas of poor TV reception which pick up programs and relay them by coaxial cable to the homes of subscribers; and carrier current (closed-circuit) systems which use wire facilities to furnish music, voice and signaling services. The technical operation of these things, too, are subject to rules to guard against unlawful radiation.

Closed-circuit television operation, in particular, is extending into many fields and its possibilities appear to be without end. Present uses include: Demonstrating survey and other medical techniques to doctors and students; Instructing several classes of a school or college at the same time; Checking signatures, etc., between branches of a bank; Watching babies in large nurseries; Guarding prisoners in jails; Relaying church, concert, entertainment and other programs to overflow or supplement audiences; Demonstrating new products to scattered groups of salesmen; Observing planes take off and land at airports; Supervising freight car movements; Detecting unnecessary chimney smoke; Checking documents in different parts of a large filing system; Serving industry as a tool to follow production and handling processes—such as watching boilers, water-level and other gages from the main control room; detecting delays in the movement of material; and otherwise enabling supervisors to see into several places at the same time. "Kibitzing" dangerous operations from a safe distance—such as those involving use of atomic energy, furnace combustion, detonation of explosives etc.
CONTROL UNIT for GOLDEN EARS

Compact and inexpensive, this unit is designed for use with the Junior Golden Ear amplifier, but is highly applicable to any amplifier.

By JOSEPH MARSHALL

The weak spot in most home-built high-fidelity systems is the control unit. It is, in fact, the weak spot of many commercial units. This is not surprising. It is by no means easy to compromise the often conflicting demands of the several jobs a control unit is called upon to do, and especially not easy to do so in a compact and inexpensive form. As an example of the extremes one can go to in trying to approach the ideal, I can cite the present control unit for the Master Golden Ear Amplifier in my own home which uses 5 double triodes (not including the phono preamplifier) and occupies a 7 x 17-inch chassis, and the same sized panel with just about a dozen knobs.

Often I have thought that this was surely a case of complication ad absurdum; but the fact is that though I designed and built many simpler units, until recently I could not arrive at one which was capable of living up to the standards of the Golden Ear.

For instance, there is the matter of distortion. We take elaborate pains to reduce distortion in power amplifiers to a fraction of 1 percent. Adding a control unit which contributes high distortion would be like throwing away the hard work and expense devoted to the amplifier. And yet it is extremely difficult to hold down distortion in a control unit. For one thing, unless we can afford a to-heavily-expense attitude, the control unit must be single sided, rather than push-pull, for the simple reason that providing tone equalization in push-pull is a very complicated matter. Thus we are deprived of the distortion-canceling benefits of push-pull configuration. Further, since tone equalizers are included it is also hard to make use of the distortion-canceling properties of negative feedback. Single-sided amplifiers without feedback can produce large amounts of distortion (by high-fidelity standards) even with outputs of 1 or 2 volts.

There is also the matter of satisfactorily tone compensation. I don’t think anyone will argue with the proposition that a good tone-control circuit should provide direct boosting or attenuation without readjustment of the volume control. There aren’t too many good circuits which provide direct boost.

A tone-control circuit should also control the bass or treble but leave the rest of the band unaffected. When you want to bring out the drums, you don’t want to change the contralto into a female baritone; nor when bringing up the snares and triangles do you want to change the baritone into a thin tenor. Unfortunately, the simpler tone-control circuits do not fill this specification. Even a reasonable amount of bass boost usually results in a boomy voice.

Finally, when independent bass and treble controls are involved, the two should be reasonably, if not completely, free of interaction. This is far from true in the case of the average control circuits; satisfactory setting of the controls takes considerable skill.

Another important consideration is frequency response. The better high-fidelity amplifiers today have bandwidths of around 13 octaves and even more; and—as I have repeatedly pointed out—this wide bandwidth is essential for faithful, distortion-free reproduction. In contrast, the typical single-sided control unit is flat—in the flat position—from perhaps 30 to 12,000 cycles, with rapid slopes at the extremes. Of course this minimizes the range of the tone-control circuits since part of the boost is needed merely to flatten the response of the control unit itself. Worse yet, however, the slopes produce distortion, especially at low frequencies. And yet, here too, without the benefits of push-pull operation and negative feedback, it is very difficult if not impossible to obtain wide bandwidth.

Finally, there is the matter of so-called “loudness control.” Without getting into debate in a field already very noisy with argument, we can say that it would be nice to be able to preserve a reasonably good tone balance when changing the volume level. The high-fidelity crank may be perfectly happy to spend two or three minutes adjusting—in proper coordination—the volume, bass, and treble controls, every time he changes the volume level. But his wife—and most people who buy high-fidelity systems—would much prefer to simply turn the volume control up or down and still maintain a reasonably good tonal sound. Much design energy is currently being expended on loudness controls and some are very complicated with their stepped or variable slopes, etc.

Even then, most designers confess their failure to solve the problem satisfactorily by including a switch to remove the loudness control from the circuit.

By no means to be disregarded is the matter of physical size and form of the control unit. To meet the infinite variety of installation problems and preferences, the unit should be small, compact, and capable of being inserted in an odd corner of a cabinet, or used by itself in plain sight, of being a part of a single cabinet, or of being used remotely.

A simple and compact job

When—in view of all the above—I present the simple unit pictured and diagrammed here, the reader is entitled to lift his eyebrows high and to look with skepticism at any claims made for it. And I am not going to say that here is the perfect control unit. It is not as good as flexible as the master outfit mentioned above; but it costs only a fraction as much and occupies less than one-tenth the space. Only one or two people besides myself have noticed any difference, and these were either engineers or high-fidelity cranks. Furthermore, I am the only one in the family who understands the operation of the big unit, whereas all members of the family find this one simple to use properly. I could not conscientiously recommend the master unit except to the very cranks of cranks; whereas, I do not hesitate to recommend this one even to all cranks. Its performance is good enough to bring out the best qualities of the Golden Ear amplifiers and to me, the proud brainfather, that is adequate praise.

Let us look at the performance of this small handful of gadget to see how it meets the various conditions I have mentioned. The distortion level, though higher than I would like it to be, is...
Left, photo shows front view of compact control unit.
Right, rear view of control unit shows jacks and socket.

still low enough to take nothing discernible away from the performance of top-quality amplifiers. The IM distortion (60 and 7,000 cycles, 4–1) is under 1% until the output exceeds 1½ volts, and rises to 2% at levels of 3 to 5 volts. The Golden Ear amplifiers are among the least sensitive of all amplifiers, because of the large amounts of feed-back they incorporate. However, less than 0.2 volt will produce an output level high enough to drive most women out of the house and to break almost any lease. At this level the distortion is still low enough to take nothing discernible away from the performance of top-quality amplifiers.

First of all, it is a direct-acting tone-control circuit. Turning either bass or treble controls up or down brings an immediate boost or attenuation with no need to compensate the volume control. Second, it is a circuit in which the turnover on both ends varies with the amount of boost or attenuation. Thus the turnover is below 100 cycles for a boost of 6 db; it rises to about 200 cycles at 12 db; and at maximum boost of some 20 db the mid-frequencies are still relatively unaffected to the ear. The treble turnovers are similarly variable. This results in very pleasant and satisfactory tone compensation; large amounts of boost can be applied to the extremes of the spectrum, with very little audible effect on the mid-frequencies. The total range of control from maximum boost to maximum attenuation at the two extremes of 20 and 20,000 cycles approaches 50 db for the bass and is over 40 db for the treble. This includes the unit as a whole, not merely the tone control unit, and therefore includes all circuit gains and losses. Finally, because this is a feedback circuit, the distortion is minimized except at the points of maximum change in the volume control setting up or down which produce compensation which is pleasant.

It's not perfect

This circuit has one fault: the volume is not completely cut off at the minimum position of the volume control. However, radio and TV receivers will have volume controls which can be set to produce complete cutoff if desired. If the record input is too high to produce an acceptable minimum volume, a resistor of 500,000 ohms or more can be inserted between record input and the appropriate point on the switch to reduce input level to the desired degree. This system could be used with the other inputs, the resistors being selected so that each input source delivers the same input signal. This, however, is a small price to pay for the virtues of loudness control and reduced distortion which the circuit yields. (Complete control of volume with somewhat higher bass boost could be obtained by using an IRC type Q17-13X control and returning the feedback to the 25,000-ohm tap.)

Because of the two feedback loops, the control unit is excellent for remote operation. The feedback on the input stage reduces the input resistance and therefore cable losses at high frequencies; the feedback in the output stage reduces the output resistance and therefore losses in cables as much as 25 or 30 feet of shielded cable can be used with losses moderate enough to be compensated for easily with the treble boost control. The on-off switch on the volume control controls the whole audio system. Two wires, one in the cable feed on one side of the 117-volt line to the switch. So the circuit does rather better at meeting the specifications for a high-quality control unit than one might believe possible. Whether the result is measured by ear or by instrument, it is a superior control unit, despite its small size and simplicity. It will not harm the performance of even the most expensive combination of amplifiers, pickups, and speakers; on the contrary, it will work considerably better than most. The over-all performance will in any case be cost given in the certified parts list.

Construction details

The unit (shown in Fig. 1) is very simple to construct. It is mounted within in a 3 x 4 x 5-inch Flexi-Mount aluminum case to match the phono preamplifier (to be described in a future article). The two units could be combined in a single larger case; but I recommend separate cases for better isolation and a better over-all noise figure, as well as greater flexibility in placement.

There is only one critical point. The treble control shows a 500,000-ohm potentiometer with a linear taper and a tap at 250,000 ohms. Only a linear control with a mid-tap will result in
obtaining a flat position at mid-rotation and equal amounts of attenuation and boost. Unfortunately, such units are hard to find. The prototype uses a Mallory UF55-T254. While it is not exactly correct, it comes very close to being right. The flat position is a little to the attenuation side of center; but the center position will provide just enough boost to make up for line and program losses beyond 10,000 cycles.

20 cycles useful without instability, and will keep the transient response up to that of fine power amplifiers. All Golden Ears except the Junior provide a V-R tube regulated source of 150 volts for this purpose.

The wiring is done in two steps. The turret socket is wired with the plate and cathode resistors, bypass and coupling capacitors. The rest of the wiring is done on the panel after the controls are mounted. Fig. 2 shows the recommended wiring of the tone-control circuits as viewed from the rear or wiring side. Note that the two coupling capacitors must be connected to the points indicated to obtain clockwise boost. The various resistors and capacitors are supported by the terminals of the controls. Be sure the .0047-µf capacitors are the miniature type specified. Ordinary ones will take too much space. Connection to the second-stage grid is through the 1,000-ohm resistor with spaghetti tubing over the bare wires. The connections to the two plates are through the coupling capacitors, also covered with spaghetti. The vector turret socket is mounted on a small square of aluminum bent to make a bracket and punched with a hole for the socket. This bracket must be positioned precisely with the tube shield in place. There is just room enough to permit the cover to slip on and off, if this bracket is properly placed. Do not leave out the tube shield; the two feedback loops might produce instability without it.

A 5-position single-pole switch of the miniature type permits the choice of 6 inputs. One for the phono-equalizer and another for a tape recorder are phono jacks mounted on the cover of the case. The two radio and the TV input are fed via the cable which brings the operating voltages. Or, rather, this cable consists of two cables wired together: one is a 3-conductor shielded cable for the audio circuits; the other a 6-conductor unshielded cable for the plate and filament supplies. Although the model pictured has a cable jack and plug, the jack could be dispensed with and the plug used only at the far end, the power supply or amplifier. In that case the cable could enter the cabinet through a grommet.

The only precaution to take in assembling the unit is to make the leads certified parts list

-Tape jack, 10 contact, type A8.
- 3 x 4 x 5-inch Flexi-Mount case.

Total cost of the above, as purchased from a large mail-order house, was $12.09.

Fig. 1—The Golden Ear control and tone compensation unit.

Fig. 2—Wiring of tone-control circuit between the parts on the case and points on the cover long enough so that when the cover is slipped on there is enough of a crack or opening to permit easy soldering.

Whether used with Golden Ear or other amplifiers, this control unit will add greatly to the flexibility of performance, and, equally important perhaps for the other members of the household—to the ease and simplicity of operation and therefore to the pleasure the whole family obtains from the high-fidelity installation.

Next Month we expect to present Milady's Golden Ear amplifier, which is essentially a revolutionary method of construction which will hide all clumsy handiwork and mistakes, and produce a piece of equipment which Milady of the household will not object to having in plain view.
VAST amount has been written about what we call "high-fidelity." Some is original work; much of it has been lifted from standard works, revised, and offered as something new. Old fallacies and errors are repeated, apparently through lack of the necessary technical knowledge, and these sometimes become accepted principles of design.

I believe that I invented the concept of high-fidelity in 1927; at that time I was, as now, seriously interested in music, and it so happened that my job was designing speakers and amplifiers for the phonographs we had in those days. They were not very good and we invariably used some sort of balanced armature speaker with a large paper diaphragm. The moving coil, or dynamic speaker, had been invented a long time previously by the English scientist Sir Oliver Lodge, but nothing very much had been done about making it. More had been done about making it superior to the "tin trumpets," but not good enough to compete with the remarkable "Kone" speaker of Western Electric. Then the American designers Rice and Kellogg produced a real dynamic speaker in, I think, 1926 or 1927, and the modern reproducer was born.

The Rice-Kellogg was so good that I thought it had possibilities of becoming better. The hidden meaning of this remark forms the foundation of the whole science and art of reproducing music. Earlier speakers were not even an imitation of music, because they lacked bass and extreme treble. The R-K was not very good above about 5,000 c.p.s. but it reproduced bass of a sort we had never heard before, simply because it had a diaphragm that could move. The sound of this speaker was the first clear signal that electrical gramophones could be designed to give some sort of approximation to an original performance instead of just being a little better than musical toys. Why not, therefore, make them better still? As both an engineer and a musician, I felt that was a suitable question.

I have used the expression "the science and art of reproducing music," and I want to emphasize something that is not generally understood by the layman. It is not possible to define musical appreciation in terms of mathematical equations alone; something must be added. Similarly, the design of audio equipment intended to give a close approximation to an original performance is basically mathematical (amplifier design, for example, is entirely mathematical). But, particularly in the speaker, some design features cannot be computed; they are best thought of as the outcome of inspired hunches.

The best mathematical essay on the mechanics of speaker design is the book "Loudspeakers" (long out of print) by Dr. N. W. Maclachlan. The mathematician will enjoy the elegant treatment, but it is heavy going for the ordinary reader. Maclachlan shows that only the simplest of diaphragm behavior can be analyzed. When the book first appeared, a colleague of mine said that "Mac" had pulled off a remarkable tour de force, but it didn't tell us how to design speakers. That was true, but it wasn't Mac's fault. The complete behavior of a speaker diaphragm cannot be analyzed; you can only listen to it and hope that it sounds good, and some musical knowledge is required if you desire to criticize it with authority.

For example, a question often put to me is, "What is the damping factor of your speaker?" The formula for the damping factor at bass resonant frequency can be found in any standard engineering textbook. The factors in the equation include: a figure for the damping resistance equivalent to the combined effect of friction and acoustical loading on the cone; the impedance of the voice coil plus that of the secondary of the output transformer and the connecting leads and of the primary related to the secondary; the effective plate resistance of the output stage of the amplifier; the frequency of the bass resonance; and the shunt capacitance of the system. Now I could reply to this question by saying that I can't answer it until he tells me what his output stage is, what sort of output transformer he has (in exact mathematical terms), how long his speaker leads are, what their capacitance is, and at what frequency he wants the figure. Then, if he has the patience to wait while I work out the equation, he can have his damping factor. If this seems poor salesmanship, all I need do is to check up on the damping factors of other speakers and quote a better figure than anyone else; I couldn't be proved wrong, and it would sound impressive. But the honest answer to the question is, "I haven't the faintest idea." And my truth seeker would consider me a fool.

I am pleading for sanity in assessing speakers. A speaker cannot possibly have a wide and level frequency response; it must be free from intermodulation distortion; it must have a good polar diagram at all frequencies; it must have a good "attack" to reproduce transients faithfully, and good damping to avoid hangover; and, most elusive quality of all, it must have absolutely no "personality" whatever. A speaker is not a musical instrument, it is a reproducer of musical instruments, and must not add any sort of...
An electrostatic speaker is nothing more nor less than a capacitor, one plate of which is a metallic diaphragm. A good early type was the Oscilloplan (Fig. 1) of Hans Breitg, a German designer, in 1957. This had a 12-inch thin aluminum diaphragm tightly stretched across an annular mounting ring. Behind this was a perforated nonmetallic screen, and behind the screen was a plate forming the inner electrode of the capacitor. A polarizing voltage of (about 2,500) was applied to the unit to set up a condition of strain, and the speech frequencies were added across the capacitor (Fig. 2). At low frequencies the movement of the aluminum diaphragm was appreciable and the insulating screen prevented short-circuiting. Unfortunately, when the diaphragm was near the screen the polarizing voltage sparked across, with disturbing acoustical results, and the frequency response was uneven. With the arrival of talking films it was thought that a battery of such speakers (they were conveniently thin and light) could be used, spread across the whole projection screen, but extended testing gave little promise of satisfactory results. Other electrostatic speakers were made of pleated metalized paper on aluminum electrodes, but these had no bass response and were feathery at high frequencies. In all types, the polarizing voltage was a nuisance, even dangerous. I have mentioned these to show that there is very little new under the sun. It is it is difficult to acquire a valid patent on speakers—all has been done before—and we can look for no great progress until someone invents an entirely new method.

Attention therefore can be directed toward the ordinary dynamic speaker, in which a more or less conical diaphragm carries at its apex a coil of wire which oscillates in a magnetic field. Such a speaker cannot reproduce low frequencies unless it is mounted on a baffle, because as the sound from the front of the diaphragm is 180° out of phase with that from the back, the slower longer sound waves will cancel out each other unless prevented from doing so by an obstruction—the baffle plate. The baffle need be not too large; its effective size is the total distance from the front of the cone, around the edge of the baffle, to the back of the cone. The most economical baffle therefore will be circular, and the most economical box spherical, considered from the viewpoint of raw materials.

A direct radiator's performance depends on the design of the diaphragm, the voice coil, the magnet system, and the mounting of the whole unit. The last point will be considered under housing design; the other three will be discussed now.

Someone sometime in the past said that it is impossible to design a single diaphragm which will reproduce the whole range of frequencies required for high-fidelity reproduction. I may be the originator of this fallacy, for I produced the first tweeter-woofer combination as far back as 1929, and put it on the market in 1930. I revised it in 1931 because I didn't like it. It is difficult to produce a single-diaphragm speaker to cover all frequencies, but it is far from impossible. Another fallacy is that the perfect diaphragm would be an infinitely rigid piston of no mass. I have shown (Audio Engineering, January, 1953, "The Great Loudspeaker Mystery") that if such a perfect diaphragm could be made, it could reproduce only one frequency at a time. Loudspeakers do reproduce many frequencies simultaneously, and it is obvious that they can do so only because the cone does not behave like an infinitely rigid piston; in other words, cones "break up." It is the designer's task to see that they break up in a controlled manner, so that the frequency response shall be as level and smooth as possible.

The high frequencies come from the apex zone of the diaphragm; the lows are generated by the cone moving as a whole. The bass reproduction is not affected by the breakup at high frequencies because the movement of breakup is so small that there is no output at other than high frequencies. For a given cone, the harder the material the better the treble response—a cone made of blotting paper would have no top response worth considering. This led to the widespread practice of doping the apex of the cone to make it harder.

On the other hand, for good response in the bass, the cone should move as a nearly rigid piston, since the amount of air to be moved at very low frequencies is considerable; it would therefore seem logical to make the cone material harder and stiffer for low-frequency reproduction, and such proves to be the case. A very stiff cone made of high-grade Bakelite-impregnated paper gives cleaner and more powerful bass than one made of molded pulp, the commonly

**Fig. 2.—Oscilloplan speaker circuit.**

**Fig. 3.—Front view shows nodes in a straight-sided conical diaphragm.**

**Fig. 4.—Diagram shows side view of nodes in an exponential diaphragm.**

**Fig. 5.—Low-frequency wave motion.**
used material. Molded cones are used because they are cheaper to produce and capable of being made within fairly close limits, but they are too soft for the best bass reproduction. If they are stiffened by being doped, to improve the bass, they will not break up in the desired manner, and the added weight of the dope will impair the treble response as well as the attack, since good transient reproduction depends not only on good frequency response but on low inertia of the moving cone—it must respond almost instantaneously to the kick of a transient wave. This point will be discussed again when I deal with multiple-unit speakers.

Apart from frequency response the diaphragm material affects the “color” of the reproduction. Some organ pipes and musical instruments are made of wood, others of brass or steel, or even silver. These materials are not used haphazardly. Wooden pipes and instruments have a tone color of their own and very distinct from that of metallic sound producers. A speaker is also a sound producer and the vibrating part will have its tone color associated with the material of which the cone is made; but a speaker is primarily a sound reproducer and should have no tone color. Metal diaphragms are therefore undesirable, even if they are strong for a given mass. Soft paper is nearly inert, but poor at both the low and the high ends of the frequency scale. If the paper is doped to improve the treble, it must be done in such a way that coloration is not introduced. This can be detected only by ear since it does not show up on a measured response curve.

The size of the diaphragm has an important bearing on the performance of the speaker, but the size is related to the freedom of suspension. For example, if one speaker is fitted with an 8-inch flat diaphragm and another with a 13-inch, for equal inputs the 8-inch cone will have to move about 2½ times as much as the 13-inch to produce the same acoustic output. This is of importance only for low frequencies since the 8-inch cone has a larger radiation area. Other things being equal, and provided a sufficiently free suspension avoids clipping of the input signal through nonlinearity of output, the size of the cone is no positive indication of bass reproduction capabilities.

But other things are not equal. I have shown that the diaphragm should be rigid for good bass reproduction, and a large cone is not so rigid as a small cone, for a given cone material. With a given mass the cone material is of great importance, but large cones are used to increase power-handling (since free suspension is a very tricky matter) at low frequencies. If the cone is rigid, its weight will spoil the response in the treble; if it is soft, the bass response will be impaired by nodding even before the limit of input power is reached. The node pattern is a function of the applied frequency and the phenomenon is not restricted to speaker cones; every suspended system develops nodes when an oscillating force is applied to it.

In a speaker diaphragm, which can be conical or exponential in section, nodes will cause loss of output at fundamental frequencies and introduce harmonic frequencies. If the power input is increased until the limit of movement has been reached, the proportions will be approximately one-twentieth of the fundamental, one-eighth of 2nd harmonic and the rest of 3rd. The strongest cone, for a given mass of material is one with an included angle of 90°, but such a narrow cone causes undue focusing of the highs. If the cone angle is widened to obtain good forward radiation, as is usual, the diaphragm will be weakened radially and nodes will show up in the form of a flower pattern when the cone is viewed from the front (Fig. 3). The exponential cone was developed to overcome this defect, but it is weak axially and the node pattern can be seen from the side (Fig. 4).

The large cone has a further defect. I have pointed out that cones must break up to reproduce more than one frequency simultaneously. This breakup occurs in concentric waves radiating from the center of the cone. Very short waves (high frequencies) will die out quickly; longer waves will continue to the edge of the cone (Fig. 5). Parts of the cone will be out of phase with other parts. In a large cone they may be 180° out of phase. Acoustic measurement with a sine-wave input will show irregularities in the response, but reproduction of music involves the reproduction of complex waves. Phase distortion therefore will be inevitable; the amplitude of the component frequencies may be reproduced approximately correctly, except for loss of output at the low frequencies (as explained above), but the lower frequencies will be out of phase with respect to the highs. It is impossible to lay down hard and fast rules concerning design, but in a general way it can be said that this sort of phase distortion is less with small diaphragms.

Attempts to control the cone breakup and remove the defects just described are seen in the use of concentric molded depressions or ridges in the cone. One cannot express any opinion on the value of this by comparing two different speakers, one with rings and one without, for other design features are also present. The only test is to have two identical speakers, one with a plain cone, the other with a ridged cone of the same weight, and make direct comparison measurements between the two under precisely similar test conditions. I have done this and found no noticeable difference in frequency response in the middle register and treble; but molding ridges into the outer zone of an exponential diaphragm increases axial rigidity, reduces the formation of nodes, and improves bass.

A favorite method of trying to overcome the conflicting requirements of treble and bass reproduction in a single diaphragm is to add a tweeter cone to the diaphragm voice-coil assembly (Fig. 6). This method was invented by Voigt in about 1934, and it is beyond argument that the Voigt twin cone had more treble output than a Voigt single cone. But the Voigt was a horn-loaded speaker of unusual electro-acoustic efficiency and required only 1 or 2 watts to produce a very sensitively a direct radiator but without success, although the treble response was improved. A direct radiator is not as efficient as a horn-loaded speaker, and application of 4 or 5 watts to the tweeter cone caused undesirable flutter, giving a tissue-paper effect to the reproduction. This could be overcome by cementing damping material to the free edge of the tweeter cone, but the added mass destroyed the treble output. Some manufacturers have tried to avoid this trouble by molding the small cone into an exponential shape, and it is partially successful, but the apex of an exponential cone is not even a cone but almost a parallel-sided tube, and focusing of the highs is very pronounced.

Other methods of modifying the main cone have been tried, but any departure from the main cone material will increase the mass and decrease the treble response; ideally the designer should try to reduce the mass at high frequencies. This can be done by a special design of voice coil.
what is OPTIMUM LOAD?

By NORMAN H. CROWHURST

EVERYBODY knows about loads, so we won’t start by explaining what a load is—yet. The word “optimum” means “best,” but it should be qualified. If someone asked you what is the best tube type on the market, you would need to know what he wanted it for: a low noise level input stage; a high-gain preamplifier stage; a driver stage; or a power-output stage—name just a few. The same thing is true about the plate load for any given tube. What do you want the plate load to do?

Probably the most common use of the term optimum load is in connection with output tubes, where we are interested in getting the maximum power output from a tube without exceeding its plate dissipation rating. In such a case, optimum means the load for giving maximum output without over-driving the tube. But it may not be as simple as that. What kind of output do you want? Square wave? Or something similar to the input wave? Or do you want it to have the lowest possible distortion while still giving close to its maximum output? Another application of output tubes is when a specific output power is required with a minimum of input grid swing. This can be called optimum load for maximum sensitivity. All these objectives cannot be obtained with the same optimum load value for the same tube.

Fig. 1—Equivalent battery circuit.

Leaving tubes behind for the moment, let’s assume we have a battery from which we want to operate a heating element. The element can be wound to whatever design and characteristics we want it for: a low noise level input stage; a high-gain preamplifier stage; a driver stage; or a power-output stage—to name just a few. The optimum resistance which accounts for the drop in terminal voltage when current is drawn from the battery. Fig. 1 shows this idea. Let’s put in some figures. Suppose the battery is a group of small cells giving 24 volts, and having an internal resistance of 12 ohms. The total resistance which determines the current, is the internal plus the external heater resistance. The voltage across the heater can be obtained by Ohm’s law and the wattage dissipated by the heater is terminal voltage times current. We can tabulate this for different values of heater resistance. (See wattage table.)

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<td>0.1</td>
<td>14.4</td>
<td>0.16</td>
</tr>
<tr>
<td>47</td>
<td>59</td>
<td>0.1</td>
<td>14.4</td>
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<tr>
<td>48</td>
<td>60</td>
<td>0.1</td>
<td>14.4</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Fig. 2—Varying the load resistance.

Fig. 3—A basic type output circuit, the particular case dealt with. The conditions should be emphasized: Audio signal level at the grid is well inside the maximum swing allowable for the grid bias used, and is restricted to this level; the output variation considered is the power in the plate load as plate load value is varied, using the fixed grid input.

If we wanted an output tube to provide its maximum gain in terms of power in the load, we should use an optimum load equal to the plate resistance of the tube. But gain is usually easy to obtain elsewhere. The more difficult thing with power tubes is to get a large audio output with reasonable plate dissipation. So we start at a different place. We assume that whatever grid swing is needed will be found somehow, although it will generally be advantageous to use a tube with a small grid-swing. The problem is to get the biggest possible swing in plate voltage and current at the same time, so the output watts are as high as possible, with little distortion.

Matters are complicated because tube characteristics have boundaries. We have assumed we were well enough within these boundaries so we could ignore their existence. But in each kind of tube there are at least three boundaries that have to be considered. Fig. 4 shows the case for triode types, and Fig. 5 for tetrode or pentode types. In each case dashed lines are used to show how the curves would go in theory if there were no boundaries at all.
The wattage-dissipation curve, a line of rated close to maximum conditions, is and for any tube when it is to be operated at some specific value of positive grid-voltage curve will determine this boundary. For pentode and tetrodes the zero grid curve applies as boundary above the knee, but in the vertical part it is advisable to set the boundary over, as the curves merge here, so that use of the zero grid curve would cause severe distortion.

The third boundary is the line representing zero plate current. Plate current does not normally go into reverse, and before it reaches zero there is a converging of the characteristics that will cause distortion, so the boundary should be set at some minimum value of plate current. This can be called the minimum plate-current boundary.

In addition to these three boundaries that apply every time, there is another that sometimes chips in, while in other cases the three regular boundaries take care of it automatically. This is: maximum permissible plate voltage.

For any given tube the optimum plate load is found by varying the slope of the load line (varying the plate-load resistance) until the product of plate voltage and plate current swings is a maximum. The slope of this line gives a value of optimum load. (Calculation procedures for determining the power output of tubes are given in the RCA Receiving Tube Manual, Technical Series E3T, pages 17 to 21.)

Load values for triodes are not usually too critical. A value two or three times greater than the rated optimum will not introduce distortion, but the power will be reduced somewhat. In triode output tubes the optimum load is several times the plate resistance—usually three times, and often five or more times. Further increase of plate load improves waveform slightly, increases output voltage swing slightly, but reduces output power, because the current swing is cut down more than the voltage swing is increased. Use of a plate load less than about three times the plate resistance results in distortion, unless the grid input swing is restricted, which limits the output.

For pentode and tetrode tubes, the term optimum load can have a stricter meaning. Working at a level a little below maximum output, variation of the load changes the nature of the distortion. In triodes, all the curvature is in the region of the minimum plate current boundary, which results in 2nd harmonic distortion. In tetrodes and pentodes, curvature is also introduced at the positive grid-swing boundary when the top end of the load line swings below the knee of the curves, representing load values higher than optimum. The higher order harmonics are introduced, and the amount of second harmonic depends on how the two sources of curvature balance one another. It is possible, by selection of load value, to eliminate 2nd harmonics altogether. An analysis of distortion from typical tetrode or pentode tubes is shown in Fig. 6. For some purposes the point where the 2nd harmonic disappears, or the total harmonic is a minimum, is considered the optimum load.

We have assumed that the object is to get the maximum output with minimum distortion. But as in audio work the maximum output is somewhat of an unused figure, reached at only fairly rare peaks, it can be said that distortion is more important at lower output levels. The exact curvature of the characteristic along any given load line follows a rather complicated law. The result can lead to the following kind of experience: Assume that plate load is made adjustable, so that it can be varied. With a harmonic analyzer connected to give minimum distortion at or near full output, turn the level down 10 or 20 db. Readjustment of the plate load will probably reduce distortion at this reduced level. Consequently it is probably better to choose a load value that gives minimum distortion at low levels, even though the distortion at maximum level may be up slightly.

In later articles we will consider frequently asked questions such as: Can feedback modify optimum load? What is optimum load for push-pull circuits? Just what does a cathode follower do and what does it not do?...
MAGNETIC-TYPE pickups are used in most high-quality audio systems today. To understand the equalizing circuits that must be used with them, we must treat groove-width vs output a little differently from the way we think when crystal or other constant-amplitude pickups are used.

Last month we showed how records are made when, as is always the case commercially, magnetic cutters are used to engrave the groove. Let us briefly refresh our memories with the aid of Fig. 1, a chart showing groove width against frequency for constant-voltage input to the recording cutter.

Pattern 1 shows what happens when an unequalized magnetic cutter is used. The groove becomes wider as frequency decreases and narrower as frequency increases. This is exactly offset by the equalizing circuit which produces more output for a given stylus movement as frequency rises and less output as frequency decreases. Since the two devices—cutter and pickup—are complementary, let us lump them together and consider only the transfer characteristic between the input of the cutter and the output of the pickup. If we do that, we find that the pickup output is exactly proportional to the voltage input to the cutter, regardless of frequency. Let us, furthermore, become parties to the convention common in the record industry that says, "The frequency characteristic of a record is always shown as if it were to be played back with an ideal unequalized magnetic pickup." Thus, regardless of the actual fact that with constant input to the cutter the groove width decreases with rising frequency, we show the frequency characteristic or curve of a record as simply the voltage input to the cutter (usually translated to decibels) against frequency.

If we make a record without equalization, then curve A of Fig. 2 will show the frequency characteristic. The flat line means that between 50 and 10,000 cycles the record follows the constant-velocity magnetic characteristic.

Now look at Fig. 1 again. With the constant-velocity cut of pattern 1, the low-frequency grooves are so large that the spiral would have to be very widely spaced. Not only would we get very little playing time, but the cutter would have to be built so that the cutting stylus could describe very wide swings, a great mechanical difficulty. So we insert an equalizer in the recording system which attenuates frequencies below a certain frequency (let us assume it is 500 cycles) at the rate of 6 db per octave. This means that by the time the audio signal reaches the cutter terminals, the voltage is directly proportional to frequency below 500 cycles.

With the magnetic cutter, the cutter itself makes a groove whose width is inversely proportional to frequency. With our equalizer in the circuit, the equalizer and the cutter's own characteristic exactly offset each other. The result is that the groove width remains constant below 500 cycles, as shown in pattern 2 of Fig. 1. With the groove width restricted, we can wind a much closer spiral.

But in adding this equalizer during recording we have made a change in the record frequency curve. Instead of curve A (Fig. 2) being flat throughout its low-frequency end, we have curve B, which shows attenuation of the low frequencies at the 6-db-per-octave rate. This means that an unequalized ideal magnetic pickup will play back the record with a gradual loss of bass. If we want the pickup to reproduce sound as it originally was before being changed by the recording equalizer, we must add an equalizer of exactly opposite or complementary effect to the playback system. The playback equalizer must have the low-frequency characteristic shown by curve C. It must give the playback system an output which rises with falling frequency below 500 cycles. It is exactly opposite in effect to the recording equalizer and cancels it out, producing once again the flat characteristic of curve A.

Referring again to Fig. 1, we see that in pattern 2 the high frequencies are still very small in groove width; so small, in fact, that the audio variations compare in size to the random variations caused by disc surface irregularities and dust particles which create noise. To make the audio signal greater than the noise, we insert a second "equalizer" in the recording equipment to boost the treble. The treble recording equalizer may have the characteristic of curve D in Fig. 2. But again, we have created a deviation from the ideal constant-velocity characteristic.

So, to offset the treble recording emphasis we must have a treble equalizer in the playback system. Again, it must have an effect exactly opposite to that of the recording equalizer. Its effect is shown by curve E. Since curves D and E are exactly complementary, they can-
had a perfect frequency characteristic loudspeaker of curve A. Moreover, we have the flat characteristics used by record manufacturers. Some start the equalization standards from time to time, so that an old record may have been equalized differently than a late record. By omitting all equalizers and using one we have inserted a bass equalizer to give more playing time and a treble equalization of the treble. To produce that effect, we have used the flat characteristics to match the various equalizing characteristics to the production is simple; in circuit A the resistor and capacitor constitute a voltage divider. While the resistor opposes all frequencies equally, the capacitor presents a greater impedance at low frequencies than at high. Therefore, if output is taken across the capacitor, the output voltage will increase as the frequency decreases. In circuit B the exact opposite is true.

Either equalizer can be estimated with very little calculation. For circuit A, output decreases at the rate of 6 db per octave above the frequency at which resistance and capacitive reactance are equal. For circuit B, output decreases at the rate of 6 db per octave above the frequency at which R and Xc are equal. In both cases, at the frequency of equal impedances (usually called the turnover or crossover frequency) the attenuation is 3 db, while the rate of attenuation does not reach the full 6 db per octave immediately, being rather a gradual increase of attenuation. The sharp changes of line in Fig. 2 are ideal curves only; actual characteristics of records are really curves.

Circuit A is useful for playback equalization of the treble. To produce the characteristic of curve E, for example, in Fig. 2, the circuit of Fig. 4 could be used. The diagram shows a two-stage preamplifier with equalizer R1-C2 between stages. The reactance of C2 equals the resistance of R1 at 1,500 cycles. From the frequency upward the voltage to the grid of V2 decreases at about 6 db per octave. C1 is a large-value blocking capacitor, while R2 is a grid resistor high enough to avoid affecting the impedance of C2. These equalizers can be cascaded, as shown in Fig. 5, when greater attenuation is required, but that is rarely necessary in record playback systems.

Fig. 6 shows a simple bass-boost circuit used in a G-E preamplifier. The voltage divider has R1 as the upper or series leg, with the combination of R2 and C1 as the shunt leg. At low frequencies the reactance of C1 is insignificant. But beginning at around 500 cycles, the reactance of C1 becomes large enough to be important (27,000 ohms at just below 600 cycles) and it begins to make the shunt leg as frequency increases. This equalizer never does reach the rate of 6 db per octave, but it comes close enough for general use. The playback equalizer characteristic must exactly complement the equalizers used in making the record. Only by using the right equalizers for both bass and treble can the loudspeaker produce sound with the same tonal balance as existed at the original microphones.

**Commercial units**

Magnetic pickups require some preamplification to bring the output up to the 0.5- to 2-volt level of a tuner so that it can be switched to the input of the main power amplifier. Most preamplifiers include bass equalization adjusted to a crossover frequency somewhere between 500 and 1,000 cycles.

An example of the better standard preamplifiers is the Pickering type 230H shown in Fig. 7 and diagrammed in Fig. 8. This preamplifier has enough gain to give nominal records an average output of from 1 to 2 volts with the Pickering pickup. R1 is chosen to terminate the Pickering pickup but can be changed to suit many other pickups. Bass equalization so the treble equalizer is shown within a dashed box. Two sections similar to that of Fig. 6 are used to get excellent equalization, down to a satisfactorily low frequency. It is important to determine before buying a preamplifier (or an amplifier with built-in preamplifier) that its bass equalization gives the full 6-db-per-octave rise, for some do not.

Few preamplifiers contain any but bass equalization so the treble equalizer must be provided for elsewhere, unless, as in the case of some pickups, a satisfactory treble rolloff can be provided by terminating the pickup in a certain resistance. A unit such as the Pickering type 132E record compensator is suitable for this purpose. The pickup cable is plugged unto a jack on the side of the compensator (see Fig. 9) and a cable from the compensator goes to the preamplifier. Six switch positions provide for six different treble characteristics to match various records.

Records cannot be equalized successfully with the tone controls found on some amplifiers. These tone controls (which many people, including the writer, believe ought not to exist) are—thereapeutically—to compensate for room characteristics, but are actually for people who like to fiddle with controls. Ordinary living rooms are sufficiently dead acoustically not to add anything undesirable to the sound coming from a good speaker system. On the other hand, the controls cause an uncomfortable feeling because the listener never can...
decide whether he has the right setting, which, in fact does not exist. The only legitimate function of a tone control might be to add some bass at low volume settings; but again it is impossible to do the job right with continuously variable controls.

Several manufacturers offer preamplifier-equalizers which include a variety of bass and treble equalizer combinations for obtaining correct compensation for all kinds of records. Such a system is the Brociner unit pictured in Fig. 10. The Pickering type 410 audio input system shown in Fig. 11 is more complete in that it also includes switching for various inputs—record, tuner, etc.—as well as three variable record equalizers and a volume and power control.

The Childs preamplifier-control unit (Fig. 12) is an especially interesting device of this type. It has high- and low-frequency equalizers giving 20 different calibrated equalization curves to match any of the various recording characteristics now in use (AES, Columbia, London ffrr, etc.), a four-position input selector, and a power switch and pilot for the main amplifier.

The Childs unit is shown in the circuit diagram of Fig. 13. Both high- and low-frequency equalization is controlled by negative feedback loops with frequency-selective transfer characteristics. The feedback loop is between the plate of the second stage and the cathode of the first. Bass boost is brought about by passing the feedback signal through a 1.8-megohm resistor in parallel with one of five selectable capacitors. The combination is in series with a 51,000-ohm resistor. The capacitor and the 1.8-megohm resistor have equal impedance at a frequency just below the desired audio range; therefore the capacitance, whose reactance becomes smaller as frequency rises, causes more feedback signal transfer with rising frequency until the turnover frequency, at which it is equal to the resistance of the 51,000-ohm resistor, and at which time response flattens off. Since the feedback loop is negative, the preamplifier as a whole gives a complementary curve, which is precisely the desired 6-db-per-octave bass rise with selectable turnovers.

The 51,000-ohm resistor is paralleled by one of four capacitors selected by the high-frequency rolloff switch, giving a rising characteristic above a selected turnover frequency. This becomes a rolloff, again with precisely calibrated characteristics. In addition to precise equalization, the negative feedback, even at frequencies where it is lowest, is sufficient to give the usual feedback advantages of improved linearity and signal-to-noise ratio. The loudness control is a 17-point switch with R-C networks to add the bass compensation required by the ear at low volumes.

Having discussed the primary source of sound in high-quality systems—records and pickups—we shall inquire next month into the other main source, the radio tuner.

(TO BE CONTINUED)
In the servicing of high-fidelity equipment, circuits are tested to an extent almost unthinkable in conventional audio amplifiers. Typical of this testing is that for unbalance in push-pull stages. The low distortion in high-fidelity amplifiers is in considerable part due to the use of distortion-canceling properties of push-pull driver and output stages of amplifiers. The distortion cancellation depends on maintaining balance. The circuit of a typical high-quality audio amplifier is shown in Fig. 1.

Output stages should be balanced to 1 or 2%. R-C-coupled voltage amplifier, driver, and phase-inverting stages, should be balanced to at least 5%. To check the d.c. balance, connect a high-resistance d.c. voltmeter from plate to plate of the push-pull stage. A completely balanced stage will show zero voltage. Many high-fidelity amplifiers have provision for balancing the output stage with an adjustable resistor in the cathode circuit. Adjust this resistor until the plate to plate voltage is as close to zero as possible.

If the unbalance is considerable, or if balance can be obtained only by a marked difference in bias voltages, both the tubes and the circuit components should be checked. The plate loads and d.c. resistances on the two sides must be as nearly identical as possible. Good output transformers provide loads equal to 1 or 2%.

Plate-load resistors in voltage amplifying stages and phase inverters (Rc), should also be matched to 1 or 2% but seldom are, except in the highest-quality amplifiers. However, if measurement shows that the difference is much greater than 5%, one resistor should be replaced. Choose one whose resistance is equal within 1 or 2% to that load resistor which comes closest to the specified value, and when wiring, not to overheat the resistor; this may very easily change its value permanently.

If the two sides of the stage use different cathode resistors (Rc), check these for balance also and replace if one is more than 5% higher or lower than the other. Except in the case of output-power stages, grid resistors Rg are not critical. However, they should match at least to 10%; and in output stages which may draw grid current, it is important to preserve balance in the grid resistors.

An open-coupling capacitor C, can produce serious unbalance, and can be spotted with the headphones. If the phones show a much stronger signal on one grid than the other, check and replace the capacitor.

If the resistance of one capacitor is considerably higher than that of the other, there will be unbalance at low frequencies and harmonic distortion may not be completely canceled out. The harmonic distortion of bass tones is not in itself as noticeable or annoying as distortion at higher frequencies. However, it leads to increased inter-modulation distortion. The situation is aggravated because in most high-fidelity installations there is considerable boosting of the low frequencies in the preamplifier or control unit; therefore, succeeding stages are driven harder and produce more distortion not only within the low-frequency range but also in the mid- and high-frequency ranges.

To check capacitors for balance or to match them, feed a 60- to 100-cycle tone into the amplifier. If no audio generator is available, use the 6-volt filament circuit. Connect a meter capable of reading such a low frequency between one of the grids and ground. Adjust the input volume control to obtain a reading of 1 or 2 volts. Transfer the meter to the opposite grid without changing the volume level. The meter should give nearly identical readings at both grids. (We are assuming that the previous stage is delivering equal signals to both sides. This can be checked by measuring the voltage on the plate side of the capacitor. We also assume that the grid resistors are fairly closely matched.)

If there is more than one push-pull stage, measurements should start from the output one, to check balance all along the line.

When a push-pull stage uses a common cathode resistor, the resistor should be by-passed by a high capacitance, otherwise there will be feedback in phase to increase by addition or even multiplication. Always check this bypass capacitor. If its d.c. resistance is too low, it should be replaced because the low resistance in parallel with that of the cathode resistor will reduce the bias voltage. This can be checked by measuring bias voltage with the capacitor connected and disconnected.

Positive feedback, parasitic oscillation, or improper operation of feedback network?

High fidelity amplifiers invariably use from 12 to 30 decibels of inverse feedback through one or more loops. Serious distortion may result if the feedback loop operates improperly. Under certain circumstances the feedback can turn positive and result in parasitic oscillation. This oscillation may occur at super-sonic frequencies. There are two simple checks for such inaudible oscillations. Turn on a broadcast-band radio and tune it slowly. If the amplifier is oscillating at frequencies above 20kc, harmonics will beat with the stations in the radio receiver. If the beat disappears when the amplifier is turned off, the amplifier is generating parasitics. Another way is to break the B plus lead to the output transformer and insert a milliammeter. Momentarily disconnect the feedback loop; if the plate current drops, you can be sure that parasitic oscillation is taking place.

Commercial amplifiers are designed to prevent parasitic oscillation. If it occurs after a period of use, a component failure or deterioration can be safely assumed. First, change the tubes. Tetrodes used as triodes usually have 1000-ohm series resistors in the grid and plate circuits; check to see if these are O.K. Check the value of the series-feedback resistor Rg and the
Distortion can also be produced in the heater winding of a power transformer or the main amplifier. Also check their location. If located too close to a phonograph or to the power transformer on an adjacent chassis, they may be within the magnetic field and picking up hum this way. Check the grounding of the plugs of connecting cables. Frequent removal and reinsertion may have loosened contact between plug and jack, or dirt may have increased the resistance of the grounding contacts. Interconnecting cables may be too close to power transformers, phono motors, etc. If the main amplifier, control unit, tuners, etc., have separate power supplies, try reversing the a.c. plugs. Hum is easily traced by removing the tubes in the string one by one, starting with the preamp and working toward the speakers. It should be possible with good equipment to limit the hum to a level so low that it is audible only very close to the speakers under no-signal conditions and with bass controls flat.

Adjustment of hi-fi equipment
When a repair is made correcting the immediate defect, always adjust the equipment for peak operation. This is not difficult even without instruments. Follow these steps:
1. Check all tubes.
2. Check operating voltages and replace filter capacitors if they show deterioration.
3. Check the balance of the output stage.
4. If the unit has a hum-canceling control (see Fig. 1), adjust it for minimum hum.
5. Check the interconnecting cables for good contacts, especially for low-resistance grounds.
6. Check the various tuners, record players, etc. Tuners may need realignment. Phono needles may need replacement. Record changers may need new drive wheels or adjustment for proper cycling.

(RADIO-ELECTRONICS March, 1953.)
ULTRA HIGH GAIN

FOR conventional circuits, a gain of about 250 for a resistance-coupled pentode stage is usually the maximum obtainable. Transformer coupling will give more gain, but at the cost of increasing price, volume and weight.

But there is a way of achieving extremely high gain with only a few inexpensive, conventional components.

The method was described in a paper entitled "Ultra-High-Gain Direct-Coupled Amplifier Circuits" by Dr. Walter K. Volkers, and read before the 1950 IRE National Convention in New York. He stated that by lowering the screen voltage of pentodes below 10% of their plate supply voltage, and by increasing the resistance of their plate load 10 or more times beyond conventional values, the amplification factor of tubes so "starved" is greatly increased in spite of a decrease in mutual transconductance.

Following this principle, I built a two-tube amplifier using only five resistors, two capacitors, and an output transformer.

This amplifier delivers 0.1 watt output with an input of 2 millivolts, a power gain of about 22 db.

The circuit uses a 6AU6 "starved" pentode with a gain of about 750, direct coupled to a 6V6 power amplifier. Direct coupling is important, for only by working into the practically infinite input resistance of a negatively biased stage can the extremely high gain of the first stage be retained. The plate supply delivers 26 ma at 200 volts.

As we have all found out, one cannot get something for nothing. To get high gain, frequency response must be sacrificed. This circuit is therefore not recommended as a preamplifier for variable-reluctance pickups or other high-fidelity uses. However, there are many occasions where a 3-db response from about 180 to 2,500 c.p.s. is sufficient and even desirable. Possible uses: a very sensitive and compact signal tracer; a sensitive null detector for audio frequency impedance bridges; a lower-power modulator for communications equipment, or a general-purpose crystal mike amplifier. Used as a mike amplifier with an inexpensive crystal microphone, I obtained a very clear output at so-called "room level" when I whispered at the mike from a distance of about five feet.

To get more output, a higher plate-supply voltage is necessary. This will require some experiment to determine the proper values of load and cathode resistance for the 6V6. A 0.1-megohm volume control may be substituted for the 0.1-megohm grid resistor of the first stage.

When first constructed, the amplifier had a large amount of hum. This was almost entirely eliminated by connecting the center-tap of the filament transformer to the screen of the 6AU6, thus biasing the filament at about plus 3 volts with respect to ground.

MARCH, 1954
REMOTE controls for TV sets seem to come and go in cycles of two to three years. A number of 1951 TV sets were designed with remote viewers. Several others were available with electromechanical accessories which could be added to turn the set on and off, select channels, and adjust volume and contrast from a remote point. (See "Remote Controls for TV Promote Viewer Comfort" in the November, 1951, issue.) Now, after nearly two years during which there was no noticeable activity in this field, remote controls for TV sets are booming again. A number of manufacturers are including at least one remote-control TV receiver in their 1954 lines. Design features of these will be covered in an early issue. Gonset and Regency have recently introduced remote-control TV tuners which can be used in modernizing sets which do not include this feature.

The Gonset and Regency remote-control tuners permit full control over tuning, volume, and contrast from a remote point. The Standard Coil cascode tuner, used in both units, often provides enough gain to eliminate the booster required with some sets in fringe areas. The removable channel strips permit u.h.f. strips to be installed, making a converter unnecessary in areas where the total number of v.h.f. and u.h.f. stations does not exceed 12. The remote-control units have built-in transformer type power supplies and are available for sets with 21- or 40-mc i.f. amplifier systems. Power to the TV receiver is controlled through a receptacle across the power primary on the remote-control unit.

The Gonset unit is designed to replace the tuner in the receiver. Its installation is simple; it can be connected to most sets without removing the chassis from the cabinet. Added features are a headphone jack and a switch for muting the speaker. When the unit is attached to the TV set, the original tuner is deactivated, so all tuning operations must be made at the remote unit.

The Gonset remote control

The circuit of the Gonset remote-control unit is shown in Fig. 1. The antenna is connected to the control unit. The signal is amplified and heterodyned to the intermediate frequency in conventional manner. The 21- or 40-mc i.f. output of the 6J6 mixer is capacitance-coupled to the grid of a 6AB4 cathode follower. A 5,000-ohm potentiometer controls the signal fed into the grid, thus controlling the contrast. The output of the cathode follower is fed to the receiver through a shielded cable. This cable terminates in an i.f. coupling transformer. The secondary leads of the transformer are fitted with pins which fit into pin jacks of a miniature button-base tube socket.

When installing the unit, all tubes are removed from the original tuner and the transformer secondary leads are plugged into the plate and cathode pin jacks on the mixer-tube socket. In a few tuners, the mixer cathode is hot (above ground for r.f.), and better results can be had by connecting the yellow transformer lead directly to ground. If one side of the heater line

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Fig. 1—Schematic diagram of the Gonset remote-control model 3050 (21 mc i.f.).
is grounded, the yellow transformer lead can be plugged directly into the grounded heater terminal on the mixer socket.

Both leads of the i.f. coupling transformer have series-blocking capacitors which eliminate the possibility of short-circuits when connecting to some types of tuners.

Volume is controlled at the remote point by a 10-ohm potentiometer that is connected in series with the speaker voice coil through the speaker muting switch and a 2-wire line enclosed in a cable with the shielded lead carrying the i.f. signal. Headphones can be plugged into tip jacks across the remote volume control, and the speaker may be silenced by opening the muting switch. The switch can be used also to open the speaker circuit during commercials or when answering the telephone. High-impedance magnetic phones provide sufficient volume for persons with normal hearing. Low-impedance phones of about 600 ohms are recommended for hard-of-hearing persons.

In some instances, a strong signal may overload the tuner and make it impossible to reduce contrast sufficiently to obtain a normal picture. In such cases, the manufacturer recommends that a 1,200-ohm, ¼- or ½-watt resistor be soldered across the two outside terminals on the r.f. strip for the channel that overloads.

The Regency RT-700

The Regency model RT-700 remote TV tuner in Fig. 2 illustrates entirely different solutions to the problem of controlling volume and contrast from a remote point. The i.f. signal, contrast, and volume control voltages are all carried by a single length of RG-122/U coaxial cable between the tuner and receiver chassis. The coaxial line terminates in a potted matching unit (M6 on the diagram) and coupling and decoupling networks to the audio and a.g.c. circuits.

The potted terminating unit is mounted on the chassis close to the first i.f. amplifier socket. The i.f. grid lead connects to the grid pin of the first i.f. amplifier and the i.f. grid return goes to the ground point for the first i.f. stage.

Contrast-control circuits

Contrast is controlled from the remote tuner by supplying a variable d.c. bias voltage to the a.g.c. line in the set where the a.g.c. voltage is obtained by rectification of the video signal. When the set uses keyed or amplified a.g.c., the contrast control bias is applied to the grid of the a.g.c. keyer or amplifier tube. Two auxiliary controls are provided in the RT-730 for ease of operation of the contrast-control circuit. Approximately 50 to 60 volts of bias is developed across the series-connected 150- and 47-ohm resistors in the negative leg of the B plus supply. When the switch is set to LOCAL, full bias is applied to the cascode amplifier to prevent overloading by strong signals. Throwing the switch to DISTANT reduces the grid bias to the point where the tuner operates with maximum gain and lowest noise.

Fig. 3 shows how the contrast control is connected to receivers with simple rectified a.g.c. The circuit in Fig. 3-a is used when the a.g.c. filter resistor in the receiver is 1 megohm or higher. When the filter resistor is less than 1 megohm, the a.g.c. line must be cut and the 470,000-ohm resistor R18 spliced across the break as in Fig. 3-b.
The bias supply circuit delivers a negative voltage to the contrast control. The voltage at the arm of the control is applied to the a.g.c. line through the inner conductor of the coaxial line. The positive side of the bias supply connects to the receiver chassis through the outer conductor.

Fig. 4 illustrates the contrast-control connections for receivers using amplified a.g.c. In this circuit, the a.g.c. amplifier plate is grounded through the a.g.c. load resistor, and its cathode is supplied from a point on a B minus voltage divider. The contrast-return line must then be connected to B minus (not ground). This B minus point must be bypassed to ground by 10 μf or more. In keyed a.g.c. circuits, the contrast-controlling bias voltage is applied to the control grid of the a.g.c. keyer as in Fig. 5. The contrast-return (black) lead is shown connected to the cathode of the a.g.c. keyer. If there is a point in the receiver B plus circuit that is 10 to 20 volts less positive than the a.g.c. keyer cathode, connect the contrast-return line to it and bypass it to ground with at least 10 μf. If this B plus tap is not adequately bypassed, sync buzz is likely to occur and it may be impossible to exercise full control over the volume at the remote tuner.

Keyed a.g.c. circuits require a positive voltage from the bias supply in the tuner. This is obtained by transferring the white lead to the opposite end of the bias adjustment control.

**Remote volume control**

The volume control in the RT-700 uses a resistance-capacitance voltage divider circuit as in Fig. 6. The audio lead from the sound detector is broken just ahead of the volume control, and two series-connected .02-μf capacitors (C30 on the diagram) are inserted. The inner conductor of the coaxial cable is connected to the junction of the two capacitors. At the remote-control unit, the shielded conductor is connected to a 250,000-ohm volume control. The arm of the control is grounded through a 1-μf capacitor.

A basic circuit of the volume-control voltage divider is shown in Fig. 7. X.1 and X.2 are reactances of the left-hand .02-μf capacitor and the 1-μf unit, respectively. Moving the arm of the control varies the resistance in the lower leg of the voltage divider and controls the proportion of the total developed voltage that is applied to the input of the audio amplifier. The r.f. choke L1 (Fig. 2) isolates the i.f. signal from the remote volume control and prevents the i.f. signal level from varying with the setting of the volume control.

**Installation and adjustment**

To make the initial adjustments on the RT-700, set the local-distance switch to DISTANT, turn the remote contrast control to the minimum position, and set the receiver's contrast control to maximum. Set the remote channel selector to the strongest TV channel in the area and rotate the tuner on the set to another channel. Set the bias adjustment control R2 for a weak picture with good sync stability. If stable sync cannot be obtained, throw the area switch to LOCAL and reset the bias adjustment control and back down on the set's contrast control until the remote contrast control operates properly. When using the remote-control tuner, the receiver's contrast control should be returned to the position used in the initial adjustments.

The volume-control circuit is set up with the remote control set to the maximum position and the receiver's volume control set slightly higher than normal. The remote-control adjustment control is adjusted to bring the volume level to be varied from the preset maximum to a barely perceptible minimum.

The receiver can be operated with its built-in controls by moving the line plug from the rear of the remote-control tuner and plugging it into an a.c. receptacle and setting the remote volume control to maximum.
TESTING VIDEO AMPLIFIERS

Obtaining frequency response curves for the video amplifier requires careful selection and use of generator and probe.

By Engineering Department, Scala Radio Co.

The most common check of video-amplifier response is through use of a frequency-response curve. This method is undoubtedly best for preliminary checking, as major defects in circuit operation can be seen by a frequency-response curve.

However, the experienced technician finds that the phase characteristic of a video amplifier is even more important than its frequency characteristic. And although the phase characteristic can be approximately determined from an analysis of the frequency-response curve, few technicians have the desire to perform such an analysis. It is more practical to check phase characteristics in a more direct manner, by making a square-wave check of the amplifier.

Obviously the equipment used for such tests must have a better response than the video amplifier to be tested. This rules out much of the run-of-the-mill test equipment.

Test setups for video amplifiers must meet rigid requirements concerning input and output impedances. Unless the video amplifier sees a suitable source resistance, and unless the amplifier works into a suitable capacitance, the test results may be misleading.

The output from the video sweep oscillator should be flat, as shown in Fig. 1. Unevenness will produce distortion of the response curve. For example, when the output level varies over the swept band as shown in Fig. 2, the middle portion of the reproduced response curve will appear to be abnormally high. The curvature in Fig. 2 indicates crystal probe resonance, or improper operation of sweep generator. Some crystal probes resonate at the high harmonic frequencies present in the output of some sweep generators. In the course of circuit adjustment, the technician would misadjust the circuit in order to compensate for the unevenness in the instrument output.

The output from the video sweep oscillator should also be free from strong interfering impulses and harmonics which can develop confusing markers on the response curve. The small markers seen in Figs. 1 and 2 are such markers. As the desired markers are tuned along the curve, the undesired markers may run either forward or backward. In most cases, unwanted markers, if present, are distinguishable from desired markers upon the basis of size because the unwanted markers are usually the result of cross beats, interharmonic beats, or both which do not involve fundamental or beat-fundamental voltages.

Most video sweep generators can be tuned to sweep through zero beat, and to develop a video response curve on either side of zero beat. The output on either side of zero beat should be flat. However, there is some lower frequency, as the beat oscillators approach each other, at which pulling takes place, with the frequency of one oscillator pulling ahead to take the same frequency as the other oscillator, and the frequency of the second oscillator pulling back to take the same frequency as the first oscillator. This pulling action makes the video output meaningless at frequencies below 100 kc, even in instruments having good buffer action between the two beating oscillators. The typical output from a video sweep oscillator when sweeping through zero beat is shown in Fig. 3. (A shows a sweep 5 mc to either side of zero frequency; B shows a sweep through zero frequency, with the sweep width reduced to a few kilocycles; C shows a sweep through zero frequency, with the zero-frequency point moved to the right-hand end of the zero-volt reference line.) Commercial instruments eliminate pulling of the beating oscillator by adequate buffering between the two beat oscillators, and elimination of stray coupling.

The horizontal linearity of a video sweep oscillator can be checked by placing markers upon the swept output. As
in i.f. alignment, horizontal nonlinearity does not harm the accuracy of the alignment as long as the technician determines his frequency points along the response curve with markers.

To become familiar with the types of correct video response curves found in present-day TV receivers, the reader should refer to receiver service manuals. The video response curve should be essentially flat, with a slight amount of high video peaking. Such a video response curve, adjusted for a bandwidth of 4 mc, provides maximum picture quality. Some receiver manufacturers believe that a video-response curve should not always be flat, but may be more acceptable if there is a substantial amount of high video peaking. Some receivers provide a picture control or similarly named device which varies the amount of damping resistance across a series peaking coil, or varies the amount of bypass capacitance shunted across a video-amplifier cathode resistor. Such devices permit the viewer to vary the video-response curve.

In some receivers, the control for high video peaking is automatic, and operates with the contrast control, as shown in Fig. 4. The compensated contrast-control circuit is located in the output of the video amplifier. It can maintain a constant video-response curve as the picture contrast varies, or it can select any desired amount of high video peaking at low contrast levels. Without such compensating circuits, the high-frequency end of the video-response curve falls off as the signal-output level is reduced. The amount of high video peaking which appears on the response curve is determined by the internal resistance of the video detector. This resistance is nonlinear, as shown in Fig. 5. This is the internal resistance of the diode only, and is not the resistance presented to the driving i.f. circuit. The internal resistance of the detector tube varies from one tube to another. For this reason, changing the video detector-tube often serves to greatly improve the quality of the picture.

To obtain video-response curves, a crystal probe at the output of the video amplifier should be used. The probe should have the same input capacitance as the grid of a picture tube, so that the video amplifier is normally loaded. Excessively high input capacitance to the probe will cause the high-frequency response of the video amplifier to fall off. On the other hand, excessively low input capacitance may increase the high-frequency response. The probe used must rectify video sweep frequencies from 100 kc to 4.5 mc, and pass the envelope frequencies of the sweep output. The envelope of the sweep output may be considered as a 60-cycle square wave. In other words, the probe must demodulate the carrier component of the modulated wave (sweep output), but must develop the 60-cycle square-wave modulation envelope on the scope screen without appreciable distortion. A typical demodulator probe suitable for this application is shown in Fig. 6.

The crystal diode type used for video-sweep demodulation may be a matter of concern, as a relatively high peak voltages may be encountered during video-amplifier testing. The normal output from a video amplifier is approximately 50 volts peak-to-peak. But when the amplifier is overloaded, as it frequently is, 75 to 100 volts peak-to-peak can be developed. In such a case, crystal diodes of the least rugged type will become damaged. However, there are several types that are quite rugged. See Chart.

The crystal diode in the probe must be able to withstand double the applied peak voltage of the signal. Of course, this is true only of symmetrical waveforms, such as sine waves and square waves. For nonsinusoidal signal voltages, the crystal diode may have to withstand nearly double the peak voltage, more or less.

The manner in which these considerations tie in with commercially available crystal diodes is shown in the chart. The continuous reverse working voltage is not applied to the crystal in normal testing, but the peak back voltage may be taken as the peak-to-peak output voltage from the video amplifier when the crystal diode is used in a standard crystal probe. Most of the types in the chart may be used without extra precaution, although there are a few types that could be damaged by the high temporary transients which are often found when connecting the equipment. Crystal diodes used with video detectors have become damaged by high peak surges caused by sweep leads being dressed too close to the detector leads. Fig. 7 shows that the back current of the crystal diode increases at a rapid rate in the region of maximum back voltage. Detailed test arrangements and procedures on what has been discussed will appear in a future article.

High on the list of important considerations is the subject of square-wave response of video amplifiers. A square-wave check of video-amplifier response is especially useful, because the phase characteristic of the amplifier is given directly, as well as the frequency response. The phase characteristic is important, because nonlinear phase shift (unequal time delay at various frequencies) causes the reproduced square wave to tilt, which may show up in the picture as smear, or as...
**TELEVISION**

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<th>TYPE</th>
<th>1N34</th>
<th>1N35*</th>
<th>1N38</th>
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<td>High Back Resistance Diode</td>
<td>150-Volt Diode</td>
<td>High Conduction Diode</td>
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<td>12.75 (@1.5 volts)</td>
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</table>

*Units are matched in the forward direction at $+1$ volt so that the current flowing through the higher resistance unit is within 10% of that in the lower resistance unit. Ratings shown for each diode.

**Consist of 4 specially selected and matched germanium diodes whose resistances are balanced within ±2.5% in the forward direction at 1.5 volts. For additional balance, the forward resistances of each pair of varistor crystals are matched within 3 ohms. Ratings shown for each diode.

—Courtesy Sylvania Electric

Chart 1—Voltage and current ratings for crystal diodes used in typical oscilloscope probes.

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**MARCH, 1954**

**TELEVISION**

a false change in picture shading from the top to the bottom of the raster.

The elements of picture (video) signals are essentially square waves of various frequencies. Typical distortions suffered by square waves in passing through defective video-amplifier circuits consist of tilt, curvature, overshoot, and ringing. These distortions, of course, are in addition to attenuation of the amplitude of the square wave due to poor amplifier gain at the test frequency. Tilt occurs when the top of the square wave is not level, but slopes uphill or downhill. Such tilt is the result of phase shift. There is always some phase shift when a signal passes through an amplifier, but the phase shift should be proportional to frequency. Curvature in the reproduced square wave is caused by frequency distortion or frequency discrimination. Curvature may show up along the entire top of the reproduced square wave, or only at the corners of the wave. All four corners of the wave may be affected, or diagonal corners only may be rounded. When the peaking coils are underdamped, the leading edge of the wave overshoots its final voltage. If underdamping is severe, a ringing follows the initial overshoot.

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**Fig. 6**—Photo shows crystal probe.

**Fig. 7**—Voltage-current relationships of three germanium crystal diodes.
In Part II we discussed the ways bandwidth requirements of the color television signal can be reduced.

It was pointed out that the brightness and color information can be separated and handled as individual signals, making it possible for black-and-white receivers to operate using the brightness (Y) signal. We also covered briefly the problem of transmitting the relatively narrow bandwidth color-difference signals within the 6-mc channel occupied by the brightness signal.

To transmit the color information within the same channel as the brightness signal, several new techniques are used.

**The color subcarrier**

In the previous article, it was shown that in addition to the brightness (Y) signal, two color-difference signals are needed to produce the color picture. The third color component (green) does not have to be transmitted separately, since it can be obtained at the receiver by adding the two color signals and subtracting their sum from the brightness signal. Due to the characteristics of the average eye, only those video frequencies up to approximately 1.5 mc are needed for the red color-difference signal, and only frequencies up to approximately 0.6 mc are needed for the blue color-difference signal.

Let us assume that we wish to transmit only one of our color-difference signals along with the brightness signal, and that the color signal is the blue one (B-Y).

If we modulate the video r.f. carrier simultaneously with the brightness and blue color-difference signals, there will be crosstalk between the two signals.

The blue color-difference signal consists of frequencies between 0 and 600 kc, and the cross-talk will occur primarily at these frequencies. Since these frequency components represent the relatively large areas of the picture, the visible interference will be coarse and objectionable.

This problem can be minimized by shifting the blue color signal to the region around 3.6 mc. Cross-talk between the brightness and color signals will still be present, however, since the interference is taking place at much higher video frequencies, representing extremely small areas of the picture, the interference pattern will be fine in structure and much less noticeable to the viewer.

We see therefore that it is desirable to shift the color signal to the higher frequency components above approximately 600 kc. The output of this low-pass filter is applied to a circuit called a balanced modulator.

At the same time, a locally generated signal, or subcarrier, of approximately 3.6 mc is fed to the input of the balanced modulator. In this stage, the 3.6-mc subcarrier signal is modulated by the color-difference signal.

In the output of the balanced modulator, only the sidebands produced by the color-difference signal appear while the subcarrier is eliminated or suppressed.

The output of the balanced modulator is fed to a mixing amplifier along with the brightness signal as shown in Fig. 1. The output of the mixing amplifier—which consists of both the brightness and color signals combined—is then used to modulate the transmitter.

Fig. 2 shows the frequency relationship of the color-difference signal to the brightness signal in the transmitter output. The narrow-bandwidth (0 to 600-ke) color-difference signal has now been shifted to the region around 3.6 mc. Upper and lower sidebands extending

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**Part III—Transmitting the color subcarrier; detecting and separating the color difference signal**

By D. Newman* and J. J. Roche*

The blue color-difference signal is first fed to a low-pass filter which removes all frequency components above approximately 600 kc. The output of this low-pass filter is applied to a circuit called a balanced modulator.

At the same time, a locally generated signal, or subcarrier, of approximately 3.6 mc is fed to the input of the balanced modulator. In this stage, the 3.6-mc subcarrier signal is modulated by the color-difference signal.

In the output of the balanced modulator, only the sidebands produced by the color-difference signal appear while the subcarrier is eliminated or suppressed.

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*Allen B. DuMont Laboratories, Inc.
from 3 to 4.2 mc are present, having been generated in the balanced modulator circuit. We have now produced and transmitted a combined brightness and color signal within a 6-mc channel. At the receiver, we must separate these signals.

**Separating the signals**

Fig. 3-a is a block diagram of the video channel of an ordinary black-and-white television receiver. The composite brightness and color signal is fed to the video detector, and its modulation envelope is obtained in the usual manner. The output of the video detector is fed through regular video amplifiers in the cathode-ray tube to produce a black-and-white picture.

Of course, the color signal is still superimposed on the high-frequency portion of the detected video signal, but as we have seen previously, the interference pattern will be very fine and not too objectionable. Later we will see how the visibility of this interference pattern is further reduced.

Fig. 3-b shows a similar receiver with several circuits added to separate and detect the color signal.

The composite video signal (consisting of both color and brightness information) at the output of the video detector, is applied to a bandpass filter which passes only frequencies between 3 and 4.2 mc. Most of the brightness signal is eliminated in this process.

The color (chrominance) signal is then fed to a special type detector, called a synchronous detector. In this circuit, the chrominance signal is combined with a locally generated signal of exactly the same frequency and phase as the original subcarrier frequency used at the transmitter, as will be explained later.

**Two color-difference signals**

Up to this point, we have assumed for purposes of explanation that there was only one color-difference signal to be transmitted and received. The signal we used in the explanation was the color-difference signal whose bandwidth extends from 0 to approximately 600 kc (signal 1 in Fig. 1).

Actually we must also transmit another color-difference signal, whose bandwidth extends from 0 to approximately 1.5 mc (as was explained in the previous article). This is signal 2 of Fig. 1.

We have learned that it is possible to insert the narrow-band color-difference signal in the same channel as the brightness signal, and recover each separately at the receiver. The problem now is to insert a third signal (the wide-band color-difference signal) as well.

This is done by using two separate subcarriers at the transmitter instead of one. These subcarriers are *identical in frequency but 90° out of phase with one another.* The two subcarriers are obtained as shown in the block diagram of Fig. 1.

Subcarrier 1 is obtained from the 3.6-mc local oscillator. Subcarrier 2 is obtained by passing the output of the same oscillator through a 90° phase-shifting network.

Subcarrier 1 is modulated by one of the color-difference signals in a balanced modulator. Subcarrier 2 is modulated by the other color-difference signal in a second balanced modulator. The outputs of the balanced modulators are passed through filters to remove undesired frequency components.

The filter outputs are then combined with the brightness signal in a mixer amplifier and fed to the transmitter. In passing through the low-pass filters, the color-difference signals are delayed, due to the phase shift which takes place in the filters. The narrow-band color-difference signal is delayed more than the wide-band color-difference signal, because of the differences in filter characteristics. To equalize the delays of the three signals (brightness and two color-difference signals), additional delay is provided in the brightness and wide-band-color channels.

Fig. 5 shows the vector relationships of the unmodulated and modulated subcarrier signals. Fig. 5-a shows the unmodulated subcarrier signals which are applied to the balanced modulators. Note that these subcarrier signals are 90° out of phase with each other.

The outputs of the balanced modulators are shown in Fig. 5-b. In each case the subcarrier has disappeared, while upper and lower sidebands have been generated for each corresponding color-difference-signal frequency component. (In the process of modulation, sideband pairs are generated for each frequency component in the modulating signal as in an audio signal, for example. For simplicity, only a single pair of sidebands is shown in Fig. 5, for each of the color signals.)

Fig. 5-c shows all of the sideband components which form the chrominance signal when the outputs of the balanced modulators are combined. In the illustration, all the sideband components are shown separately. Actually, since any signal can have only one amplitude and one phase at any instant, these sideband components combine to form a resultant signal. Fig. 6-a shows this total resultant chrominance signal which is produced when the sideband components in Fig. 5-c combine. Vector addition by "completing the parallelogram and finding the diagonal" is shown, to clarify the process. This is the signal that is actually transmitted. Fig. 6-b shows how this resultant is affected when either of the sideband pairs is altered. Note that the total resultant chrominance signal changes in both amplitude and phase when this occurs. When both sideband pairs are altered, the total chrominance signal again changes in both amplitude and phase as in Fig. 6-c. Thus we see that the total chromi-
The synchronous detectors operate exactly as was described in the case of the single color signal. However, the output of each detector contains only one of the desired color-difference signals. Only one signal appears in the output of each detector because the phase of the reference subcarrier applied to it is chosen to cancel the sideband components representing the other color signal.

From the above, we can see that the frequency and phase of the subcarrier reference signals generated in the receiver must be identical to those of the original unmodulated subcarriers used in the transmitter, if reproduction of the original color signals is to be true. In other words, the frequency and phase of the subcarriers at the receiver must be synchronized with those in the transmitter.

The two subcarriers are synchronized by transmitting approximately 9 cycles (burst) of a 3.6-mc reference signal, at horizontal scanning rate intervals. This reference signal is inserted on the back porch of each horizontal blanking pulse, as shown in Fig. 8.

One of the primary reasons for locating the burst on the back porch of the horizontal blanking pulse is to avoid affecting the normal operation of the horizontal sync circuits in both black-and-white and color receivers.

The burst occurs during horizontal retrace time, when the receiver screen is normally blanked out by the horizontal blanking pulse. Also, since the burst occurs after horizontal retrace has started, it has no effect on synchronization of the horizontal sweep circuits.

Having seen how the color-difference signals can be transmitted and detected, we can now turn our attention to the refinement of, and reduction of interference in the system.

**In March**

In the more southerly parts of the country, at least, March will mark the beginning of another TV dx season. Some sporadic-E dx is usually seen in the Deep South each year before the month is over. In these same latitudes, too, warming weather increases the viewers' chances of picking up some good tropospheric dx. This will be particularly true of the Gulf States.

Farther north there will be only a very slight upturn in general reception, unless we get a stretch of unseasonably warm weather that sometimes breaks out toward the end of the month. March is generally a good aurora month for the Northerners, though TV reports from this medium have thus far been few and far between.

**Some real u.h.f. dx**

It hasn't happened often, and very likely it never will become anything like the dx we experience on channels 2 through 6, but once in a blue moon an alert viewer will come up with a u.h.f. dx prize that defies explanation. A few such were listed in the 1953 TV dx summary published last month, and now we have another.

Observer R. J. Walker, Daytona Beach, Fla., reports a 10-second flash reception of KSTM-36, St. Louis, Mo., at 2:55 pm, December 13. This is a time of day and season of the year when tropospheric dx is highly unlikely. And it is generally thought that ionospheric propagation is impossible above 150 mc or so. What was the medium of propagation, then? Well, we'd like to know, too! When we've collected a few hundred such observations, perhaps we can make a guess.

**New quarterly department**

Beginning with the next issue, TV dx information (forecasts and reports) will be carried on a quarterly basis. It is hoped to be able by this means to present a more balanced column, as each one will span all or part of a particular type of seasonal phenomena. It is hoped, also, to be able to present outstanding dx reports regularly.

To achieve the latter aim we need the full co-operation of TV dx enthusiasts. If you catch anything unusual, report it at once. Don't wait until the end of the season and mail in a complete log. Reports several months old are satisfactory for long-term study, but they don't rate as news.

Interesting things are happening almost daily in the TV dx field. Can we count on your assistance in reporting them?
ing television receivers. In adjusting an antenna with this type of mounting, start with the V in a horizontal plane. After the other adjustments have been made, readjust the angle the arms make with the horizontal.

For the service technician, an adjustable-V antenna used in combination with an outdoor type in difficult locations often can produce nearly ghost-free reception to an extent that cannot be obtained with any practical single outdoor or indoor antenna. This combination was devised by the author to solve a ghost problem which had resisted several types of installation by different technicians, but the scheme probably is not original. It consists simply of connecting an adjustable-V indoor antenna in parallel with the outdoor one, as shown in Fig. 5, and adjusting the indoor V to cancel out the ghost.

With an arrangement of this type, the owner of an intermittently haunted TV set has something to do which is more constructive than complaining to his service technician. The indoor antenna need not be adjusted nor even connected if the received picture is satisfactory without it.

Impedance mismatch when the two antennas are thus connected together will not necessarily give trouble. In fact, the auxiliary antenna may be adjusted to correct a mismatch between the receiver and the outdoor antenna system. If a mismatch does exist when the two antennas are otherwise properly adjusted, it can be corrected by the usual means, but I have not found a case where it was necessary to do so.

Since an indoor antenna alone may not give sufficient signal pickup some distance from a station, it may be thought that such an antenna could not pick up enough ghost signal to cancel out that from the outside antenna. Actually, good results have been obtained 50 miles from a station.

If you never have used an indoor antenna, try it sometime!

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G-LINE

O NE of those fantastic scientific conceptions that seem fitted only for expression in long strings of mathematical calculations has come down to us. (See photos and Fig. 1.) But radio men know that this is a very special kind of wire.

The new science-fiction-like apparatus is the G-line being made and sold as a u.h.f. lead-in by Bogen. To all appearances, it is a single wire ending in a horn-like device at each end. (See photos and Fig. 1.) But radio men know that u.h.f. does not travel readily on a single piece of wire. It tends to radiate off the wire into space, so little gets to a point any distance along the wire. For u.h.f., very special twin-line, coaxial or other types of transmission lines are needed, and even their losses go up rapidly with frequency. Is this new line some special kind of wire?

The G-line, so called after its inventor, Dr. George Goubau (Radio-Electronics, May, 1950, and June, 1951) is a very special piece of wire. The conductor, using only the inner one. The only difficulty is that we might expect the u.h.f. to radiate out in all directions from the wire, and that little would reach the end. This is just what does happen on an ordinary piece of wire. As the waves spread outward from the wire of the G-line, they are reflected back toward it again by the boundary between the insulation and air. The short waves (3-30 mc) are similarly confined to the area near the surface of the Earth by bending due to the thinning out of the atmosphere. Waves which are not too near vertical are reflected back toward the Earth, instead of going on into space.

Thus, in the G-line, signals travel much as in the exaggerated drawing of Fig. 2. The signals are picked up by an ordinary antenna with a balanced impedance of about 300 ohms. Therefore they must be launched onto the single (unbalanced) line. The launcher includes—at the narrow end, a balun (balance-unbalance transformer) and a gradually widening horn. The signals which may at first be inclined to treat the wire-horn combination as a new kind of coaxial finds the impedance rapidly going up as the horn widens, so that more and more of it follows the center conductor. A similar unit at the other end where the lead enters the house transforms the signal back to a balanced one and puts it on a standard 2-conductor 300-ohm line. The two matching units contribute a loss of only 1/2 db each, and the line itself has a loss of 1 db per hundred feet. Radiation and noise pickup are very low because of the self-contained nature of the line, and it has an almost complete cutoff below 300 mc.

Insulation presents a problem. While the field falls off rapidly with distance from the surface of the wire, anything approximating it closely would cause severe losses. Therefore the insulation must be supported wherever necessary by loops of nylon cord stretched between the ends of a small bracket, so that a minimum of solid material is brought near the line. Similar brackets are used wherever a bend is made, as the line must not have sharp turns, and 3 supports are needed for a 90-degree bend.

The new line will be especially useful wherever long runs have to be made. It will also be valuable in bad-weather and industrial areas and salt-air installations, since moisture, soot, or salt do not increase its losses.

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Fig. 1—Diagram of launcher and balun with lead-in and G-line connections.

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Fig. 2—Exaggerated illustration showing r.f. traveling between wire and surface of the insulation on G-line.
HE DRIFTS into my TV repair shop two or three times a year. He's a different individual each time, but his problem is always the same. He has studied TV theory until it's running out of his ears; what he needs now is on-the-job experience to make that theory worth something in terms of dollars and cents. He is up against a problem as old as civilization—he hasn't been able to find a job because he has no experience; he can't get any experience because he can't find a job!

I can't help him directly. I'm a small-bore operator on a side street; my shop is in front of my home. You know the setup: in slack season not half enough work for one man; when things get snowed under, a few 12- or 14-hour days clear the docks. I get by, which is just fine. But hired help I can't use.

However, I can explain how I got my experience after I'd run up against the identical problem. Like many others, I learned my TV theory at home in my spare time; making a living occupied most of my daylight hours. My only teachers were books, magazines, and a study course.

Inevitably, as does every student, I reached a point where the books began to blur. I'd absorbed all the woddage I could handle for the time being. I needed actual contact with TV sets—preferably in bad order.

I could have gotten that contact in a residential TV school, but I had a family to support and no rich uncles. A job as a helper or apprentice in a TV shop was another possibility, but a shop helper's pay is too low and his progress not fast enough for any but single, unburdened individuals. I solved the problem by creating my own experience. The method is simple and relatively cheap; it can be duplicated anywhere. It can supply any student with experience as exactly the right pace; never too fast, never too slow; whenever he wants it— evenings, week-ends, any time.

My first step was to become what amounted to a part-time dealer in TV junk. This was simple enough. I inserted a classified ad in a local paper, offering to buy old TV sets—any size, shape, or condition for cash. You don't have to be a big dealer to do this. I put a $50 maximum on my offer, thus side-stepping big stuff; I never paid more than $30 for any of the ten-inch clonkers I dragged home. $30 was my top a couple of years back—a $20 maximum would be more in line with today's situation.

Having dragged a relic home, I proceeded to restore it to working condition, which frequently took a little doing. As might be expected, there was something badly amiss with every one of my prizes. Some produced neither raster nor sound; some made with fearful planing-mill noises. Others were inhabited by gremlins or some of the many ailments common to TV sets. Sad cases every one, but you don't learn TV repairing by working with sets in good order. Assuming a receiver hasn't suffered a major burn-up (sniff well before buying), and hasn't been robbed of tubes, then the worse its condition the better for the student seeking experience.

The actual, hard-rock experience I gained in repairing those boxes was only part of the program. My next stop was to twist every nonoperating control I could find, with the idea of getting everything as far out of kilter as possible. Then I restored everything to normal, sometimes repeating the process several times. The further I progressed the bolder I became; the deeper I dig into my clonkers. I introduced defects and observed the symptoms. I practiced signal-tracing and alignment, to mention just a few of my earlier experiences. Then, after I'd milked a chassis dry of information I sold it down the river, as detailed a little later.

In one corner of my over-sized garage I fought first one piece of junk back into working order and then another—and another. A v.t.v.m. with a couple of probes, a tube tester, and some early printings by Rider and Photofact made up my equipment, plus the usual hand tools.

It's no fun—not at the start. Not for the student completely on his own, with not a soul to give him a lift when he gets stuck in the mud, which is often. It's not the most efficient method in the world, either; it involves frustrated hours of doing things the wrong way, stupid mistakes, wrong approaches, errors of both omission and commission. There were times when I'd have sold out for a fraction of the inventory.

But you can say this about the method—it works! It produces real, valuable experience. Moreover, it sticks with you, as does anything acquired the hard way; there's no time wasted simply memorizing. Another advantage is that you have neither employer nor impatient customer breathing down your neck—a handicap which can make even a experienced mechanic sometimes black out.

I started out in my garage loaded with theory but inclined to go numb from the neck up the moment I removed the back of a practical TV set. The first time I pulled one out of a cabinet and turned it over I recall sitting there for half an hour, just gawking, with a gone feeling at the pit of my stomach, wondering why I'd ever started this. The first few times I compared a schematic with a chassis I got lost so fast it was worse than pitiful. No fun at the start.

Little by little, however, stage by stage, I acquired competence and confidence, a backlog of experience. I discovered head-on attacks don't pay off in TV repairing. Strategy is the key to the jackpot; knowing when to attack a repair job via the dynamic approach, checking a.e. components with a v.t.v.m.,...
or scope, and knowing when to use the static approach, routinely checking socket voltages, capacitors or resistors. It means knowing when to use a test- and when to rely entirely on the strategic and the head-down approach is the difference between minutes and hours in wrapping up a repair job.

The strategist is always changing pace. He hangs onto an idea or a deduction just so long, then if it fails to pan out he dumps it. This is an attitude of mind to be cultivated. Let me illustrate the disadvantages of not having this attitude, by using a hypothetical Joe Doakes. Confronted with a fairly tough case of TV trouble, Joe looks the situation over and makes a quick deduction as to the probable cause. So far so good. However, Joe's test gear promptly reports that everything is under control in the suspected area. This is where real trouble starts.

Instead of changing pace and developing a second deduction, Joe stubbornly makes another pass at the original target. When this gets him nowhere, he promptly goes off. Two hours, three hours later you may find him still working over the same group of components. Meanwhile in the process of checking and re-checking it's his test gear that has indicated the cause of the trouble. But because Joe is operating strictly under Groundoff, he pays no attention to what the test gear tells him. He ignores it, knot-headedly continuing his original line of attack.

After lunch or possibly the next day, he'll come to, kick himself, and proceed to repair the TV set in a normal manner. I smiled off at this more than once. Others far more competent than I have done exactly the same thing.

The calm, cool, and collected attitude is about twenty-five per cent of the top-drawer technician. It increases his proficiency and accuracy, it insures that precious gem, customer confidence. Move slowly and deliberately; it will reduce the number of chassis unnecessarily pulled, and the number of tubes and components, I lost something on every deal—around $7.50 per box.

The prices on higher prices could have showed a profit possibly, but I wasn't necessarily trying to make money; my objective was getting experience. Keeping a constant supply of TV cadavers coming my way was the all-important item.

I started much subject with a.v.t.m. and a tube-tester; eventually I acquired a scope, sweep and marker generators, 1,000-kc crystal marker oscillator, grid-dip meter, wattmeter, capacitance-bridge, shot gun receiver to monitor WWV, complete set of service manuals, and trimmings. You don't have to be a big dealer to do this, I bought my gear on a payment at a time, in kit form wherever possible, because I couldn't afford ready-made gear. Moreover the purchases were spread out over a considerable period of time—a year or so all told.

Slow work? Well, acquiring electronic know-how is a slow process. The TV student in a hurry is licked before he starts; never less than a year and often two years must elapse before he gains enough ground to tackle general repair work.

Also pretty well licked before he starts in the TV student who expects to draw a salary while he gets his practical experience. Students pay considerably more to acquire theory, and without protest. However, the thought that practical experience must also have a price tag is something which seldom occurs to them. But that's what it amounts to when the inexperienced technician—sharp though he may be in theory—tries to hire out in Slowblow's TV shop.

Apprentice training works out well enough in some occupations, where other services may be rendered while the student learns.

Simply observing a TV repairman at work is of little value to the novice; assuming the repairman is not doubling as instructor. Ninety-nine per cent of the effort is quite invisible, consisting of mental processes.

If Slowblow takes him as a bona-fide apprentice or learner, the novice will be in Slowblow's way for a long time; he's only half a technician. Slowblow would be forced to make up his deficiencies. Slowblow must spend many hours teaching the novice the techniques he needs; inevitably the novice will make numerous and sometimes expensive mistakes. In short, he'll be audent drawing wages for being instructed!

The only practical way Slowblow can hire the student is on the basis of shop helper. Most of the time he put up aerials, pull chassis, act as general man-of-all-work. Thus the student earns his wages, but acquiring experience is strictly hit-or-miss, at a woefully slow rate.

Similarly, unless he's exceptionally lucky, or unless he can manage to take a residential course in a TV trade school, the average Joe must buy his experience—and the only visible method is along the general route I've been outlining. The cost of buying experience this way is never more than a few hundred dollars, with payments spread out over a rather long period.

Even if the student does not plan to go into business for himself, buying all this test gear is actually a necessity.

Considering the strong economic position enjoyed by the experienced, competent TV service technician, a few hundred dollars represents a trivial investment indeed.

MARCH, 1954
The increasing use of selenium rectifiers in television receivers has resulted in our receiving many queries regarding symptoms which appear when rectifiers go bad. Readers have also asked about replacement precautions and data.

A typical circuit is shown in Fig. 1 and is used in many current Philco receivers. Two selenium rectifiers are used, each having a 450-amp rating. These, in addition to the two 120-uf capacitors, form the voltage-doubling circuit.

A 1.6-ampere fuse is in series with one leg of the a.c. line, and a 7.5-ohm limiting resistor is also used to prevent excessive current peaks. When one-half of the a.c. cycle causes the input terminal A to be positive, the top selenium rectifier conducts and charges capacitor C2. The sum of these charges is double the peak value of the a.c. voltage.

In a television receiver, decreased output from the low-voltage supply can result in a shrunken picture which cannot be expanded by the width and height controls, corner shadows, poor picture quality, unstable synchronization, and low audio output. The degree to which these symptoms are present depends on the amount of voltage decrease in the rectifier circuit. Fig. 2 shows symptoms of vertical and horizontal shrinkage, as well as corner shadows caused by a decline in selenium-rectifier output.

When the rectifiers are at fault, they should be replaced with units having the same (or higher) current ratings. The 450-amp rectifiers shown in Fig. 1 can be replaced with 500-amp units, thus assuring somewhat longer life. The only factor to consider is whether or not the new units will fit in the same space used by the old units.

If possible, filter capacitors should be checked with a capacitor checker so that the power factor (leakage) can be read. Do not bridge old capacitors with new ones, as this does not eliminate any leakage. Also check the value of any series resistors and replace with values recommended in the service notes. Electrolytic capacitors used with selenium rectifiers require special consideration. Since the selenium rectifier has no warmup period, the capacitors will be subjected to high initial surge voltages. (See "Electrolytic Capacitors", February, 1954, issue.)

With respect to filter capacitor replacements, use the same values given in the receiver schematic. The values shown in Fig. 1 are only for the receiver mentioned. Other receivers may use lower-current rectifiers, or higher doubling capacitors. (Crosley chassis 411, for instance, uses 200-uf capacitors in both the doubling circuit and the filter section.)

Selenium rectifiers have the advantage of requiring no filament voltage and are fairly rugged. Their life may be as short as six months or as long as several years. Often the discussion declines gradually, so that it becomes necessary to advance both the height and width controls every few months to keep the picture filled out. Eventually both controls are at their maximum and shrinkage can no longer be corrected except by rectifier replacement.

By this time picture quality is also down, and the new rectifiers (and perhaps new filters also) will do much to give the set new life and sparkle. Don't forget to reduce those height and width controls, or your customers will be complaining about the tops of heads being chopped off, or never seeing the performer's feet!

Blanking differences

On some channels, the picture in a Transvision A-4 receiver lacks full width, while on other stations the picture fills out completely. What could cause this? I would also like your opinion regarding fine detail. Do you believe that excessive sharpness is possible?

R. Z., Eagle Lake, Texas.

There is a difference in the transmitted width of some stations. This is caused by a difference in the blanking duration; unfortunately all stations do not adhere to standards in this respect. You will also find that some stations fill out the mask to a greater extent than others do. A contributing cause in the receiver could be insufficient high voltage which will cause blooming for differences in contrast and brightness levels. The high-voltage system should be checked and brought to maximum efficiency by tube replacement.

With respect to fine detail, the correct procedure would be to align the tunes and video i.f. stages so that a 4-me bandwidth is obtained. This gives the sharpest picture. Excessive high-frequency peaking will cause repeat lines to be visible at the edges of sharply defined objects. Sometimes this is caused by incorrect peaking coils in the grid circuits.

Fig. 1—Schematic diagram of voltage doubler used in Philco model 52-T2110

Fig. 2—Insufficient low-voltage supply.
PRINTED CIRCUIT TV RECEIVER

French TV receiver may be sign of things to come

By M. BONHOMME
Editor-in-chief Toute La Radio (France)

Printed circuits are by no means a novelty, and more than one receiver on the market is partly or entirely constructed with the help of photo-engraving techniques. Not so in television. Kaye-Halbert have announced an at least partly printed-circuit television, and Sanders Associates of Nashua, N. H., have demonstrated an experimental receiver constructed with the modular system of Project Tinkertoy (Radio-Electronics, December, 1953, page 59) which uses printed circuits in conjunction with plug-in connections. For this reason the accompanying illustrations of a French television receiver made by the French firm Visseaux is particularly interesting.

All the connections and all the inductances are made by engraving (printed-circuit) techniques. The resistors in the earlier models are standard miniatures, though the Visseaux technicians state that this is a temporary step.

The illustrations here show the printed part of the equipment (the power supply still follows tradition). Nine tubes are used, five of which are dual-function types. The set is intended to receive a single station at 174.1 Mc. Bandwidth is 8.5 Mc to accommodate the French high-definition 310-line transmissions. Unquestionably the simpler demands of one-station reception have made it much easier to design and manufacture such a receiver.

Schematic diagram shows printed circuits. Used for high-definition transmission, receiver has wide bandwidth.

MARCH, 1954
GETTING THE MOST FROM

Indoor type antennas need not be "substitute" antennas; proper use makes them highly effective

By JOHN K. FRIEBORN

WETHER you are a set-owner or a service technician, the adjustable-V type indoor antenna offers advantages which often are overlooked. This type of antenna is usually regarded as a mere substitute for an outside installation. Actually, an indoor antenna often can give you a satisfactory picture when an outdoor type cannot. Unless you can place an outdoor antenna high enough to eliminate the possibility of reflections ever occurring on any channel, you cannot be sure of obtaining ghost-free reception under all conditions, except with an extremely elaborate installation. The amount of signal pickup generally is less with an indoor antenna than with an outdoor one, but the greater ease of adjusting the indoor type makes it possible to eliminate ghosts more consistently.

To obtain maximum benefit from an indoor antenna, you should have one with as many adjustments as possible and adjust it whenever the picture indicates the need. Many set-owners feel that simply paying for a receiver and its installation should be enough to entitle them to perfect television reception. However, for many locations the service technician cannot obtain good reception at all times, and the set-owner who does some additional work will be well repaid for his efforts. In many cases, the most effective thing a set-owner can do to improve the quality of his picture is to have an adjustable antenna, and adjust it when necessary.

The set-owner usually is told to "adjust for the best picture," but that is not much help in making the many adjustments possible with some antennas. Any method is satisfactory as long as the adjustments are performed in a definite order and repeated if necessary.

For example:
1. Extend each arm about halfway;
2. Adjust each arm to an angle of about 45° with the horizontal;
3. Rotate the antenna for the best picture;
4. Adjust the length of each arm individually (holding the insulators at the ends, not the metal parts of the arms);
5. Adjust the angle of each arm individually;
6. Re-check rotation, lengths, and angles, until changing any adjustment does not produce any improvement;
7. Try the antenna in different locations.

If you adjust the arms individually, often you will find that an unsymmetrical configuration of the antenna is the best one. I have found that the best picture sometimes is obtained with a position like that in Fig. 1. This may not look right to you, and it doesn't look right to me, but it seemed to suit the signal. Incidentally, the higher-frequency channels (7 through 13) do not necessarily require that the antenna arms be shorter than those for the lower channels; an antenna does not have to be one-half wavelength. In adjusting your antenna, forget oversimplified theories about what it should look like and just give the incoming signals a chance to try all the different sizes, shapes, and positions your antenna can offer.

Even with the five adjustments which are available in the standard adjustable-V indoor antenna, still another would be desirable. In fact, a different type of antenna mounting would produce better results than the present one, both theoretically and practically. With present commercial indoor antennas, the V formed by the arms is always in a vertical plane. Better results usually would be obtained with the V in a horizontal plane, since the best direction for a V-type antenna is often not necessarily the plane of the V, and television signals are received along an approximately horizontal line. (See Fig. 2.) The plane best for the antenna in a particular case usually is one tilted slightly up from the horizontal. In a number of actual cases where it has been tried by the author and others, changing the plane of the V from vertical to approximately horizontal resulted in improved signal strength so that the amount of snow was reduced, and often, a persistent ghost was removed.

To make an added adjustment possible, you must have an antenna base or mounting with some type of universal joint. Until such an antenna is manufactured, anyone wishing to experiment with it must build his own. Several devices which could be adapted for experimental mountings are available. Rubber-covered clamps with universal joints, for holding cameras and lights, are sold in photographic supply stores. Mirrors, similarly mounted, are available through radio and television supply distributors, for use in adjust-

Fig. 1—Best pictures are often obtained with unsymmetrical arrangements.

Fig. 2—Horizontal positioning of V.

Fig. 3—Layout for eliminating ghosts.
video amplifiers, as well as by improper alignment. It is preferable to have a clear and sharp picture without excessive repeat lines, which indicate abnormal high-frequency response.

Sound bars

In an RCA 21T176 there are a number of horizontal bars on the screen. (Fig. 3.)

I have tried new tubes and have made other checks but cannot find the trouble.—N. F., Milwaukee, Wis.

You mentioned having checked all tubes, but did not state whether or not you have adjusted the sound traps. If these check all right, the trouble may be caused by a.g.c. overload which causes one of the stages to go into oscillation. The a.g.c. control should be adjusted to see whether or not it makes a difference in the interference. If not, try replacing the crystal detector.

Another cause for this condition could be improper video i.f. alignment. When the alignment is overpeaked, stages may become critical, with possible oscillations. The same holds true for improper peaking coils in the video-amplifier section, as well as for defective component parts.

Capacitor failure

A Hallicraft model 17825 receiver had excessive brilliancy and I replaced a shorted .01-µf capacitor (C138) in the brightness control circuit. The set worked well for three weeks and the same trouble occurred. I replaced the same capacitor and made extensive voltage and resistance measurements, and checked the brightness control for any intermittent shorts. After another month the same trouble reappeared. Have you any suggestions as to why this capacitor would short out after a short period of time?—J. G., Brooklyn, N. Y.

The fact that the .01-µf capacitor which you replaced to correct the trouble has again become defective does not necessarily indicate a circuit defect. Since the receiver operates well for several weeks before the capacitor becomes defective it may indicate that the replacement capacitors were defective or not of the proper voltage rating. Try another replacement, using a 600-volt rating. It is possible that you have used a 400-volt rating; if so, the capacitor will be short-lived.

Uhf-vhf delta match

I would like to have an explanation of the principle involved in using a delta-match Yagi antenna for u.h.f. or v.h.f. I want to try one of these units and I understand no insulator is needed.—G. C., Saskatchewan, Canada.

In a half-wavelength antenna the voltage is high at each end and therefore the impedance is low. (See Fig. 4.) When no insulator is used, the transmission line ends can be fanned out for an increasing impedance. Thus, a perfect match can be obtained by fanning out the line for the proper distance (Fig. 5). This is established when best reception occurs. The principle can be used for either u.h.f. or v.h.f. antennas. Since the match is for a narrow frequency span the system is best adaptable to Yagi antennas.

17BP4A to 21EP4

I have a Westinghouse H658T17 which contains a 17BP4A picture tube. I wish to substitute a 21EP4. Both tubes are identical as to focus coil, deflection angle, etc. Can this be done without change to the circuit or components?—J. B. S., Sumer, S. C.

Since both tubes are identical with respect to deflection angle, etc., you could make the change without altering the circuits or additional components. Make sure the vertical and horizontal output tubes are operating at peak efficiency, and that the high-voltage system is also giving maximum output. If these components are not giving peak performance, you may not get sufficient size or brilliancy for the larger tube.

Transmitted linearity

When I set the linearity controls to get a perfect circle for one local station, I find the picture has had left-hand stretch on another channel. I can't understand how the receiver would change linearity for a different station, and I assume the trouble is in the transmitted pattern of one station. Am I right in this assumption? W. O., Chicago, Ill.

There is often considerable variation in station-pattern linearity for the seven stations in any one locality. Linearity at the station (as in the receiver) must be adjusted carefully or the transmitted picture will be distorted. For most accurate results check the linearity adjustments on your receiver with a cross-bar generator.

ON THE COVER: ANTENNA TESTING METHODS

With the scenic Catskill mountains as a background, engineer Julius Green of Channel Master, Ellenville, N. Y., is seen testing the Ultra-Bow antenna.

The experiment in process consists of measuring the characteristic impedance of the antenna. The girl, Barbara Watson, is recording standing-wave ratios as measured on a Lecher wire and is taking signal generator and voltmeter readings.

The large wooden mast behind them is used for field testing. The tower mounted on the mast can be pivoted in a vertical plane. The tower and mast represent the receiving section of a transmit-receive setup.

At the end of the tower is mounted the antenna to be tested; in this case it is the 2-bay Champion. The antenna can be rotated 360° by a selsyn motor mounted on the tower and can be controlled from a nearby laboratory. The antenna under test is rotated at a speed of 2 r.p.m., while the receiving pattern is automatically recorded.
By E. AISBERG

Ninth conversation, first half—Forming the electron image; photoelectric cells

From the original "La Télévision? . . . Mais c'est très simple!" Translated from the French by Fred Shunaman. All North American rights reserved. No extract may be printed without the permission of Radio-Electronics and the author.

In the land of the microseconds

WILL—I've got news for you, Ken!
KEN—Go ahead!
WILL—This talk about time bases and deflection circuits has got me fed right up to the neck. Can't we change the subject for a while?
KEN—It just happens I was thinking the same thing myself. We should now be able to attack the main principles of television—we've pretty well cleared up the preliminaries. How about starting to learn something on how images are transmitted, as well as received?
WILL—I do know a little about that already. For instance, I've just been reading how a TV studio has to be so brightly lighted that the actors get sunburned and...
KEN—That's what you get for picking up back-number magazines! All that was out long ago! Nowadays TV camera tubes are as sensitive as the human eye, so they don't have to burn the skin off the actors with lighting, as they did in the early days. Color TV needs a little more illumination, of course, on account of the optical filters in front of the cameras.
WILL—Then they've been making photoelectric cells more sensitive?
KEN—No, the progress wasn't made in that direction. What they've done is learn to use more of the cells, and for more of the time. Instead of lighting the cells for short instants...
WILL—Huh?
KEN—Remember the mechanical Nipkow disc we talked about a long time ago? And how each small element of the image could reflect its light onto the photocell only for the instant the hole in the disc was directly between the picture element and the tube? If you were to use a system like that for a standard 525-line scan, each of the picture elements would project its light on the cell only about a tenth of a microsecond.
WILL—That means that at 30 frames a second, each element would have a chance to get in front of the camera only about 3 microseconds out of each second. About 3-millionths of the time!
KEN—So you see that a system that could see all the light from the picture all the time would be much more sensitive—in theory at least.
WILL—Yes, over 300,000 times as sensitive—as many times as 3 microseconds is contained in a second.
KEN—Well, you can’t actually get anything like that in practice. But you could get something like 25,000 times more sensitivity.
WILL—That ought to help a little! But how are you going to illuminate every part of your image—and get it picked up by a photocell—continuously?
KEN—Why use one photocell, Will? Why not use millions instead? Then each tiny image element would have half-a-dozen photocells for itself.
WILL—Now you’re kidding! That’s impossible, of course!
KEN—Nothing impossible about it at all! But before I show you how to use millions of photocells, let’s take just one and see how it works. Look at this hookup. When light falls on the photosensitive cathode, it emits electrons. They are attracted by the positive anode, and from there go back to the battery, B1. Meanwhile, the upper plate of capacitor C, connected to the cathode, is charged . . .
WILL—. . . more or less positive, because of the negative electrons the cathode has lost.
KEN—Now, switch S turns 30 times a second, and—for a very short instant—connects the negative terminal of the high-voltage supply to the cathode. What happens?
WILL—Capacitor C’s top plate gets back the lost electrons from the negative end of the high-voltage supply (battery B1).
KEN—Exactly! But, as the electrons from the battery neutralize the positive charge on capacitor C’s upper plate, a corresponding negative charge is released from the lower plate. These electrons go to the positive pole of the battery through resistor R.
WILL—I see what happens. The current through resistor R is bigger or smaller according to the amount of light that falls on the photocell. And of course it produces a voltage drop across the resistor. So if we connect the control grid of an amplifier tube, as in the layout, its output will vary with the amount of illumination. But haven’t you got a pretty heavy positive bias on that grid?
KEN—No. You’re looking at the photocell battery. The amplifier is interested only in battery B2, its own supply. Both cathode and grid return are connected to B2’s negative terminal. Standard hookup, no?
WILL—Sorry. I missed that one. But what I still can’t see is how you’re going to capture all those image elements with your photocell.

Millions of cells—impossible!

KEN—Try to imagine a surface completely covered with photocells like this one. Their cathodes are all connected to contacts. The switch passes over all these contacts 30 times a second. Each cathode is also connected to its capacitor C. The lower plates of all these capacitors could be connected together—or you could use a common lower plate, like they show in the diagram of a multiple-section electrolytic—and you would need only one resistor R for all the cells. Each cell now takes its turn putting its voltage on the amplifier grid. Now if we illuminate all these cells together . . .
WILL—. . . your system will work—in theory, that is! You’re saying that there’ll be a voltage on the amplifier grid—at any given instant—proportional to the light falling on the photocell connected to the switch at that instant.

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Ken—Your mental pickup is good today! Now keep in mind that the light is falling on all the photocells all the time, so the voltages are the results of an accumulation of charge for the thirtieth of a second between two discharges.

Will—But all this is ridiculous! How are you going to assemble your panel of 300,000 photocells? And where are you going to get a switch that will make and break 9,000,000 contacts a second? It can’t be done!

Nothing is impossible.

Ken—But it is done—on the photosensitive mosaic of the iconoscope, which is what I’ve been leading up to.

Will—Photosensitive mosaic...?

Ken—Yes. It’s a thin layer of silver deposited on a sheet of mica. After the silver is deposited, the sheet is heated. That makes it expand and cracks the silver layer up into millions of little bits, each separated from the others by a gap of insulating mica. Then cesium vapor is deposited on them, making each of these little silver islands a photocell.

Will—I know about heating paint on metal cabinets to get a crackle finish. But crackle-finished silver is a new one on me. So that’s how you get your millions of photocells!

Ken—that’s how. Or at least it’s how we get the most important part of the cells—the cathodes. And you only need one anode for all of them, so that’s no problem.

Will—But how about the capacitors in the cathode circuits.

Ken—Very easy—just plate a thin layer of metal on the other side of the mica sheet. Then each cathode forms one plate of a capacitor and the metal on the other side of the mica becomes the common lower plate we’ve been talking about. You understand, of course, that the cathodes don’t have to be regular or symmetrical, because there are several of them in the space we’ve been allotting to one picture element. The capacitance of each of these tiny capacitors is proportional to its size, so the voltage induced on the common capacitor plate is the same for the same amount of light on the picture element, whether it’s represented by two or three larger islands or a half-dozen smaller ones.

Will—Wonderful! And now I begin to see that the switch to contact each of these tubes is going to be the electron beam in a cathode-ray tube.

Ken—I suppose watching me draw this diagram of an iconoscope didn’t help you any?

Will—Well, it is a funny shaped thing.

Ken—that shape is highly functional. You have to put the photomosaic where it can be swept by the electron beam and at the same time be exposed to the light from the scene you are televising. One face of the tube has to be flat so that a lens can form an image of the televised scene on the photomosaic. To keep it out of the way of the light, the electron gun is mounted in a cylindrical tube at an angle of about 45° from the mosaic. And the common anode for all of them is a metallic film deposited over part of the inside of the glass.

Will—it looks as though the beam is focused electrostatically and swept magnetically.

Ken—that doesn’t matter. You could do it the opposite way and it would still be an iconoscope. What is important is that all the cells of the mosaic are continuously being illuminated by the rays of light from the corresponding points on the televised scene. That is, the positive charges on each cell—due to loss of electrons as the light strikes it—keep on increasing as the light keeps on jarring more electrons loose.

Will—and what happens to the electrons?

Ken—they are attracted by the anode. But we’re more interested in the positive charges. As they accumulate on the mosaic they form a visible electronic image of whatever you are televising. Then the electron beam sweeps over each cell 30 times a second; replaces the lost electrons and wipes out the image. Of course that releases the negative charges on the other side of the mica dielectric, and produces a current that travels through resistor R and sets up a voltage across it...

Will...which depends on the amount of light on the element of the image the beam is passing over at the instant! Why, the iconoscope is really very simple! (To be continued)
I SEND YOU
18 BIG KITS
of Radio Television parts and equipment.
Much of your training will be actual construc-
tion work. You receive truly
PRACTICAL instruction that prepares you
for your Radio-Television career.

YOU BUILD the Television set and
the powerful superhet radio receiver shown
above. IN ADDITION to the other test units
shown here (many are not shown because of
lack of space). All equipment I send you le
YOURS TO KEEP.

NEW! NO OBLIGATION PLAN

You Have No Monthly Payment Contract to Sign
Pay For Your Training as You Earn and Learn
You can get into Radio-Television, today's fastest growing big money
opportunity field, in months instead of years! My completely new
"package unit" training plan prepares you in as little as 10 months
or even less! No monthly payment contract to sign—thus NO RISK to you!
This is America's finest, most complete, practical training—gets you
ready to handle any practical job in the booming Radio-Television industry.
Start your own profitable Radio-Television shop . . . or accept a good pay-
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during the past 21 years—and stand ready to train you, even if you have no pre-
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All your 10 months of training is IN YOUR
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present job and income while learning. With
each training "package" unit, you receive
extra plans and "Business Builder" ideas for
spare time Radio-Television jobs. New tele-
vision stations everywhere, open vast new
opportunities for trained Radio-Television
Technicians—and those in training. If you
expect to be in the armed forces later, there
is no better preparation than practical
Sprayberry Radio-Television training.

Approved for Veterans under the G. I. Bill

MARCH, 1954
THE MOST Outstanding OSCILLOSCOPE IN HEATHKIT HISTORY

NEW MODEL 0-9
OSCILLOSCOPE KIT

MODEL 0-9
$59.50
SHIPPING WT.
28 LBS.

GOOD DESIGN
Terminal board for quick access to deflection plates—provisions for Z axis input—astigmatism control—balanced push-pull deflection amplifiers—internal sync on either positive or negative peaks.

VERTICAL AMPLIFIER
High impedance input with 6A84 cathode follower, twin triode 12AU7 Cascade amplifier, 6C4 phase splitter and 12AT7 push-pull high gain deflection amplifier. Sensitivity .025 volts per inch.

HORIZONTAL AMPLIFIER
Five position input switch for choice of external input—line sweep—line sync—internal sync and external sync. Uses 12AU7 input stage, half as triode phase splitter driving 12AT7 push-pull high gain deflection amplifier. The remaining half of the 12AU7 used as retrace blanking amplifier.

POWER SUPPLY
New heavy duty internally shielded 100 milliampere power transformer. Efficient high voltage filtering system—voltage regulation completely eliminates trace bounce or jitter.

The Heathkit 0-9 is the ideal general purpose oscilloscope for educational and industrial use. Radio and TV servicing and any other application requiring the instantaneous reproduction and observation of actual wave forms.

Heathkit LOW CAPACITY PROBE KIT
No. 342
$3.50
SHIP. WT. 1 LB.

Heathkit VOLTAGE CALIBRATOR KIT
MODEL VC-2
$11.50
SHIP. WT. 4 LBS.

Heathkit ELECTRONIC SWITCH KIT
MODEL S-2
$23.50
SHIP. WT. 11 LBS.

Heathkit SCOPE DEMODULATOR PROBE KIT
No. 337-B
$3.50
SHIP. WT. 1 LB.

Anouncing the newest addition to a brilliant series of Heathkit Oscilloscopes, the outstanding new model O-9 instrument. This Oscilloscope features a brand new 5UP1 cathode ray tube for really fine hairline focusing, good intensity and freedom from halation.

NEW FEATURES
Efficient voltage regulation system maintains rock steady trace stabilization. New retrace blanking amplifier circuit—amplifier band width further extended through efficient circuitry. Calibrated 1 volt peak-to-peak reference—wiring simplified by ready laced and formed wiring harness—new phasing control.

Heathkit LOW CAPACITY PROBE KIT

Osilloscope investigation of high frequency, high impedance or broad band width circuits requires the use of a low capacity probe. The Heathkit Low Capacity Probe features a variable capacitor to provide the necessary degree of instrument impedance matching.

Heathkit ELECTRONIC SWITCH KIT

The basic function of the Heathkit S-2 Electronic Switch kit is to permit simultaneous oscilloscope observation of two separate traces which can be either separated or super-imposed for individual study. Continuously variable switching rates in three ranges from less than 10 cps to over 2000 cps. Individual gain controls for each input channel and a positioning control.

Heathkit SCOPE DEMODULATOR PROBE KIT

In applications such as trouble shooting TV, HF, IF and video stages, the frequency ranges encountered require the demodulation of signals before oscilloscope presentation. The Heathkit Demodulator Probe will fulfill this function and readily prove its value as a service accessory.
Heathkit IMPEDANCE BRIDGE KIT
MODEL IB-2
$59.50
SHIPPING WT. 15 LBS.

Another new, outstanding instrument design so typically characteristic of Heathkit operation in producing high quality instrument kits at the lowest possible price. A new, improved model Impedance Bridge Kit featuring modern cabinet styling, with slanted front for ease of operation and interpretation of scales at a $10.00 price reduction over the preceding model. Built-in adjustable phase shift oscillator and amplifier with all tubes of the battery operated type completely eliminates warm-up time. The instrument is entirely AC line operated. No bothersome battery replacements.

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

A newly designed two section CRL dial provides ten separate "units" switch settings with an accuracy of 0.5%. Fractions of units are read on a center setting with calibrated wire-wound control. A special minimum capacity, shielded, balanced impedance matching transformer between the generator and the bridge. The correct impedance match is automatically switched to provide constant load operation of the generator circuit. The instrument uses 0/5% precision resistors and condensers in all measurement circuits.

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

Heathkit AUDIO WATTMETER KIT
MODEL AW-1
$29.50
SHIPPING WT. 6 LBS.

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

The Heathkit Audio Wattmeter features five full scale power measurement ranges from 5 milliwatts up to 50 watts with db ranges of -15 db to +48 db. The instrument has a power measurement rating of 25 watts continuous and 50 watts maximum for intermittent operation. Non-inductive resistance load impedances of 4, 8, 16, and 600 ohms are provided through a panel impedance selector switch. Frequency effect is negligible from 10 cycles to 80,000 kc. A conventional VTVM circuit utilizes a 12AU7 twin triode tube. The meter bridge circuit uses four germanium diodes for good linearity.

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

Heathkit LABORATORY GENERATOR KIT
MODEL LG-1
$39.50
SHIPPING WT. 16 LBS.

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

Individual shielded oscillator and shielded variable and step attenuator provide flexible control of RF output. The circuit features a 6AP4 high frequency oscillator, a 6A9V5 amplifier with grid modulation, 12AU7 400 cycle oscillator and modulator, OB2 voltage regulator tube, and a selenium rectifier for the transformer operated power supply.

The smart professional instrument appearance and over-all flexibility of operation will prove a decided asset to any industrial or educational laboratory. The Heathkit Laboratory Generator sets a new level of operation, far superior to any instrument in this price classification.
HEATH COMPANY

The Heathkit RF Probe Kit will prove invaluable. A precision multiplier resistor mounted inside the two-color, sleek, plastic probe body provides a multiplication factor of 100 on the DC ranges. RF probe body is housed in the new, smartly-styled polished aluminum housing with two-color polystyrene probe ends and a low capacity, flexible shielded test lead. The kit is complete with all necessary material and a detailed assembly sheet as well as instructions for probe operation.

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

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

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

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

RANGES
Voltage ranges selected entirely for service convenience. For example 1½ volt full scale low range for measuring portable radio filament voltages, bias voltages, etc., 150 volt full scale range for AC-DC service work, 500 volt full scale range for conventional transformer operated power supply systems. Complete voltage ranges AC and DC, 0.15—150 volts, 150—1,500 volts. DC current ranges, 0-10 milliamperes — 100 milliamperes — 1,000 milliamperes. Resistance measurements from 0.1 ohm to 20 megohms x 1 x 1,000 x 10,000. DB coverage from —10 db to +65 db.

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

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

The Heathkit MM-1 represents a terrific instrument value for a high quality 20,000 ohms per volt unit using all 1% deposited carbon type precision resistors. Here is quality, performance, functional design, and attractive appearance, all combined in one low priced package.
Here is the new Heathkit Battery Eliminator necessary for modern, up-to-date operation of your service shop. The Heathkit Model BE-4 furnishes either 6 volts or 12 volts output which can be selected at the flick of a panel switch. Use the BE-4 to service the new 12 volt car radios in addition to the conventional 6 volt radios.

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

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

**New Heathkit 12 Volt BATTERY ELIMINATOR KIT**

**MODEL BE-4**

$31.50

SHIPPING WT. 18 LBS.

**CHECK THESE Features**

- Either 6 or 12 volt operation
- Continuously variable voltage output
- Constant ammeter and voltmeter monitoring
- Automatic overload relay — self-resetting
- Two 10,000 mf condensers
- New 18 disc split type heavy duty rectifier unit
- Fuse protection

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**Heathkit VIBRATOR TESTER KIT**

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

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

**NEW Heathkit VARIABLE VOLTAGE ISOLATION TRANSFORMER KIT**

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

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**Heathkit BINDING POST**

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

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**Heathkit TECHNICAL APPLICATION BULLETINS**

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

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**Heathkit COMPANY • Benton Harbor 20, Mich.**
Proudly announcing an entirely new, advanced model TV and FM sweep generator, the Heathkit Model TS-3. This new design provides features and combinations of functions not found in any other service type instrument. Every design consideration has been given to the requirements of the TV service man to provide a flexible, variable sweep source with more than adequate RF output and complete frequency coverage throughout the TV and FM spectrum.

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

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

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

Packed features:
- INCREDUCTOR controllable inductor
- TV and IF sweep deviation 12-30 mc
- 4 mc-220 mc continuous frequency coverage
- Oscillator operation entirely on fundamentals
- Output in excess of 100,000 microvolts
- Automatic amplitude circuit
- Voltage regulation
- Simplified operation

**NEW Heathkit**

**TV ALIGNMENT GENERATOR KIT**

**MODEL TS-3**

$44.50

**SHIPPING WEIGHT**

18 POUNDS

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

The oscillator circuit consists of a 12AT7 triode oscillator, the other half as a cathode follower output which acts as a buffer between the oscillator and the rest of the generator. This circuitry eliminates oscillator frequency shift usually caused by external circuit loading.

All coils are factory wound and adjusted, thereby completely eliminating the need for calibration and the use of additional calibrating equipment. The stable low impedance output features a deep and variable attenuator for complete control of RF level. A 6C4 triode acts as a 400 cycle sine wave oscillator and a panel switching system permits the choice of either external or internal modulation. The transformer operated circuit is easy to assemble, requires no calibration, and meets every service requirement for an adjustable level variable frequency signal source, either modulated or un-modulated.

**NEW Heathkit**

**SIGNAL GENERATOR KIT**

**MODEL SG-8**

$19.50

**SHIPPING WEIGHT**

8 POUNDS

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

**NEW Heathkit**

**BAR GENERATOR KIT**

**MODEL BG-1**

$14.50

**SHIPPING WEIGHT**

6 POUNDS

HEATH COMPANY  •  Benton Harbor 20, Mich.

NEW Heathkit TUBE CHECKER KIT
MODEL TC-2
$29.50
SHIP. WT. 12 LBS.

The new Model TC-2 Heathkit Tube Checker features many circuit improvements, simplified wiring, and a roll chart drive and illumination of roll chart. The instrument is primarily designed for the convenience of the radio and TV service man and will check the operating quality of tubes commonly encountered in this type of work. Test set-up procedure is simplified, rapid, and flexible. Panel sockets accommodate 4, 5, 6, and 7 pin tubes, octal and local, 7 and 9 pin miniatures, 5 pin Hytron and a blank socket for new tubes. Built-in neon short indicator, individual three-position lever switch for each tube element, spring return test switch, 14 filament voltage ranges, and line set control to compensate for supply voltage variations, all represent important design features of the TC-2. Results of tube tests are read directly from a large 41/2" Simpson three-color meter, calibrated in terms of Bad-Good. Information that your customer can readily understand. Checks emission, shorted elements, open elements, and continuity.

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

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

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

CHECK THESE NEW FEATURES

- Simplified harness wiring
- Improved, smooth, anti-backlash roll chart action
- Optional roll chart illumination
- Individual element switches
- Portable or counter style cabinet
- Spare blank socket
- Contact type pilot light test socket
- Simplified test set-up procedure
- Line adjust control
- 41/2" three-color meter

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

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

Heathkit POWER SUPPLY KIT
MODEL PS-2
$33.50
SHIP. WT. 17 LBS.

The Heathkit Laboratory Power Supply features continuously variable, regulated voltage output with good stability under wide load variations. A 41/2" Simpson plastic enclosed panel mounted meter provides accurate meter output information of voltage or current. All panel terminals completely isolated from the cabinet. Separate 6.3 volt AC supply at 4 amperes for filament requirements. Ripple component exceptionally low, stand-by switch provided to eliminate warm-up time of the tube circuit.

LABORATORY AND SERVICE SHOP BOOKLETS

"Planning Your Service Business" by John T. Fye, and "Establishing the Industrial Electronics Laboratory" by Louis B. Garner, Jr., are booklets available to Heathkit customers at no charge. These booklets, written by nationally recognized authorities, outline the various requirements and considerations for establishing your own service business or for setting up an industrial electronics laboratory. Full attention is given to various details that are frequently overlooked when projects of this nature are undertaken. Just write in to the Heath Company requesting your free copy, or attach a memo to your next order.
The former operated instrument are servicing of pressly for the radio and TV service man, An tracing at the receiver antenna input. channel, used in conjunction with a newly applied to a suspected circuit component or gain per stage. The instrument can also be used for visual as well as electron ray channels are constantly monitored by an electron beam indicator, so that visual as well as aural signal indications may be observed. The instrument can also be used for comparative estimation of gain per stage.

A decidedly unusual feature is a noise localizer circuit in conjunction with the audio probe. With this system, a gain sformance circuit development.

HEATH COMPANY • Benton Harbor 20, Mich.
Here is the latest Heathkit addition to the ham radio field, the AT-1 Transmitter Kit, incorporating many desirable design features at the lowest possible price. Panel mounted crystal, stand-by switch, key click filter, AC line filtering, good shielding and low VFO or crystal excitation—up to 55 watts input. Built-in power supply provides 425 volts at 100 ma.

This kit features pre-wound coils, single knob band switching, 52 ohm coaxial output, plus in chassis provisions for VFO or modulator and rugged clean construction. Frequency range 80, 40, 20, 15, 11, and 10 meters. Tube line-up 6AG7 oscillator-multiplier, 6L6 amplifier-doubler, 5U4G rectifier. Physical dimensions 8½" high x 13½" wide x 9" deep.

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

NEW Heathkit ANTENNA COUPLER KIT

New Heathkit Antenna Coupler, especially designed for the Heathkit AT-1 Transmitter. The Antenna Coupler can be used with any 52 ohm coaxial input—up to 73 watts power. Low pass filter with cut-off frequency of approximately 36 mc — L section tuning network—neon tuning indicator — rugged, compact construction — transmitter type variable condenser, and high Q coil are all outstanding features. The AT-1 has both inductance and capacitance tunings for maximum operating versatility. Dimensions 8½" wide x 4" high x 4½" deep.

NEW Heathkit COMMUNICATIONS RECEIVER KIT

This is the new receiver kit you have repeatedly asked for, the Heathkit Communications Receiver. The perfect companion piece for the AT-1 Transmitter kit. Many outstandingly desirable features have been incorporated in the design of the AR-2: such as, electrical bandwidth—high gain miniature tubes — IF transformers—high sensitivity and good signal to noise ratio—another RF gain control with optional automatic volume control or manual volume control—conventional audio gain control. Noise limiter—stand-by switch—stable BFO oscillator circuit that can be switched to transformer operation, etc. All contribute to a high performance standard.

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MARCH, 1954
The point-contact transistor is a natural for a code-practice oscillator. It requires no warmup time and it can deliver enough output to drive a speaker or several headsets on a fraction of the power input required by a vacuum tube. Its circuitry is much simpler and more compact.

The fact that a transistor has no filament to heat up before the circuit can operate is a decided advantage in a code-practice oscillator because no power is consumed when the key is open, and the circuit starts oscillating the instant the key is closed. The saving in filament power greatly increases the efficiency of the circuit.

By taking advantage of the characteristics of the 2N32 point-contact transistor we can even eliminate entirely some of the usual oscillator-circuit components. This simplifies the layout, and the fact that the point-contact transistor operates on smaller B voltages and currents than a vacuum tube means that the remaining components can have very small voltage and power ratings. This reduces size and cost, and is a big step toward miniaturization. All these favorable factors were utilized in the design and construction of the experimental audio oscillator described here.

**Built-in feedback**

The effectiveness of the point-contact transistor as an oscillator is due partly to its built-in feedback circuit. As shown in Fig. 1 the collector and the emitter have a common coupling impedance (Rb) in the base lead which feeds a part of the output back into the input circuit in the correct phase for oscillation. Only a small additional impedance is needed in the base arm to overcome the effects of the external components in the emitter and collector circuits.

Emitter and collector currents flow in opposite directions in the base lead. Collector current Ic is larger than emitter current Ie in point-current transistors, so the resulting base current Ib is the difference in the two currents flowing in the same direction as the collector current. Ib flows through Rb to produce a voltage at point A that is in phase with the emitter signal. Thus we have the positive feedback required for oscillation.

The schematic of the oscillator is shown in Fig. 2. A 2N32 point-contact transistor is connected in a relaxation oscillator circuit. The output waveform is a modified pulse having a pleasing tone quality. (A sine-wave oscillator was tried, but gave much less output than that obtained from the relaxation-oscillator circuit.)

The output-transformer primary is the external base-circuit impedance which provides the additional feedback needed to sustain oscillation. The oscillator is keyed by opening and closing the 22.5-volt battery circuit. When the key is open there is no current drain and no power is consumed. This eliminates the need for an on-off switch. The current drain on the battery is determined by the external resistance in the emitter circuit; with the values shown this drain should be less than 5 mA, and in normal use even a hearing-aid battery should last approximately 6 months.

The external resistance in the emitter circuit affects not only the collector current but the oscillator frequency as well. Reducing the value of this resistance increases the collector current and decreases the frequency. In this circuit R1 (which should not be less than 4,700 ohms) limits the collector current to a value which will not damage the transistor; R2 controls the frequency of oscillation.

The only critical values in this circuit are the resistor R1 and the battery voltage. Almost any output transformer designed to couple a pentode or beam-power tube to a speaker voice coil will do. The speaker itself can be any size. The voltage rating of capacitor C is not important so long as it is rated for at least 22.5 volts. The parts used in this oscillator were chosen for their small physical size.

The fairly wide variation in the internal characteristics of transistors of the same type may call for some experimenting with R1 to obtain the desired performance.
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sired frequency range, but in no case should R1 have a value less than 4,700 ohms. Do not allow the circuit to oscillate below 200 cycles, or the transistor may be damaged by excessive collector current.

Construction hints

The writer has access to complete shop facilities; therefore, the mechanical construction of the unit illustrated may seem quite elaborate to the average experimenter. However, almost any housing and component layout can be used, and there are no shielding problems. Lead lengths are not critical. The battery mount is probably the biggest mechanical problem. A fairly simple and easily constructed mount for an RCA VS084 or similar battery is shown in Fig. 3. Screw a pair of \( \frac{1}{4} \) -inch angle brackets to a rectangular base of bakelite or similar insulating material. Recess the mounting holes in the bottom of the base so that the heads of the screws cannot short against the metal cabinet. Soldering lugs under the nuts provide good electrical contact. Solder a 6-32 brass nut over the inner face of the hole in the upright of each bracket so the two 6-32 contact screws are parallel to the base and in line. File the tip of each screw to a 60° point to fit the small hole in the terminal of the battery. Adjust the screws to hold the battery firmly between them and tighten the lock-nuts on the outsides of the brackets to keep the screws from loosening. This mount provides adequate mechanical support for the battery and good electrical contact to its terminals. When wiring, watch the transistor terminals carefully. Hooking a transistor up wrong will ruin it as quick as will putting B voltage across a tube filament; and transistors are more expensive than most tubes. Of the three leads coming out of the transistor’s base, the collector is the one most widely sepa-
The rule is that the collector and emitter are rated from the other two. The base dictates the size of the oscillator. For transformers, the physical size of the oscillator is determined to a large extent by the output transformer. The base circuit and emitter match to a large extent those who may wish to miniaturize the output transformer as the external feed is nearer the emitter than the collector. Those circuits nearer the collector than the oscillator have relatively low internal impedance compared with the internal impedance of the collector. These poor impedance match accounts for the comparatively poor match between the collector and emitter, and hence the circuit oscillating. Output is taken from the collector.

**Alternate circuit**

Those who may wish to miniaturize the oscillator even more, the circuit in Fig. 4 eliminates these two large components. It has the advantage of reducing cost as well as size, but these are obtained at the expense of power output.

In the modified circuit, a 1,000-ohm resistor replaces the primary of the output transformer as the external feedback impedance of the circuit. Output is taken from the collector through $C_1$. This gives a very poor impedance match because almost any headset or speaker which may be used will have relatively low internal impedance compared with the internal impedance of the collector. This poor match accounts for the comparatively low power output because maximum power output is obtained only when the source and load impedances are matched. This circuit is also affected more by the variations among transistors than is the circuit of Fig. 2, and considerable experimenting may be required to obtain the desired results.

Vary the value of $R_1$ for the desired tone and the best operating characteristics.

The unit in Fig. 2 and the photographs lend itself quite readily to group or class practice, as well as to private or mobile requirements, and has sufficient power output to be used with a class of 15 to 20 persons. Its self-contained power supply gives it the advantage of portability, and its use is not limited to locations where power lines are available. Not only is this oscillator useful to anyone interested in amateur radio, but it affords an excellent opportunity for one to become familiar with transistors and their associated circuitry.

The author wishes to acknowledge the advice of R. M. Cohen and R. E. Klepinger on the electrical design of the oscillator and the advice of Ed Milavec and Don Beaulieu on the mechanical design.

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**Materials for code oscillator**

Miscellaneous: 1-2N3220 transistor; 1-4,700-ohm resistor, 1/2 watt; 1-5,000-ohm potentiometer; 1-0.5 uf paper capacitor; 1-miniature output transformer (approximate); secondary to match speaker voice coil; 1-2 x 3-inch PM speaker; 1223-volt hearing-aid battery; RCA VS-584 or equivalent; chasis, cabinet, hookup wire, and hardware.

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The transistor wrist-watch receiver is a regenerative, capacitance-tuned set.

TECHNICAL details on the transistorized wrist radio designed by Lt. Paul Cooper and Joseph O'Brien at the Signal Corps Engineering Laboratories, Fort Monmouth, N. J., have been released by the Signal Corps. The radio was built to demonstrate the feasibility of constructing a small radio receiver with transistors. This printed-circuit model, was fabricated by Harry French of the laboratory. The reduced power requirements of transistors as compared to vacuum tubes made it possible to use a very small battery which is included in the wrist case.

The receiver (see diagram and photo) uses three transistors; one as a regenerative r.f. stage and two as audio amplifiers. A point-contact transistor (type 1729) is used in the regenerative stage. Regeneration is controlled by varying the coupling between the two coils. A miniature capacitor is used for tuning. The audio is amplified by two p-n-junction transistors (type TA-153). A bead diode (type 1764) is used as a detector and another one is used as a d.c. return. (Information on the exact commercial equivalents of the transistors and diodes was not available but we understand that the 1729 is similar to the 2N25, the TA-153 is similar to the 2N34, and the diodes (1764's) are roughly equivalent to 1N84's—Editor.)

The power supply is a 6.5-volt battery (½ x ½ inch) consisting of five 1.3-volt RM-412 mercury cells. Battery drain is about 20 milliwatts and battery life about 10 hours. Although in strong-signal areas no antenna is needed, usually a 1-foot wire should be used. The 2,000-ohm earphone is a small Telex hearing-aid type. The transistors can be replaced without making any circuit adjustments.

The receiver tunes from 1000 to 1600 kc; it has sharp selectivity, and a sensitivity of 50 microvolts. A number of New York stations (35 miles from Fort Monmouth) can be tuned quite satisfactorily. When the receiver is in the vicinity of radiators, such as telephones, the reception is improved to the extent that signals from the set can be heard 30 feet from the earphone.

In the evolution of the receiver, it was found that with a 60-foot outside wire antenna, only one regenerative stage was needed to hear New York City at Belmar, N. J., 45 miles from New York. With the addition of a single audio stage and an output transformer, a loudspeaker could be used. Two stages of audio were needed to compensate for the elimination of the antenna. In metropolitan areas the coils alone will pick up sufficient signal. In the wrist version, the antenna can be built into the strap.

When the receiver is held near the body both the tuning and regeneration are affected by body capacitance. The regeneration should be checked for each tuning adjustment. Regeneration can be more easily controlled electronically than by moving a coil. One method is to insert a small 2,000-ohm potentiometer in series with the collector coil.

Another is to use a trimmer capacitor for feedback from collector to emitter. In this case, the collector coil can be replaced with a resistor.

The selection of a power source was primarily determined by the point-contact transistor which operated best with 6 volts. Junction transistors, however, can be satisfactorily operated from a 1½-volt source. With minor modifications, the power requirements can be reduced by a factor of 2.5; and by replacing the point-contact transistor in the regenerative stage with a junction type the requirements can be reduced considerably more.
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MARCH, 1954
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The design of a radio for portable and emergency use is largely a compromise. Due to limitations of space, weight, and power supply, we cannot include all desirable features. At the outset we must decide: do we prefer to have high gain, loudspeaker volume, selectivity, low drain, compactness, simple tuning, high fidelity, low cost, etc. Which of these will we simply have to do without?

The standard portable circuit, with its four or more tubes, gives excellent results, but uses too much current to be practical in emergency periods when a set might have to be left running most of the time and when batteries might well be unobtainable. The little one-tube (usually duo-tube) receivers use less current, but have low gain. Two- or three-tube regenerators feeding headphones can be made with high gain, but are usually tricky to tune, and are intermediate in their power requirements. Ultra-compactness is also out, as it implies small batteries, with a limited...
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MARCH, 1954
life and presumably limited availability in emergency periods.

The receiver described here gives good speaker volume on all local stations and some distant ones. For the more distant, headphones are provided. The set has very high gain and selectivity, permitting operation in skyscrapers, while walking along the street, even in a cellar or subway. It has sufficient selectivity to separate high-power local stations, and pick up stations 500 miles or more away. It tunes with a single dial and is contained in an aluminum box only 3 x 5 x 7 inches; batteries, speaker, and all. The receiver carries its own whip antenna which can be collapsed to 18 inches, or extended to almost 5 feet.

Last but not least, the battery drain is amazingly—almost unbelievably—low. The maximum A battery drain is 80 ma, but we get satisfactory results with about 50 or 60 ma from a single type 950 cell. This means that you can use a cell after it has been discarded as too old for a flashlight or buzzer! As for the B supply, we use a 45-volt battery. When the radio is set to maximum gain, this battery has to supply about 1.6 ma. For local reception this is reduced to about 50 microamperes. Obviously batteries are not a problem here. Reception is satisfactory long after the batteries are too old to function in other portable radios.

How can we combine such high gain with such low drain? The secret is in the use of function transistors as well as tubes. The lineup includes 2 subminiature tubes, 2 transistors, and a crystal detector. We have mentioned the power supply for the tubes. The transistors need, in addition, 3 penlight cells. The current consumption is so low that these cells will last a long time.

The schematic is shown in Fig. 1. It is a superheterodyne circuit using tubes in the r.f. and i.f. stages. The audio is handled by the two type CK722 transistors. The detector is a 1N34 crystal. In an experimental hookup I tried to eliminate the crystal, using a transistor for detection-amplification. Results were not satisfactory. Using the separate detector requires a second audio transformer, but it is well worth it.

The high-frequency portion of the circuit is conventional in most respects. The tubes are subminiature types. They are rated at 40 ma at 1.26 volts each, but they function very well with much lower currents. A 20-ohm potentiometer (rheostat) is used to reduce filament voltage to 1.25 or less. This unit can also act as volume control to some extent. When the cell gets really old, this potentiometer can be turned down to zero resistance for maximum volume. With a dead cell, it should always be turned up for low drain and filament protection.

The antenna coil is the well-known Vario-loopstick. I cut off the 13-inch enamelled wire lead from it and connected its terminal to the auto whip antenna. Tune this coil with the whip extended to its most commonly used length. I have done this with only a single section since this is the length we ordinarily use. The whip is extended to its full length only when needed to overcome the most unfavorable listening conditions.

The oscillator coil is a Miller universal type (unshielded). It is mounted below the small chassis which measures only 4 x 2 ½ x 1 inches. All other coils, including the i.f. transformers, are mounted above the chassis. Disregard the taps on the grid winding of the oscillator coil.

The variable ganged capacitor is a conventional but small superheterodyne unit. It measures about 2 inches along each dimension. The mail-order catalogs show a capacitor that is even smaller than ours by about ½ inch along each dimension. Inquiry in several radio stores failed to locate one, however. Since this capacitor is the largest unit on the chassis, it pays to obtain the smallest one you can find.

The i.f. transformers are Miller K-Tran type. The first is an input, the second an output. We found that they need careful adjustment with a non-metallic screwdriver. Try not to press down while you are rotating the screw setting, since this changes the tuning.

The r.f. alignment is as usual. Tune the Vari-loopstick for maximum signal on a station near 600 kc. Then adjust the trimmer on the antenna section of the dual capacitor while tuned near 1400 kc.

The 1N34 detects the signal and generates a d.c. component in this circuit. On powerful stations the current may go as high as 80 microamperes. During alignment, a microammeter may be inserted in the test jack. Every change in tuning, antenna length, or location of the set will show up by a corresponding increase or decrease in meter reading. This is a great help in getting maximum performance from the set.

Fig. 1—Schematic diagram of the high-gain, low-drain portable radio receiver.
An alternative detector circuit is shown in Fig. 2. This one permits the use of a v.t.v.m. (at the test point) for measuring signal intensity. In this case, a pin jack may be used instead of the phone jack.

The transistors are coupled by tiny transformers; UTC type S03 subouncers. The high-impedance windings connect in the collector circuit in each case. Subminiature “in-line” sockets are used for the CK-722 transistors. The transistor supply is 4.5 volts from penlight cells. This part of the circuit should offer no difficulty. However, for maximum sound output and minimum distortion, you may experiment with the values of each base resistor.

A 3½-inch speaker is used for this set. Smaller sizes are manufactured and could be used. However, it is doubtful they are as efficient and they probably do not reproduce as well. The matching transformer is a type designed for a 6K6 pentode. I was unable to find a miniature type so settled for the smallest conventional unit that could be found.

During experimental work on this circuit a sad accident ruined the tubes. After this, I inserted a 860-ohm resistor in series with the plate battery. This resistor protects the tube filaments by limiting current from the B battery. It was left in permanently after I discovered that it didn’t affect the set performance. It drops the B voltage by about 1 volt.

After using this set a short while I soon discovered that it overloaded on some of the stronger local stations. Several of these are located about 5 miles from me. To eliminate overload, I inserted a large resistance (56,000 ohms) in series with the plate battery. This reduces power input to the tubes by dropping the B voltage to about 25 volts. Due to lower gain, distortion is greatly reduced. Of course, this also cuts down battery drain to a fraction of 1 milliamperre, and greatly extends battery life! A toggle switch shorts out the 56,000-ohm resistor when high gain is needed.

This portable is easy to assemble, convenient to carry about, and is a source of much entertainment. It may be played for long periods continuously without worrying about battery costs, so it is ideal for children to play with.

Fig. 2—Alternative detector circuit.

Like other portables, results may vary sharply from one location to another. For example, one local station came in consistently poor when the receiver was set on a table in my room. I was surprised one day to find that moving the receiver only a few feet away made a world of difference. In many cases, I found that performance is improved when the metal box is grounded. Indoors, this is done by setting the box on a metal cabinet, a radiator, or a grounded appliance. Outdoors, I auto-
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Centralab also has a Junior Compentrol. It is furnished in 1/2 and 1 meg., plain and switch types, for use in radio sets (5 or more tubes, meg., plain and switch types, for pentrol. It is furnished in 1/2 and 1 $4.50. Centralab distributor - net price, $4.50.

I have made tests to determine the end-point to which batteries are still usable. Good reception is possible with a B voltage of about 20 volts and an A supply less than 0.9 volt! At these potentials, the current drain is very small indeed.

This set requires batteries whose total cost is under $1.75, yet they outlive batteries for conventional portables by a factor of 10 to 1 or more. Over a period of many months, or years, this set should prove much more economical than less expensive sets that consume batteries in a relatively short time.

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The formula for frequency is $f = \frac{1}{2\pi L C}$.

6.28/LC.L is the inductance of the tank coil and $C$ is the capacitance across it. This equation is correct if $L$ has negligible capacitance itself. If the coil is closely wound or has many layers, its self-capacitance, $C_s$, will be considerable. In that case $C$ must be added to the capacitance across the coil to make up the total tuning capacitance $C_T$.

Probably the easiest way to measure $C_s$ is as follows. Use a calibrated tuning capacitor to resonate the coil at some frequency $f$ and note the tuning capacitance, say $C_0$. Now tune to the second harmonic ($2f$) and record the new value of capacitance as $C_1$. The basic frequency formula shows that doubling frequency is equivalent to dividing the LC product by 4. When we measured with frequency $f$, the inductance-capacitance product was $L(C_s + C_1)$. When the circuit is tuned to the second harmonic the product $L(C_s + C_2)$ is one-fourth the first product.

Therefore we write $L(C_s + C_1) = \frac{4}{3} L(C_s + C_2)$. Therefore if we know $C_1$ and $C_2$, we can easily determine $C_s$.
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We here at RADIO-ELECTRONICS find it heart-warming to read the many letters of good wishes and encouragement that are written regularly to little Freddie Thomason, armless and legless son of Herschel Thomason, radio technician of Magnolia, Arkansas. Most of these letters accompany contributions to the Fund, and through the generosity of our readers, the Help-Freddie-Walk-Fund has climbed to over $11,300.

Mr. Thomason writes in appreciation: "... this is more than we ever dreamed of, and we appreciate every penny of it. Freddie is still going to kindergarten and likes it a lot. All of the kids seem to get a big kick out of him coming, and they will do anything for him." He has promised to keep us informed of Freddie's progress.

We would like to make special mention of the following donations:

- $85.00 from W. Austin, and $10.50 from Van Ferguson, RADIO-ELECTRONICS authors who turned their checks over to the Fund.
- $1.00 from Bruce Tanner, a boy with cerebral palsy, and Mrs. Lois Roberts, the woman who cares for him, who saw the story about Freddie in the Backboard Review, official paper of "Little Princess" Ranch.
- $19.50 from the Men's Fellowship Class of St. John's Methodist Church, Memphis, Tennessee.
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For five-year-old Freddie to live a normal and productive life, it will be necessary to fit him with mechanical appliances which will enable him to walk and take care of himself. All these cost money—thousands of dollars. Won't you send in your donation whenever you can? No amount is too small to receive our sincere thanks and acknowledgment by letter. Make all checks, money orders, etc., payable to Herschel Thomason. Address all letters to:

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HOW TO INSTALL AND SERVICE AUTO RECEIVERS
by Jack Darr

An expert gives practical, detailed instructions on how to install and service all types of automobile radios. Shows where to run lead-ins, how to install antennas, eliminate noise and gives methods for vibrator testing. Furnishes a complete list of tools, spare parts and other equipment in addition to business procedures for the setting up of an auto radio shop or service department.

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This test bridge is an extremely useful instrument for the service bench. It measures the exact values of a wide variety of capacitors and resistors to 1% accuracy. Capacitors of all types can be tested. The operation is quick and simple.

The basic circuit of the resistance section is a Wheatstone bridge, shown in Fig. 1. R, is the unknown resistor, \( R_s \) is the variable resistor (dial), \( R_c \) is the resistance standard, and \( R_r \) is the range resistor. The generator is an audio transformer that delivers 60-cycle a.c. to the bridge. When the arms are balanced there will be no voltage between points A and B. This is a null condition. On either side of this condition voltage will appear, due to the unbalanced condition of the resistance arms.

A similar arrangement is used to measure capacitance. The bridge circuit of Fig. 2 is almost the same as that of Fig. 1 except that two arms contain capacitors instead of resistors. \( C \) is the unknown capacitor, \( C_s \) is the standard. \( R_r \) balances out the resistive component of \( C \). These circuits combine nicely since \( R_r \) and \( R_r \) are the same in both bridges. A d.p.d.t. switch is used to change from one circuit to the other.

The complete schematic is shown in Fig. 3. A 1:3 audio transformer provides the 60-cycle bridge voltage. The secondary is the high-impedance side and provides a voltage step-up. To increase the impedance of this source, resistors \( R_2 \) and \( R_3 \) are inserted. Resistor \( R_1 \) loads the transformer and reduces the no-load voltage to about 200. The source voltage should be poorly regulated so that with a small resistance across the terminals the voltage will be reduced to a safe value. At times there may be as little as 5 ohms in the circuit.

The calibrated dial of \( R_{13} \) serves for both resistance and capacitance measurements. This potentiometer should have a linear taper and should be wire-wound. Another bridge, ohmmeter, or resistors of known accuracy should be used to calibrate the dial directly in ohms. This should be done before \( R_{13} \) is connected into the circuit. The accuracy of the completed bridge is dependent upon this calibration, so every effort should be made to obtain an accurate dial marking.

\( R_4 \) through \( R_9 \) are 1% tolerance, 1-watt resistors. In the author's instru-

Easy-to-build instrument measures resistance and capacitance with a high degree of accuracy

By ALAN G. SORENSEN

Front view of R-C test bridge. Main dial must be carefully calibrated.

Photo shows underchassis view of bridge. Layout of parts is not critical.
The lower values were wire-wound resistors. R11 is the resistance standard and should also be 1% or better. Capacitor C1 is the capacitance standard and must be within 1%.

R12 is the power balance or power factor control. In most commercial bridges this control is calibrated in power factor percentage. However, for a general-purpose unit, there is no real power factor percentage. However, for bridges this control must be within 1%.

Capacitance which would otherwise appear external inductance bridge.

A switch and jack were provided so that the amplifier and tuning-eye null indicator might be used with an external inductance bridge.

Construction

The construction is simple and straightforward. A heavy wire should be used for the bridge itself and stray capacitance should be kept to a minimum. Parts placement is relatively unimportant; most any layout could be used. An ICA 3926 grey cabinet, National knobs, and a chrome stripe for decoration (ICA 3513) were used to provide a matching and neat-looking instrument.

The terminals are small ceramic feed-through insulators to reduce stray capacitance which would otherwise appear in parallel with the capacitor under test. These were later replaced with the new General Radio 938 terminals. The stray capacitance across the terminals in the original instrument was 3-µµf. This must be subtracted from the dial reading when measuring small capacitors. The final requirement is to very accurately calibrate the main dial directly from R13 in ohms.

Operation of the completed bridge is quite simple and quick. After a couple of minutes warmup, the null eye glows a bright green, and the instrument is ready.

4. Advance the AMPLIFIER GAIN control slightly so that the null eye is at null. The amplifier gain control may then be adjusted for the sharpest null. By reading the value shown on the main dial and multiplying it by the RANGE switch setting, the value of the resistor under test, in ohms, may be determined.

Capacitance:

1. Set the function switch to CAP.
2. Set the RANGE switch to a range that will include the capacitor under test. If the approximate value is unknown, try all ranges one by one.
3. Connect the unknown capacitor to the instrument terminals. A pair of very short test leads may be used.
4. Advance the AMPLIFIER GAIN control slightly so that the tuning eye will show only a small wedge of black.
5. Slowly turn the main dial and watch for an eye opening. When the eye is at its widest point the bridge is at null. The amplifier gain control may then be adjusted for the sharpest null.
6. Adjust the POWER BALANCE control to a position where the null is stable. The amplifier gain control may be adjusted during the test. If the approximate value is unknown, try all ranges one by one.
7. Connect the unknown capacitor to the instrument terminals. A pair of very short test leads may be used.
8. Advance the AMPLIFIER GAIN control slightly so that the null eye will show only a small wedge of black.
9. Slowly turn the main dial and watch for an eye opening. When the eye is at its widest point the bridge is at null.

Materials for Test Bridge

Resistors: 1-1,000, 1-2,000, 1-2,500, 1-5,000, 1-10,000 ohms; 1-1 megohm, 1 watt; 1-10 megohms, 1 watt; 1-100, 1-1,000, 1-10,000 ohms.

Capacitors: 1-0.01 µf, 1% mica; 1-0.1 µf, 400 volts; 1-220, 220 volts; 1-10,000, 1-100,000 volts.

Miscellaneous: 1-power transformer, 500 volts c.t.; 1-3.3 volts of 2 amp.; 1-12 steps audio transformer; 1-357, 1-357, 1-5Y3-GT, tubes; 1-off power switch; 1-400 d.c. switch; 1-1 p.f. toggle switch; 1-tuning-eye assembly; 1-pilot light and assembly; 1-1 amp fuse and holder; 1-test terminal (General Radio 938); 1-cabinet 8 x 12 x 8 inches (ICA 3926); 1-chassis 7 x 9 x 2 inches; 1-socket; 1-calibrated dial; knobs; sockets; line cord; hardware, wire, etc.

6. At null, adjust the POWER BALANCE potentiometer to broaden the null and reduce any fuzziness. Readjust the main dial for the sharpest null. The amplifier gain control may have to be readjusted.

7. The value of the capacitor may be determined by multiplying the value shown on the main dial by the RANGE switch setting.
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1. A super-seal keeps the electrolyte from evaporating even under the toughest conditions of heat and humidity.
2. All these capacitors are aged at 85°C to build a tough dielectric film that will stand up under high heat.
3. All aluminum container prevents the “creeping” corrosion that occurs in capacitors when any other metal is permitted to contact the electrolyte.
4. Sangamo electrolyte is really pure. Continuous laboratory control of every batch keeps the chlorine ion concentration to less than 10 parts per million. That’s 99.999% pure, or better!
5. No lead breakage. Sangamo uses a special wire that resists bend fatigue. A specially designed rivet that "cradles" the lead gives additional protection.

P.S. These wire lead tubulars fit those tight corners—Their compact design gives maximum capacity in minimum space. See your Sangamo Distributor for all your capacitor replacement needs.

SANGAMO ELECTRIC COMPANY
MARION, ILLINOIS

TEST INSTRUMENTS

taken from the main dial and the RANGE switch.

<table>
<thead>
<tr>
<th>Range</th>
<th>Resistance</th>
<th>Capacitance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 ohm to 10 ohms</td>
<td>10 to 100 µf</td>
</tr>
<tr>
<td>2</td>
<td>10 ohms to 100 ohms</td>
<td>100 to 1000 µµf</td>
</tr>
<tr>
<td>3</td>
<td>100 ohms to 1,000 ohms</td>
<td>.001 to .01 µf</td>
</tr>
<tr>
<td>4</td>
<td>1,000 ohms to 10,000 ohms</td>
<td>.1 to 1 µf</td>
</tr>
<tr>
<td>5</td>
<td>10,000 ohms to 100,000 ohms</td>
<td>1 to 10 µf</td>
</tr>
<tr>
<td>6</td>
<td>100,000 ohms to 1 megohm</td>
<td>10 to 100 µf</td>
</tr>
<tr>
<td>7</td>
<td>1 megohm to 10 megohms</td>
<td>10 to 100 µf</td>
</tr>
</tbody>
</table>

The table shows the ranges covered by the instrument.

TRANSISTOR LAYOUT BOARD

Saves Experimenting Time

When experimenting with transistor circuits you will find that this breadboard layout will save you hours of work. After wasting many hours soldering and unsoldering connections, I figured that there must be an easier way. There is.

Cut a 4-inch square from sheet bakelite, % or 3/4 inch thick. Drill eight holes for the Fahnestock clips and four holes for the mounting feet. The holes for the transistor mounting clips are 120° apart on the circumference of a circle having a radius of % inch. Assemble the clips and feet as shown in photograph. This panel provides for straightforward wiring. In a matter of seconds you can change any part of the wiring. By reorienting the socket you can change the basic circuit from grounded-base to grounded-collector or grounded emitter. Transistor socket leads should be spaced 120 degrees apart so that they will fit directly into the clips. I used General Cement No. 6302 clips, 11 inch long. Fahnestock No. 533 clips are the same size and may be used. If you have larger clips on hand, you can use them on a little larger panel.

If you have ever experimented with different circuit arrangements, you will appreciate this layout. With transistors becoming more available, new applications will be developed requiring experimentation.—J. R. Steen

P.S. These wire lead tubulars fit those tight corners—Their compact design gives maximum capacity in minimum space. See your Sangamo Distributor for all your capacitor replacement needs.

Those who know choose Sangamo

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SC54-V

RADIO-ELECTRONICS
**DISPLAY IN ELECTROTHERAPEUTICS**

The scope display gives the surgeon immediate visual information

**By F. J. G. Van Den Bosch, D. Sc.**

**At the International Congress of Anestiology held in Paris during 1951, there was a discussion on the apparatus for the automatic application of anesthesia developed by Dr. R. G. Bickford at the Mayo Institute. (See “Brain Waves Control Anesthesia” in the November 1950, issue of Radio-Electronics.)** This apparatus is based on the use of the electrical activity of the brain. By this is meant the frequency and amplitude of the electroencephalographical waves. Dr. Bickford’s equipment is an important development in the use of the electroencephalograph (EEG) as a powerful instrument for neurologists.

The apparatus described by Dr. Bickford (Fig. 1) consists of a 3-stage capacitance-coupled symmetrical amplifier. Its output is fed into a 6AG5 pentode that is biased to cutoff so it acts as a rectifier and amplifier. Potentiometers in the cathode circuits adjust the cutoff point and one in the grid circuit regulates the amplitude of the input. A 0-1-ma meter in the plate circuit measures the average current and indicates the average electrical level.

When the 6AG5 is conducting, C1 charges until its potential is high enough to unblock the 6SN7-GT one-shot multivibrator. The multivibrator discharges C1 and produces a pulse which fires the 2D21 thyratron. Thus the electrical energy level of the brain is transformed into a series of pulses that increase in frequency as the energy level increases.

The thyratron fires, it conducts momentarily and produces a pulse in the coil of the stepping relay where it is integrated and shifts a wheel a fraction of a turn. This wheel controls the syringe mechanism used to administer the anesthetic. Since the brain-energy level decreases with the depth of anesthesia, it is possible to regulate the instrument to stabilize anesthesia to the desired level, and keep it there as long as needed.

EEG (electroencephalographic) readings show that before the application of anesthetic, the average brain-wave frequency is about 20 cycles, with a relatively small amplitude; with the onset of anesthesia the amplitude increases while frequency decreases. As anesthesia progresses the frequency settles at about 2 cycles per second and amplitude diminishes gradually with the anesthesia. When a waveform no longer appears on the recorder or scope, it corresponds to a grave inhibition of the brain. It appears that no electrical activity corresponds to death.

When my attention was called to the Mayo and Bickford publications, I was very much interested, as I had already done some work with electronic equipment for operating theaters. Recently I used with considerable success a visual and acoustical aid for display of electrical activity of the heart muscles (electrocardiograms) during a surgical operation. The apparatus was...
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Fig. 4—The schematic diagram shows circuits used in vertical amplifier for a scope for electrocardiograms and electroencephalographic displays.

Fig. 5—Electrocardiographic (EKG) and electroencephalographic (EEG) recordings. The EKG traces are shown in the top rows and the EEG’s are below.

a Cossor type 1049 oscilloscope paralleled by a low-frequency amplifier with a loudspeaker.

Both these were fed from a pre-amplifier that I designed for the purpose. Its circuit is shown in Fig. 2. The first two stages are direct-coupled 6SQ7’s, and the third is R-C coupled and uses a 6J5. When used with the Cossor oscillograph it is advisable to
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Now produce UHF signals for TV receiver tests at a fraction of the cost of a UHF generator. Individual calibration guarantees extreme accuracy of UHF frequency. Any VHF signal generator output at 60 MC is converted by the PHILCO Model G-8000-C to UHF. The VHF sweep or marker signal beats against the UHF oscillator, producing UHF signals with the same characteristics as the VHF input signal. It's economical... it's a PHILCO exclusive!

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MARCH, 1954
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There is really a third reason—CUSTOMER SATISFACTION—which results from the combination of better electrical and mechanical performance of AMPHENOL antennas. Customer satisfaction with better viewing results in better business for all.
use the capacitor shunted by a resistor in the input lead from the electrocardiograph.

Interference and artifacts

I could not see how, in the Bickford apparatus, it would be possible to cut out all the unwanted voltages produced by radiations, bad grounds and noisy power lines. I had been greatly troubled by various types of electrical interference and artifacts during the operations I had assisted in with my equipment. By grounding all apparatus, as well as the operating table, and by using coaxial as input leads, I was able to get trouble-free electrocardiograph recordings when the patient was at rest and no one was touching him (that is: before the actual operation began). Fig. 3 is a small portion of an electromyogram (recording of electrical muscle activity) taken on a patient before being anesthetized or operated. It was of the left arm muscle. At the bottom appears as a reference marking, the 50-cycle line frequency.

Having experienced interference even with the anesthetist, I applied grounding techniques to him. But when the surgeon started operating there was a kind of interference that varied according to whether he was only touching the body, shifting organs, or cutting into them. In my view this kind of interference cannot be avoided.

On several occasions during surgical operations I have been able to ascertain that nerves continue to react in a normal manner though the patient is under a heavy anesthetic. It is quite logical that, for example, nerve cells and fibers dealing with pain will continue to act—if situated on a healthy part of the body—and transmit their messages to the brain. There these messages will be detected and the brain—although under anesthesia—must produce some electrical reaction. And this reaction will certainly translate itself on the EEG. This is apart from the fact that the surgeon may manipulate nerve fibers and thus induce amorous voltages whose peaks will certainly drown out the EEG. With all this in mind I was anxious to see what use we could make of the equipment designed by Dr. R. D. Bickford. The first step was to build a suitable cathode-ray oscilloscope with two equally balanced amplifiers to enable me to get on one trace the EEG and on the other trace the ECG (electrocardiogram) as a control. The double trace would be obtained with a multivibrator switch.

The circuit of the amplifier is shown in Fig. 4. The first two tubes (V3, V4, V5, V6) are two 6SL7's. They are followed by a 6AK5 on each side. Switches S1 and S2 enable V3 and V4 to have 6J7's as cathode bias resistors. Switch S3 allows insertion of a capacitor to provide the necessary time-constant.

I followed several operations and show in Fig. 5 three of my recordings. These were selected for their interferences, but since the recordings were taken at a rate of 6 cm per minute

FROM THE LABORATORIES OF AMPHENOL comes a new concept in lightning arrestors, designed not only to protect the television receiver from the hazards of lightning but to give full protection to the signal strength as well. This is the new model 114-328 AMPHENOL Lightning Arrestor, the result of long months of research by skilled engineers. This Arrestor's low-loss performance means better picture quality—VHF or UHF. Its unique design assures easy installation—a sure-grip of flat, tubular or open-wire lead-in.
they involve quite sufficient time for a device like Dr. Bickford's integrator to administer too much anesthesia.

No EEG waves can be seen (the recordings were taken at too low a speed) and only the amplitude is shown as a thick line. Frequency can be followed, however, if displayed visually the same as the variation in amplitude of the EEG, but I made the recording at a very low speed to show the length, continuity and degree of interference which would make it difficult—or impossible—to work any equipment automatically from pure EEG activity during a surgical operation.

What we found however was that we had a very good visual aid to guide the anesthetist in administering anesthesia, just as the electrocardiograph helps the surgeon greatly with its acoustical aid, once he has trained himself to use its various sounds to ascertain not only the cardiac and respiratory condition, but also the traumatic condition of his patient. The EEG displayed on a cathode-ray tube is also a good indication of the patient's narcotic condition.

Friends have suggested that—to reduce interference—I might even "ground" the surgeon. That would present almost unsurmountable difficulties and would not eliminate interference. From my own experience, I fail to see how Dr. Bickford's apparatus—though an ingenious device which certainly has its uses—could be operated efficiently during a surgical operation, since interference (or artifacts, if you prefer the term) would dominate the voltages developed by the EEG. I have come to believe that it would be unwise to try to design automatic electronic devices which would, with the aid of voltages produced by the patient during surgical operation for use in the operating theater.

**Display needed**

Indicating electronic devices are sadly lacking and no doubt will render immense service in the future, and in my opinion, research and development in the physical and electronic field should—at this stage—be directed toward indicating instrumentation rather than the operative apparatus.

I am still of the opinion that certain techniques applied by electronics in other fields should be applied to the medical field. For example, in the early days of radar, all the display then considered necessary was a cathode-ray tube as indicator; display had a controlling effect on radar by the end of 1945. Similarly what is required in medicine is display. As a start why not have all the different EEG channels displayed at once on a single C-R tube? That should present no difficulty to a good electronic engineer. With a 10-way electronic switch controlling the tubes which supply the vertical plates (there must be one final tube for each channel) while at the same time controlling the input tubes, it should be possible to present 10 channels simultaneously. This can be achieved with a frequency of about 20
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MARCH, 1954

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A remarkable value! 6 tubes are used in the IF amplifier: (2) 6AU6 1st IF, (2) 6AU6 2nd and 3rd IF's, (2) 6AU6 limiters and 6AL5 discriminator. High gain, wide-band response (200 KC) for highest fidelity, 20 to 20,000 cycles. Distortion less than 1/2 of 1%. Drains 40 ma @ 220 volts. Chassis plate dimension: 11 3/4" x 2 1/2". Shipping weight: 3 lbs.

FM Tuner Kit

$15.25

FM-11 tuner is available in kit form with the IF Amplifier mounted in the chassis, wired and tested by us. You mount the completed RF Tuning Unit and power supply, then after some simple wiring, it's all set to operate. 11 tubes: 6J6 RF amp, 6AG5 converter, 6C4 oscillator, 6BA6 1st IF, (2) 6AU6 2nd and 3rd IF, (2) 6AU6 limiters, 6AL5 discriminator, 6AL7-GT double tuning eye, 5Y2-GT rectifier. Sensitivity 6 to 10 microvolts, less than 1/2 of 1% distortion, 20 to 20,000 cycle response with 208 variation. Chassis dimensions: 12 1/2" wide, 8" deep, 7" high. Illustrated manual supplied. Shipping weight 14 lbs.

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The original 15 tube deluxe FM/AM pre-fab kit. Redesigned on a smaller chassis. The tuner now measures 14" wide by 12" deep by 7 1/4" high. This attractive new front and dial assembly opens up new applications where space is at a premium. Kit includes everything necessary to put it into operation - puched chassis, tubes, wired and aligned components, power supply, hardware, etc. Kit comprises FM-3 tuning unit, IF-6 amplifier, AM-4 AM tuning unit, magic eye assembly and complete instructions. All tubes included. Shipping weight 19 lbs.

AM-4 Tuning Unit

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Tops in AM superhet performance! A 3-gang tuning condenser gives 3 tuned stages with high sensitivity and selectivity. Assembly is completely wired, tested and aligned ready for immediate use. Frequency coverage 540 KC to 1650 KC at a sensitivity of 5 microvolts. Tubes: 6BA6 RF amplifier, 6ARE converter, 6BA6 IF amplifier and 6AT6 detector. Drains 30 ma @ 220 volts. Mounts on a chassis plate measuring 4" x 7 1/4". Shipping weight 2 1/2 lbs. Dial available at $3.85.

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Model 690
Marker Generator
Crystal controlled. High .25 volt R.F. output. Provides dual markers with any TV sweep generator. This unit features an electronic eye-directly incorporating a Non-Parallax shadow type dial. In conventional type dials, error generally is introduced in setting frequencies since the baseline or indicator is at a slight distance from the scale. This distance, however slight, can introduce error if the scale is not viewed directly at right angles.

In alignment of any type of receiver, the marker generator is the unit that is to be relied upon and must therefore be consistently accurate in frequency settings. The Hickok Non-Parallax dial can be viewed from any angle without introducing error. The 45 inches of dial can be self calibrated within crystal accuracy (.05%) since the unit includes a self contained crystal calibrator.

Leading features of this unit are:
1. The simple and time saving method employed in calibration of the dial—there is no counting of beats—no interpolation—no remembering of frequencies.
2. Provision for calibrating any other signal generator to crystal accuracy.
3. Complete R.F. coverage up to and including channel 83. All channels have picture and sound settings marked directly on the scale—this eliminates checking on another instrument.
4. The marker can be modulated with a self contained 400 cycle signal. This is especially valuable in stage-by-stage alignment and eliminates the introduction of another instrument.

Model 691
Heterodyned Marker Adder
This unit, in conjunction with the Model 695 Sweep Generator and Model 690 Marker Generator provides the utmost in television alignment techniques. It takes the guesswork out of receiver alignment and eliminates many errors previously introduced by overloading due to markers. The 691 provides a marker visible at all times (including trap points) and will not change in amplitude or distort the response curve whatsoever. This feature, in addition to the accuracy and minimum leakage of the other units (690 - 695), will greatly simplify any alignment.

The outputs of the sweep generator and marker generator are heterodyned and applied to an oscilloscope in such a manner that the marker signal will never pass through the receiver itself—therefore cannot cause overloading.

In short, we can say that we are calibrating the oscilloscope with a marker which is visible at all times—even on the base line.

The 691 is specifically designed as a companion to the HICKOK 690 Marker and 695 Sweep Generator; however, it will work well with any of your present equipment that has an output of 50,000 microvolts or more.

Many leading TV engineers have tested this new Hickok equipment and highly compliment its frequency, stability and ease of use. Today's fastest, most complete and accurate solution to TV alignment tasks. See your jobber today or write factory direct for complete technical information.

Model 695
Sweep Generator
This is a completely new electronic sweep generator that will exactly fill top requirements of the professional TV serviceman. There are no moving parts to produce vibration or to wear out. This unit, although moderately priced, features a sweep signal that is absolutely linear and without amplitude modulations.

This unit has technical advantages over other sweep generators because:
1. The unit is completely triple shielded to assure a minimum of leakage from the unit as is engineerly possible. It is possible to attenuate the signal down to 3 microvolts, and the unit has a maximum output of 300,000 microvolts.
2. A bias voltage, variable from 0 to 12 volts, and metered directly by the voltmeter on the front panel, eliminates the usual time-consuming method of obtaining bias voltage from dry cells. Since this bias varies with variable with continuous tuning, one can determine more accurately the effects of bias on the overall response curve and can align sets more sensitive for "Griggs area" reception or align them to prevent "overloading" when the station signal is very powerful.

3. Two sweep generators provide complete VHF coverage (Channels 2 - 13) on fundamentals and heterodyned output IF frequencies 0 - 50 Mc. This assures a strong signal necessary for accurate alignment of "Front ends."

4. Continuous tuning and an easy-to-read scale marked off in channels literally provides the serviceman with a fool-proof method of alignment.

5. An internal method of "retrace blanking" provides a reference base line and eliminates confusion sometimes brought about by retrace curves.

6. Even though the sweep width is varied, it will not be necessary to readjust the phasing control.

7. As is common to all Hickok Signal generators, a Standby position is incorporated in which the plate voltage is removed from all the tubes leaving all voltages alone to keep the unit at a constant temperature and ready to operate the moment the Range Selector Switch is rotated.

8. The instruction manual accompanying the unit gives complete, detailed and easy-to-follow instructions on correct alignment procedures, reception of the instrument, and a thorough understanding of alignment.

All of these features have been developed with the TV serviceman in mind.

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THE HICKOK ELECTRICAL INSTRUMENT COMPANY

MARCH, 1954

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▲ Fifty-four in '54! 243 scientific and engineering papers will be presented, skillfully grouped by related interests into 54 technical sessions. More than half these sessions are organized by IRE Professional Groups, thus making the IRE National a federation of 21 conferences in one. The whole provides a practical summary of radio-electronic progress.

▲ 600 Exhibitors "spotlight the new!"—A mile and a half of exhibits line the avenue of this show, intriguingly named for the elements of radio—such as "Instruments," "Components," "Airborne," "Radar," "Transistor," "Audio," "Microwave," etc., filling the four acres of the great Kingsbridge Armory to capacity. An expanding radio industry shows why it is growing by proving how engineering research pays out in new products. The exhibits themselves are an education, condensed to one place—reviewed in four days.

▲ Kingsbridge is the solution! Only the combined facilities of the Waldorf-Astoria Hotel, plus the three great halls in the Kingsbridge Armory, seating 906, 720, and 500 respectively, are able to keep pace with the increased technical papers program of the IRE Convention. The show had to move because the U. S. Treasury took over Grand Central Palace. The immense Kingsbridge Armory, connected to the very satisfactory Lexington Avenue Hotel area by direct express subway, serves well to expand the already outgrown exhibit facilities of the Palace and provide space for 200 new firms to exhibit, as well as seat greater audiences at the high-interest sessions. In addition to the subway, free busses leave the Waldorf every ten minutes in which you may travel in the congenial company of fellow engineers, direct to Kingsbridge.

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This established radio & television manufacturing firm in Western New York has openings for:

Test Engineers
Technicians
Trouble Shooters
Aligners

Applications should contain details of past experience. Write to

Personnel Manager, H. E. Dudley
STROMBERG-CARLSON COMPANY, Rochester 3, N. Y.
Are you satisfied with the position you now hold? Do you feel you're worth more money? Are you pleased with yourself, your work, your associates... and your future? What does the next year hold for you... and the year after that?

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

If you are looking for a REAL opportunity... If you want to grow with a GROWING INDUSTRY... If you want to grasp the success that should be yours, then we say to you, study TV Servicing.

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

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

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

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

It costs so little to gain so much
RCA Institutes makes it easy for you to take advantage of the big opportunities in TV Servicing. The cost of the TV Servicing Home Study Course has been cut to a minimum. You pay for the course on a pay-as-you-learn unit lesson basis. No other home study course in TV Servicing offers so much for so little cost to you.

SEND FOR FREE BOOKLET—Mail the coupon—today. Get complete information on the RCA INSTITUTES Home Study Course in Television Servicing. Booklet gives you a general outline of the course by units. See how this practical home study course trains you quickly, easily. Mail coupon in envelope or paste on postal card.

MAIL COUPON NOW!

RCA INSTITUTES, INC., Home Study Dept. RE354
350 West Fourth Street, New York 14, N. Y.

Without obligation on my part, please send me copy of booklet "RCA INSTITUTES Home Study Course in TELEVISION SERVICING." (No salesman will call.)

Name ___________________________ (please print)
Address ___________________________
City ___________________ Zone ______ State ____

RCA INSTITUTES, INC.
A SERVICE OF RADIO CORPORATION of AMERICA
350 WEST FOURTH STREET, NEW YORK 14, N.Y.

MARCH, 1954
WE SPECIALIZE EXCLUSIVELY IN TUBES RECEIVING—TRANSMITTING—SPECIAL PURPOSE

The only thing we handle (is TUBES) of every kind and description—serving the industry for years. Thus, we can give you a more comprehensive selection of types and sizes. Advantages for you are many. All our tubes are commerically tested. From amongst the 3500 different types we have in stock, for immediate delivery, we can supply you with the nearest to any of the common types. These you will find a sampling of our immense variety—therefore we urge you to order any other unlisted types.

Minimum order 5% (please include 25% with order).

All tubes individually boxed. Prices F.O.B., our warehouse, New York City.

FREE: Send for our latest listing.

WE MAKE SURE YOU'VE GOT TO "LICK" THAT NEXT JOB MAKE SURE YOU'VE GOT WHAT IT TAKES! XCELITE PR "99"

AND! It's Now Available with Detachable Reamer! Tops in shops, and "out" on gobs of jobs, the "99" has all it takes! Contains 13 quick-change nut drivers and regular and Phillips screw-drivers, all fitting that husky, man-sized Xcelite handle. (Now more useful than ever with the new Xcelite super-hard-handle!) and a complete "tool chest" you can take with you—a real buy at only $1.95, less your discount.

To Order: 50c each, plus 5c for post. XCELITE INCORPORATED, Orchard Park, N. Y.

OPPORTUNITY ADLETs

Rates—5¢ per word (including name, address and initials). Minimum ad 10 words. Each must announce all ads except those placed by accredited agencies. Discounts, 10% for 10 consecutive issues. Misleading or objectionable ads not accepted. Order for May issue must reach us before March 31, 1954.

Radio-Electronics, 25 W. Broadway, New York 7, N. Y.


QUADRADO RIA 45s TELEVISION 50c. Give make and model. Diagram Service, Box 672-IE, Hart- ford, Conn.

TUBE AND RADIO, TRANSMITTING, AND SPECIAL PURPOSE TYPES BOUGHT, SOLd, AND EXCHANGED. Send for free catalogue on new and used instruments at a savings. Hamilton In- strument Co., 148 Liberty Street, New York, N. Y.


DYNIS WHOLESALE—50c ITEMS—CATALOG. Mathews, 1506 Broadway, New York 2, N. Y.

INSTRUCTION BOOKLET FOR NEW TWIN CRYSTAL radio set worth $50 or more. By expert. Potential Radio Company, 446 Crown Street, Brooklyn.

ALPHEX cOORDINATOR, ANGLE AND CHANNEL. Plain and perforated sheet. William Rudolf, Fairlawn, Ohio.

AMATEUR RADIO IN FUN, Fifty Pages. Easy to understand. code and theory for Novice Class license. $1.00 Satisfaction Guaranteed. Radiographic, 2906 North Green River, Chicago, Illinois.

COMPLETE TELEVISION BROADCASTS, 4c each. 145 South Boulevard, Arlington 4, Virginia.


THE SERVICE RUNAROUND

Radio-Electronics will be happy to print future contributions similar to the ones below, giving personal experiences of radio and television technicians. We shall pay $10 for each contribution used by this department. The contribution may be either serious or humorous, but should be an actual experience encountered by a service technician.

Add any contributions to:

Editor, The Service Runaround

25 West Broadway

New York 7, New York

A DOCTOR'S APPOINTMENT

Our doctor-customer was angered by the non-performance of his video set and was too busy to make an appointment so that a service technician could see the set. He berated us and the receiver we'd sold him. Meantime his warranty was running out and we didn't want to be in a position where we might be suspected of delaying repairs till a set was out of warranty.

Finally we had one of our men, who was unknown to the doctor, call him up as a patient and make an appointment. When the repairman got to see the medico, he told him he was then to look at the set, and asked him how much time he allotted a patient and what his office fee was.

The doctor said he generally figured on 20 minutes per patient, so our technician went to work and luckily spotted the trouble in the allotted time. He handed the doc the regular fee, but the doctor handed it back with a smile and complimented our man on his novel approach.—Harvey Miller

RUNNING WATERS

This opus could be called "The Case of the Running Water." It happened in the East End of Montreal.

During the freezing months of winter we received a call from a customer. Our repairman who answered their plea for assistance was one of our more highly skilled technicians, as the customer's home was some distance from the shop and we didn't particularly relish a return engagement, nor was it practical at that time. Upon arrival, the technician inquired of the trouble and was told the set "hissed" (which we thought was not unusual, considering the programs it was receiving), but try as he might, the thing just wouldn't work. Several days later the hissing returned and there came another complaint.

The set was under guarantee but the expiration date was close at hand and we thought it possible that the customer who was using up time and money to have his set thoroughly checked. But he had never been a nuisance before and we couldn't falsely accuse, so we told our way back through another snowstorm. Of course, upon arrival the cupboard was bare. No hissing, no boiling, no nothing. Just a clear, sweet picture. "But it hissed at eight o'clock last night," he protested, "and it did it the..."
"Color Television is here—not around the corner, or in the developmental labs, but here! The big question now is... Are You ready for Color TV?

"You may now have a successful TV servicing business. When color sets come to your bench for servicing, will you be able to handle them?

"Color Television is a vast new field, embodying entirely new concepts... principles of light and vision, radically new circuitry."

First Home Study Course in Color TV

Now is the time to prepare. Now, for the first time, you can train yourself for the opportunities in this brand-new field. The just-announced RCA Institutes Home Study Course is the first home study course covering all phases of color television. Offered only to those already experienced in radio-television servicing, it explains the "why" of basic theory, as well as the "how-to-do-it" of servicing techniques.

Planned and written by RCA instructors, the entire course is based on the practical experience of RCA engineers—the men who have pioneered in the research and development of color television since the very first color experiments, many years ago.

RCA Institutes conducts a resident school in New York City offering day and evening courses in Radio and TV Servicing, Radio Code and Radio Operating, Radio Broadcasting, Advanced Technology. Write for free catalog on resident courses.

Remember when black-and-white television first became a reality? Overnight, the demand for men who knew television grew. Even now, a shortage of qualified servicemen exists. Think, then—of the even greater demand for servicemen who will understand the many additional problems of color reception!

Costs so little to gain so much

RCA Institutes makes it easy for you to prepare yourself now for color television. Not only is the cost of the home study course for qualified servicemen extremely low, but you pay for the course on a pay-as-you-learn basis.

Send for FREE Booklet—Mail the coupon, today. Get complete information on the RCA INSTITUTES Home Study Course in Color Television. Booklet gives you a general outline of the course lesson by lesson. See how thoroughly you can learn Color TV.

MAIL COUPON NOW!

RCA INSTITUTES, INC., Home Study Dept. RE-354
350 West Fourth Street, New York 14, N. Y.

Without obligation on my part, please send me copy of booklet "RCA INSTITUTES Home Study Course in Color Television." (No salesman will call.)

Name: ____________________________
Address: _________________________
City: _____________________________ Zone: ______ State: ________________
Here is a list of parts useful for many, many applications. Which if furnished individually would regularly cost many times the Low Fries we show, such as Amplifiers, Transformers, Remote Controls for Electric Blankets ... but now available at a mere fraction of original cost because the maker had more controls than he might have assembled thus partly assembled—can be modified for various remote control uses or fully taken apart for the high quality parts alone.

Others offer these identical units as Big Barains, and truly so, all up to double our prices. Order from B.A. Now whilst they last at the Ridiculous Low Prices below.

Complete Assembly, including 1-6SL7GT, 1-6SN7GT, 1-G120 and Plastic Cabinet as pictured...

No. 1AB3 $2.88 Each
Special Each $2.50
* No. 1AB1B as above, except of tubes and cabinets.
Special Each $2.50

FREE! WRITE US IF YOU DON'T HAVE B-A's 1954 CATALOG LOG NO. 541.

THE SERVICE RUNAROUND

night before!" We decided to remain until eight o'clock, nine o'clock, ten o'clock ... and then came eleven o'clock. No hiss tonight.

We became rather fond of the customer (he always served beer during our visits). We felt if the set really was hissing, then we must maintain our professional reputation the trouble must be eliminated.

We therefore removed the set, installed it on the test bench in the shop and instructed the shop personnel ... "Make this set hiss." We neglected to ask our customer if he could somehow represent the sound of the hiss, either with his mouth or some instrument. So we amended our foolish error by telephoning him and asking that question. Yes, if we would turn the water tap open and let the water run slowly, then we would have an exact reproduction. We turned on several taps, and finally found one that sounded like a perfect corona discharge. "O.K., boys, look for a corona discharge," we said. But said in relation, not in relation.

We crossed our fingers, and without calling for an appointment drove to the customer's home with the set. (We may as well mention it was again snowing.) When we arrived his wife apologized for the condition of the kitchen where the set was normally installed. "Just cannot dry in the snow you know ... cotta dry all the kid's diapers in the kitchen . . . ."

"Ha, ha! So your television set has been hissing, eh?" we asked. "Well lady, you can grow orchids in your kitchen with this humidity . . . ."

And so ends our tale. It was so hot and humid that the insulation broke down within the set and caused a perfect corona. Naturally it didn't hiss while we were insulated and didn't want us to see diaphone streamers over the kitchen, she refrained from washing at the times of our service calls. Hence no humidity.—J. S. Birnbaum

MERRY CHRISTMAS

During the Christmas season a customer phoned and complained that the set was going on and off. I went out on the call and sure enough, just like the tick of a clock, the set went on and off. I suspected a bad connection and listened carefully for peculiar sounds like intermittent arcing. I did not detect anything unusual, so I connected an a.c. voltmeter across a.c. interlock socket. Sure enough, up and down went the meter pointer. This was a new one on me.

I had been admiring the flashing ornamental lights on the Christmas tree when I suddenly noticed that they flashed on and off with the receiver. Then it hit me! I checked the set's line cord and found that it was plugged into the light fixture! We had a good laugh, then I cleared up the trouble and left.—Harold F. Palmer

A MEATY ONE

During World War II, a lot of old receivers with 24-A's were dropped out
JFD JetOMIC

Produces brilliant deep fringe UHF performance—plus. Produces heretofore unachieved gain of:
Staked* UHF Rhombic on Channels 14 to 83.
Stacked Jet conical on every VHF Channel 2 to 13.
Featuring exclusive no-loss isolation network—Only 1 lead to set.
Model Jet 454 Single $16.50 list
Model Jet 454 S* Stacked 34.50 list
* complete with stacking transformers

Guaranteed to out-perform any other VHF or UHF-VHF antenna. Both units factory pre-assembled with renowned Jet-action all-aluminum construction. Write for Forms 230 and 241.

the most powerful

JFD SUPER-Jet

Delivers Spectacular Deep fringe VHF performance—plus. Packs Unprecedented gain of:
Single 10-Element VHF Yagi on each channel from 2 to 13.
Stacked UHF Bowtie—Reflector off side lobes on Channels 14 to 83.
Model Jet 213 Single $20.75 list
Model Jet 213 S* Stacked 42.50 list
* complete with stacking transformers

in antenna history!
HOW CAN I, A Dealer, GET TO THE BOTTOM OF THIS BIG CONTROVERSY OF "WHOSE ALL-CHANNEL ANTENNA OUTPERFORMS WHOSE?"

DO AS THOUSANDS OF OTHER DEALERS ARE DOING...

Test the super "KATYS" Yourself!

Find out for yourself, in your own area, why KAY-TOWNES can honestly guarantee that a super "KATY" will outperform any other all-channel TV antenna on the market today!

If we were in your shoes, with a local Dealer-Service reputation to protect... and add to... we would do exactly as you should do! WE WOULD RUN OUR OWN PERFORMANCE TESTS ON THE SUPER "KATYS"!

In the next few months, many of our competitors are going to attempt to copy the "KATYS"... just as they did our "BIG JACK". We have already taken the necessary steps to stop them... and to protect our dealers. This is the price forced upon us, because of our recognized leadership in the field of "fringe area" antenna design.

When you stop to think, it is easy to understand why KAY-TOWNES is so far ahead of the pack. While the others have been busy "commercializing" strictly on production to satisfy the huge demand, KAY-TOWNES has been working toward the "reception perfection" demanded by today's more cautious buyers of Television!

4½ YEARS OF DEVELOPMENT, with our resources and energies trained upon the objective of designing and engineering the world's finest TV antenna, has produced the super "KATYS". What the super "KATYS" will do toward the betterment of Television enjoyment is a foregone conclusion.

Look for KAY-TOWNES' big consumer ads appearing in Life Magazine... Country Gentleman... Progressive Farmer... and many other of the leading home publications!

The combined readership of all these publications will add up to more than 30,000,000 individual readers in the most productive "fringe areas" in America! Think what this means in terms of selling help for you!

COPYRIGHT 1954
WHO CAN I BELIEVE

Who IS TELLING THE TRUTH ABOUT TV ANTENNA PERFORMANCE... and who isn't!

WE CAN ONLY ANSWER FOR OUR OWN ANTENNAS...

AND THEN LEAVE THE ENTIRE QUESTION UP TO YOUR OWN GOOD, QUALIFIED JUDGMENT!

THE NEW, KAY-TOWNES SUPER "KATYS" ARE POSITIVELY GUARANTEED TO OUTPERFORM ANY OTHER ALL-CHANNEL ANTENNA ON THE MARKET TODAY!

This is an absolute fact, and not simply an advertising statement! In our search for a perfect All-Channel Antenna design we have, in the past 4½ years, developed countless arrays with ability to perform as well and often better than any competitive design available. We didn't stop there!

The more we probed into the secrets of TV reception, the more convinced we became that with the right research and study, the right engineering and experimentation we could finally develop a truly amazing and outstanding TV Antenna. We didn't stop until we did just that!

We've crossed and recrossed our engineering trails many times. We've made every test and check possible. We stake our reputation and future on the positive GUARANTEE we make for the KAY-TOWNES SUPER "KATYS"!

What does this Guarantee mean to you... a Dealer?

First of all, it means that we are absolutely sincere with you! It means that we are willing to stand behind the Super "KATYS" with all the resources at our command. It means that you can finally sell an All-Channel TV Antenna you can depend on to do the best possible receiving job for any installation!

KAY-TOWNES ANTENNA COMPANY
ROME, GEORGIA

Recognized leaders in the field of fringe area antenna design
Designed for quick, simple installation, these Stancor flybacks save your time. There are no holes to drill, no leads to splice. Terminal board layouts duplicate the original units—even include choke coils, resistors, tube sockets and any other components that are on the original.

Stancor TV replacements are listed in Sams' Photofact Index, Counterfacts, Rider Manuals and Tek-Files.

SCALA SUPER-MARKER INJECTOR mixer-amplifier unit mixes small sample of sweep voltage with small sample of marker voltage (from external sweep-marker generator). Injects a large, stable pip into scope being used for alignment of TV receiver. Marker pip is always same size—from base line to top of curve. Pip does not affect pattern on scope, even at resonance peaks; Greatly speeds up and simplifies alignment jobs. Separate video and marker gain controls. May be used with any standard marker generator, sweep generator, and scope. Five tubes and Germanium diode. Size, 10x8x7". Cables and instructions supplied. For operation from 110-120 volts, 60 cycle AC. Net, at leading jobbers, $67.50.

SCALA TEST PROBES—
—May be accurately used with all oscilloscopes—

SCALA TEST PROBES—

The service runaround

and put back into service. These tubes (remember?) had large, conspicuous grid caps.

One day I got a call from a woman who complained that her radio was very weak. Also she noticed that by putting her finger on the grid cap she could increase the volume. This she said, was very tiresome while trying to listen to her favorite programs.

When our technician arrived he found that her inventive genius had gone into action and she had removed about two pounds of sirloin steak from the refrigerator and wired it to the grid cap! Only after she found that the meat somehow did not attract the radio waves did she decide to have the set repaired.

—Ralph C. Lippert

BATH-NIGHT BREAKDOWN

The customer who had bought one of our best television receivers called to complain that every time someone took a bath, his set went out completely. (The set was not in the bathroom.)

We checked every component to no avail; then the antenna and lead-in came in for a microscopic examination.

Sure enough, the plastic 300-ohm lead was almost rubbed bare of insulation from close contact with the hot-water pipe that ran from the boiler. The pipe was copper and when a continuous stream of hot water ran through it for a time, it expanded just enough to short out the wires in the worn plastic.

—Henry Josephs

OPPORTUNITY KNOCKS

Street and house numbers in our area are being changed, and this has led to considerable confusion, especially since many street signs and house markers have already been painted out pending the assignment of the new numbers.

When I called at a house recently to deliver a repaired radio, the lady who answered the door-bell turned out to be the wrong one on the wrong street. But this gave me an opportunity to identify myself and tell about our service, and not only did I get two radios for repair, but she promised to come in to see our line of television receivers.—Harry J. Miller

END
Buy on our radically new

Time Payment Plan

SUPER METER

A COMBINATION VOLT-OMH MILLIAMMETER PLUS
CAPACITY REACTANCE INDUCTANCE AND DECIBELE MEASUREMENTS

ADMDED FEATURE: The Model 670-A includes a special
GOOD-BAD scale for checking the quality of electrolytic condensers at
a test potential of 150 Volts.

SUPER METER

SUPER METER

NO INTEREST!!

NO CARRYING

CHARGES!!

Superior's new
Model 670-A

The Model 670-A comes
in a rugged, crackle-finished steel

TUBE TESTER

STEEL CABINET complete with

EXTRA SERVICE - The Model TV-II may
be used as an extremely sensitive Con-

Superior's new
Model TV-II

Superior's new
Model 660-A

AN AC OPERATED

SIGNAL GENERATOR

PROVIDES COMPLETE COVERAGE for AM-FM & TV Alignment

SPECIFICATIONS:

- Generates Radio Frequencies from 100 Kilocycles to 100 Megacycles on fundamentals and from 60 Megacycles to 200 Megacycles on powerful harmonics.
- Accuracy and Stability are assured by the use of high performance tuned Hi-Q coils, e.g. R.F. available separately or modulated by the internal audio oscillator. - Built in 600 cycle sine wave audio oscillator used to modulate the R.F. signal so that it can be used for radio testing of receivers, amplifiers, and hearing aids, etc. - R.F. Oscillator Circuit: A high transconductance heptode is used as an R.F. oscillator, mixer and amplifier. Modulation is effected by electron control in the mixer section through the oscillator from lead changes and affording high stability.
- A.F. Oscillator Circuit: A high transconductance triode connected as a high-mu triode is used as audio oscillator in a High-C Colpitts Circuit. The output (over 1 Volt) is nearly pure sine wave, • Attenuator: A 5 step herder type of attenuator is used.

TUBES USED:
I-6866 as R.F. Oscillator, mixer and amplifier.
I-4866 as Audio Oscillator.
I-6166 as Power Rectifier.

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. B-94, 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked. I am estimating the down
payment, with order and agree to pay the monthly balance at
the rate indicated. I understand that there will be no carrying, interest or
any other charges. I understand I may cancel the agreement at any time
without penalty. Name______________________________
Address_________________________________________
City__________________________Zone________State______

SPECIFICATIONS:

TUBES USED:
I-6866 as R.F. Oscillator, mixer and amplifier.
I-4866 as Audio Oscillator.
I-6166 as Power Rectifier.

MODEL 670-A Total Price $28.40
$10.00 down payment. Balance $8.50
monthly for 6 months.

MODEL TV-II Total Price $23.50
$10.00 down payment. Balance $3.00
monthly for 6 months.

MODEL 660-A Total Price $22.95
$10.00 down payment. Balance $2.50
monthly for 6 months.

I enclose $__________as down payment.
I ship COD. for the down payment.

MARCH, 1954
If you want professional sound quality

Sound engineers know that the selection of a fine amplifier, pickup and speaker system is only part of the story; that unless the turntable is of equal quality, music reproduction must suffer. That is why they insist on such high standards for turntable performance.

do as the professionals do...

Rek-O-Kut precision turntables are made to conform to the highest standards in the professional field, and they certainly represent the finest you can use in the home. A Rek-O-Kut turntable will make all the difference in the world. The finer your present system, the more apparent the improvement will be. Whether you select the deluxe T-12H or the standard LP-743, the entire performance of your sound system will become a new and thrilling experience.

use a

REK-O-KUT precision turntable

Rek-O-Kut Precision Turntables are priced from $59.50. Write for specifications and descriptive literature to Dept. J-13

The REK-O-KUT COMPANY

Manufacturers of Professional Disc Recorders and Specialized Sound Systems.

Arkay Precision Audio Amplifier

10 Watt high-fidelity equipment. Separate tone controls for bass and treble through inverse feedback circuit; 14 watt output at 32 db. less than 3% distortion; frequency response ± 1 db from 30 to 20,000 cps. Tone controls produce maximum bass boost of 8 db. at 160 cps. Treble controls produce maximum treble boost of 18 db. at 10,000 cps. Hum: 76 db. below rated output.

Arkay

RADIO KITS, INC., 120 CEDAR STREET, NEW YORK 4, N.Y.

HEADSET
SALE!

HS-33 ........ $4.50 each
HS-23 ........ $4.00 each
Plug PL-60 Western Electric on cord

BRAND NEW

TALLEN CO., Inc., Dept. RE
119 Carlton Ave., Brooklyn 5, New York

WITH THE TECHNICIAN

JOINT SERVICE PROJECT

Philadelphia's WFIL and WFIL-TV are joining with the Council of Radio and TV Service Dealers and Service Technicians' Associations to conduct an intensive public service campaign stressing proper care and maintenance of home radio and television receivers.

David Krantz, chairman of the Industrial Relations Committee for the Council, announced that more than 2,500 service technicians from Eastern Pennsylvania, New Jersey, and Delaware will participate in this campaign. Through interviews conducted on programs over WFIL and WFIL-TV, and spot announcements throughout the stations' schedule, listeners and viewers will be constantly alerted to the need for expert care and service for their sets.

In announcing the stations' participation in the public service campaign, general manager Roger W. Clipp said, "Along with constant efforts to improve programs, we cannot lose sight of the millions at home who receive those programs and of the qualified service technicians who keep their sets operating at a high level of efficiency. This campaign, undertaken in co-operation with the Council of Radio and Television Service Associations, will familiarize our audience with the objectives and Code of Ethics of the group, and help our listeners and viewers to keep their sets in good working order."

NATESA ISSUES AWARDS

Joining with other branches of the electronics industry and with the mayor and Chamber of Commerce of Indianapolis, the National Alliance of Television and Electronic Service Associations honored Howard W. Sams with its "Friend of Service Management" award, January 7. Chief speakers at the event were Mayor Clark, of Indianapolis, and Frank Moch, president of NATESA, who stated that the award was presented to Sams for his efforts in behalf of the service business and his contributions to the training of service personnel.

A similar award was presented to John T. Thompson of General Electric's tube department, in which the G-E tube department was cited for the second year, "for outstanding service to television service management in creating a high level of efficiency. This campaign, undertaken in co-operation with the Council of Radio and Television Service Associations, will familiarize our audience with the objectives and Code of Ethics of the group, and help our listeners and viewers to keep their sets in good working order."

MOCH AGAIN HEADS TISA

Frank J. Moch was re-elected president of the Television Installation Service Association, Chicago. Also re-elected were John Cecich as vice-president, Jerome Mann as treasurer, and Rubin Saxner as secretary. Newly elected officers are Ralph Friedman, second vice-president, and Russ Havill, sergeant-at-arms.

TISA's membership is stated to have gained approximately 20% during the past year, and now numbers about 75 service companies.

RADIO-ELECTRONICS
NOT JUST CLAIMS

FACT - 53 CLAIMS GRANTED IN 5 UNITED STATES PATENTS -
$2,585,670; 2,609,503; 2,625,655; 2,644,091; 2,661,423, others pending.

These antennas positively receive ALL channels 2-83 from ALL directions without a rotor motor.

FACT - These antennas have consistently OUT-GAINED and OUT-PERFORMED all others in actual public demonstrations.

FACT - These antennas will unquestionably OUT-PERFORM all others, on YOUR roof, with YOUR set, or YOUR money back.

FACT - SAVES YOU MONEY. Eliminates rotor motor, uses only ONE transmission line, uses only ONE antenna for both UHF & VHF—and only ONE simple, quick installation.

FACT - Perfect pictures have consistently been received as far as 3 times the guaranteed distances.

FACT - ONLY one antenna, ONLY one transmission line, ONLY one installation. You solve once and for all your PRESENT and FUTURE antenna problems.

FACT - MONEY BACK GUARANTEED TO RECEIVE ALL CHANNELS 2-83 FROM ALL DIRECTIONS AND POSITIVELY OUTPERFORM ALL OTHER ANTENNAS WITH OR WITHOUT A ROTORMOTOR.

PLUS 9 POSITION ELECTRONIC ORIENTATION SWITCH

4 CONDUCTOR TRANSMISSION LINE

Low Loss External Air Dielectric
Matched Impedance
Eliminates End Sealing
Eliminates Condensation
Up to 50% Less Loss Than Tubular When Wet
Easily Spiraled
No Breaking or Shorting
Patents Pending - T. M. Reg.

ALL CHANNEL ANTENNA CORP.,
70-07 Queens Blvd., Woodside 77, N. Y. Hickory 6-2304
CORNELL-DUBILIER
UHF AND VHF TV ANTENNAS

Here—in one brand name is the answer to ALL your antenna requirements! A full range of antennas—all precision manufactured...with highest quality materials...each an outstanding value. Make sure of the best installation possible...SPECIFY CDI!

TELEVISION
Big demand for graduates
B.S. DEGREE IN 27 MONTHS in radio including TV engineering—VHF, UHF, AM and FM. Students use over $100,000 worth of equipment including 2 large commercial type transmitters in new TV lab. Intense specialized course includes strong basis in mathematics, science and advanced design in radio and TV.

Hundreds of young men each year are earning engineering degrees in this recognized institution. Start any quarter. Many earn a major part of expenses in the industrial center. Low tuition. Complete in one year.

Also B.S. DEGREE IN 27 MO. in Aeronautical, Chemical, Civil, Electrical and Mechanical Engineering. G.I. Gov't approved. Enter March, June, Sept., Dec. Free catalog. ENROLL NOW.

INDIANA TECHNICAL COLLEGE
1734 E. Washington Blvd., Fort Wayne 2, Indiana

Watch for the April issue of RADIO-ELECTRONICS on the newsstands March 24

WITH THE TECHNICIAN

COLOR ON LONG ISLAND
The Long Island Television and Radio Technicians Guild is sponsoring a Color Forum, in which the fundamentals of color theory and servicing will be discussed. At the introductory session held at the American Legion Hall, Williston, L. I., attendance broke all records. Approximately 250 service technicians turned out to learn about color TV.

Murray Barlowe led the discussion, stressing the complexity of color TV circuitry and the necessity of additional knowledge and new shop equipment to handle color problems. He stated that the screwdriver technician—already given a near-fatal blow by television—is now entirely through, and that, with color, servicing becomes an industry which will require highly specialized skill, complete knowledge of the subject, and—considerably better compensation.

COUNCIL ELECTS HAAS
The Philadelphia Council of Radio-Television Associations has elected Albert M. Haas of the Television Contractors Association (TCA) as its 1954 chairman. Ray Cherrell, of the Northeast Television Service Dealers Association, was elected vice-president, and William Wile, Jr., of the Television Service Dealers Association, secretary. Dave Krantz was appointed chairman of the broadcast and public relations committee.

A TECHNICIAN'S LOT
The inspirational little piece below is reprinted from ARTSNY News, by special permission of that organization. Its authorship is attributed to Seymour Weinberg of the Associated Radio-TV Service Technicians:

When a television set starts acting crazy, When the picture rolls and horizontally runs, When the video and sound are weak and hazy, A technician’s lot is not a happy one. When a customer starts hollering for service And you have some other jobs that must be done, When his visits and his phone calls get you nervous. A technician’s lot is not a happy one. When your wife complains you’re never home enough to take her. When all your friends go out to have some fun, When your customers call you a gyp and a faker. A technician’s lot is not a happy one. When a customer starts hollering for service And you have some other jobs that must be done, When you have some other jobs that must be done. You must make the public realize you’re human.

When a television set starts acting crazy, When the picture rolls and horizontally runs, When the video and sound are weak and hazy, A technician’s lot is not a happy one. When a customer starts hollering for service And you have some other jobs that must be done, When his visits and his phone calls get you nervous. A technician’s lot is not a happy one. When your wife complains you’re never home enough to take her. When all your friends go out to have some fun, When your customers call you a gyp and a faker. A technician’s lot is not a happy one. When a customer starts hollering for service And you have some other jobs that must be done, When you have some other jobs that must be done. You must make the public realize you’re human.

NEW ORLEANS OFFICERS

The Radio, Television and Appliance Association of New Orleans elected Robert V. Schumert president; Stanley B. Rehmherz, vice-president; Wesley P. Massey, secretary; and Leonard E. Sorge, treasurer of the organization for 1954.

A silver plaque was presented to the retiring president, Robert J. Magoni, "in recognition of outstanding service" to the association. The presentation was made by Morris Warnick, a past president of RTAA.
NEW DESIGN

G-E has announced development of its first receiving tube type intended primarily for use in color TV receivers.

The tube, type 6BJ7, is a miniature triple diode. Its primary use is as the d.c. restorer for the three signal channels of color receivers. The electrical characteristics of each section of the 6BJ7 are similar to those of each section of the 6AL5 twin triode.

Maximum ratings for the 6BJ7 are: peak inverse plate voltage, 330; peak plate current per plate, 10 ma; d.c. output current per plate, 1 ma; heater-cathode voltage (heater positive with respect to cathode), 100; (heater negative with respect to cathode), 330.

G-E has announced two new 21-inch picture tubes of the 90° deflection type. They are about 3 inches shorter than corresponding narrower-deflection types. The tubes, types 21ACP4 and 21ACP4-A (aluminized), are of all-glass, rectangular construction.

Both tubes are 20 inches in over-all length. The 90° feature provides an increase up to 7% in screen area over tubes with narrower deflection angles. The tubes have an external conductive coating which acts as a filter capacitor when grounded.

Typical operating conditions for the 21ACP4 and the 21ACP4-A are: anode voltage, 16,000; grid 2 voltage, 300; grid 1 voltage, -28 to -72; ion trap intensity, approximately 40 gausses.

RCA has announced two new tube types: the 6BY6 and 6197.

The 6BY6 is a pentagrid amplifier of the 7-pin miniature type. It is intended for use as a gated amplifier in television receivers, where it may be used as a combined sync separator and sync clipper. The 6BY6 has separate base-pin terminals for grids 1 and 3. Each of these grids can be used independently as a control electrode, and has a sharp cutoff characteristic. The sharp cutoff permits good sync clipping and noise cancellation with relatively low input signals. Furthermore, grid 3 is processed to minimize secondary emission and the resultant possibility of blocking.

An important feature of the 6BY6 is its favorable current ratio of plate current to grids 2 and 4 current. With this ratio, the output signal can be.

MARCH, 1954

NEW DESIGN

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You, too, can have the lines—that meet your exact leadline conditions—whether you are a TV Set Dealer or Service Organization making the finest television reception installations, or a TV fan that demands sharp, "SNOW-FREE" pictures.

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Model 355-K Complete Kit $14.95
Model 355 Factory Wired 19.95
- Operates on channels 3, 4 or 5
- Provides 16 vertical and 12 horizontal bars
- Switch permits selection of vertical/horizontal or "stuck by"
- Output Voltage: 100,000 microvolts

CATHODE RAY TUBE CHECKER

An easy, fast and fully reliable instrument for testing oscilloscope and TV picture tubes without removing from the scope or the set.

Model 630-K Complete Kit $17.95
Model 630 Factory Wired 24.95
- Provides bridge measurement of peak beam current
- Indicates short and open elements in the electronic gun
- Tests picture tubes with picture tubes
- 1/2" cables permit testing of tube directly in set

SINE & SQUARE WAVE AUDIO GENERATOR

An extremely useful instrument for the audio enthusiast. A reliable test for high fidelity performance of preamplifier, amplifier, speaker, and other components.

Model 377-K Complete Kit $31.95
Model 377 Factory Wired 49.95
- Wired Bridge Circuit - 1% precision resistor
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- Square Waves: 50 to 50,000 cycles
- Response: -1.5 db from 60 to 150,000 cycles

Illustrated catalog of TV KITS

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- Vertical sensitivity: .1 mV per div. to 1 mV per div.
- Useful response from 5 to 500 kc TV-type multivibrator sweep generator

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Free mail-order catalog of TV KITS. Plus new TV KITS for all latest circuits.

Instructograph Company

NEW DESIGN

obtained with relatively low-power input to grids 2 and 4.

The 6197 is a 9-pin miniature sharp-cut-off pentode having very high transconductance. It is designed for frequency-divider and pulse-amplifier circuits in electronic computers and other on-off controls involving long periods of operation under cutoff conditions.

The stable cutoff characteristic of the 6197 permits a consistent cutoff bias to be maintained, and eliminates control-grid emission.

Among the features of the 6197 are radiation fins on grid 2 to increase its dissipation capabilities, a getter shield to minimize interelectrode leakage, and a pure tungsten heater to give long life under conditions of frequent on-off switching. Grid 3 and cathode have separate base-pin connections.

RCA also announces manufacture of germanium point-contact type sealed-in-glass crystal diodes, including: the 1N34-A, the well-known general-purpose diode for use in low-power rectification; the 1N38-A, a large-signal type with a peak inverse voltage rating of 100; the 1N54-A, a high-back-resistance type for use in clipping circuits, high-impedance high-voltage probes, d.c. restorer circuits, and high-impedance detector circuits; the 1N55-A, a large-signal type with a peak inverse voltage rating of 150; the 1N66-A, a high-conduction type featuring an exceptionally low dynamic impedance; the 1N58-A, similar to type 1N55-A but with a lower peak inverse voltage rating.

Sylvania has announced the 6AM8, a diode-pentode. The new tube is similar to the 6CB6 plus one-half of a 6AL5.

The pentode section of this 9-pin tube type has a transconductance of 5,800, and is intended for use as the last video i.f. amplifier in television receivers. The addition of the diode
allows the tube to be a combined i.f. amplifier and video detector, thus aiding in the reduction of tubes used in TV receivers.

A new mirror-back picture tube—the 21FP4C, has been announced by CBS-Hytron.

This tube, which may be used to replace the 21FP4, is aluminized, with low-voltage electrostatic focus. Using electromagnetic deflection, it has an all-glass, rectangular-bulb, cylindrical face-plate that gives greater contrast and a reflection-free viewing surface.

The aluminum-backed screen reinforces light output and provides brighter, sharper pictures, without additional demands on the other components of the set.

The 21FP4C has an electron gun designed for use with a single-field, external ion-trap magnet. Its outer conductive coating, when grounded, acts as a high-voltage filter capacitor.

The mirror-back (aluminized) screen reflects light output to the viewer that would otherwise be lost to the rear of the screen.

An addition to its line of twin-tetrode tubes has been announced by Amperex. The tube, type 6360, is a miniature twin-tetrode having an over-all length of 3 1/4 inches, and a diameter of 1/4 inch.

The tube is particularly useful in low-drain, mobile transmitters and multiplier chains where its ability to increase the power level quickly and produce a balanced output make it ideal for driving higher-power and higher-frequency push-pull stages.

The 6360 is designed for use as a class C amplifier and oscillator, frequency multiplier, and modulator for frequencies up to 200 mc at maximum ratings. It can deliver 16 watts at 200 mc under ICAS conditions. As a frequency tripler from 67 mc to 200 mc, it can deliver 5 watts under ICAS conditions.

END
ENCLOSURE KITS

G & H Wood Products Co., 75 N. 11th St., Brooklyn 11, N. Y., has announced a kit series based upon the Klipsch corner-enclosure design by Cabinet Art for 12 and 15 inch speakers.

Ratings are: 110-120 volt, 50-60-cycle a.c. input, 250 watts with an 8-ohm 12-watt d.c. load.

Model D-612 is housed in an 18-gauge steel cabinet finished in blue hammerloid. It weighs 20 pounds and measures 12 x 7 x 6 1/2 inches.

POWER RESISTORS

International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa., has introduced two new high-temperature resistors, types PW-7 and PW-10.

Wire elements are wound on glass fiber cores with axial leads 1 1/2 inches long and 0.18 inch in diameter. Body dimensions of PW-7 are 1 13/8 x 1 1/4 x 1 3/8 inches; of PW-10, 1 1/4 x 1 1/4 x 1 1/4 inches. These element-led assemblies are sealed into a ceramic case with a cement which provides a mechanical protective bond between the resistive element, the terminals, and the case. Type PW-7 is available from 0.5 to 5100 ohms; type PW-10 ranges from 1 to 20 ohms. Both are available in ± 3% and ± 10% tolerance.

Types PW-7 and PW-10 are recommended for circuits where a short resistor is required with an actual wattage dissipation of 7 or 10 watts or less.

COLOR TV RECTIFIERS

International Rectifier Corp., 1521 S. Grand Ave., El Segundo, Calif., has announced a series of selenium rectifiers for color TV sets. The rectifiers in this series are designed for capacitive loads of 600, 700, and 750 ma and are produced with maximum input voltage ratings of 130, 172, and 195 volts r.m.s.

A bellows type spring contactor affords a lower forward drop, lower temperature rise, and longer life. The 2 x 3-inch plate size allows wider latitude in chassis layout. The photo shows a type RS100, a fixed-stack, rated for 195 volts r.m.s. input and 600 ma output.

HIGH PASS FILTER

Service Instruments Co., 422 S. Dearborn St., Chicago, Ill., has designed a u.h.f. high-pass filter, the HP2, to pass ultra-high frequencies with less than 1 db rejection and to reject all u.h.f. with an attenuation of from 45 to 50 db.

According to the company, the HP2 filter eliminates F.M. interference on u.h.f. radio channels, 6 and 7, and it prevents interference from converting F.M. transmitters.
MIKE STAND

Atlas Sound Corp., 1451 39th St., Brooklyn 18, N. Y., has announced their new Model MS-25 microphone stand with an “air-cushioned” telescoping section.

The safety mechanism prevents the stand from crashing down and breaking. In addition, MC series of magnetic microphones. These microphones are designed to provide a high-quality signal to the audio system in varying conditions of heat and humidity.

MC-100 and MC-110 are similar, but MC-110 has a mu-metal shield ring for reducing hum pickup. This unit is specially designed for use with transistor circuits, but are applicable to other systems.

TEMPERATURE-COEFFICIENT SLIDE RULE

Sprague Products Co., 81 Marshall St., North Adams, Mass., has introduced a new capacitor temperature-coefficient slide rule which speeds and simplifies ceramic capacitor installation problems.

Varied stock of N750 and NPO type ceramic capacitors which are to be connected in parallel to equal a capacitance of intermediate temperature of the required capacitance. MC-1100C, MC-1100D, and MC-1100E are similar, but MC-1100C has a mu-metal shield ring for reducing hum pickup. This unit is especially designed for use with transistor circuits, but are applicable to other systems.

SELENIUM RECTIFIERS

Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J., has introduced the Universal line of selenium rectifiers for replacement purposes. These units are of eyelet construction and are equipped with mounting hardware for simplified installation into the radio or television chassis.

Code numbers and ratings of the new selenium rectifiers making up the line are: 132B, rated at 100 ma; 132A, rated at 300 ma; 132B, rated at 300 ma; 132A, rated at 120 ma; and the 1327A, rated at 500 ma.

UHF ANTENNA

TV Products Co., 1452 228th St., Springdale Court, N. Y., has introduced a single-box, u.h.f. corner antenna, radio receiver and amplifier, and a wideband switch for selection of the entire sound spectrum, from 20 to 20,000 cycles.

DRAWER CABINETS

General Industries Co., 5738 N. Elston Ave., Chicago 30, III., has announced a complete line of 26-inch drawer cabinets for small-parts filing, storage, in factories, offices, schools, homes, workshops, and garages.

Model J-20, pictured here, consists of 20 clear plastic drawers, 1/8 x 1/4 x 1-7/16 inches in a welded-steel casing.

Other units include models ranging from 8 to 128 drawers, portable cabinets, and portable models with carrying handles.

NEW AM-FM-TUNER

Fisher Radio Corp., 4241 Vos Park Dr., Long Island City 1, N. Y., announces the new model 50-RT FM-AM tuner which, with the cartridge remains stationary in the receiver, is the only one of its kind with the double-tapered needle rotates in switching back and forth to play both for and wide-range grooves.

The cartridge is a 6-1/2-watt, 50,000-cycles-per-second, 12-inch, 1/8-inch diameter wire-wound parallel-wound coil transformer. Response is ±1 db from the FM and audio circuits, and ±2 db from the AM circuit.

TUBE CADDY

Windsor Electronic Tube Co., 1315 Shepard Bay Rd., Brooklyn 25, N. Y., has announced the Tube Caddy, a portable carry-all for holding tubes, meters, and other equipment for on-the-spot servicing.

NEW AMPLIFIER

Video Corporation of America, 229 W. 28th St., New York 1, N. Y., has announced the VC-6 amplifier, designed for use in television, phonograph, or TV receivers. The unit supplies a push-pull output of 6 watts and a frequency response of 50-10,000 c.p.s., which it must be able to maintain for a continuous wave or a wide-band response of a conical. The 15-inch coaxial loudspeaker, RF-475, has a 100-pound permanent magnet of Alnico V metal.

The 15-inch coaxial loudspeaker, RF-475, has a 100-pound permanent magnet of Alnico V metal.

NEW DEVICES

RCA Victor Division, RCA, Harrison, N. J., has announced the new WR-49 AM radio-frequency signal generator, useful as a TV and radio signal tracer as well as an alignment oscillator and marker designed for a wide range of AM or FM radio, and TV service operations and other applications which require a continuous wave or modulated r.f. sine-wave signal from 8 kc to 30 mc.

A signal generator is the built-in blocking capacitors connected in series with the r.f., and a.f. cable connectors. The capacitors provide d.c. isolation of the attenuator circuits and a large gain to the output of the instrument probes each time the test operation is started.

Other operating conveniences include: a separate output jack board, a fine-tuning control to facilitate precise setting of the output frequency, and a special testing assembly which makes possible rapid tuning and reading of the exact frequency setting.

CONICAL YAGI

RMS (Radio Merchandise Sales), 206 Brondole Ave., New York 52, N. Y., has announced a new conical Yagi antenna for v.h.f., the Magwump. This antenna is a singleunit model Y-50, which is in one chassis a high-frequency and a low-frequency switch for selection of the entire sound spectrum, from 20 to 20,000 cycles.

The combined receiver-amplifier, the SR-405, units in one chassis is a high-frequency and a low-frequency switch for selection of the entire sound spectrum, from 20 to 20,000 cycles.
V.H.F. COLLINEAR YAGI
Technical Applications Corp., Saybrook, N. Y., has developed an all-channel V.H.F. collinear Yagi antenna, the Trapper.

This antenna, model 1800, has a forward director and two tuned driven elements with auto-match stubs, one high-band reflector and one low-band reflector.

For fringe and ultra-fringe installations, two standard Trapper antennas are used with the associated stacking equipment supplied.

DETECTION COMPONENTS
RCA Victor Division, RCA, Harrison, N. J., has developed three 90-degree TV deflection components. The RCA 220D1 is a deflection 90-degree, ferrite-core, deflecting yoke, similar to the RCA 2T1/D1. Major differences include smaller core, weight, molded vinyl insulation, and a molded-base terminal frame. The 220D1 provides good side-and-corner resolution and freedom from pitch-tension distortion substantially equal to that obtained with 70-degree systems. The RCA 23891 is a dc to 18 kV, ferrite-core, horizontal output (flyback) transformer for use with the RCA 220D1 yoke. It will provide full scan of a 169-degree linekip driven by an RCA-6CD6-0 operating at only 250 volts, and a cathode current of 115 ma.

The new RCA 220D7 is a low-cost equivalent to the 220T1 in performance and life expectancy, it is similar to electrically and mechanically the standard RCA 220T1.

PORTABLE RECORDER
Magnemite Division, Ampex Corp., New York 1, N. Y., has announced a compact 8-pound weather-light magnetic tape recorder, the Flyweight Magnemite, designed for rugged field use.

The unit employs a fly-ball governor-controlled, high shielded electric motor with built-in noise suppressor which assures constant speed and freedom from hysteresis during the full life of the motor. A built-in cold shows when motor batteries should be replaced.

NEW DEVICES

UFH ANTENNA
JFD Manufacturing Co., Inc., 6011 1st Ave., Brooklyn 4, N. Y., has added a corner reflector for fringe reception to its v.h.f. line. The model UHF15 Golden Rig features 4-way bridging for elimination of ghost-producing vibration. This antenna has gold-colored anticorrosion plating.

SWEEP GENERATOR
Hickok Electrical Instrument Co., 10531 dumb Ave., Cleveland 1, Ohio, has announced a u.h.f. sweep alignment generator which is an all-electronic sweep that features no moving parts and provides fundamental output on channels 4-8 with 0.5 volt r.f. output.

STANDOFF INSULATOR
The Inslon Corp., America, 36-02 30th Ave., Long Island City, N. Y., has announced a new strap type standoff insulator that accommodates all standard television transmission lines. A low-loss polyethylene grommet is the eye of the device. The insulating material holds flat, lead-in ribbons, tubular twin leads, coaxial cable, and adjustable steel strap permits the insulator to be used on any pipe diameter up to 1/2 inch in diameter. The assembly is tightened by a captive tension nut through which the threaded end of the insulator screw eyes pass. All metal surfaces are heavily tinned plated.

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and
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- NO ADDITIONAL PARTS NEEDED
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For Forces hee Personnel
would have a desire to
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Radio Theory and Construction Practice expressed simply and clearly. You will gain a knowledge of basic Radio Principles involved in radio transmission, radio reception, audio amplification and servicing by radio. The Progressive "Ed-Kit" is used by many Radio Schools and Clubs in this country. It is used for training and rehabilitation of Armed Forces Personnel and Veterans throughout the world.

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PROGRESSIVE "EDU-KITS" INC.
through their anode coils. At the same time, less current flows through the anode coils of B and C. These conditions are reversed during the next half audio cycle. Currents in the T2 primary are no longer cancelled out, and audio power is transferred to the loudspeaker.

The third winding on each core is for biasing the core magnetism. P is adjusted to bias the cores for linear response and high gain. C1 and C2 are used to bypass any carrier current that may remain. Although the fundamental carrier frequency is largely eliminated due to balancing and bypassing, some harmonics may be present. The network LCR is added to eliminate them.

A stage like the one shown here can amplify a.f. over a range of 200-2500 cycles. The carrier should be about 10,000 cycles.

SELECTIVE CIRCUIT

Patent No. 2,653,194
Walter Lyons, Flushing, N. Y. [assigned to Radio Corp. of America]

This patent has as its objective, a means of obtaining high selectivity without the use of multiple heterodyne circuits and filter arrangements. Quartz crystals, having a very high Q, are sharply selective. In filter networks, crystals produce high loss so amplification is generally needed. This circuit combines sharp selectivity and high gain. It passes a very narrow band: 100 cycles at a carrier frequency of 60 kc.

The pentodes are in push-pull and each crystal feeds one of the tubes. One crystal is ground for a frequency slightly above the applied carrier frequency. The other resonates at a frequency slightly below the carrier. Due to the push-pull connection, the circuit can have no output if the grids are fed with identical (in phase) signals. If the applied signals are dissimilar (out of phase), output does exist.

At frequencies far from the carrier, each crystal transmits an identical signal. For example, assume a 50-ke carrier. At 48 kc, the crystals may be assumed identical, for their resonance points are very close to 50 kc. Thus we get no output at 48 kc or any other frequency far from the carrier. Within the pass-band (that is, between the crystal frequencies), the story is different. Here, one crystal acts like an inductance because it is being operated above its resonant frequency. The other crystal acts like a capacitance since it is operating below its resonant frequency. Each tube receives a signal that differs in phase from that of the other. Thus, output exists only within the very narrow range of frequencies between the resonant frequencies of the crystals.

A ganged pair of resistors shunts the crystals. They control damping and bandwidth. The adjustable screen resistance permits balancing of the tubes for zero output when the grid signals are identical.

RELAY CONTROL CIRCUIT

Patent No. 2,622,195
John W. Smith, Cedar Rapids, Iowa. [assigned to Collins Radio Co., Cedar Rapids, Iowa]

Using an ordinary relay, this circuit provides a slow release. The relay is energized quickly; the release time is long.

NEW PATENTS

WHEN WILD WINDS HIT...

PERMA-TUBE STAYS UP

and so does your reputation!

Here's why PERMA-TUBE backs up quality service:

1. PERMA-TUBE IS STURDY . . . it's made of special, high-strength J&L Steel.

2. PERMA-TUBE IS CORROSION-PROOF . . . it's treated with vinylite—then coated inside and outside with a metallic vinyl resin base.

3. PERMA-TUBE IS EASILY INSTALLED . . . it's the only mast with both ends of the joint machine fitted.

Here's proof of Perma-Tube's superior strength.

Ordinary masts and Perma-Tube were subjected to regular deflection and permanent set tests with the following results:

<table>
<thead>
<tr>
<th>Mast</th>
<th>Size and B W Gauge</th>
<th>Bending Force To Produce 2½ lbs Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1/4&quot; OD x 20 Ga.</td>
<td>1870 inch pounds</td>
</tr>
<tr>
<td>B</td>
<td>1/4&quot; OD x 18 Ga.</td>
<td>2740 inch pounds</td>
</tr>
<tr>
<td>C</td>
<td>1/4&quot; OD x 17 Ga.</td>
<td>2780 inch pounds</td>
</tr>
<tr>
<td>Perma-Tube</td>
<td>1/4&quot; OD x 18 Ga.</td>
<td>2930 inch pounds</td>
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<tr>
<td>E</td>
<td>1/4&quot; OD x 15 Ga.</td>
<td>4270 inch pounds</td>
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<tr>
<td>Perma-Tube</td>
<td>1/4&quot; OD x 16 Ga.</td>
<td>4560 inch pounds</td>
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<tr>
<td>E</td>
<td>1/4&quot; OD x 16 Ga.</td>
<td>5590 inch pounds</td>
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J&L STEEL
STEEL CORPORATION—Pittsburgh

MARCH, 1954
WHAT EVERY SERVICEMAN SHOULD KNOW —— No tube checker reading of "Good" can positively insure that a specific tube will function properly in a TV set or any other circuit. A substitution test at an actual set will do that. This is particularly true of tubes used in color and sweep circuits and other moisture sensitive parts. Indicators, resistance, modulators, etc.,

YOU PLAY IT SAFE when you buy Windsor tubes—because every tube you ship has been carefully pretested in a radio or TV set for PEAK PERFORMANCE under actual operating conditions. We WRITE FOR ADDITIONAL information: FREE -- 1Ve Pentron tape carrying case included--1200 ft. plastic tape with plastic reel included. Write for further details.

WASHINGTON
1515-C SHEEPSHEAD BAY ROAD, BROOKLYN 35, N. Y.

BUY AND SELL — WINDSOR TUBES, WITH CONFIDENCE

We carry all brands of new tape, including brands that are no longer made. We also stock Special Purpose and NOS (New Old Stock) parts. We also sell Special Purpose and Transmitting Tubes at similar prices. We also stock Testing Equipment and Testing Equipment for similiar savings!

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• Each reel individually boxed.
• Choice of high quality brands. Each reel contains approximately 125 tubes, including meters and tools.
• All 1/4 inch long x 1/4 inch wide x 1/4 inch high. The reel is securely boxed. It is also compact.
• Properly constructed with heavy backplate, covering. Strong plastic handle. Choice of only top quality brands.

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1.50 for 5 7500 feet
1.25 for 5 10,000 feet
1.25 for 5 15,000 feet
1.00 for 5 30,000 feet

All necessary parts and instr., included. Makes highest grade sound on the market reg. price.

100 ASSORTED RESISTORS
Carbon Infused, New in current EIA cases. Values as stated. $100.00 for 3. of 100, 52. of 250, 50 of 500, 25 of 1000, 10 of 10000 ohms. All new. Each 25c. We ship by the box of 100.

Savvy TV receiver with a Hi-Gain Booster. Banish weak fringe areas, reduce snow. This unit comes to you in a shock insulated High-Gain Tuner box. 616 Tubes in very efficient Hi-Q Circuit. Has 8 tuned circuits along side reactances and individual compensation providing vacuum tubes. Built in 1/4 inch high, heavy mold plastic. All necessary parts and instr. Included. Makes highest grade sound on the market reg. price.

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The new 1954 TV manual is the most valuable offer by Supreme Publications in their 20 years of business. This mammoth television manual sold at only $2, or the TV manuals for previous years are amazing bargains and the best ever. This is the last time for previous years for only $2 each. The TV manuals for previous years are amazing bargains and the best ever. Only a publisher who can offer such bargains based on tremendous volumes-volume sales. Every time you set out in your shop all eight Television Manuals listed in coupon. Order for the new 1954 TV manual to see what an amazing bargain you are letting go for only $2. Send trial coupon or ask your jobber.

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Radio Diagram Manuals Send TV manuals order. We ship manuals prepaid. Satisfaction guaranteed on your money back.

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SUPREME PUBLICATIONS
Available from Leading Parts Jobbers

MARCH, 1954
Pericodic Blinking

This simple circuit controls flashing gaseous lamps. The inventor describes it in connection with toys. Two lamps are set to light alternately. Among other applications, the blinking lights may be placed at the wing tips of a toy plane or may illuminate the eyes of a teddy bear. The circuit is drawn with recommended component values.

When first connected, LM1 will break down because it is across the entire battery voltage. A voltage drop appears across R1 so LM2 cannot flash. As C charges through (LM1) it opposes the battery voltage. Finally, there is insufficient current through LM1 and it goes out. At this moment LM2 breaks down, even though its potential difference is only 40 volts.

C discharges through R2 until there is sufficient voltage to break down LM1 again. The drop across R1 reduces the available voltage for LM2 and this lamp goes dark, completing the cycle.

Magnetic A.F. Amplifier

This amplifier operates at audio frequencies, and is capable of a power gain of about 10. It needs no attention and has nothing to wear out.

The four ring-type reactors A, B, C, D, have laminated, saturable cores. Each has three windings as shown, the top of each being an anode or exciting coil. Rectified a.c. from a carrier source flows through the anode coils and magnetizes the cores in the same direction. The carrier voltage should be at least four times greater than the peak audio voltage to be amplified. It may be about 250 volts.

Concord's
BUY OF THE MONTH

Sensational
SELF POWERED
2 WAY
PHONE SYSTEM

Sensitve 2 way phone system Operate with telephone like clarity over distances of up to one mile. Phones made of rugged phosphor bronze with self-contained shockproof bow-tie rubber. Full size 1 1/2 volt flashlight battery. Has full size 24 carat gold plated. Certified with push to talk switch, saving clipping. Leads and wall brackets without a doubt, one leads and wall brackets. Complete with sensory service, office or home item. Never offered. Complete with batteries...

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is momentarily reduced to H. This leaves only one intersection (G) between load and collector. A new phase active emitter reduces the peak, for example from B to H. The collector load line is shown as L. It intersects the curve at 3 points: E, F, G. Since F lies below H. The collector load line is shown as L. It intersects the curve at points: E, F, G. Since F lies below H. Therefore, the output impedance is very low. The tube grids are fed out of phase. This portion has negative resistance. There-
SENSITIVE ALL-WAVE REGENERATIVE SET

After experimenting with a number of simple receiver circuits, I now have a set that is more stable and easier to tune and adjust than any set of its type that I have ever seen. Its sensitivity is good and I hear lots of dx on it with a 15-foot indoor antenna.

The set uses a 6SK7 detector with the regeneration control in the screen circuit. The relatively small grid resistor and the use of a remote-cutoff tube tend to eliminate squelching and pulling. A set of all-wave plug-in coils are used for short-wave reception. If the set is to be used for broadcast only, use a standard broadcast r.f. coil and tuning capacitor. It is a good idea to use a straight-line frequency capacitor such as the National SE or SEH series. A high-gain-ratio vernier tuning dial such as the National Velvet Vernier is essential for short-wave tuning and very helpful when using the set on the broadcast band.

The a.f. amplifier is a 6SH7 with a standard interstage a.f. transformer connected in reverse and used as the output coupling unit. The transformer is not essential but it provides a better impedance match and higher gain, eliminates d.c. through the phones, and cuts the phones at ground potential.

The power supply is a half-wave type using two filament transformers connected back-to-back. The dual 200-mu filter capacitor was on hand. Smaller values of capacitance may be used.

Many SWL’s hesitate to use a regenerative receiver because they are afraid that it will reradiate and cause interference. With this set, reradiation could not be detected on a receiver in the next room when it was operated just beyond the point of oscillation (the normal operating point for c.w. reception). Radiation could be detected only when the regeneration control was advanced almost to the end of travel. However, this setting results in a marked reduction in volume so it is unlikely that the set will be operated in this manner. When operated properly, this set is no more of an offender than the average a.c.-d.c. superhet.

This set is not in the HRO class but it is perfect for those who want a lot of receiver for a little money.—Charles Erwin Cohn

(Winding details for coils for 10 to 500 meters is shown above. In all cases, the tickler (L2) should be wound below grid coil L1 and should have the smallest number of turns which permits the detector to oscillate over the entire band. If the detector suddenly clicks or plops into oscillation as the regeneration control is advanced, try using a larger or smaller grid resistor and cut down on the number of turns on L2. In any receiver, the smoothest control of regeneration is obtained...
when the grid leak resistance and the number of tickler turns are optimum for a given operating voltage. Even if you use commercial plug-in coils, you may still find it necessary to experiment with the circuit for best performance.—Editor)

PARTS FOR ALL-WAVE REGENERATOR

Miscellaneous:

- Plug-in coil forms and wire
- Choke
- Single plate to single grid
- Electrolytic 1-200 µf, 150 volts, dual
- Spaced variable ceramic or mica
- Resistors: 1-1-megohm, 1-560,000, 1-33,000, 1-100 ohms; chassis, dial, headphones, wire, hardware.

I.F. SELECTIVITY SWITCH

The i.f. circuits in many superhet receivers tune too sharply to provide high-quality output on local stations. Sideband cutting can be reduced by installing the selectivity switch described in Radio Constructor (England). The diagram shows how the selectivity switch is added to a receiver with a single i.f. stage. In small a.c.-d.c. sets, C1 and R1 would probably have to be added to the circuit. In larger sets these components may already be present as the decoupling network for the i.f. amplifier. C2 is the r.f. bypass capacitor for the detector load consisting of R2 and R3. Lift C2 off ground and connect it to the B plus side of the transformer primary as shown. Connect a d.p.d.t. switch so it shorts windings of the transformer. C2 now serves as the decoupling network for the i.f. amplifier. C2 is the r.f. bypass capacitor for the detector load consisting of R2 and R3. Lift C2 off ground and connect it to the B plus side of the transformer primary as shown. Connect a d.p.d.t. switch so it shorts windings of the transformer. C2 now serves as the decoupling network for the i.f. amplifier.

The volume will drop when the switch is thrown to BROAD. You can compensate for some reduction in gain by increasing the value of R1.

TV TEST PROBES

The need for special probes for TV servicing was discussed at length in the articles on TV signal tracing in the issues of this magazine. Demodulator or detector probes are simply high-frequency rectifiers which convert TV carrier and i.f. signals into voltages which can be faithfully displayed on the screen of a scope. When pulses and video waveforms are to be studied, a special compensated probe must be used.
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Rohn Towers are built of heavy duty
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struction lies in the fact that hundreds
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Rohn Towers assure you of trouble-
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give unquestioned satisfaction year in
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Sales acceptance has been phenomenal
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which has withstood every test
known! Why "experiment" with an
unproved tower design when you can
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So we ask you, "Why take chances
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is self-supporting to 50' and can be installed
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The No. 20 — The heavy duty Rohn Tower,
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RADIO-ELECTRONICS to minimize high-frequency losses
cased by capacitance of the cable and
input capacitance of the scope. Voltage-
divider probes are used when viewing
high-amplitude waveforms.

The TV test probes shown in Figs. 1,
2, and 3 are described here through

courtesy of the Cornell-Dubilier Elec-
tric Corp. Fig. 1 is the diagram of a
detector probe which may be used in
servicing AM and TV receivers. The
output of the 1N34 detector is filtered
and applied to the input of the scope
to show the modulation envelope.

Fig. 2 is a compensated probe for
picking up video and complex pulse
waveforms and applying them to a
widesband scope without distortion. The
22-megohm resistor and 5-50-µuf trim-
mer are in a shielded probe connected
to the scope by low-capacitance coax
such as RG-59/9. Keep the cable length
below 3 feet to reduce shunt capaci-
tance. Adjust the trimmer so its capaci-
tance equals the sum of the cable and
scope input capacitances.

The capacitive-divider probe in Fig.
3-a is used to observe pulses and wave-
forms too high to be applied to the
scope's vertical amplifier. Fig. 3-b
shows the schematic of the probe. The
voltage applied to the input divides
across the capacitors in inverse pro-
portion to their capacitance. Thus, if
C1 (the plate-to-filament capacitance of
the 1X2-A) is 1 µf, and C2 and C3
are in a shielded probe connected
to the scope by low-capacitance coax
such as RG-59/9. The voltage ratio will be
100 to 1.

Cement the 1X2-A in one end of a
1-inch (outside diameter) polystyrene
tube with its plate cap protruding to
serve as a shield. Insulate the casing to protect
the operator against accidental shock.
Drill a hole through the wall of the
tube with its plate cap protruding to
serve as a test prod. Slip a metal cas-
ing over the plastic tubing to serve as
a shield. Insulate the casing to protect
the operator against accidental shock.
Drill a hole through the wall of the
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the operator against accidental shock.
Drill a hole through the wall of the
tube with its plate cap protruding to
serve as a shield. Insolate the casing to protect
the operator against accidental shock.
on the receiver chassis. It can be used to the meter and leads from any voltages of a receiver. Furthermore, it isolates the meter quickly to the voice-coil circuit makes it possible to connect an output and layout is shown in Fig. 1-a.

The 1,000-ohm (d.c. resistance) coil came off an old relay. The core was fashioned from laminations removed from a small transformer or choke. To use the unit, connect the coil leads to the output meter and then hook the hinged core around an insulated voice-coil lead and close it. Current flowing in the half-turn primary produces an indication on the output meter. The hookup is shown schematically in Fig. 1-b. If the voice coil lead is long enough, more than one turn can be used. Just divide the reading by the number of turns. The more turns used, the greater the sensitivity.—G. L. Garton

ANCHOR FOR MIKE CABLE

Microphone cables should be anchored near the base of the stand to prevent the hazard of a person tripping over the loop hanging from the mike, and also to give a neater appearance by having the cable lay along the floor right up to the base of the stand.

A suitable anchor must be easy to release when the mike is removed and must be firm enough that it won't scratch the stand. By slipping little rubber blocks, or corks, over a shower curtain ring as shown in the illustration, a very handy anchor can be quickly made. Let the clip lie against the base of the mike stand so the cable hugs the upright and the floor as closely as possible.—Hugh Lineback
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TRY THIS ONE

HANDY CONSTRUCTION KINK

Model airplane dope is a handy item for the constructor to keep on hand. When constructing or converting a piece of rather complex apparatus, I put a small dab of bright-colored dope on each nut or bolt as soon as it is tightened and a drop of color on each soldered joint. This simplifies the task of checking all joints for a soldered connection. Ground lugs and other bolted connections which have loosened and cause trouble can be located quickly by looking for spots where the dope has flaked off. This method has been successfully used in radio factories for many years. It results in a great saving of time.—Harold J. Weber

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WARPED SPEAKER CONES

Frequently we get small table-model receivers that have warped speaker cones. Much of this trouble is caused by excessive heat radiated from a rectifier or power-amplifier tube mounted close by. After repairing the speaker, we prevent an early recurrence of the trouble by placing an asbestos shield between the offending tube and speaker.—Robert E. Riddle

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For quick setups of equipment where there is danger that excess line cord may cause a person to stumble—such as a temporary PA installation in a crowded place—here is a neat way to handle the extra wire. It may take a few tries before you can build up speed, but it is well worth the effort. In addition to preventing injuries, it also safeguards equipment which might be thrown to the floor in the course of an accident.

Make a series of loose hitches as illustrated in the photo. You'll find the motions just sort of come naturally, so don't try to figure out the loops in the picture.

The drawing shows how to start—then you just keep going, and stick the plug through the final loop to lock the chain. To get the line back to its original length you just draw the plug back through the last loop, and zip—the whole string of loops vanishes quick as a wink!—Hugh Lineback

SWITCHING DUAL SPEAKERS

On page 150 of the October, 1953, issue, Mr. Howlett describes a speaker-selector switch which maintains the correct match across the output transformer. The diagram here shows a simplified circuit which permits the use of a 2-pole, 3-position switch to be used instead of the 4-pole, 3-position type specified in the original item.

At the first two positions, the 8-ohm speakers are connected singly; at the third position, in parallel.—Jack Palmer END

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DUPLX POWER SUPPLY

? I purchased a 3,000-volt center-tapped transformer rated at 800 ma. The dealer told me that I could use it to supply power to the final and modulator of a 1-kw phone transmitter. I would like to run the final at 2,500 to 3,000 volts but I cannot get more than 1,475 volts d.c. out. Please show me how I can get more than this out of the supply so that I can run the rated input to my final.—Wm. L., Florence, S. C.

A. The bridge-type supply shown in the diagram provides two independent output voltages. One is approximately equal to the full a.c. voltage across the secondary winding and the other is about one-half this value. For your purpose, V1, V2, V3, and V4 should be 872's. You can use 866's for a total current drain of 500 ma, or 819's or similar tubes if the drain does not exceed 250 ma. The phone-c.w. switch is included to open the low-voltage circuit and shut off the modulators when tuning up or working c.w.

This circuit can be used whenever it is desirable to obtain separate output voltages from a transformer whose full secondary voltage is equal to the highest voltage. For example, an 800-volt center-tapped transformer can be used in this circuit to supply 400 volts d.c. to a driver and 800 volts to a booster amplifier in a high power PA system.

In this case, a single 83, 5U4-G, 5R4-GY or similar tube can be substituted for V1 and two separate tubes of the same type with the plates strapped together can be used for V3 and V4.

In this circuit, the total current drawn by the supply should not exceed the maximum d.c. load current rating given by the rectifier manufacturer.

V-R PREAMP AND EQUALIZER FOR PHONOGRAPH AMPLIFIER

? Please print a diagram of a pre-amplifier and tone control which will permit me to use a variable-rectance pickup with the phono amplifier described in the December, 1952, issue.—S. F. R., Timmonsville, S. C.

A. The diagram shows a 2-tube pre-amplifier-equalizer which can be used between a V-R pickup and any conventional amplifier which does not have these circuits built in. If you do not require an elaborate tone control, you can omit the 12AU7 and its components and feed the 6SC7 output directly into the amplifier through the .05-µf blocking capacitor. Add the switch and .002-µf shown in the section enclosed by the dashed lines. If you use the 12AU7 equalizer circuit, omit the switch and the .002-µf capacitor.

All wiring should be short and direct. Heater leads should be twisted and dressed into the corners of the chassis well away from signal leads. It would be better to use a channel of the amplifier and tone control which will permit me to use a variable-rectance pickup with the phono amplifier described in the December, 1952, issue.—S. F. R., Timmonsville, S. C.

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the length of the elements may vary according to the manufacturers' standards for bandwidth, gain, and front-to-back ratio.

To cut your antenna for a higher frequency while retaining its present characteristics, measure the length and spacing of all elements and record these on paper. Now, multiply each dimension in inches by the lowest frequency of the channel for which the antenna was originally designed. The products of each set of figures gives a constant which is used in determining the length of the corresponding dimension in the new antenna.

Take each of these constants and divide it by the lowest frequency of the new channel for which the antenna is to be cut. This gives the new dimension in inches. For example, suppose that you measure the channel 5 radiator and find it to be 78 inches long. The lowest frequency in channel 5 is 76 mc. The product of the radiator length and the channel frequency gives 5548 as the constant for the new radiator, regarding the channel 5 radiator and the lowest frequency in channel 5 (76 mc). The result gives 73 inches long. The lowest frequency in channel 6 (82 mc). The result gives 67.6 inches as the length of a channel 6 radiator.

**SHOPLIFTER ALARM**

I have not been able to prevent shoplifters from removing electrical tools and appliances from the display counters in my store. At present, I am using a relay and alarm circuit which is completed through a loop of flexible hookup wire which passes through the handle or holes in the frames of the different appliances, as shown in the diagram. This is far from foolproof. For example, if the wire is stripped at A-A, and then twisted together, the tools can be removed without sounding the alarm simply by cutting the wire at B.

Can you devise a protective setup which might work? I want to use a system in which the appliances are all plugged into receptacles as they would be when in use. I don't care to have control current flowing through the line cords because all switches would have to be on and the voltage would have to be very low to prevent the tools from operating under all conditions. —E. J. L., Chicago, Ill.

A. Many 3-way portable receivers have power change-over switches which resemble a standard power-line receptacle. Plugging the set's line cord into the receptacle on the chassis operates **”the eye tells why”**

`SHOPLIFTER ALARM`  
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Since most of the better TV sets are made with ROGERS Deflection Yokes, this same top quality yoke should be used for replacement. With over 25 years of electronic know-how, ROGERS Precision Engineered Products make TV sets perform like new.

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a multipole double-throw switch which sets up the circuit for battery operation.

Most of these switches operate through pressure of the prongs on the line plug. There is no control voltage on the line cord or plug. You can install a number of these switches on a panel and wire the switch contacts to sound the alarm if any of the appliance plugs are removed from the receptacle.

### QUESTION BOX

I want to use my square-wave generator to check the response of the video amplifiers in TV sets. To what frequency should I tune the oscillator for this test?—V. R., Martins Creek, Pa.

A. There are different opinions as to the relationship between the frequency of the square wave and the bandpass of the amplifier under test. Some engineers maintain that when an amplifier passes a square wave without distortion, it is flat from f/10 to 10f, where f is the square-wave frequency. Others work between 3-db (cutoff) points. To check low-frequency response, they set the generator to 10 times the amplifier response at 3 db and watch for an undistorted wave on the scope. For the high-frequency check, they set the generator to a frequency whose 21st harmonic is the same as the amplifier response at the high-frequency cutoff point. In any case, it takes practice and familiarity with one's scope and generator to get the best results from a square-wave test.

A video amplifier is designed for a given bandwidth with predetermined input and output impedances and known values of stray-wiring and shunt capacitances. When any test instrument is connected directly across the input or output of a video amplifier, it will upset the normal operating conditions and cause misleading observations. Long test leads to the scope and generator will increase the stray capacitance of the circuit. The amplifier must work from and into the proper load impedances.

In TV broadcasting, special buffer amplifiers, probes, and other adapters are used with the scope and generator to prevent disturbing the inherent response characteristics of the circuit under test. You will not be able to rely on any square-wave response measurements that you make unless you can be sure that the frequency-determining constants of the circuit have not been altered by connections to the test instruments.

### POWER SUPPLIES

I would appreciate having diagrams of two power supplies which operate from a 6-volt d.c. supply. The output of one supply should be high enough to give a bright flash from a NE-20 or NE-51 neon bulb. The other should deliver 25 volts d.c. at 15 amp.—W. M. W., San Francisco, Calif.

A. If the neon lamp is the only drain on the first supply, it would be more
TO THE
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GRADUATE
WITH EXPERIENCE IN
RADAR
OR
ELECTRONICS

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MARCH, 1954
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TECHNOTES

TROUBLE IN G-E 803

After replacing the horizontal output transformer, the picture distorted when the brightness or contrast control was advanced. The trouble was finally traced to the lead which runs from terminal 4 on the transformer to damper-tube pins 2 and 3. This lead ran too close to the lead between transformer terminal 5 and the blue side of the width coil.

The trouble was eliminated by dressing the lead from terminal 4 along the top of the chassis.- Geo. R. Anglado

SELECTING A TV MAST

Before mounting a TV or FM antenna above a bright-colored sloping roof, make sure that the mast tubing you use is rustproof inside and out. The fact that rust weakens the mast so it must be replaced in a few years may not be nearly as important to many home owners as the fact that the rust may cause unsightly, hard-to-remove stains on the roof. Most home owners will appreciate your thoughtfulness and will be glad to pay the slight increase in the cost of using a more expensive type of mast.

If you are not sure that the tubing is rustproof on the inside, plug the top end with a large cork and then wrap the end with several layers of plastic electrician's tape to be sure that water will not get in.- Henry O. Maxwell

UNUSUAL HUM PROBLEM

An a.c.-d.c. type 3-tube portable receiver was brought in with a bad case of hum. Initial checks of tubes and filters did not eliminate the trouble nor shed any light on its cause, so we settled down to examine the circuit layout.

We found that the volume control was mounted on the cabinet away from the chassis. The audio ground lead was used to carry a.c. from the switch on the control to the chassis. There was enough a.c. voltage drop in just the few inches of this ground lead to introduce an abnormal hum in the amplifier. The hum level was brought down to normal by running a separate lead from the switch to the chassis and clipping the ground lead to the chassis. There was enough a.c. voltage between the switch and the cold lead of the volume control.

As a general rule, it is not a good idea to have the same wire carry both a.c. power and the signal. There is bound to be some hum pickup.- Wayne Miller

PACKARD BELL 2710 CHASSIS

The 0.25-amp fuse in this TV set was blown intermittently. A voltmeter connected to the cathode of the damper-tube showed that the a.c. voltage dropped sharply just before the fuse blew. A complete check showed that the horizontal linearity transformer was intermittently shorting to ground. The trouble cleared up when the short was eliminated.- Manuel E. Silva
TECHNOTES

SENTINEL MODELS 454 TO 457

Tearing and rolling on strong signals may be caused by overloading of the third i.f. amplifier if it is not caused by the area control being in the wrong position (in the weak- or medium-signal positions in a strong-signal area). Overloading of the third i.f. amplifier occurs in early production runs of these models because its plate voltage is too low to permit it to handle strong signals. This trouble can be eliminated by transferring the plate lead of the 6CB6 third i.f. amplifier from the 160-volt to the 265-volt line. Use the following procedure:

1. Change the third i.f. cathode resistor (R25) from 82 to 220 ohms, 1/2 watt.
2. Remove the connecting lead between the screen (pin 6) of the 6CB6 and terminal 1 of the fourth video i.f. transformer.
3. Connect a 1,000-ohm, 1/2-watt resistor between terminal 1 of the transformer and the 265-volt B plus line.
4. Add a 0.001-µf, 500-volt capacitor between chassis ground and terminal 1 of the i.f. transformer. The diagram shows the revised circuit—Sentinel Service Department

ADJUSTING U.H.F. STRIPS

Types Q and R i.f. strips for tuners in Sentinel TV receivers are prealigned at the factory for the specified channel. But, if you feel that further adjustment is needed after checking the i.f. antenna and ascertaining that signal strength is adequate at the receiving location, a slight readjustment of the oscillator slug may be all that is necessary. Center the fine-tuning control for this operation. If this does not produce a sufficient improvement, try the following:
1. Turn the chassis on its side with the tuner at top left as shown in the drawing. Remove the tuner shield, rotate the channel selector to the desired channel, and check the signal strength with a sensitive meter.

TRY IT for 10 DAYS on Money-Back Guarantee:

For 10 days trial, try this Transvlsion TV COMPONENT TESTER for 10 days. Then, if you are not 100% satisfied, you may return it. Your purchase price, less 10% (our cost of handling and repacking) will be promptly refunded.

NEVER BEFORE SUCH GREAT VALUE.

For $39.95 you can test and measure, on your present TV, the same components that were originally intended for a TV the cost of which is over $300. This is a savings of over $200. There are 520 tubes, transistors and electronic components on the board of this TV COMPONENT TESTER. And you actually test all these. The cost of the TV COMPONENT TESTER alone is over $100. Don’t wait for the节段 TV test board rush. Have it now. 

For $239.95, you can test and measure all of the components of a TV. You save over $800. There are 1,060 components on the board of this TV COMPONENT TESTER. And you actually test all of these. The cost of the TV COMPONENT TESTER alone is over $250. Don’t wait for the节段 TV test board rush. Have it now.

JOBOER INQUIRIES INVITED
sired channel, and remove the four antenna strips that are removable with the tuner in this position.

2. Insert the screwdriver edge of a plastic aligning tool into the bottom of slug 1 and notice if its presence affects the picture. If picture strength increases, turn the slug clockwise about \( \frac{1}{4} \) turn or until the picture and sound improve to the best possible extent. Advance the slug a little further to compensate for removing the tool from the coil.

3. If the picture strength does not change when the plastic tool is inserted in slug 1, turn the slug counterclockwise \( \frac{1}{4} \) turn or until best picture and sound are received.

4. Turn slug 3 in the same amount and in the same direction as slug 1 was turned for the best picture.—Sentinel Service Bulletin

**BARKHAUSEN OSCILLATIONS**

Barkhausen oscillations (one or more black vertical lines on the left side of the screen) in the Stromberg-Carlson 421 and 521 series receivers may be cleared up by adjusting the horizontal drive control or by replacing the horizontal output tube.—Stromberg-Carlson Current Flashes

**PHILCO 51-T1875**

This receiver was brought in with an intermittent hum that could be stopped temporarily by jarring the cabinet. By carefully tapping various components, we localized the trouble in the aluminum can type electrolytic capacitor mounted above the chassis. The twist-type lugs were not tight enough to maintain a good electrical connection between the can and the chassis.

The situation cleared up when a capacitor mounting bracket was clamped over the electrolytic and bolted firmly to the chassis.—Peter Bedrosian

**PHILCO 645**

After several of these models had come in for various repairs and tube replacements, I noticed that all seemed to have a moderate amount of nonlinear distortion in the audio section. A check with an audio oscillator and scope failed to show up any nonlinearity.

Since the distortion was most noticeable on strong signals, I decided that it was probably due to blocking or plate-current cut-off in one of the stages.

After checking the r.f., mixer, and i.f. stages, the trouble was traced to the nonlinear behavior of the second detector. It was distorting on positive signal peaks. I cleared the trouble by replacing the original 350,000-ohm diode load resistor with a 100,000-ohm unit. This resulted in perfect linearity. A potentiometer was used to determine the correct value.—G. F. Oberto

**CROSLEY 56TG**

Check the a.v.c. voltage if reception is weak. If it is abnormally high, remove the a.v.c. leads from pin 2 on the 45W4 socket and install a separate tie point. Excessive a.v.c. voltage is due to leakage to unconnected pins within the tube.—Geo. R. Anglado

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PEOPLE

Charles F. Stromeyer was promoted to executive vice-president of CBS-Hytron, Danvers, Mass. With the company since 1942, he was most recently vice-president in charge of manufacturing and engineering.

D. W. Gunn was appointed general sales manager of Electronic Products, Sylvia Electric Products, New York, N.Y. He was formerly assistant general sales manager of the Electronic Products Sales Division. In his new position, he succeeds Harold P. Gilpin, who retired after 21 years of service with the company.

G. Richard Fryling and W. Henry Fryling, president and vice-president respectively, of Erie Resistor Corp., Erie, Pa., were presented with a testimonial.

W. H. Fryling, center, and G. R. Fryling, right, receiving presentation.

Joseph H. Quick was elected president of the National Co., Malden, Mass. He has been a director and member of the Executive Committee of National and was formerly president of Harrington & Richardson Arms Co. He has also been associated with RCA, Philco and Sylvania.

A. Melvin Skellett and Lawrence L. Hardin, Jr. were named to the posts of vice-president in charge of manufacturing and engineering, and director of the Research Division, respectively, of National Union Radio Corp., Hatboro, Pa. Both are long-time employees of the

RADIO-ELECTRONICS
company. Skellett was also elected to the Board of Directors.

G. W. DeSousa, formerly manager of the General Electric Tube Department marketing administration, was named to succeed G. L. Roark as manager of equipment tube sales. Mr. Roark was recently upped to department marketing manager. M. J. Strehle, previously manager of intra-company sales for the department, succeeds DeSousa.

Clifford Shearer

Clifford Shearer joined RMS (Radio Merchandise Sales), New York City, as advertising manager. He was formerly with a leading catalog publishing firm in the electronics field.

Gardiner G. Greene, has become president and principal stock holder of Browning Laboratories, Winchester, Mass. He is the founder of Workshop Associates and became director and vice-president of the Electronics Division of Gabriel Co. when Workshop merged with it. Dr. Glenn H. Browning, former president of Browning Laboratories when Workshop Associates and became director and vice-president of the Electronics Division of Gabriel Co. when Workshop merged with it. Dr. Glenn H. Browning, former president of Browning Laboratories, becomes chairman of the Board.

Joe Chapman Lane, Jr. was promoted to manager of Advertising and Sales Promotion for the Westinghouse Electronic Tube Div. Elmira, N. Y. In his new position he will be responsible for trade magazine advertising and sales promotion.

Obituaries

Sylvan A. Wolin, pioneer sales and advertising executive in the capacitor industry, died suddenly from a heart attack at his home in Englewood, N.J. He was 42.

Herman H. Smith, pioneer manufacturer of electronic hardware, died suddenly at his home in Brooklyn, N. Y., recently.

Ernest B. Loveman, a member of the executive staff of Philco Corp., Philadelphia, collapsed and died of a heart attack in the reception room of the company's main plant.

Personnel Notes

... Joseph B. Elliott, W. Walter Watts, Dr. Elmer W. Engstrom and Charles M. Odorizzi, RCA vice-presidents, were promoted to executive vice-presidents in charge of their respective operations in an organizational realignment by the Radio Corporation of America. Joseph

MARCH, 1954
... Paul P. Wickman was named merchandising manager of dealer products in the creation of a new communications link between the General Electric Tube Department's replacement sales organization and its distributors and dealers. Wickman was formerly Boston district sales manager for Tube Department replacement sales.

... E. L. Lee, B. E. Barnes, M. L. Jones, and W. E. Vande Kieft were appointed* regional electronic sales engineers for United Motors Service, Division of General Motors, Detroit. They will work with Delco electronic parts distributors in the Eastern, Southern, Central and Western regions, respectively.

... Bob Middleton joined the Sales-Engineering Div. of Simpson Electric Co., Chicago. He will conduct lectures for service technicians throughout the country. Middleton was formerly with RCA and Precision Apparatus.

... Dean L. Nordquist was promoted to assistant advertising manager of Electro-Voice, Inc., Buchanan, Mich. He joined the company in 1952.

... Dick O. Klein, vice president and general manager of Raytheon Distributors, Inc., was appointed director of marketing for the Television and Radio Division of Raytheon Manufacturing Co., Chicago, and at the same time named assistant vice-president of the parent company.

... Jerome V. (Jerry) Deevy rejoined National Union Radio Corp., Hatboro, Pa., as director of industrial relations. He had been with the company ten years prior to 1953, when he resigned to become an independent consultant.

... Ralph R. Stubbe was promoted to chief engineer of General Instrument Corp., Elizabeth, N.J.

... Frank M. Folsom, president of Radio Corp. of America, was presented with a gold clock and weather vane by Brig. Gen. David Sarnoff, RCA Board chairman, on behalf of the company's 65,000 employees, on Folsom's 10th anniversary with the company.

... Gordon LeMay joined Tele-Matic Industries, Brooklyn, N.Y., as assistant sales manager. He had been with Terminal Radio Corp., N.Y.C.
Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of Radio-Electronics on which the item appears. All literature offers void after six months.

AUDIO HANDBOOK

Arrow's 1954 Audio Handbook is a well-illustrated 104-page catalog. The first 33 pages are devoted to "audio facts," featuring 4 pages on binaural sound reproduction, 14 pages on loudspeakers with construction details for cabinets, a 4-page excerpt from Weiler's High-Fidelity Simplified entitled "The How, What, Why, and Where of High Fidelity," and a 10-page reprint of Weil's "Phono Facts" (74 pointers for the person selecting phonograph equipment).

The remaining 71 pages illustrate and give specifications for amplifiers, tuners, speakers and speaker cabinets, and associated audio equipment.

Write to Arrow Electronics Inc., 82 Cortlandt St., New York 7, N. Y. for free copy.

ANTENNA BOOKLET

RMS has published a 32-page catalog illustrating and describing its line of TV antennas and accessories. The booklet is indexed by product groupings and includes a gain reference chart for v.h.f. antennas.

Free from RMS (Radio Merchandise Sales, Inc.), 2018 Bronzdale Ave., New York 62, N. Y.

GOVERNMENT PUBLICATIONS

A list of 17 government publications on electricity, electronics, radar, radio, and television has been issued by the Superintendent of Documents. Subjects covered range from basic reference works on electricity to advances in printed-circuit techniques, and prices run from 5¢ to $1.25. The highest-priced publications are two books on radar fundamentals, one of 474 pages and one of 394 pages.

Write the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for the list, "Electronics, Radar, Electricity, Radio and Television." A full catalog number is necessary for ordering.

RECORDER-HEAD DATA

Sound Talk Bulletin No. 27 discusses the problems of tape-recorder head alignment and head wear. The 3-page bulletin covers azimuth alignment and tape skewing, importance of head contact, and the effects of head wear on magnetic tape recording and reproduction. In addition, it includes an 8-step chart to determine high-frequency response loss caused by head problems.

Available free upon request from Minnesota Mining and Manufacturing Co., 900 Fauquier St., St. Paul 6, Minn.

MARCH, 1954
(how to convert tv sets for larger picture tubes)

cover price $10.95

How To Convert TV Sets
For Larger Picture Tubes

For writing in...mails. All inquiries must be postpaid.

Lafayette...5894/AX-9903, is described in a new
26-page booklet. Included are detailed
data, application notes, typical
performance curves, special features, and
a description of the construction of this
tube.

Available without charge from An-
perex Electronic Corp., 230 Duffy Ave.,
Hicksville, L. I., N. Y.

WALL CATALOG

Sprague's C-452 wall catalog consists of five
pages tabbed for the popular service
types of electrolytic, ceramic,
and molded-papertubular capacitors,
as well as a printed networks.
Listings include capacitance, voltage rating,
dimensions, catalog number, and list
price of each of the units.

Available free from Sprague Prod-
ucts Co., 81 Marshall St., North Adams,
Mass.

UNITIZING EQUIPMENT

The 1954 edition of the Alden hand-
book, Ideas—Techniques—Designs de-
scribes new and improved components
for unitizing electronic equipment. It
provides new data and planning sheets on
plug-in packages and basic chassis for
unitizing equipment and giving it rapid
interchangeability. Also improvements
and components for indicating and
monitoring operation of electronic
equipment with tiny tell-tales are de-
scribed. New models of connectors and
interconnecting systems that allow
color-coding for easy circuit tracing
have been described.

The booklet is available to manufac-
turers and designers writing on their
letterhead to Department HB, Alden
Products Co., Brockton, Mass.

OSCILOGRAPH BULLETIN

General Electric has issued a 12-page
bulletin, Electronic Test Equipment, illus-
trating and describing a synchronizer
test unit, electronic control amplifier
test unit, computer systems test unit,
and signal data converter test unit.

Copies may be had by writing Cal-
tronics Corp., 11905 Hindry Ave.,
Los Angeles 45, Calif.

Written primarily for the "practicing engineer, home constructor, radio service technician, recording studio or sound system operators, and professional audio technician," this work can be read with profit by any music lover whose knowledge of electronics is enough to permit him to read a schematic.

The author devotes a short first chapter to defining the term "high fidelity," then follows with one on sound and hearing. The various components of a high-fidelity system—speakers, enclosures, crossover networks, and amplifiers—are then covered in chapters interspersed with a discussion of distortion and of high-fidelity circuits. High-fidelity radio receivers, records and record players, and magnetic recording each receive a chapter.

The longest chapter in the book is entitled "Custom Installation of High-Fidelity Equipment," and covers technical, subjective, business and mechanical angles. Several plans and photographs of custom installations are included.

Though aimed at the professional man, there is much fundamental information for the less technical reader, as well as for the electronic technician whose experience in audio has been limited. Though the book has a few weaknesses and unbalances (test records, for instance, are dismissed in two paragraphs while speaker enclosures receive 60 pages) there is more information in simpler and clearer language in this book than the reviewer has seen in any other on the subject.


This is the first of a long series of books which will compete for the attention of engineers specializing in electronic circuit and design work. It is an important book because it gathers much of the desired information on the characteristics and applications of transistors into one text for the first time. The hundreds of illustrative schematic diagrams cover the applications of transistors adequately. Before this the engineer has had to content himself with the information made available in technical journals.

All the authors are engineers at the General Electric Electronics Park Laboratories at Syracuse, N. Y.

Rather than to the service technician, this book is directed to the graduate student and the practicing engineer. Transistors came into the industry at a time when many practicing circuit-design and applications engineers had completed their formal training. Thus for the most part the individuals who will be most likely to profit from this...
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Type of text are the younger men in the industry and those who have been keeping up with the phenomenal developments in this new field. It would be a mistake for any of the older practicing engineers to bypass this book. It is hardly likely that any engineer can afford to be without some first-hand knowledge of transistors and their applications.

There are three main sections, treating low frequency, high frequency, and nonlinear applications. The low-frequency section considers such important topics as small and large signal applications, audio, i.e. and ultra-sonic amplifiers. Since transistors are limited in their frequency response this is the most important part of this text at the present time. However, since the frequency limitation is being moved forward almost daily, there is ample treatment of the basic principles of high-frequency operation and design considerations for high-frequency circuits with special consideration for video amplifiers.

The book is replete with circuit data on oscillators, i.e., r.f., and audio amplifiers, as well as flip-flops, multivibrators and pulse amplifiers. The chapter on feedback will be of especial interest to those engineers interested mainly in the audio applications of transistors.—PA


First appearing more than 20 years ago, this new fifth edition contains a series of 43 nomograms (or abacs as the British term the providing essential data required in receiver design. Each chart is accompanied by a page of illustrated text supplying pertinent radio theory. Use of the charts is demonstrated with clear examples.

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